

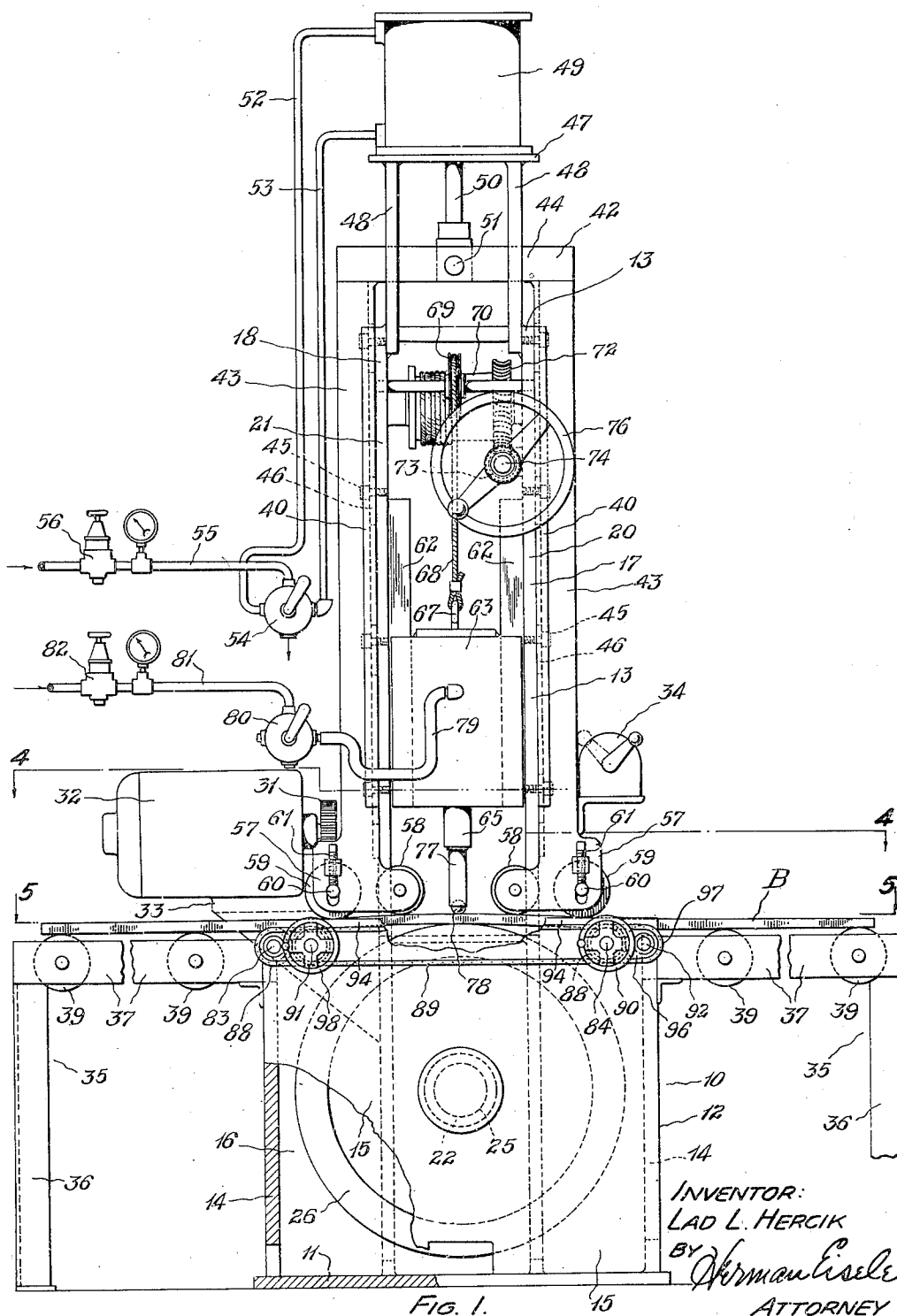
Nov. 1, 1949

L. L. HERCIK
METHOD OF AND APPARATUS FOR RECTIFYING
DISTORTION IN METAL BODIES

2,486,844

Filed Feb. 27, 1948

