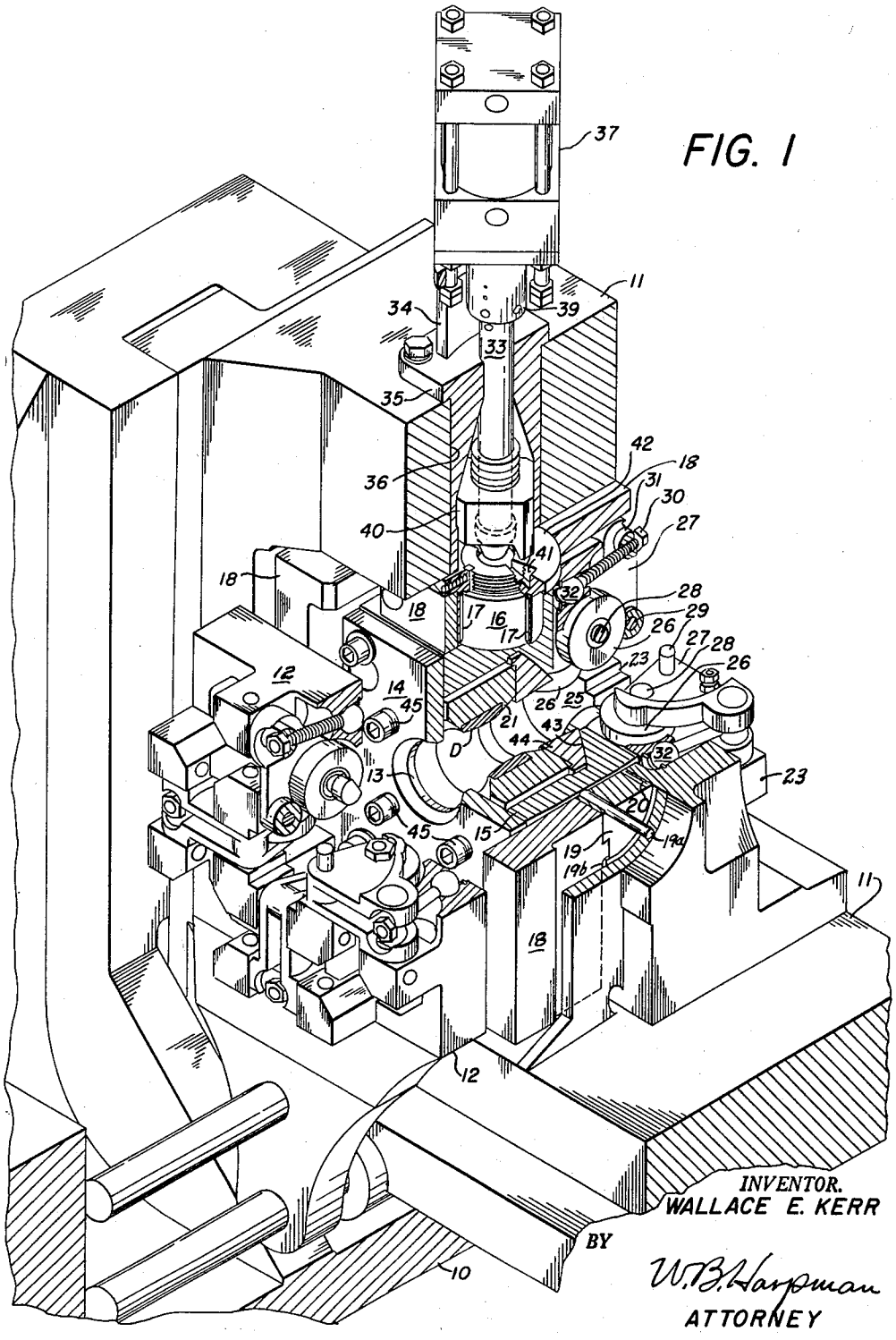
March 15, 1960 W. E. KERR 2,928,526

DIE ASSEMBLY

Filed June 7, 1954 8 Sheets-Sheet 1

FIG. 1



INVENTOR.
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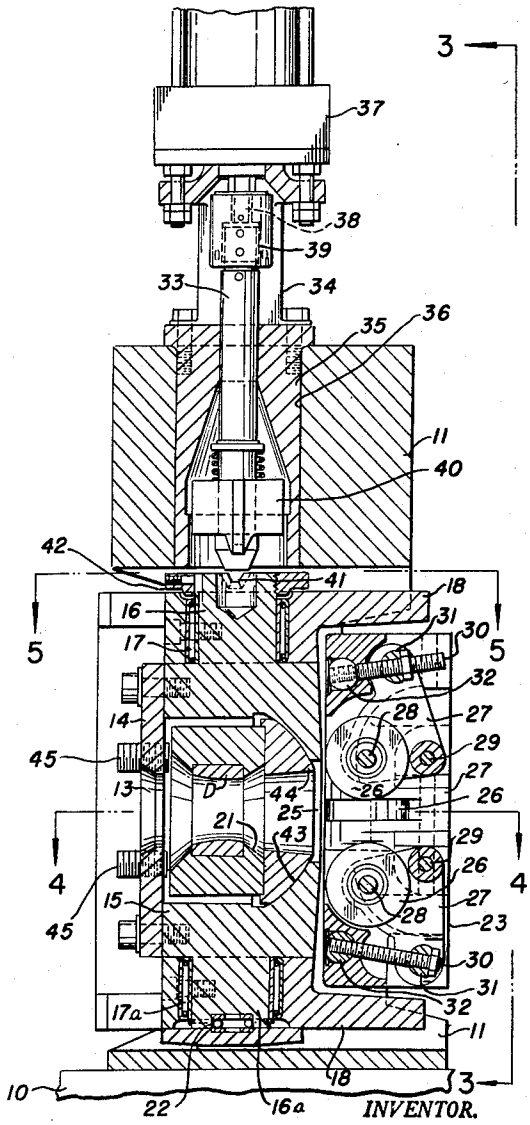
ATTORNEY

