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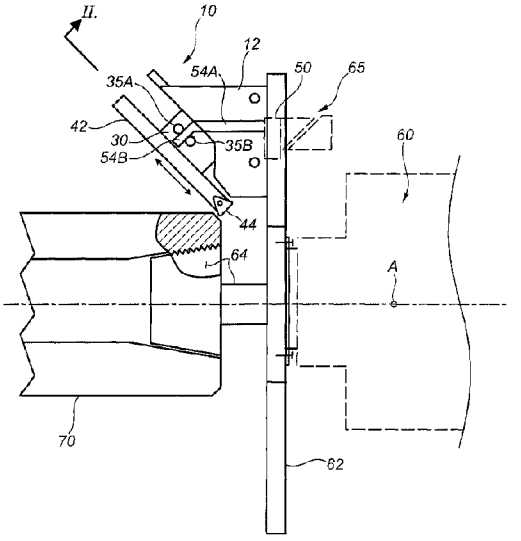
(54) **Titre : DISPOSITIF DE BISEAUTAGE POUR MACHINE A RECTIFIER LES TUYAUX**
(54) **Title: BEVELLING APPARATUS FOR PIPE RE-FACING MACHINE**



(57) **Abrégé/Abstract:**
In an improvement to a pipe re-facing machine having a rotatable flange plate and a coaxially-mounted collar rotatable with and longitudinally movable relative to the flange plate, a support bracket projects from the flange plate, and a support block is retainingly mounted to and movable relative to the support bracket in an angled radial direction. The support block is adapted to receive a tool holder carrying a cutting element. An actuating mechanism is engageable with the support block such that longitudinal movement of the collar will move the support block relative to the support bracket. The actuating mechanism can thus move the cutting element in an angled direction relative to the axis of a tubular workpiece, thereby enabling machining of a bevelled edge on an annular shoulder of a tubular workpiece non-rotatably mounted to the re-facing machine by longitudinally moving the collar while rotating the flange plate.

ABSTRACT

In an improvement to a pipe re-facing machine having a rotatable flange plate and a coaxially-mounted collar rotatable with and longitudinally movable relative to the flange plate, a support bracket projects from the flange plate, and a support block is retainingly mounted to and movable relative to the support bracket in an angled radial direction. The support block is adapted to receive a tool holder carrying a cutting element. An actuating mechanism is engageable with the support block such that longitudinal movement of the collar will move the support block relative to the support bracket. The actuating mechanism can thus move the cutting element in an angled direction relative to the axis of a tubular workpiece, thereby enabling machining of a bevelled edge on an annular shoulder of a tubular workpiece non-rotatably mounted to the re-facing machine by longitudinally moving the collar while rotating the flange plate.

BEVELLING APPARATUS FOR PIPE RE-FACING MACHINE

FIELD OF THE DISCLOSURE

The present disclosure relates in general to apparatus for re-facing the seal faces of tubular workpieces such as drill pipe and drill collars, and in particular to apparatus for bevelling the perimeter edges of the seal faces of such workpieces.

BACKGROUND

Oil wells and gas wells are typically drilled into the ground by rotating a "drill string" made up of multiple sections (or "joints") of drill pipe connected end-to-end by means of threaded joints, with a suitable drill bit attached to the bottom of the drill string. The drill string typically incorporates heavier tubular members known as heavyweight pipe or drill collars, positioned between the drill bit and the assembly of pipe sections, in order to increase the vertical load on the drill bit and thus enhance its operational effectiveness. Drilling fluid (or "mud" as it is commonly referred to in the industry) is circulated under pressure downward through the drill string and out through ports in the drill bit, and upward to the surface via the annulus between the drill string and the wellbore.

A typical drill collar is fabricated with a "pin end" having a tapered external (i.e., male) thread, and a "box end" having a tapered internal (i.e., female) thread for mating engagement with the pin end of another drill pipe section or drill collar. As well, each pin end of the drill collar is formed with an annular shoulder adjacent the base of the male thread, and the outer face of each box end of the drill collar is formed with a corresponding annular shoulder. When a drill collar connection is "made up" by threading the pin end of one collar into the box end of another collar, the annular shoulders of the pin end and box end are brought into compressive metal-to-metal contact so as to create a mechanical seal preventing leakage of drilling mud. Because of this important function, the annular shoulders of the pin and box ends of the drill collars may

alternatively be referred to as "seal shoulders" or "torque shoulders", and the contact surface of a torque shoulder may be referred to as a "seal face".

In order for torque shoulders to serve their sealing function as effectively as possible, the seal faces should ideally be uniformly planar and precisely perpendicular to the longitudinal axis of the drill string, and the seal faces should ideally be very smooth, and free from even minor damage or defects.

It is also customary and highly preferred to chamfer or bevel the outer circumferential edges of the seal faces (typically at an angle of approximately 45 degrees), primarily to protect the seal faces from damage during shipping and handling of the drill collars as well as from impact damage that could otherwise occur in the outer regions of the seal faces after a drill collar assembly has been made up and put into service. Although the angled faces of the bevelled edges do not come into contact with other components and do not have a direct sealing function, these angled faces as well should ideally be smooth and free from defects, for reasons discussed later in this document.

Unfortunately, the seal faces and bevelled edges of drill collars and other oilfield tubular items are commonly damaged due to rough handling, accidental impacts, and other incidents of typical well-drilling operations and the sometimes harsh environments in which these operations are conducted. Even minor damage to a seal face, such as scratches and nicks, can significantly impair the effectiveness of the mechanical seal between mating seal faces, to the point where there is no practical option except to replace the damaged tubular and, if possible, to re-face the damaged tubular to restore the stringent seal face requirements discussed above (to facilitate or enable later re-use in the field). Because of these stringent requirements, re-facing of torque shoulders must be carried out with great precision, and one way to do so is to ship the damaged tubulars to a machine shop at an off-site location. However, that is not an ideal option due to transportation costs and lost field production time, and/or the need to have an on-site stock of replacement tubulars, ready for installation while the damaged tubulars are being re-faced in the shop.

A number of machines have been devised for re-facing damaged tubulars in the field, to avoid the cost and inconvenience of shipping them to a machine shop. One particularly good example of such a machine is disclosed in U.S. Patent No. 4,149,436 (Blattler) and corresponding Canadian Patent No. 1,080,948. The Blattler machine provides a threaded mandrel adapted to receive either the pin end or box end of a tubular workpiece such as a drill collar, the other end of which is supported by a suitable steady rest or other support means. The mandrel and the workpiece are stationary (i.e., non-rotating) during operation of the machine. A cylindrical shaft coaxially disposed around the mandrel rotates a flange plate onto which a tool holder is mounted, with the tool holder being radially movable toward or away from the longitudinal axis of the shaft (and, in turn, toward or away from the workpiece). Biasing means, in the form of a helical spring, is provided to bias the tool holder inward toward the workpiece axis.

The Blattler machine incorporates a wedge mechanism that engages the tool holder such that longitudinal movement of the wedge relative to the cylindrical shaft and toward the tool holder has the effect of displacing the tool holder radially away from the workpiece axis. As may be best seen in FIG. 2 in US 4,149,436, the Blattler machine includes a collar assembly (85) which coaxially surrounds and rotates with a hollow shaft (48), which in turn is coaxially disposed around a non-rotating adapter (14) to which a tubular workpiece may be mounted. The collar (85) is axially slidable relative to the adapter and the rotary tool head (60), which is not axially movable relative to the adapter. A first wedge mechanism component ("wedging member 95") is mounted in association with the sliding collar (85), and a second wedge mechanism component ("actuating arm 84") is mounted to a tool holder (62), which in turn is mounted to the rotary tool head (60) so as to be radially movable relative thereto. The actuating arm (84) extends over and engages a sloping surface of the wedging member (95) such that axial movement of the collar (85) toward the rotary tool head (60) will cause radially outward movement of the actuating arm (84) and, in turn, the tool holder (62), and vice versa.

This apparatus is typically set up in an initial position such that a cutting tool mounted to the tool holder is positioned radially clear of the workpiece but longitudinally positioned to cut a desired depth into the torque shoulder of the mounted end of the

workpiece. The cylindrical shaft is then rotated, thus also rotating the faceplate and the tool holder about the non-rotating workpiece. The wedge mechanism can then be gradually withdrawn longitudinally away from the workpiece, such that the rotating cutting tool progresses radially inward and machines a new seal face, removing any previously existing damage or defects.

In order to re-face the bevelled edge of the torque shoulder, a separate tool holder is mounted to the flange plate of the machine, with a bevelling tool having a cutting edge oriented to match the desired bevel angle. The radial position of this separate tool holder is pre-set and does not change during re-facing of the torque shoulder edge. With the seal face re-facing tool positioned away from the workpiece (by suitable manipulation of the previously-discussed wedge mechanism), and with the bevelling tool radially positioned for alignment with the torque shoulder edge, the rotating cylindrical shaft is moved longitudinally, over the stationary mandrel, toward the workpiece, such that the bevelling tool engages and re-faces the bevelled edge of the torque shoulder.