4 Sheets-Sheet 1



INVENTOR:
LAD L. HERCIK
BY *Norman Eisele*
ATTORNEY

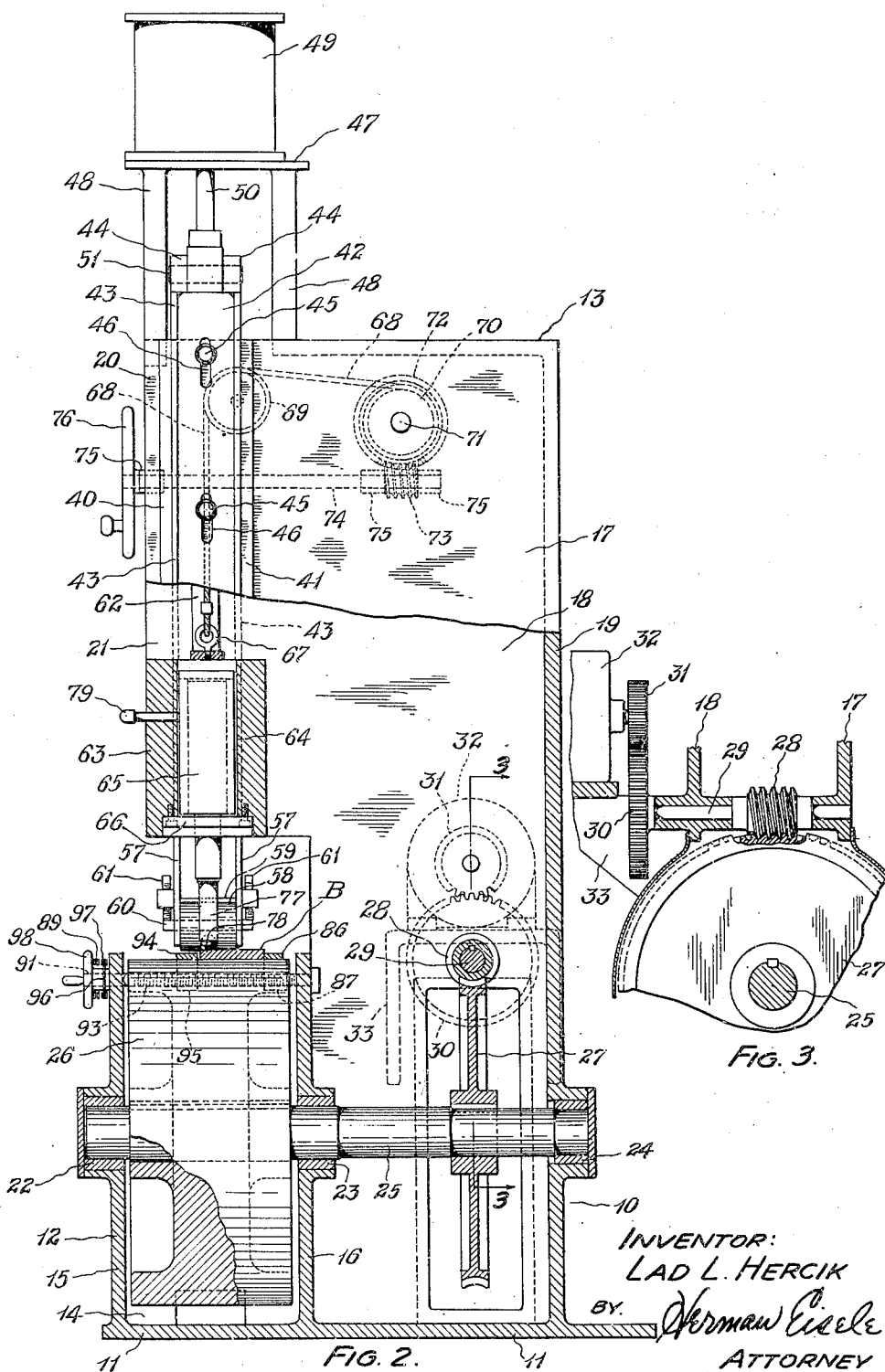
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4 Sheets-Sheet 2