March 15, 1960 W. E. KERR 2,928,526

DIE ASSEMBLY

Filed June 7, 1954 8 Sheets-Sheet 2

FIG. 2



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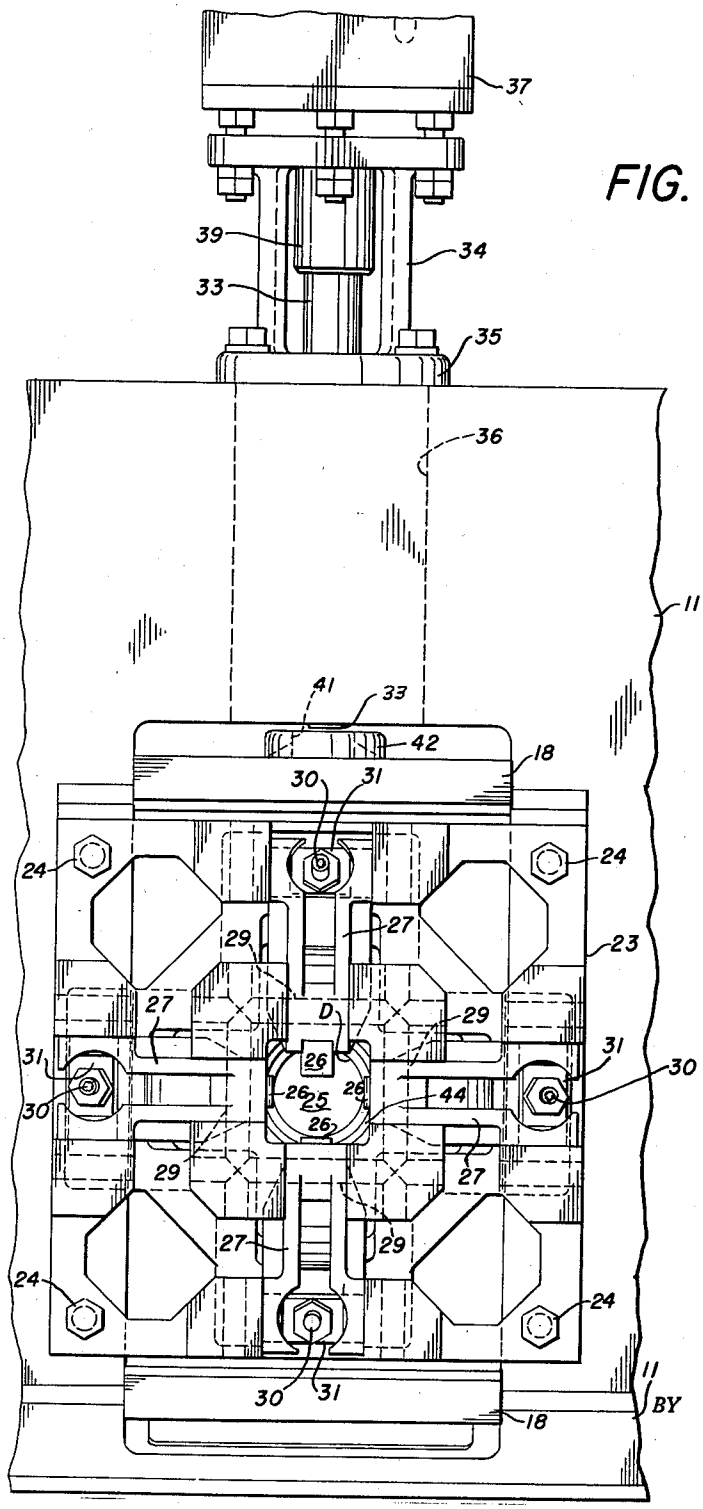
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DIE ASSEMBLY

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FIG. 3



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DIE ASSEMBLY

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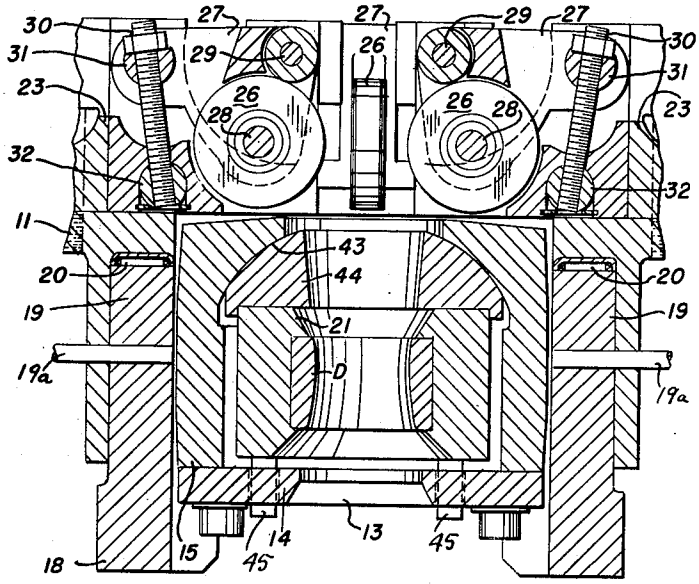