In accordance with the operational principles described above, the Blattler machine re-faces the face of the torque shoulder by moving the corresponding cutting tool across and parallel to the seal face, which facilitates the production of a suitably smooth machined surface. However, re-facing of the bevelled edge of the torque shoulder is accomplished by what may be referred to as a plunge cut, meaning that the cutting tool is plunged or forced against and into the workpiece. This process is not conducive to production of an optimally smooth machined bevel surface. Using this process, the cutting tool is susceptible to intermittently catching or bouncing on the workpiece surface due to factors such as mandrel flex or "backlash" resulting from an excessive plunge rate. This can cause what is commonly referred to in machining parlance as "chatter", which in turn causes the cutting tool to create gouges or other defects in the bevel surface. Such defects in the bevel surface are highly undesirable, particularly because if they occur near the inner perimeter of the bevel surface they can also create unacceptable defects in the seal face. In that event, re-facing of the seal face may have to be repeated.

It is clearly desirable, therefore, to re-face the bevel edges of torque shoulders using means that do not involve "plunging" motion of the cutting tool, in order to avoid chatter and resultant workpiece damage. Ideally, this operation would be carried out by moving a cutting tool across and parallel to the bevel face, in a manner analogous to the re-facing of torque shoulders as accomplished using the Blattler machine. Unfortunately, the Blattler machine as disclosed in U.S. Patent No. 4,149,436 cannot carry out this mode of operation, and it is apparent that there are no other known machines or apparatus that are capable of re-facing the bevel edge of a torque shoulder in this desirable fashion.

Accordingly, there is a need for methods and apparatus for machining or re-facing a circumferential bevel edge on the end of a tubular member using a cutting tool that moves across and parallel to the face of the bevel. There is a further need for apparatus that is capable of carrying out such a bevel re-facing operation and is also adaptable for retrofitting onto re-facing machines that provide for only radial movement of the cutting tool relative to a tubular workpiece.

BRIEF SUMMARY

The present disclosure teaches embodiments of an improvement in a pipe-refacing machine of the general type having:

- a tubular shaft rotatable about a rotational axis;
- a flange plate mounted to and rotatable with one end of the tubular shaft and rotatable therewith, with the flange plate having an outer face perpendicular to the rotational axis and also having an opening through which the rotational axis passes;
- a stationary and non-rotatable adapter disposed at least partially within the tubular shaft proximal to the opening in the flange plate, for receiving a threaded end of a tubular workpiece such that the longitudinal axis of the workpiece is coincident with the rotational axis; and
- a tubular collar coaxially disposed around the tubular shaft so as to be rotatable therewith and movable relative thereto in a direction parallel to the rotational axis.

In broad terms, the improvement comprises:

- a support bracket projecting from the outer face of the flange plate;
- a support block adapted to receive a tool holder, with the support block being retainingly mounted to the support bracket so as to be movable relative to the support bracket in an angled radial direction forming an acute angle relative to a radially-outermost portion of the flange plate, and with the acute angle corresponding to the bevel angle of a bevelled edge to be machined or re-faced on an annular shoulder of a tubular workpiece mounted to the adapter; and
- actuating means for effecting angled radial movement of the support block relative to the support bracket.

In one embodiment, the support bracket comprises a base plate having a raised section contoured for sliding engagement with a mating recess in the support block. In one variant of this embodiment, the raised section is in the form of a parallelepiped of trapezoidal cross-section.

In another embodiment, the support bracket comprises a contoured rail member oriented parallel to the desired bevel angle to be machined on an annular shoulder of a tubular workpiece, and the support block comprises a runner block contoured for retainingly mating engagement with the rail member so as to be movable along the rail member.

In one variant, the actuating means comprises an actuator arm operatively engageable with the support block, with the actuator arm being connected to a slide bracket extending through and radially movable within a radial slot through the flange plate. The slide bracket has a first wedge component operatively engageable with a second wedge component associated with the tubular collar, such that longitudinal movement of the tubular collar (i.e., parallel to the rotational axis) will cause the second wedge component to urge the first wedge component and the slide bracket in a radial direction, thereby causing the actuator arm to move the support block relative to the support bracket. The actuator arm may be formed with an angled outer section disposed

between a pair of guide rollers associated with the support block, such that actuator arm remains effective to move the support block in either direction while the angled outer section is movable between the guide rollers transverse to the direction of travel of the support block, to accommodate the angled (or bi-directional) movement of the support block in response to uni-directional (i.e., longitudinal) movement of the tubular collar.

In another variant, the actuating means comprises a rigid actuator bar extending through a radial slot in the flange plate, with the one end of the actuator bar being swivellingly mounted to the support block and the other end of the actuator bar being swivellingly mounted to the tubular collar, such that longitudinal movement of the tubular collar will cause the actuator bar to move the support block relative to the support bracket. The swivelling connections of the actuator bar accommodate angled movement of the support block in response to longitudinal movement of the tubular collar.

Optionally, biasing means may be provided to bias the support block in an angled radial direction away from the rotational axis (i.e., such that the a cutting tool mounted to a tool holder mounted to the support block will be biased away from a workpiece mounted to the adapter). By way of non-limiting example, the biasing means may comprise a helical spring.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments will now be described with reference to the accompanying figures, in which numerical references denote like parts, and in which:

FIGURE 1 is a schematic side view of a tubular workpiece mounted to a prior art re-facing machine, with a first embodiment of a bevelling apparatus in accordance with the present disclosure mounted in association with the flange plate of the re-facing machine.

FIGURE 2 is an oblique view of the bevelling apparatus illustrated in FIG. 1.

FIGURE 3 is an exploded isometric view of selected components of the bevelling apparatus of FIG. 1.

FIGURE 4 illustrates the bracket assembly of the bevelling apparatus.

FIGURE 5 illustrates the sliding tool-support block of the bevelling apparatus.

FIGURE 5A illustrates one alternative form of the inner lug member shown in FIG. 5.

FIGURE 6 illustrates the tool slide actuator of the bevelling apparatus.

FIGURE 7A is a side elevation of a prior art re-facing machine, shown with bevelling apparatus in accordance with the present disclosure mounted to the flange plate of the machine, and with a tubular workpiece in position for mounting to the mandrel of the re-facing machine.

FIGURE 7B is an end view of the assembly shown in FIG. 7A.

FIGURE 8A is a more detailed end view of the flange plate of a re-facing machine having radial slots for receiving both a seal face cutter and a bevel cutter.

FIGURE 8B is a schematic side view of a tubular workpiece mounted to a re-facing machine having a flange plate as in FIG. 8A, with both a seal face cutter and a bevel cutter mounted to the flange plate.

FIGURE 9 is schematic side view of a second embodiment of a bevelling apparatus in accordance with a second embodiment of the present disclosure.

FIGURE 9A illustrates various components of the alternative actuation mechanism of the embodiment illustrated in FIG. 9.

FIGURE 9B is an exploded isometric view of selected components similar to FIG. 3, illustrating modifications for purposes of the alternative actuation mechanism as in FIG. 9.

FIGURE 10 is perspective view of a third embodiment of a bevelling apparatus in accordance with the present disclosure.

DETAILED DESCRIPTION

As generally depicted in FIG. 1, a first embodiment of a bevelling apparatus in accordance with the present disclosure (and indicated in FIG. 1 by reference numeral **10**) is mounted to the rotatable flange plate **62** of a re-facing machine **60**, such that bevelling apparatus **10** is movable radially relative to the rotational axis **A** of re-facing machine **60**. Re-facing machine **60** has a non-rotating mandrel **64** having a longitudinal axis coincident with axis A and adapted to coaxially engage a tubular workpiece **70** and to hold it stationary (i.e., non-rotating) while flange plate **62** rotates. The configuration of the workpiece-engaging end of mandrel **64** depends on the workpiece **70**; for example, mandrel **64** would have tapered male threading to engage the box end of a drill collar (as in FIG. 1) or, alternatively, tapered female threading to engage the pin end of a drill collar.

As may be understood from FIGS. 1 and 8A in particular, a radial movement mechanism **65** is radially movable within a radial slot **63A** or **63B** in flange plate **62** of re-facing machine **60**. Radial movement mechanism **65** (which does not form part of the broadest embodiments of the bevelling apparatus) may comprise a wedge mechanism as in U.S. Patent No. 4,149,436, or any other suitable mechanism capable of providing controllable radial movement relative to re-facing machine **60**. As will be explained in greater detail below, bevelling apparatus **10** is coupled to radial movement mechanism **65**, on the workpiece side of flange plate **62**, such that actuation of radial movement mechanism **65** will produce corresponding radial movement of bevelling apparatus **10**.

In the embodiment more particularly illustrated in FIGS. 2 through 6, bevelling apparatus **10** includes a mounting bracket comprising a bracket assembly **20** with a pair of side plates **12** rigidly connected (such as by welding) to opposing side edges **21A** and **21B** of bracket assembly **20** as shown. Bracket assembly **20** has an outer end **20A** and an inner end **20B**. Bracket assembly **20** comprises a base plate **22** plus a raised section **24** in the general form of a parallelepiped having a trapezoidal cross-section, with the wider portion of raised section **24** being disposed above and parallel to upper surface **22U** of base plate **22**. The trapezoidal configuration of raised section **24** is a matter of design

preference, and is not essential; in alternative embodiments, raised section **24** could have a different cross-sectional configuration without departing from the scope of the present disclosure.