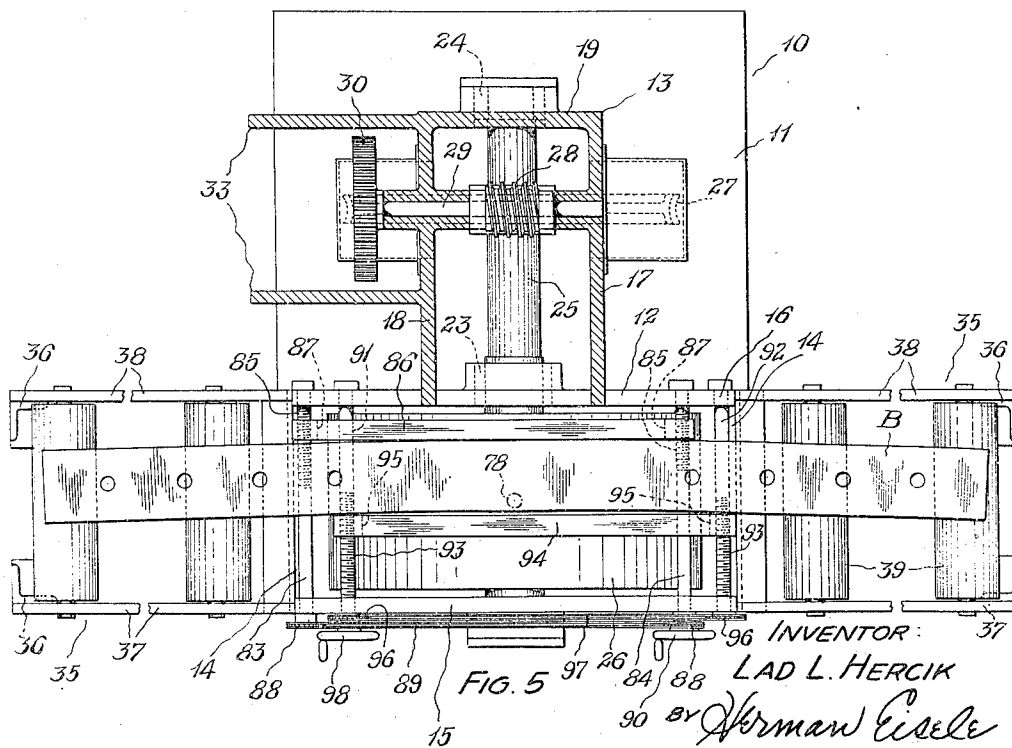
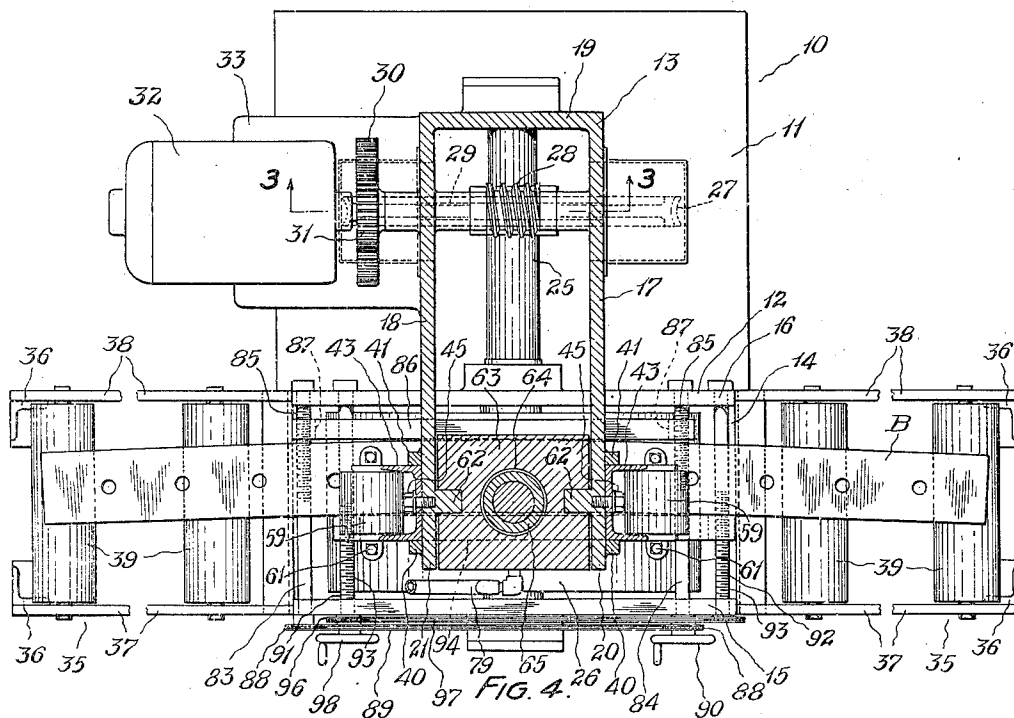
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4 Sheets-Sheet 3