FIG. 4

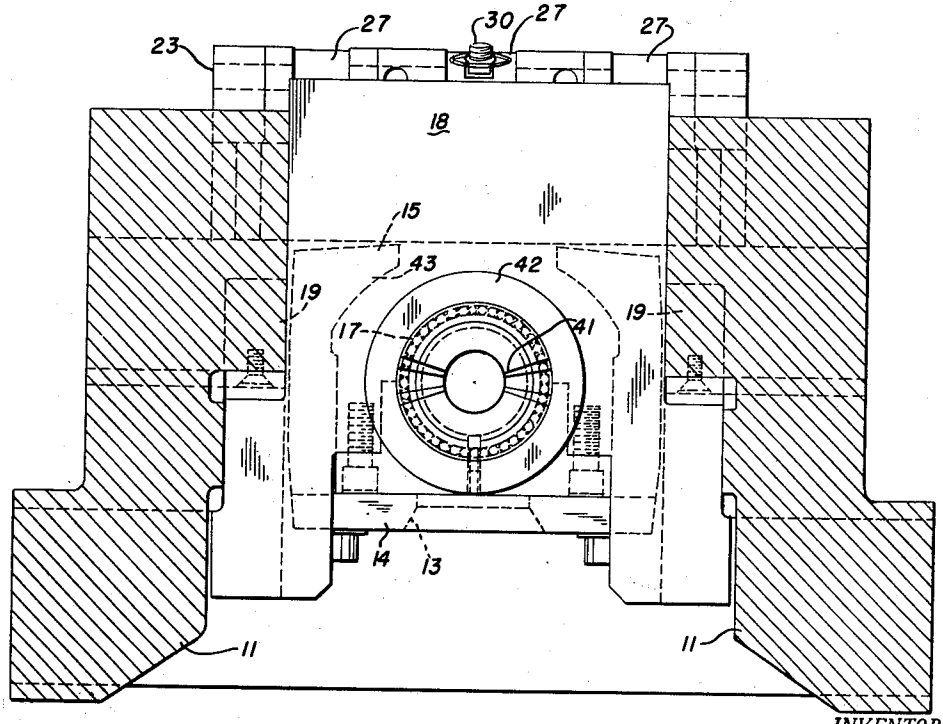


FIG. 5

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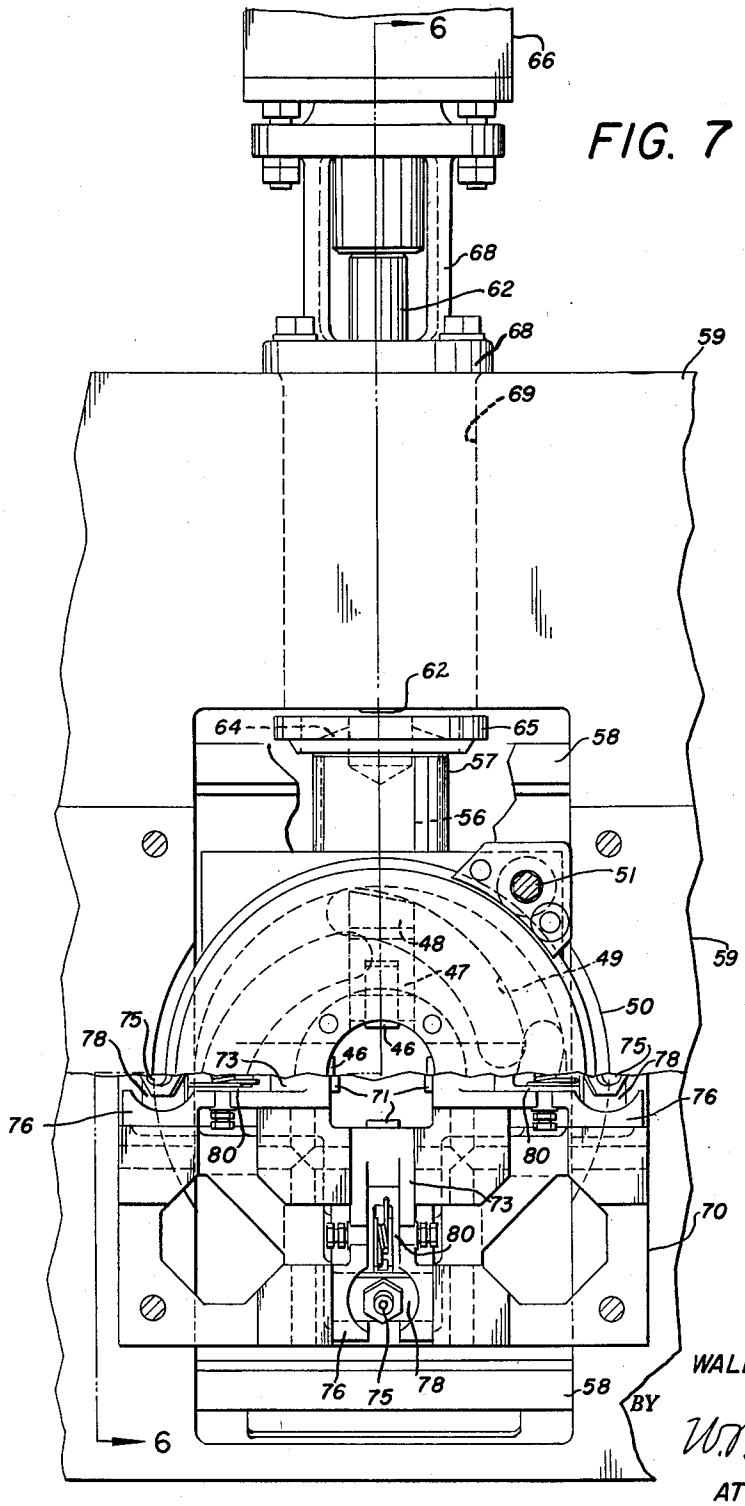
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March 15, 1960 W. E. KERR 2,928,526

DIE ASSEMBLY

Filed June 7, 1954 8 Sheets-Sheet 5

FIG. 7



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March 15, 1960 W. E. KERR 2,928,526

DIE ASSEMBLY

Filed June 7, 1954 8 Sheets-Sheet 6

FIG. 6

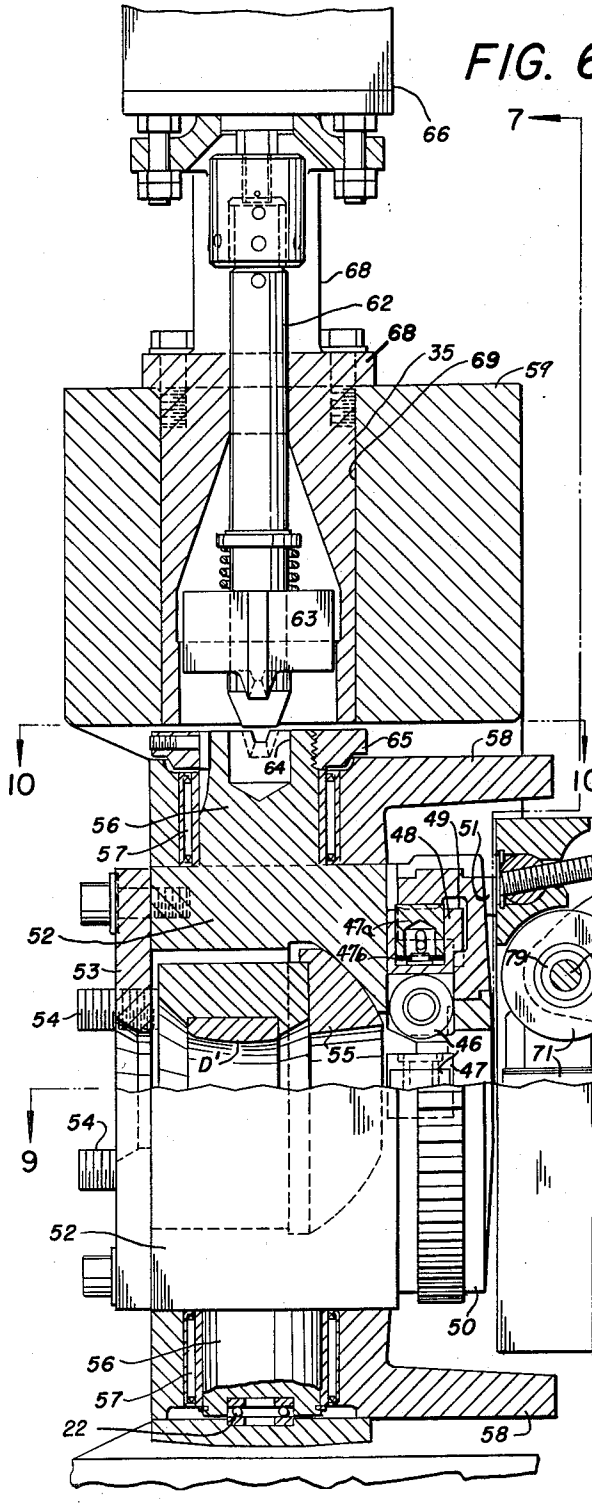
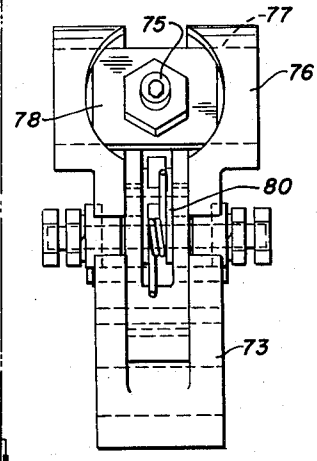