Raised section **24** extends approximately between outer end **20A** and inner end **20B** of bracket assembly **20**. Base plate **22** has an elongate slot **23** adjacent and parallel to one side of raised section **24**. On the other side of raised section **24**, proximal to outer end **20A** of bracket assembly **20**, base plate **22** has an outer lug member **26** projecting above upper surface **22U**, with a typically unthreaded bore **26A**. Bracket assembly **20** is suitably adapted for secure mounting to flange plate **62** of re-facing machine **60**.

Bevelling apparatus **10** further includes a sliding block **30** having an outer end **30A** and an inner end **30B**, upper face **30U**, lower face **30L**, and side edges **31A** and **31B**. Formed in lower face **30L** of sliding block **30**, and extending between outer and inner ends **30A** and **30B** thereof, is a trapezoidal channel **36** configured for a close-tolerance sliding fit with raised section **24** of bracket assembly **20**. Formed in upper face **30U** of sliding block **30**, and extending between outer and inner ends **30A** and **30B** thereof, is a two-section keyway **37** comprising a lower section **37L** and a narrower upper section **37U**. As may be best understood from FIG. 3, keyway **37** is configured to receive a tool holder **40** of known type, having an upper section **41** slidably disposable within upper section **37U** of keyway **37**, and a lower section **43** slidably disposable within lower section **37L** of keyway **37**. Tool holder **40** will typically be provided with one or more set screws **42** or other means for releasably fixing the longitudinal position of tool holder **40** relative to sliding block **30**. A bevelling tool **42** with cutting element **44** may be mounted to tool holder **40** as seen in FIG. 1 (tool holder **40** not being visible in FIG 1).

The width of sliding block **30** is such that it cannot impinge upon outer lug member **26** of bracket assembly **20**, and such that its side edge **31B** will at all times be clear of elongate slot **23** in base plate **24** (or at least will not overlap slot **23** so as to interfere with the operation of bevelling apparatus **10**).

An inner lug member **32** having a threaded bore **32A** is rigidly connected to inner end **30B** of sliding block **30**, such that the portion of inner lug member **32** in which

threaded bore **32A** is formed projects beyond side edge **31A** of sliding block **30**. When sliding block **30** is slidably engaged with raised portion **24** of bracket assembly **20** as previously described, threaded bore **32A** of inner lug member **32** will be aligned with unthreaded bore **26A** of outer lug member **26** of bracket assembly **20**. As shown in FIG. 2, a helical spring **82** is positioned between inner lug member **32** and outer lug member **26**, and then an adjustment bolt **80** (having drive head **84**) is inserted through unthreaded bore **26A** of outer lug member **26** and helical spring **82**, whereupon the threaded end of bolt **80** engages threaded bore **32A** of inner lug member **32**. It may be readily understood, therefore, that the static longitudinal position of sliding block **30** relative to bracket assembly **20** can be adjusted by rotating drive head **84** as required. However, sliding block **30** will remain slidingly movable relative to bracket assembly **20** by a longitudinal force applied to sliding block **30** in the direction toward outer end **20A** of bracket assembly **20**, with helical spring **82** serving as a biasing means which will return sliding block **30** back toward its static position upon relaxation of the longitudinal force.

Inner lug member **32** may be connected to sliding block **30** by any suitable means such as welding or, alternatively, by means of one or more bolts **33** (or machine screws), for purposes of which inner lug member **32** may be provided with one or more bolt holes **32B** as shown in FIG. 5A. Alternatively, inner lug member **32** may be formed integrally with sliding block **30**.

As shown in FIGS. 1, 2, and 3, an outer roller **35A** and an inner roller **35B** are mounted to and extend laterally from side edge **30B** of sliding block **30**. Rollers **35A** and **35B** are spaced apart in the longitudinal direction, with the clear spacing between rollers **35A** and **35B** being set to suit the width of the actuator arm **54** of a tool slide bracket **50**, as may be seen in FIGS. 1 and 6. Tool slide bracket **50** comprises a base member **52** adapted (such as by means of mounting holes **52A**) for mounting to radial movement mechanism **65**. Actuator arm **54** has an inner section **54A** connected (such as by welding) to and projecting outward from base member **52**, plus an outer section **54B** which is angled, relative to base member **52**, as appropriate to bevel a tubular workpiece **70** at a desired angle.

As may be seen in FIG. 1, when bevelling apparatus **10** is mounted in association with the flange plate **62** of a re-facing machine **60**, with base member **52** of tool slide bracket **50** directly connected to radial movement mechanism **65**, angled outer section **54B** of actuator arm **54** is disposed (preferably with only nominal clearance) between rollers **35A** and **35B**. When radial movement mechanism **65** is actuated, so as to move tool slide bracket **50** radially inward in the plane of flange plate **62**, outer section **54B** of actuator arm **54**, due to its angular orientation, will bear against inner roller **35B**, having the effect of applying a longitudinal force urging sliding block **30** toward outer end **20A** of bracket assembly **20**. As may be seen from FIG. 1, this will cause sliding block **30**, and bevelling tool **42** in turn, to move both radially inward and at an acute angle relative to rotational axis **A** – more specifically, at an angle corresponding to the desired angle for the bevelled face to be machined on the end of workpiece **70**. As sliding block **30** continues its inward movement, outer section **54B** of actuator arm **54** will necessarily move between rollers **35A** and **35B** in the direction transverse to and toward base plate **22** of bracket assembly **20**. It is for this reason that elongate slot **23** is provided in base plate **22**, so that the free end of outer section **54B** of actuator arm **54** can freely pass both transversely through and longitudinally along slot **23**.

The operation and use of bevelling apparatus **10** may now be readily understood having regard to the preceding description. With a tubular workpiece **70** mounted to mandrel **64** as shown in FIG. 1 and longitudinally positioned as desired, the initial or static position of sliding block **30**, and in turn the position of bevelling tool **42** relative to the end of workpiece **70**, can be set as desired by appropriate rotation of adjustment bolt **80**. Re-facing machine **60** can then be actuated so as to rotate flange plate **60** and bevelling apparatus **10**. Actuation of radial movement mechanism **65** will then cause bevelling tool **42** to move toward workpiece **70** in a direction parallel to the desired bevel face plane. As bevelling tool **42** thus rotates around workpiece **70** and concurrently moves angularly inward, cutting element **44** will engage workpiece **70** and machine the desired bevelled shoulder edge.

As schematically illustrated in FIG. 8B, bevelling apparatus in accordance with the present disclosure makes it possible to re-face the bevelled shoulder of a tubular

workpiece **70** concurrently with re-facing of the seal face, using the same basic re-facing machine. This is possible because both operations are carried out without having to move or reposition workpiece **70** longitudinally relative to the re-facing machine. This provides a decided advantage over prior art methods and apparatus which require seal faces and bevelled shoulders to be re-faced in separate and sequential operations.

FIG. 9 illustrates a second embodiment of the beveller that uses an alternative mechanism for effecting radial movement of a modified sliding block **30'** and bevelling tool **42** relative to re-facing machine **60**, instead of the wedge mechanism used in the prior art Blattler machine (per U.S. Patent No. 4,149,436). Except as described herein and illustrated in FIGS. 9, 9A, and 9B, the details of the components of this alternative embodiment correspond to those in the previously described and illustrated embodiment.

The alternative embodiment of FIG. 9 includes a bracket **94** (illustrated in detail in FIG. 9A) which has a first flange **95** and a second flange **96**. First flange **95** has a hole **95A** for receiving a swivel pin. Second flange **96** extends through elongate slot **23** in base plate **22** and is securely mounted to sliding block **30'**. As shown in FIG. 9B, sliding block **30'** differs from sliding block **30** in FIG. 3 in that it does not include any rollers **35**. In the illustrated alternative embodiment, the mounting of second flange **96** to sliding block **30'** is accomplished by means of bolts or machine screws (not shown) through holes **96A** in second flange **96** and into threaded holes **39** in one side of sliding block **30'**. However, alternative means for securely mounting second flange **96** to sliding block **30'** may be used instead of bolts or machine screws without departing from the scope of the present disclosure. Although bracket **94** is shown in FIG. 9A as being of generally Z-shaped configuration, this is by way of example only; bracket **94** could be of any functionally suitable shape and configuration,

Referring to FIG. 9, re-facing machine **60** includes a collar assembly **61** (similar to collar (85) in US 4,149,436) surrounding and rotating with a hollow shaft (not shown, but corresponding to hollow shaft (48) in US 4,149,436), which in turn is disposed coaxially around non-rotating mandrel **64** (not shown in FIG. 9). Collar **61** is axially movable along the hollow shaft and relative to flange plate **62** of re-facing machine **60**.

Referring to FIG. 9A, a bracket **66** of any suitable configuration, with a hole **66A** for receiving a swivel pin, is mounted to collar **61**. A rigid bar **90** (of straight or other suitable configuration) has first and second ends **92** and **93**, with associated holes **92A** and **93A** for receiving swivel pins.