FIG. 8



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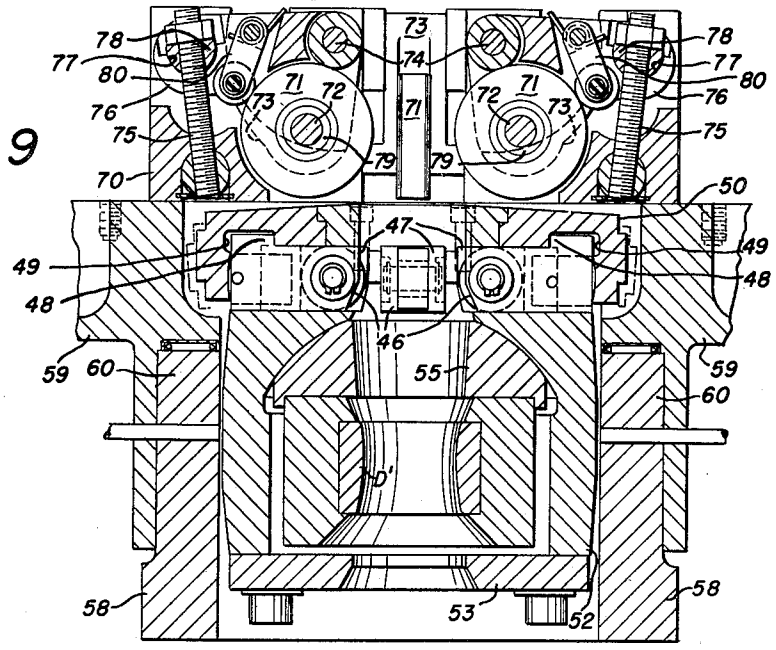
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DIE ASSEMBLY