Referring again to FIG. 9, rigid bar **90** is disposed through a radial slot **67** in flange plate **62**, with first end **92** swivellingly mounted to bracket **66** by means of a swivel pin extending through holes **66A** and **92A**, and with second end **93** swivellingly mounted to first flange **95** of Z-shaped bracket **94** by means of a swivel pin extending through holes **93A** and **95A**. Accordingly, axial movement of collar **61** moved away from flange plate **62** will cause rigid bar **90** to pull sliding block **30'** along raised section **24** of bracket assembly **20** toward flange plate **62**, in an angular direction corresponding to the desired angle of bevel to be formed on a tubular workpiece **70** by bevelling tool **42** mounted to sliding block **30'**. Therefore, angled movement of bevelling tool **42** relative to the end of a mounted workpiece **70** is effected by axial movement of collar **61**, but the operative mechanism is the swivelling linkage provided by rigid bar **90** rather than a wedging mechanism.

FIG. 10 illustrates a third embodiment of a bevelling apparatus in accordance with the present disclosure. In this embodiment, a bevelling tool **42** with cutting element **44** is carried by a tool holder **40** (not shown in FIG. 10) which is received a keyway **137** in a sliding block **130** (which is generally similar to sliding block **30** and sliding block **30'** in the other illustrated embodiments). As shown in FIG. 10, sliding block **130** is secured to a runner block **122** which is longitudinally movable along a rail member **120**, which in turn is secured to a rail-mounting block **110** secured to the rotatable face plate **62** of a re-facing machine **60**, with the angle of rail member **120** relative to face plate **62** being selected to suit the angle of the bevelled shoulder to be re-faced using the apparatus.

An adapter block **140** is secured to either or both of runner block **122** and sliding block **130**, and a bracket **142** (functionally analogous to bracket **94** in the embodiment in FIGS. 9 and 9A) is secured to adapter block **140** by fasteners **144**. Movement of runner block **122** along rail member **120** is effected by means of an actuating mechanism

essentially the same as the mechanism illustrated in FIGS. 9 and 9A and previously described herein. In other words, a rigid bar **90** is disposed through a radial slot **67** in face plate **62**, with rigid bar **90** having a first end **92** (not shown in FIG. 10) swivellingly mounted to an axially-movable collar **61** associated with re-facing machine **60**, and a second end **93** swivellingly mounted to bracket **142** by means of a swivel pin disposed through hole **93A** in second end **93**. Axial movement of collar **61** away from face plate **62** will cause rigid bar **90** to pull sliding block **130** along rail member **120** toward face plate **62**, in an angular direction corresponding to the desired angle of bevel to be formed or re-faced on a tubular workpiece **70** by bevelling tool **42** mounted to sliding block **30'**.

Runner block **122** and rail member **120** may be of any suitably mating configuration such that runner block **122** is retained on rail member **120** as it travels therealong. In the illustrated embodiment, runner block **122** and rail member **120** are shown, respectively, as runner block and ball guide rail components of a ball rail system as manufactured by Bosch Rexroth AG (details of which can be viewed at http://www.boschrexroth.com). However, this is by way of example only, and the embodiment shown FIG. 10 is not limited to the use of these or any other particular types of runner block and rail member. By way of non-limiting example, variant embodiments could use roller rail system components as manufactured by Bosch Rexroth AG, or could use custom-fabricated runner blocks and rail members. Movement of runner block **122** along rail member **120** could be sliding movement or rolling movement or a combination of sliding and rolling movement.

It will be readily appreciated by those skilled in the art that various modifications of the illustrated embodiments may be devised without departing from the scope and teaching of the present disclosure, including modifications which may use equivalent structures or materials hereafter conceived or developed. It is to be especially understood that the disclosure is not intended to be limited to any described or illustrated embodiment, and that the substitution of a variant of a claimed element or feature, without any substantial resultant change in the working of the apparatus, will not constitute a departure from the scope of the disclosure. It is to also be appreciated that

the different teachings of the embodiments described and discussed herein may be employed separately or in any suitable combination to produce desired results.

In this patent document, any form of the word "comprise" is to be understood in its non-limiting sense to mean that any item following such word is included, but items not specifically mentioned are not excluded. A reference to an element by the indefinite article "a" does not exclude the possibility that more than one of the element is present, unless the context clearly requires that there be one and only one such element. Any use of any form of the terms "connect", "engage", "couple", "attach", "mount", "secure", or any other term describing an interaction between elements is not meant to limit the interaction to direct interaction between the subject elements, and may also include indirect interaction between the elements such as through secondary or intermediary structure.

Relational terms such as "parallel", "perpendicular", "coincident", "intersecting", and "equidistant" are not intended to denote or require absolute mathematical or geometrical precision. Accordingly, such terms are to be understood as denoting or requiring substantial precision only (e.g., "substantially parallel") unless the context clearly requires otherwise. Wherever used in this document, the terms "typical" and "typically" are to be interpreted in the sense of representative of common usage or practice, and are not to be understood as implying essentiality or invariability.

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. A bevelling apparatus, for use in association with a pipe-refacing machine of the type having:

(a) a tubular shaft rotatable about a rotational axis;

(b) a flange plate mounted to one end of the tubular shaft and rotatable therewith, said flange plate having an outer face perpendicular to the rotational axis and having an opening through which the rotational axis passes;

(c) a stationary and non-rotatable adapter disposed at least partially within the tubular shaft proximal to the opening in the flange plate, for receiving a threaded end of a tubular workpiece such that a longitudinal axis of the workpiece is coincident with the rotational axis; and

(d) a tubular collar coaxially disposed around the tubular shaft so as to be rotatable therewith and movable relative thereto in a direction parallel to the rotational axis;

wherein said bevelling apparatus comprises:

(e) a support bracket mountable to the flange plate of a re-facing machine so as to project from the outer face of said flange plate;

(f) a support block adapted to receive a tool holder, said support block being retainingly mounted to the support bracket so as to be movable relative to the support bracket in an angled radial direction forming an acute angle relative to a radially-outermost portion of the flange plate, with said acute angle corresponding to a bevel angle of a bevelled edge to be machined or re-faced on an annular shoulder of the tubular workpiece mounted to the adapter of the re-facing machine; and

(g) actuating means for effecting angled radial movement of the support block relative to the support bracket.

2. The bevelling apparatus as in Claim 1, wherein the support bracket comprises a base plate having a raised section contoured for sliding engagement with a mating recess in the support block.

3. The bevelling apparatus as in Claim 2, wherein the raised section is in the form of a parallelepiped of trapezoidal cross-section.

4. The bevelling apparatus as in Claim 1, wherein the support bracket comprises a contoured rail member oriented parallel to the desired bevel angle to be machined on an annular shoulder of a tubular workpiece, and wherein the support block comprises a runner block contoured for retainingly mating engagement with the rail member so as to be movable along the rail member.

5. The bevelling apparatus as in Claim 1, wherein the actuating means comprises an actuator arm operatively engageable with the support block, said actuator arm being connected to a slide bracket extending through and radially movable within a radial slot through the flange plate, said slide bracket having a first wedge component operatively engageable with a second wedge component associated with the tubular collar of the re-facing machine, such that longitudinal movement of the tubular collar will cause the second wedge component to urge the first wedge component and the slide bracket in a radial direction, thereby causing the actuator arm to move the support block relative to the support bracket.

6. The bevelling apparatus as in Claim 5, wherein the actuator arm has an angled outer section transversely movable between a pair of guide rollers associated with the support block.

7. The bevelling apparatus as in Claim 1, wherein the actuating means comprises a rigid bar extending through a radial slot in the flange plate, said rigid bar being swivellingly mounted at one end to the support block and at the other end to the tubular collar, such that longitudinal movement of the tubular collar will move the support block relative to the support bracket.

8. The bevelling apparatus as in Claim 1, further comprising biasing means biasing the support block in an angled radial direction away from the rotational axis.

9. The bevelling apparatus as in Claim 8, wherein the biasing means comprises a helical spring.

10. In a pipe-refacing machine of the type having:

(a) a tubular shaft rotatable about a rotational axis;

(b) a flange plate mounted to one end of the tubular shaft and rotatable therewith, said flange plate having an outer face perpendicular to the rotational axis and having an opening through which the rotational axis passes;

(c) a stationary and non-rotatable adapter disposed at least partially within the tubular shaft proximal to the opening in the flange plate, for receiving a threaded end of a tubular workpiece such that a longitudinal axis of the workpiece is coincident with the rotational axis; and

(d) a tubular collar coaxially disposed around the tubular shaft so as to be rotatable therewith and movable relative thereto in a direction parallel to the rotational axis;

the improvement comprising:

(e) a support bracket projecting from the outer face of the flange plate;

(f) a support block adapted to receive a tool holder, said support block being retainingly mounted to the support bracket so as to be movable relative to the support bracket in an angled radial direction forming an acute angle relative to a radially-outermost portion of the flange plate, with said acute angle corresponding to a bevel angle of a bevelled edge to be machined or re-faced on an annular shoulder of the tubular workpiece mounted to the adapter; and

(g) actuating means for effecting angled radial movement of the support block relative to the support bracket.

11. The improvement defined in Claim 10, wherein the support bracket comprises a base plate having a raised section contoured for sliding engagement with a mating recess in the support block.

12. The improvement defined in Claim 11, wherein the raised section is in the form of a parallelepiped of trapezoidal cross-section.

13. The improvement defined in Claim 10, wherein the support bracket comprises a contoured rail member oriented parallel to the desired bevel angle to be machined on an annular shoulder of a tubular workpiece, and wherein the support block comprises a runner block contoured for retainingly mating engagement with the rail member so as to be movable along the rail member.

14. The improvement defined in Claim 10, wherein the actuating means comprises an actuator arm operatively engageable with the support block, said actuator arm being connected to a slide bracket extending through and radially movable within a radial slot through the flange plate, said slide bracket having a first wedge component operatively engageable with a second wedge component associated with the tubular collar, such that longitudinal movement of the tubular collar will cause the second wedge component to urge the first wedge component and the slide bracket in a radial direction, thereby causing the actuator arm to move the support block relative to the support bracket.

15. The improvement defined in Claim 14, wherein the actuator arm has an angled outer section transversely movable between a pair of guide rollers associated with the support block.

16. The improvement defined in Claim 10, wherein the actuating means comprises a rigid bar extending through a radial slot in the flange plate, said rigid bar being swivellingly mounted at one end to the support block and at the other end to the tubular collar, such that longitudinal movement of the tubular collar will move the support block relative to the support bracket.

17. The improvement defined in Claim 10, further comprising biasing means biasing the support block in an angled radial direction away from the rotational axis.

18. The improvement defined in Claim 17, wherein the biasing means comprises a helical spring.

FIG. 1

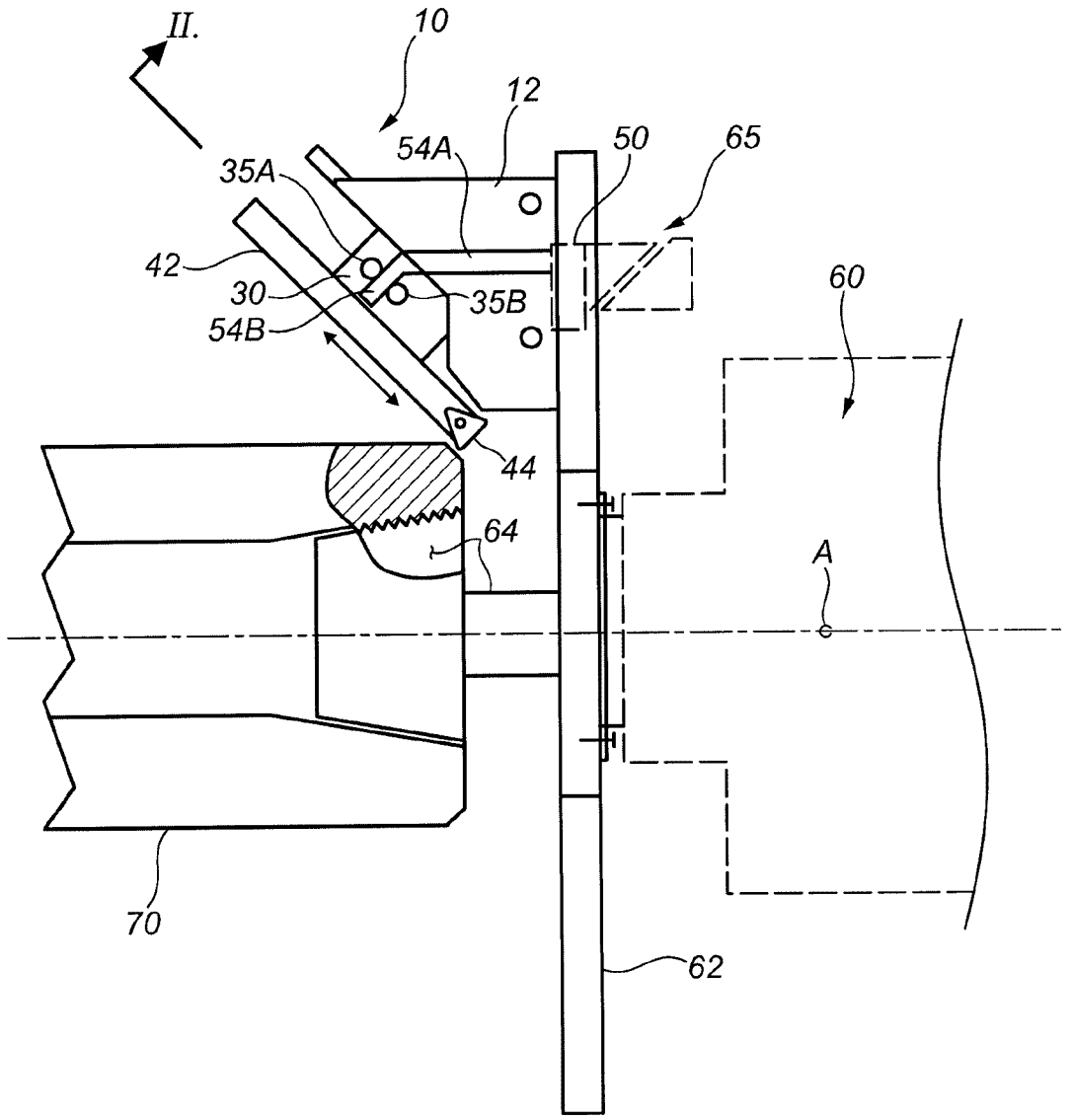


FIG. 2

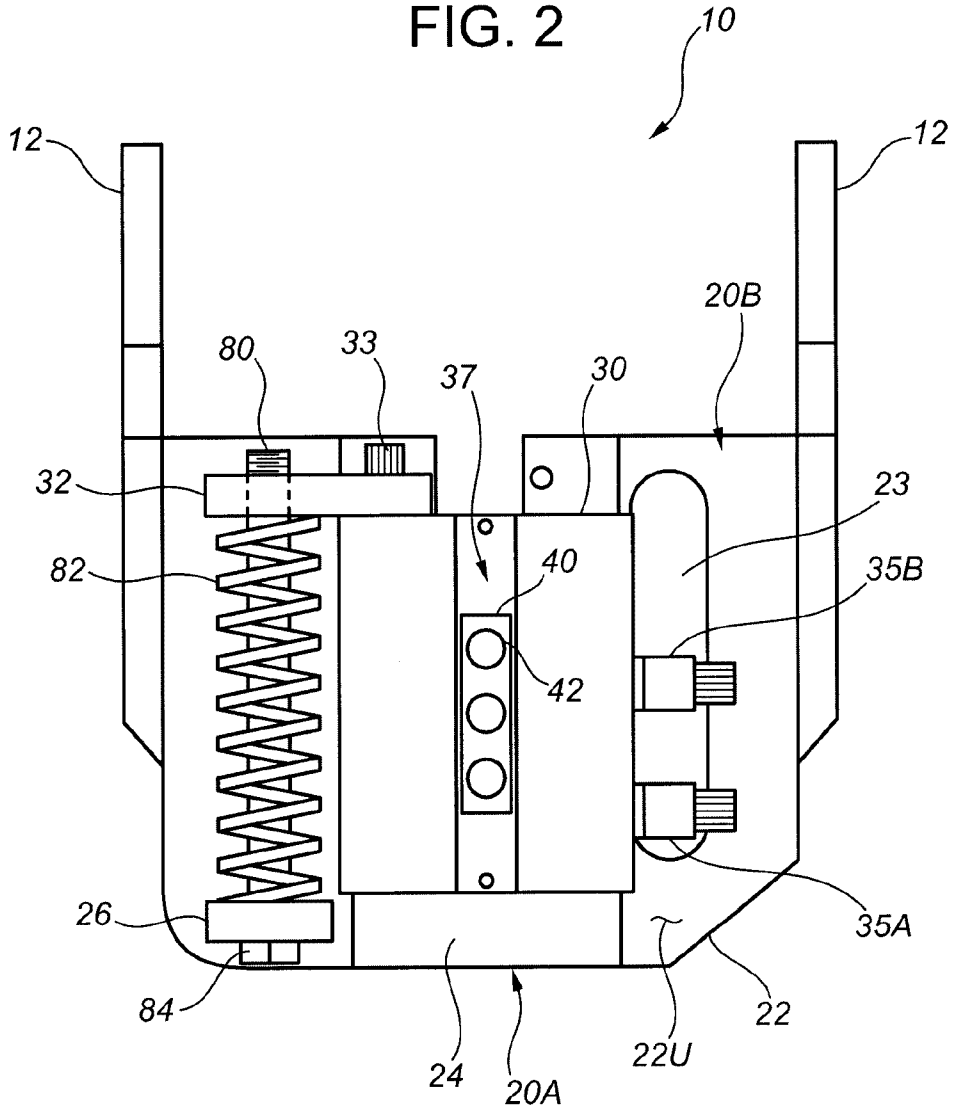
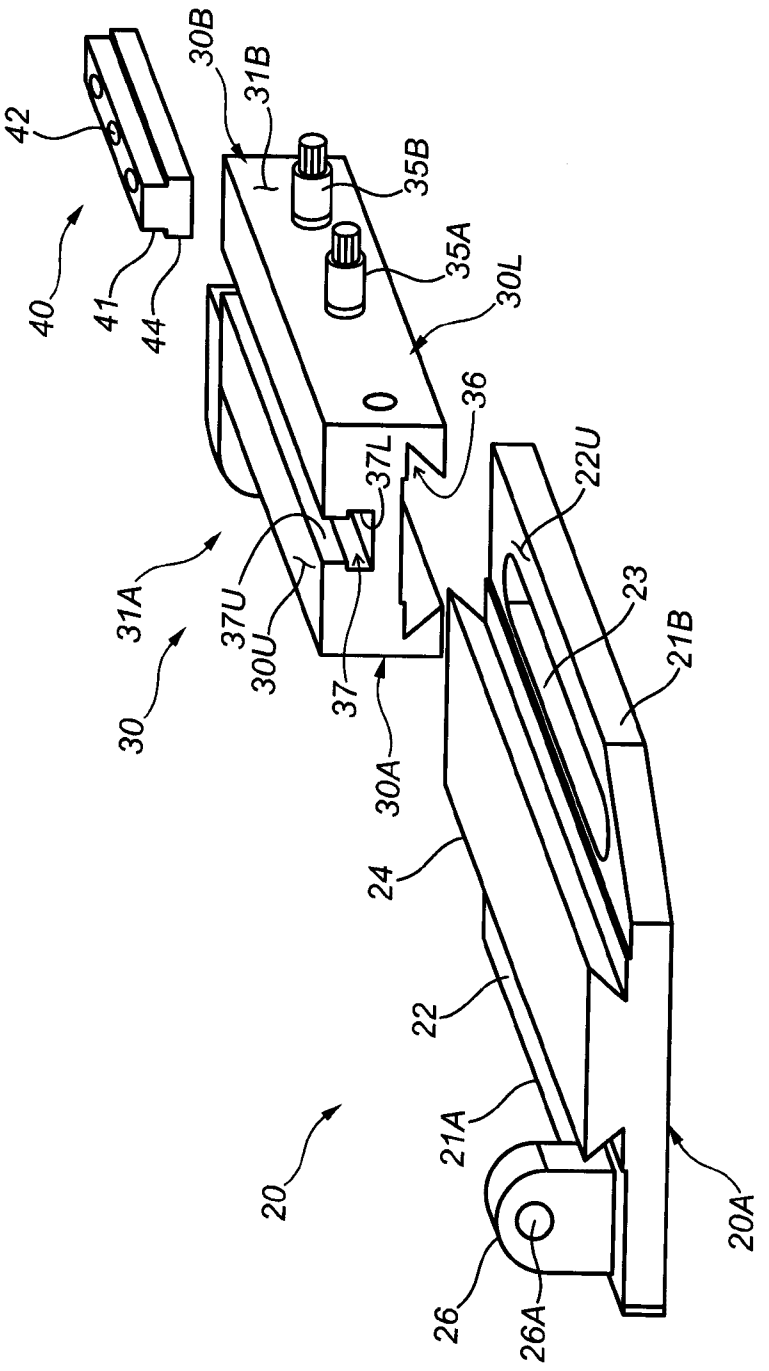