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FIG. 9



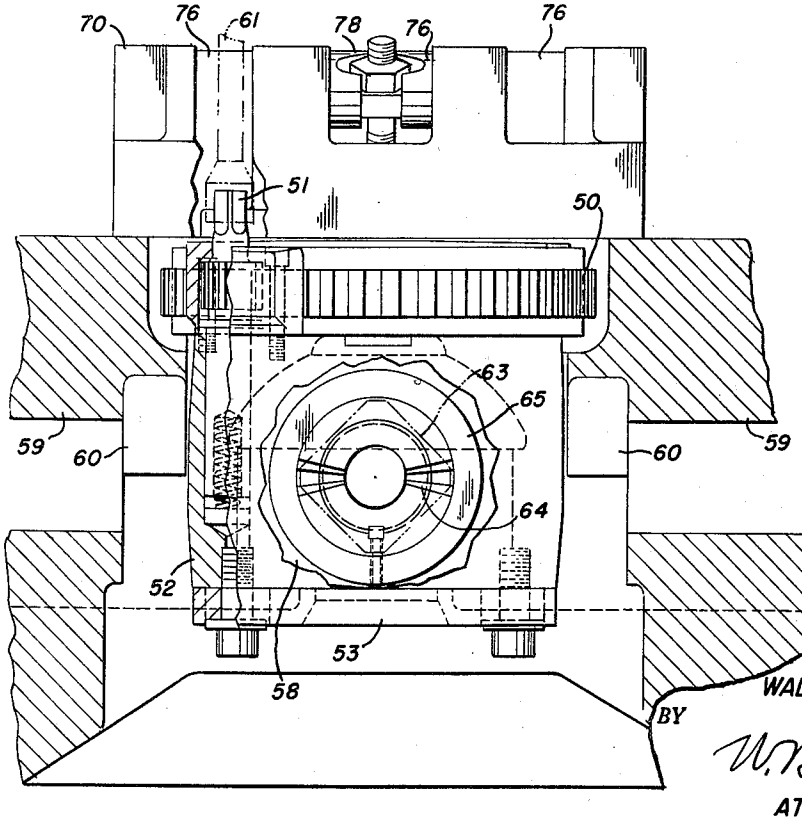


FIG. 10

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DIE ASSEMBLY

Filed June 7, 1954 8 Sheets-Sheet 8

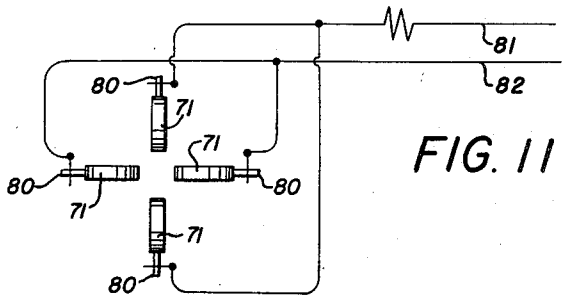


FIG. 11

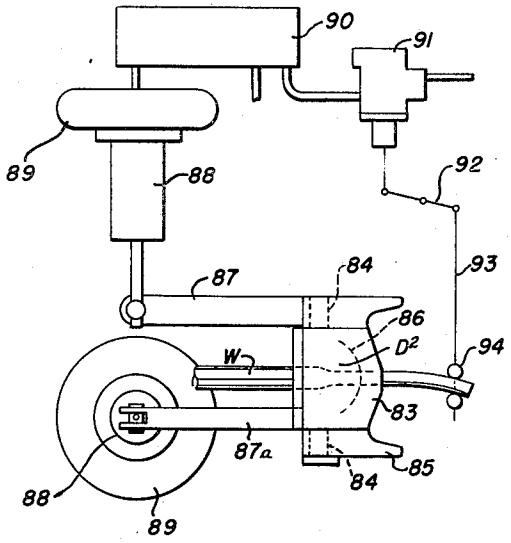
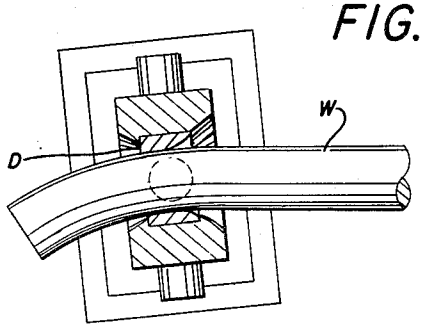


FIG. 12

FIG. 13



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United States Patent Office 2,928,526
Patented Mar. 15, 1960

2,928,526

DIE ASSEMBLY

Wallace E. Kerr, Poland, Ohio

Application June 7, 1954, Serial No. 435,015
3 Claims. (Cl. 205—3)

This invention relates to drawing die assemblies and more particularly to die assemblies for use in the cold drawing of metal stock such as bars, rods and other metal articles.

The principal object of the invention is the provision of an improved die assembly arranged to utilize the drawn product to effect control of the cast of the die and hence eliminate deflection in the drawn product.

A further object of the invention is the provision of a drawing die assembly arranged to impart continual progressive corrective casting to the die whereby an axially straight drawn product may be produced regardless of progressive variations as to size, geometric form, hardness, straightness, surface, inclusions, grain size, etc., as well as variations in die lubricant, the presentation of the stock to the die and such other factors as have heretofore resulted in deflections in the drawn product.

A still further object of the invention is the provision of a method of producing a longitudinally and uniformly straight drawn product through the use of the drawn product for continually and progressively casting the die through which the drawn product is passing.

A still further object of the invention is the provision of a drawing die assembly which will insure that the push-through ends of the drawn product emerge from the die assembly in straight, axial relation so as to properly enter the gripping jaws of the draw buggy.

A still further object of the invention is the provision of a die assembly incorporating target means for receiving the push-through ends of stock being drawn and a die mounted for universal movement so that the stock passing through the die and engaging the target means acts as a lever moving the die responsive to the irregularities in the stock entering the die to produce a uniform longitudinally straight product.

A still further object of the invention is the provision of a die assembly arranged for fixedly casting or swiveling the die in a universally movable die mounting.

Those skilled in the art of cold drawing of various metal articles, such as steel bars and the like, will recognize that the method of die drawing and the die assembly disclosed herein will eliminate several of the difficulties heretofore inherent in a die drawing process.

One of the difficulties eliminated is the tendency of a section of stock to be drawn, upon being introduced into a drawing die and pushed therethrough, to curve and thereby move away from the gripping jaws of the draw buggy. Those skilled in the art will recognize that such curving or deflection of the stock to be drawn can be corrected by slanting or casting the die with respect to the axis of the entering stock thereby changing the relative areas of engagement between the die and the stock and eliminating the tendency of the stock to curve.

Proposals have been made in the past to so slant or cast the drawing dies and have been partially successful for the immediate object—that of drawing the stock into the gripping jaws of the draw buggy. At such time as the draw buggy tensions the stock, the drawing dies heretofore known in the art become immovable with the result that whatever cast or slant exists in the drawing die remains throughout the drawing operation and produces undesirable deflection in the drawn piece. During the drawing of the stock with the die assemblies heretofore known in the art, the irregularities in the stock affect the area of engagement of the drawing die therewith and, as a result, impart various curves to the stock emerging from the drawing die.

The present invention acts to utilize such irregularities to continuously re-position the drawing die so as to continuously offset any tendency of the irregularities to impart deviation to the drawn product.

As hereinafter disclosed, the principal point of novelty making possible the accomplishment of the aforesaid objects will be found to comprise the universally movable mounting of the drawing die, the mounting being arranged for fixed positioning of the die during the initial positioning of the stock to be drawn through the die and thereafter freed so that the die will move as a result of lever action imparted thereto by the stock being drawn engaging the target means provided.

Those skilled in the art will observe that the movable mounting of the drawing die is in itself incapable of effecting the desired results without the presence and action of the target means which in the present disclosure comprises a structure incorporating rollers for engagement with the drawn stock after it emerges from the drawing die.

The target means comprising the structure, including the rollers, is spaced with respect to the drawing die and independently supported and is capable of directing the drawn stock on a given line.

With the foregoing and other objects in view which will appear as the description proceeds, the invention resides in the combination and arrangement of parts and in the details of construction hereinafter described and claimed, it being the intention to cover all changes and modifications of the example of the invention herein chosen for purposes of the disclosure, which do not constitute departures from the spirit and scope of the invention.

The invention is illustrated in the accompanying drawing wherein:

Figure 1 is a perspective view of the die assembly with parts broken away and parts in cross section.

Figure 2 is a side elevation of the die assembly on the headstand of a draw bench with parts in cross section.

Figure 3 is a back elevation of the die assembly shown in Figure 2 of the drawings and taken on line 3—3 of Figure 2.

Figure 4 is a horizontal section taken on line 4—4 of Figure 2.

Figure 5 is a horizontal section taken on line 5—5 of Figure 2.

Figure 6 is a side elevation with parts broken away and parts in cross section illustrating a modified form of die assembly.

Figure 7 is a back elevation of the modified die assembly, wtih parts broken away, taken on line 7—7 of Figure 6. Section lines 6—6 on Figure 7 indicate the section of Figure 6.

Figure 8 is an enlarged detail elevation of a portion of the die assembly shown in Figures 6 and 7 and taken on line 8—8 of Figure 6.