FIG. 3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40
41
44
30B
31B
35B
35A
30L
36
37L
22U
23
21B
31A
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30U
37
30A
30
24
22
21A
20
20A
26
26A

FIG. 4

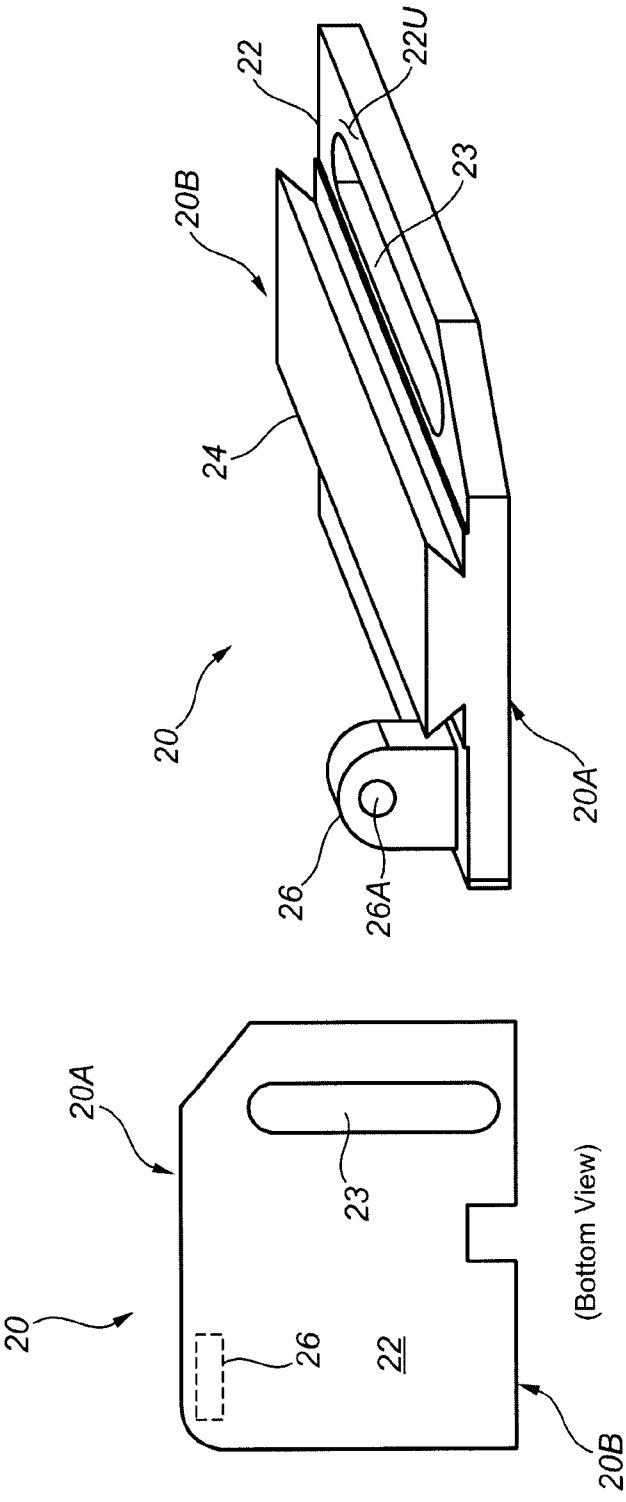
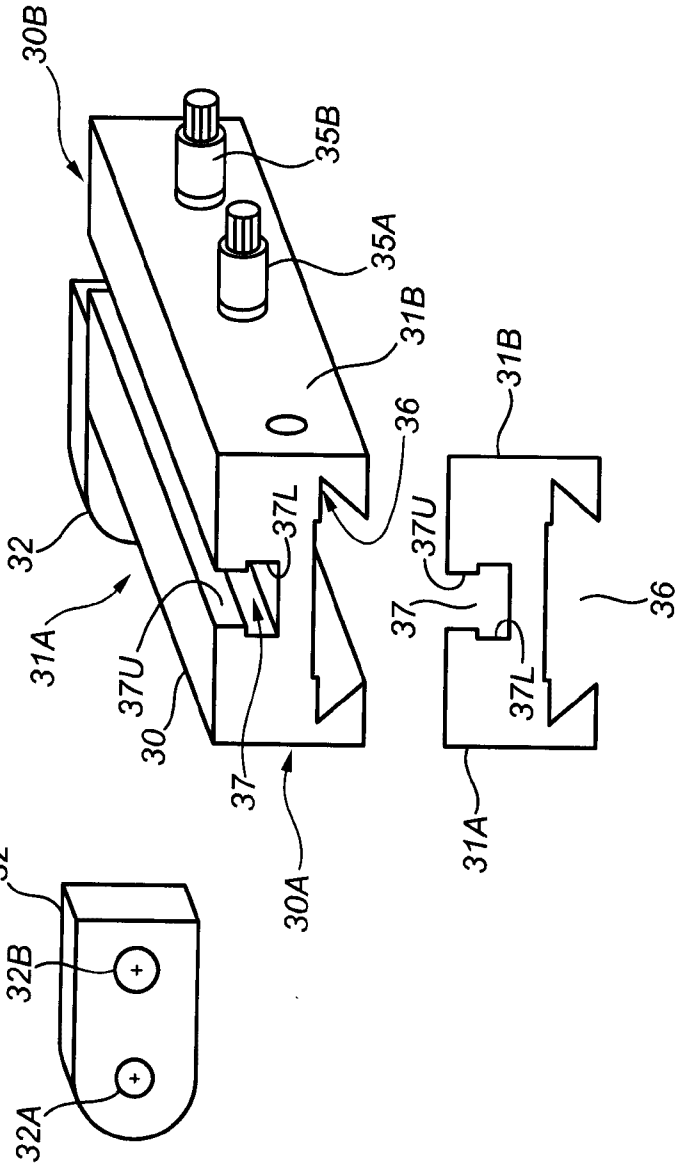


FIG. 5


30B
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36
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37L
37U
31A
37U
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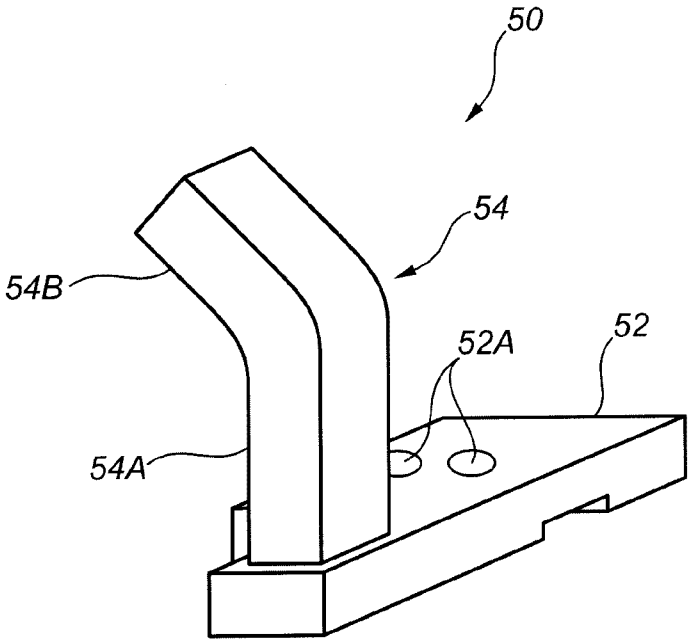
30
37
30A
31B
36
37L
31A