Figure 9 is a horizontal section taken on line 9—9 of Figure 6.

Figure 10 is a horizontal section taken on line 10—10 of Figure 6.

Figure 11 is a schematic diagram of an electrical circuit for automatically locking and unlocking the die assembly shown in Figures 1 and 7 of the drawings.

Figure 12 is a symbolic diagram of a modified means for casting a drawing die assembly during a drawing operation.

Figure 13 is a symbolic diagram of a drawing die and an object drawn therethrough and showing the influence of the die with respect to deflecting the drawn article.

By referring to the drawings and Figures 1 and 2 in particular, it will be seen that the headstand of a draw bench is generally indicated by the numeral **10** and that a multiple die block **11** is positioned thereon in a manner known in the art and adjacent the area of the draw bench on which a draw buggy (not shown) is operated. The die block **11** has at least one horizontal opening therethrough and means for positioning a drawing die in said opening, including a first movable gimbal **18** positioned in said opening for oscillating movement about the horizontal axis of said gimbal. A second gimbal **15** or support for a drawing die is positioned in said first gimbal **18** for oscillating movement about the vertical axis of said second gimbal **15**. A drawing die D is positioned in said second gimbal **15** with its axial opening on the horizontal axis of said opening in said die block **11**. The headstand **10** of the draw bench also supports a steady guide **12** in position in front of the die block **11** so that bars, tubes or other workpieces to be drawn through the dies carried by the die block may be steadied by the steady guide **12**.

The steady guide **12** is positioned on the pass line and, other than receiving and guiding the article to be drawn, it has no part in the present disclosure.

After leaving the steady guide **12**, the forward end of the work piece to be drawn enters the die carrying portion of the die block **11** and passes through an opening **13** in a plate **14** which is removably secured to the support for the drawing die which is the second or inner gimbal **15**. The inner gimbal **15** is movably mounted on its vertical axis through vertical trunnions **16** and **16***a* which are positioned in anti-friction bearings **17** and **17***a*, respectively, mounted in vertically aligned openings in the first or outer gimbal **18**. The outer gimbal **18** is provided with horizontal semi-trunnions **19** which engage rollers **20, 20** positioned in semi-annular raceways in the die block **11**, one or more of the rollers **20. 20** being of resilient material to urge the remaining rollers from bottoming toward retaining abutments **19***b* as seen in Figures 1 and 5 of the drawings. Pivot pins **19***a* retain the outer gimbal **18** in the die block **11**.

The die D mounted in a die casing **21**, which in turn is mounted in the inner gimbal **15**, is thus universally movable on the respective axes of the vertical trunnions **16** and **16***a* of the inner gimbal and the horizontal axes of the semi-trunnions **19** of the outer gimbal. The inner gimbal **15**, and specifically the lower vertical trunnion **16***a* thereof, is supported on a ball thrust bearing **22** so that the respective gimbals are free to move when the drawing tension of a workpiece is engaged in the die D.

It will be observed that the vertical trunnions **16** and **16***a* of the inner gimbal have a relatively small resisting radius while the semi-trunnions **19, 19** of the outer gimbal have a similarly small resisting radius, which factors contribute to the freedom of motion of the die mounting means thus formed and particularly during a drawing operation.

Immediately adjacent the die block **11** there is a target roller frame **23** which is secured to the die block **11** by a plurality of fasteners **24, 24**, as best shown in Figure 3 of the drawings.

By referring to Figures 3 and 4 of the drawings it will be seen that a workpiece passing through the die D will continuouly emerge therefrom and enter an opening **25** in the target roller frame **23** so that a plurality of rollers **26, 26** spaced circumferentially about the target roller frame **23** will be engaged thereby while the workpiece is still passing through the die D. Each of the rollers **26** is mounted on a mounting bracket **27** by means of pivotal shafts **28, 28** secured thereto. Each of the mounting brackets **27** is in turn pivoted as by a secondary pivotal shaft **29** to the target roller frame **23** and is movable with respect thereto (see Figures 2 and 4 of the drawings) by adjustment screws **30, 30**, each of which is secured at one end to a sphere **32**, and retained by snap rings in sockets in the frame **23**. The other ends of the screws **30, 30** transversely threadably engage cylindrical members **31** mounted in the respective mounting brackets **27** and lock nuts secure the assembly in desirable adjustment.

It will thus be observed that by rotating the screws **30**, the mounting brackets **27** may be moved with respect to their pivots **29** so as to move the rollers **26** toward and away from the pass line therebetween on which an article to be drawn is positioned.

It will be seen that a rod to be drawn, for example, passing through the die D and centrally of the plurality of rollers **26** will act as a lever to tilt or cast the die D responsive to deflections in the rod as the same engages the rollers **26** which are pre-set in fixed position to rotatably contact the surface of the rod.

Those skilled in the art will recognize that in initially positioning a workpiece such as a rod, for example, through the die D and through the area defined by the rollers **26, 26** will require that the die D be held stationary so that the point of the workpiece emerging from the rollers **26** may be in alignment with the gripping means of the draw buggy and therefore be capable of being gripped thereby and the drawing operation performed.

In order to hold the die mounting, hereinbefore described as comprising the inner gimbal **15**, and the outer gimbal **18** in such stationary relation for the initial presentation of the workpiece therethrough, means has been provided and comprises a locking bolt **33** which is positioned vertically above and in axial alignment with the trunnions **16** and **16***a* on the inner gimbal **15**.

As illustrated in Figures 1 and 5 of the drawings, the locking bolt **33** is positioned within an upper bore of a supporting member **35** carried in a vertical opening **36** in the die block **11**. Uprights **34** mount a pneumatic piston and cylinder assembly **37**, a piston rod **38** of which depends from the assembly and is coupled as at **39** to the upper end of the locking bolt **33**. The lower end of the locking bolt **33** is provided with a spring pressed toothed clutch **40** which is adapted for registry with mating recesses **41** formed in an enlarged matching clutch member **42** affixed to the trunnion **16**, as best shown in Figure 1 of the drawings. The clutch **40** is square and slides within a supporting member.

Those skilled in the art will observe that when the piston and cylinder assembly **37** is actuated so as to move the piston rod **38** downwardly as shown in Figures 1 and 2 of the drawings, the clutch **40** will engage the matching clutch **42** and thereby hold the inner gimbal **15** against movement while the locking bolt **33** moves downwardly and engages a center axial recess within the trunnion **16** to hold the outer gimbal **18** stationary.