FIG. 5A

32
32B
32A

FIG. 6



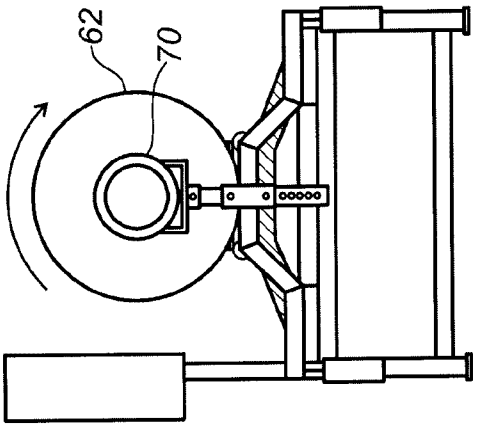

62
70

FIG. 7B

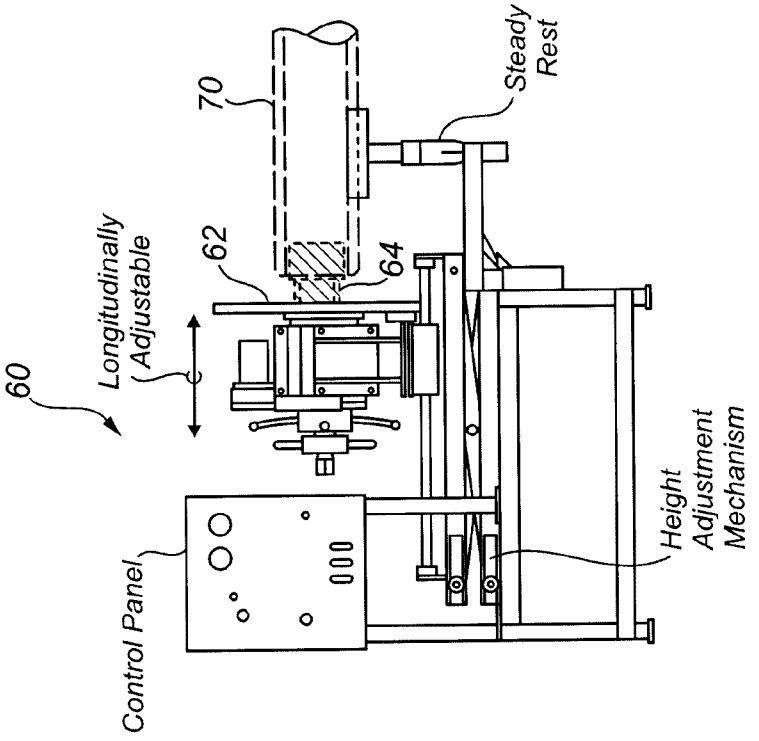

60
Longitudinally Adjustable
62
64
70
Steady Rest
Control Panel
Height Adjustment Mechanism

FIG. 7A

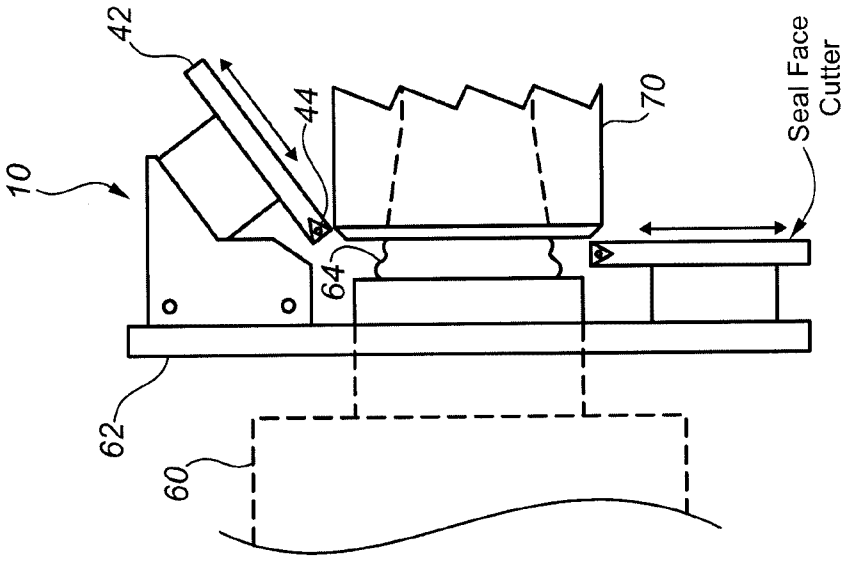


FIG. 8B

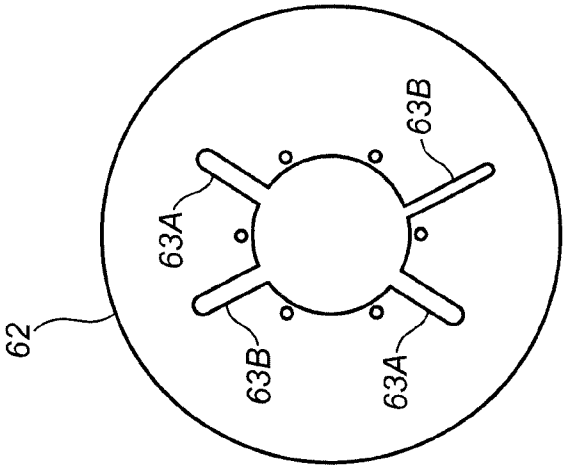


FIG. 8A

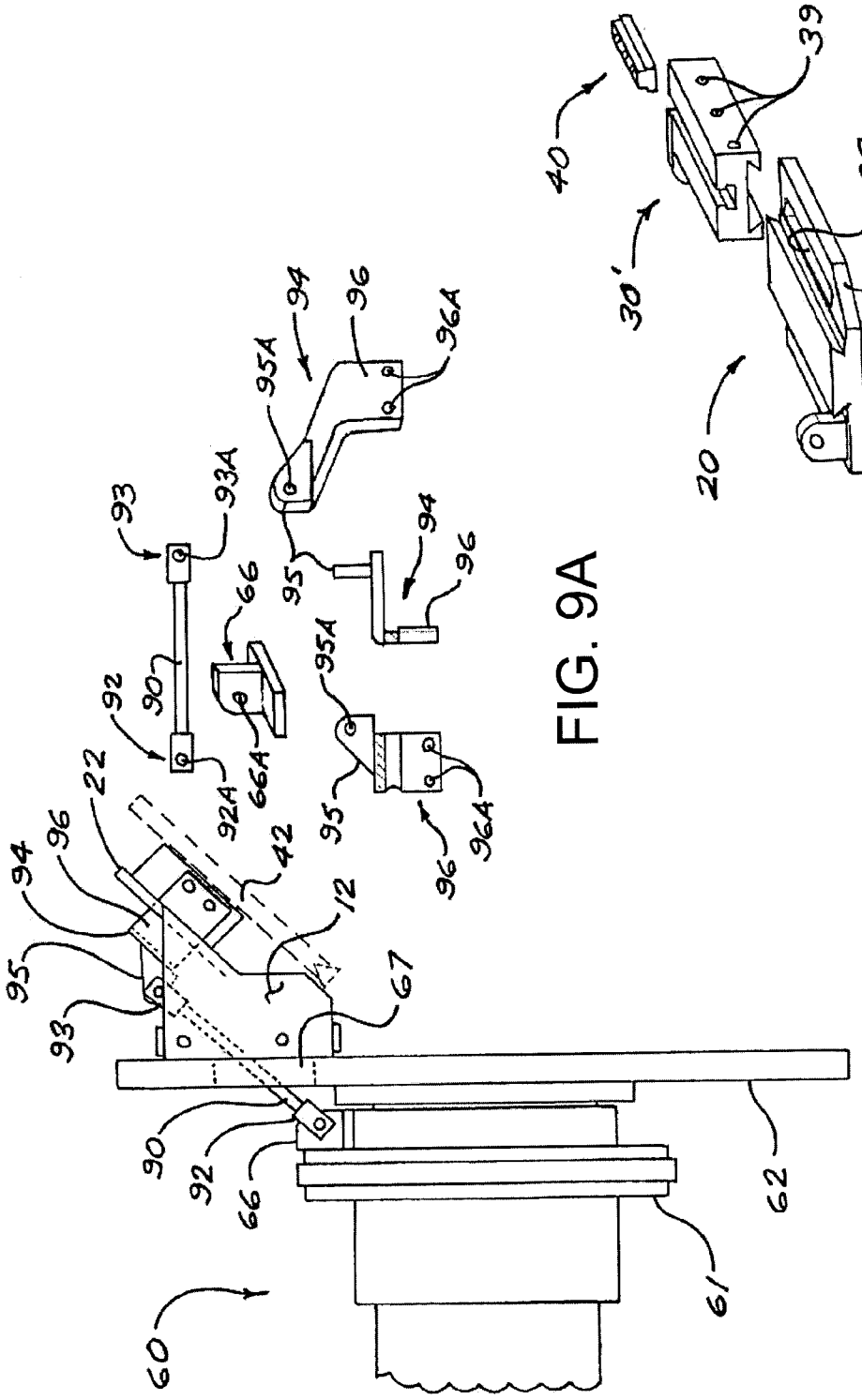


FIG. 9

FIG. 9A

FIG. 9B

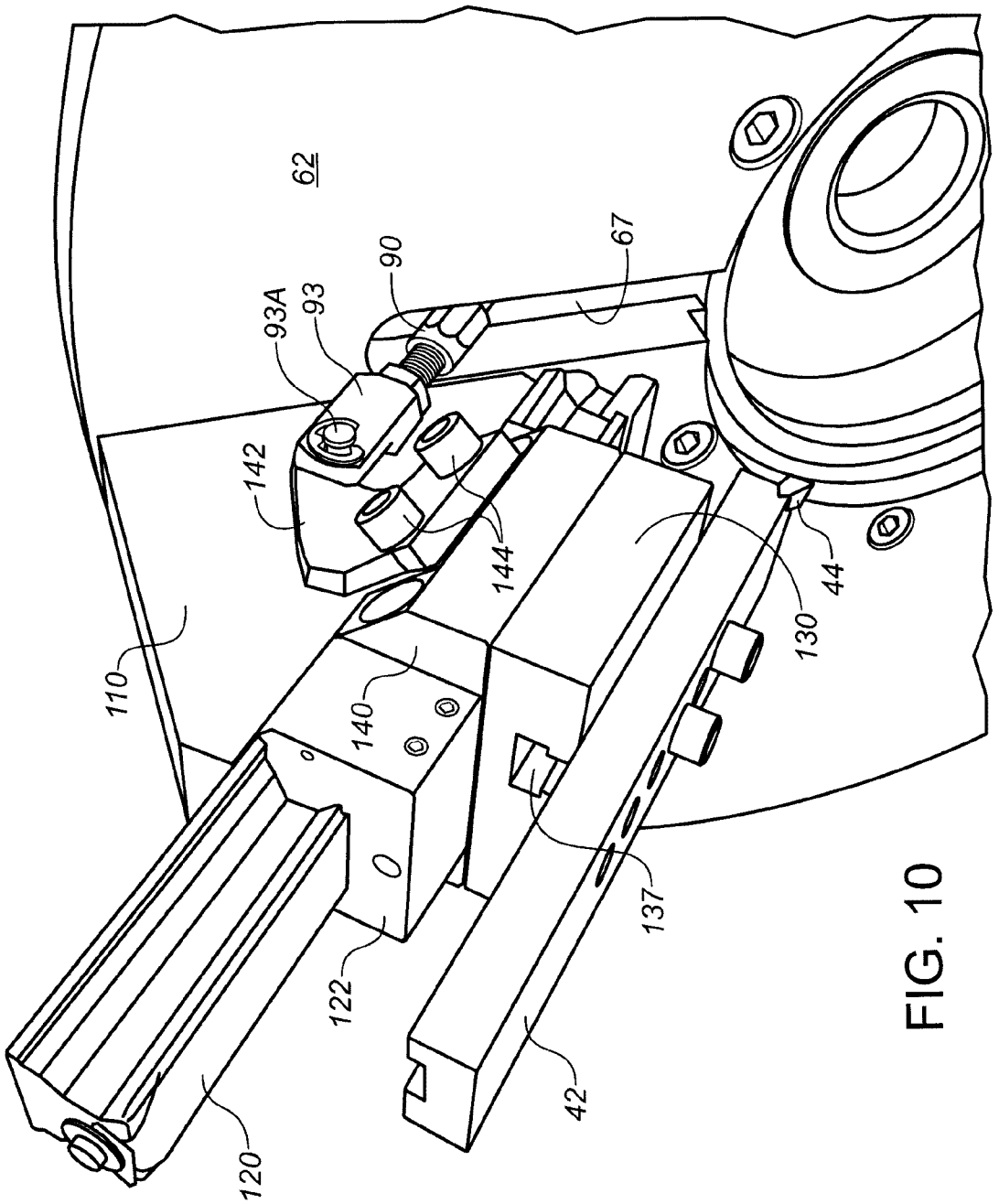
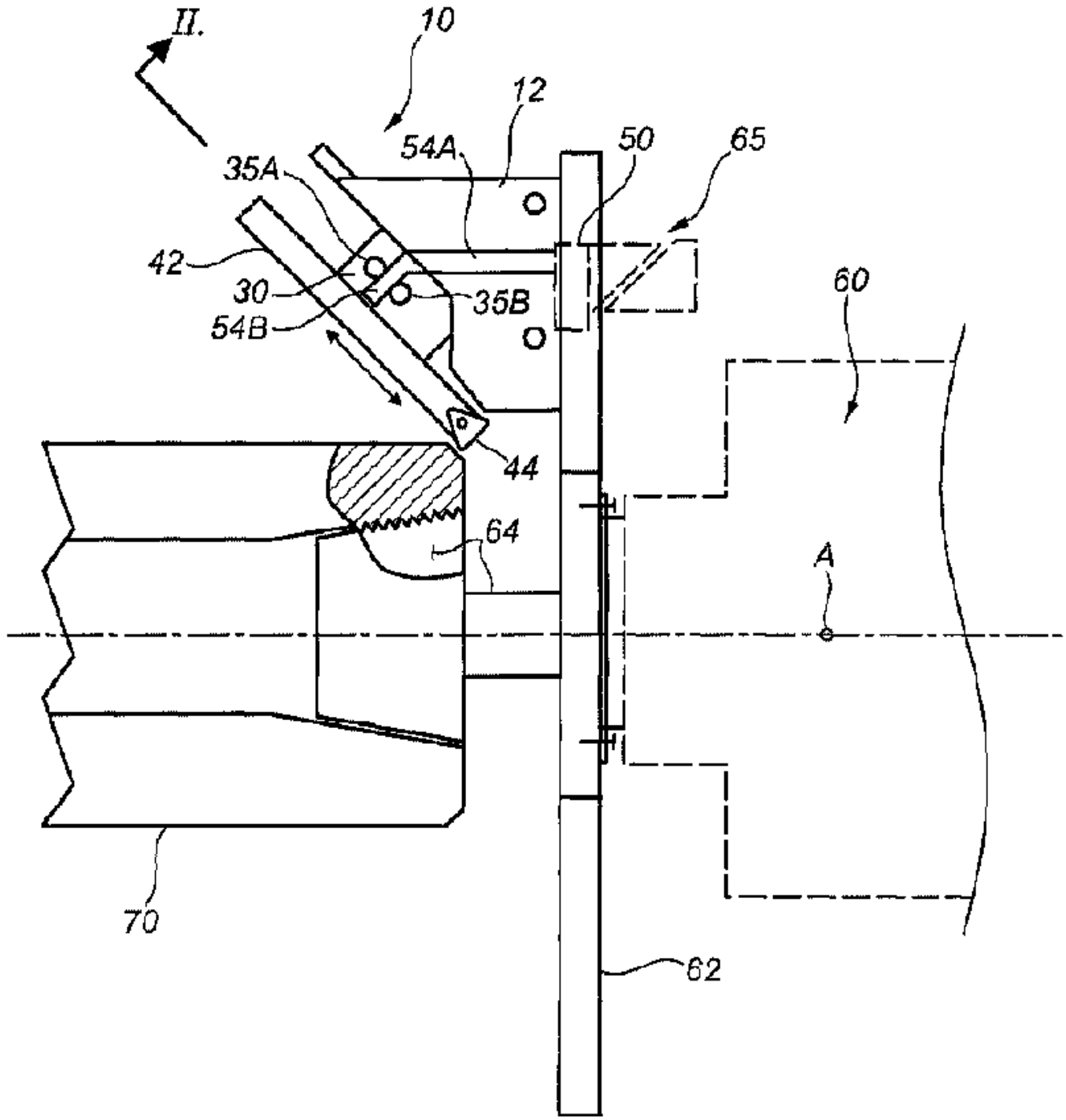


FIG. 10


II.
10
12
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A
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