Automatic means for effecting the movement of the pneumatic piston and cylinder assembly and hence the locking bolt **33** are preferably incorporated in the device, and hereinafter described. Such means are conveniently controlled through electrical circuits utilizing the target rollers **26**, heretofore referred to, and the workpiece to be drawn, as at such time as the workpiece is engaged only in the die D in the gimbals **15** and **18**, the same must be held stationary, whereas when the workpiece advances out of the die and engages the target rollers **26**, the gimbals **15** and **18** must be free to move and hence the pneumatic piston and cylinder assembly is retracted to effectively withdraw the locking bolt **33**.

From the description thus far it will occur to those skilled in the art that the invention disclosed herein is applicable to a multiple unit installation on a con-

ventional draw bench having a normal rated triple draw capacity of 1½" rounds or equivalent drawn bar size. It will be obvious that multiples of the die assembly may be used on a single draw bench in which case additional steady guides **12** will be employed. Each steady guide **12** is adapted to be individually adjusted to accommodate any stock bar, tube size or geometric shape within its range.

In the preferred embodiment of the invention, the inner gimbal **15** is provided with the face plate **14** having the opening **13** therein through which the workpiece to be drawn is introduced into the die and, so that the die itself may be adjusted with respect to the gimbal **15**, the same is formed with a die ball receiving seat **43** in which a die ball **44** is positioned so as to support the die D, as best shown in Figures 1 and 2 of the drawings.

The plate **14** is provided with tapped openings in which adjustment screws **45** are positioned, the inner faces of which engage the die casing **21**, and it will occur to those skilled in the art that the screws **45** comprise conventional means for adjustably positioning the die ball **44** and the die D in the inner gimbal **15** so that a workpiece pushed therethrough will be caused to maintain a substantially axial straight form and thereby properly enter the area between the plurality of target rollers **26** and emerge therefrom to enter the gripping means of the draw body.

Since the die construction may comprise any one of several types known in the art and inasmuch as some of such constructions are quite short with respect to the area thereof within the die, the die may not be completely sensitive to the casting signal transmitted through the drawn stock. To anticipate and eliminate such an objection, a modification of the construction disclosed in Figures 1, 2, 3, 4 and 5 may be found to be desirable and wherein steady rollers may be rotatably affixed to the die support which is the second or inner gimbal, as shown in Figures 6 and 9 of the drawings and wherein the steady rollers are indicated by the numerals **46**.

The steady rollers **46** are each movable radially with respect to the pass line through the device which corresponds with the cross section line **9—9** in Figure 6 of the drawings. Each of the steady rollers **46** is resiliently mounted on a radially movable member **47** which has a rearward projection **48** engaged in an arcuate cam slot **49** in a rotatable cam disc **50**. Each of the members **47** has a bore mounting a movable plunger **47***a* engaged upon a leaf spring **47***b* and through which motion from the cam is transmitted.

Thus rotation of the cam disc **50** as occasioned by a pinion **51** will simultaneously move the plurality of steady rollers **46** radially with respect to the pass line and thus permit close adjustment of these rollers to the workpiece thereby in effect extending the area of the die as the assembly just referred to is mounted directly on an inner gimbal **52** which corresponds in other respects to the gimbal **15**.

The inner gimbal of the modified construction includes a face plate **53** which acts, through adjustment screws **54**, to retain a die D' in operative relation to a die ball **55**. The inner gimbal **52** has vertical trunnions **56**, **56** which are rotatably mounted in bearing assemblies **57**, **57** as in the case of the inner trunnion **15** heretofore described.

The vertical trunnions **56** are thereby rotatably positioned in an outer gimbal **58** which is positioned in a die block **59** by semi-trunnions **60**, **60** which correspond with the semi-trunnions **19**, **19** heretofore referred to.

By referring now to Figure 10 of the drawings a representation of a socket wrench **61** may be seen engaged upon the pinion **51** for adjusting the steady rollers **46** radially and in this connection it will be observed that the pinion **51** is movable axially against spring means so that it may engage and disengage fixed internal teeth within its enclosing mounting and thus unlock and permit the steady roller adjustment.

In the case of the form of the invention heretofore described and illustrated in Figures 1, 2, 3, 4, etc., means is provided for locking the inner and outer gimbals **52** and **58** against motion during the initial engagement of the workpiece in the die and this means comprises a locking bolt **62**, the lower end of which is provided with a spring pressed toothed clutch **63** engageable in a recess **64** positioned partially in the trunnion **56** and partially in a matching clutch member **65** which is affixed thereto.

The locking bolt **62** is actuated by a pneumatic piston and cylinder assembly **66** which is supported on the die block **59** by a supporting member **68** which is positioned within a vertical opening **69** in the die block **59**.

The target rollers employed in the modified structure of Figures 7, 8, 9 and 11 of the drawings are substantially the same as those heretofore described in connection with Figures 1 through 5, etc., and includes a target roller frame **70**, the target rollers being indicated by the rollers **71** and each of the same is pivoted by pivots **72** to brackets **73** which are in turn pivoted as at **74** to the mounting frame **70**. Adjustment screws **75** actuate in the same manner as the adjustment screws **30** heretofore referred to.

In Figure 8 of the drawings one of the mounting brackets **73** is illustrated in greater detail, the bifurcated uppermost portion **76** thereof clearly illustrating a cylindrical recess **77** in which the cylindrical member **78** on one end of the adjustment screw **75** is seated.

In Figures 6 and 9 of the drawings the rollers **71** are shown as having an annular insulating section **79** together with an electrical pickup **80** engaged against the roller **71** so that an electric circuit in connection with the pickup **80** is extended to the annular body of the roller **71** and not electrically connected with the pivot **72**. Thus, a workpiece entering the die D' passing through the die ball **55** and through the area of the steady rollers **46** will engage the target rollers **71** which are adjustable to the diameter of the workpiece and which may then be used for establishing an electrical circuit which may be used for controlling the pneumatic piston and cylinder assembly **66** heretofore referred to.

Thus, a workpiece may enter the die D' while the locking bolt **62** is holding the gimbals **52** and **58** immovable and upon contacting the target rollers **71** and completing an electric circuit, the locking bolt **62** may be withdrawn to permit the free movement of the die mounting as also hereinbefore described.

By referring now to Figure 11 of the drawings a symbolic electrical diagram illustrates such a circuit as conductors **81** and **82**, which are respectively connected by the pickup **80** to the pairs of adjacently disposed target rollers **71**. A workpiece serves to bridge the area between the rollers **71** and will thereby close a circuit through the conductors **81** and **82** which may then be used for actuating a spring biased solenoid valve (not shown) which in turn may control the pneumatic piston and cylinder assembly **66**.

It will be obvious to those skilled in the art that this same arrangement may be used for controlling the locking bolt **33** of the initially described device herein.

In Figure 12 of the drawings another method of casting a freely movable drawing die is symbolically illustrated and includes the die D^2 positioned in an inner gimball **83** having vertically extending trunnions **84** which are in turn journaled in an outer gimbal **85** provided with horizontally extending semi-trunnions **86** which may be received in a die block to permit universal movement of the die D^2 with respect to a workpiece W shown extending therethrough. Suitable arms **87** and **87***a* extend from the gimbals **85** and **83** respectively and are adapted to be moved by a respective motor of a pair of diaphragm motor assemblies **88** and **89** which are in turn

in communication with a source of pneumatic pressure 90 and a multiple control valve 91 which in turn is actuated by levers 92 engaging means 93 having rollers 94 engaging the workpiece W and responding to horizontal and vertical deflections from a desired axial position thereof and transmitting such motion through the levers 92 to the control valve 91 and thereby casting the die D^2 as aforesaid.

Other means of utilizing the workpiece to control the casting or slanting of the drawing die will occur to those skilled in the art and it will be recognized that all such means require the presence of the principal point of novelty in this disclosure, that of universally mounting the drawing die so that it may be moved responsive to deflections in the workpiece, either directly through the workpiece acting as a lever thereon or by such additional mechanical structure as described herein and illustrated in Figure 12 of the drawings.

By referring to Figure 13 of the drawings a diagrammatic illustration of a die D and a workpiece W may be seen, it being observed that for the purpose of disclosing the distribution of the elongation within the workpiece drawn through the die D, the sketch of Figure 13 shows the die D cast or slanted with respect to the axis of the entering workpiece.

It will be seen that external radial forces exerted onto the opposite sides, for example, the top and bottom sides, of the workpiece within the constricting taper of the die are equal and as the bearing area of the workpiece is less at said top side than at said bottom side of the workpiece, the pressure per unit area is greater at the top side than at the bottom side. Hence, an elongation at the top side greater than at the bottom side occurs as the workpiece moves throught he reducing zone for the die so that the reduced workpiece is bowed downwardly as shown.

By re-casting the die to overcome the unequal bearing areas of the stock, the drawn product may be straightened and continuously drawn on an axial straight line as long as the die is continuously cast or slanted relative to and in accordance with such deflections as occur in the workpiece being drawn.

It will thus be seen that the die assembly disclosed herein operates to produce an axially straight workpiece by so positioning the drawing die for universal movement that the deflections of the workpiece passing therethrough reflect in deviations from the axial alignment thereof to vary the flexure of the workpiece against the target rollers to cause the workpiece to act as a lever to re-position the drawing die and thus effect a self-correaction responsive to the deflection of the workpiece and whereby an axially straight workpiece is obtained.

It will thus be seen that the several objects of the invention as hereinbefore set forth are achieved by the provision of the method of die drawing as herein disclosed on the apparatus herein illustrated and described and that, accordingly, the several objects of the invention have been met.

Having thus described my invention, what I claim is:

1. A drawing die assembly comprising a fixed die block having an opening therethrough; a construction including a die axially affixed therein, so defining a die axis generally aligned with said opening and a pass line and so seated on said die block to afford a degree of die casting universal angular movement with respect to said die block; target means beyond said die block, including a frame secured to said die block and comprising bodies disposed about said pass line and affixed within said frame; a workpiece thrust into, through and beyond said die, so contacting said bodies and being thereby centrally confined with respect to said pass line; said workpiece thereby serving as a lever to orient said die casting movement angularly and upon successive degrees of workpiece unstraightness successively appearing intermediate said die and bodies, said workpiece further serving to successively reorient casting movement with respect to said pass line and thereby effecting the cast and recast of said die with respect to said die block.

2. In a drawing die assembly comprising a fixed die block having an opening therethrough; a construction including a metal drawing die axially affixed therein and the axis of the said die generally aligned within said opening and with a pass line therethrough and being movably seated on said die block to afford a degree of die universal casting movement with respect to said die block, said construction including an element of a locking means; a frame secured to said die block and spaced beyond said construction; target means comprising bodies disposed about said pass line, affixed within said frame and each of the said bodies constituting a contact for an uncompleted electrical control circuit; a locking means withdrawably affixed to said die block, engaged within said element for locking said casting movement, said locking means including an actuating assembly for effecting disengagement thereof; an electrical circuit and control for controlling said actuating assembly; a metal workpiece thrust into, through and beyond said die and contacting said bodies thereby simultaneously imposing onto said workpiece multifold functions of effecting a bridge therebetween the said bodies, thus completing said electrical circuit, actuating said control and actuating assembly and thereby effecting withdrawal and disengagement of said locking means as said bodies serve to confine said workpiece centrally with respect to said pass line; also thereby said workpiece serves as a lever to orient the disposition of the said axis of the said die angularly with respect to said draw axis thereby effecting the cast of said die with respect to said die block.

3. In a drawing die assembly embodying a fixed die block having an opening therethrough; a support including a die axially affixed therein and the axis of the said die generally aligned within said opening and with a pass line therethru and being movably seated on said die block to afford a degree of die universal angular casting movement with respect to said die block; a device affixed to said support and spaced beyond said die, said device having members retained therein and disposed about said pass line, each said member mounting a steady roller likewise disposed about said pass line; target means beyond comprising a frame secured to said die block, bodies mounted therein and disposed about said pass line; a workpiece thrust into, through and beyond said device so contacting said bodies; a spring intermediate each said respective member and steady roller to effect constant close adjustment thereof to said workpiece which being confined centrally with respect to said pass line by said bodies serves as a lever applied to said device to angularly orient the die casting movement and upon successive degrees of workpiece unstraightness successively appearing intermediate said device and bodies, the workpiece further serving to successively angularly reorient said die casting movement with respect to said pass line thereby effecting the said universal angular cast and recast of said die with respect to said die block.

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