INVENTOR:
LAD L. HERCIK
BY *Norman Eisele*
ATTORNEY.

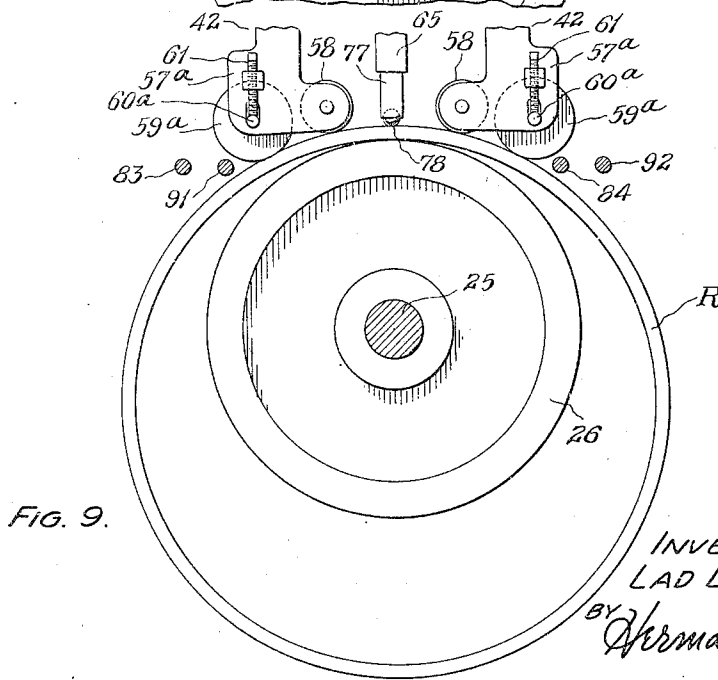
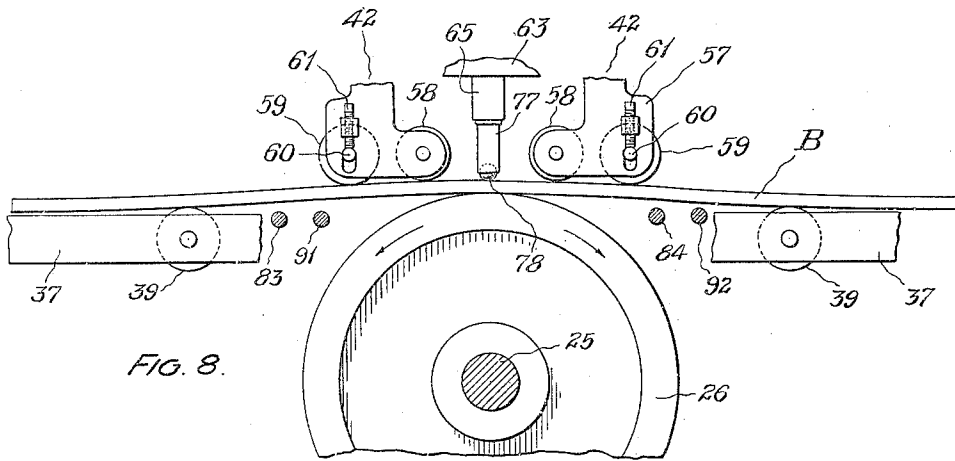
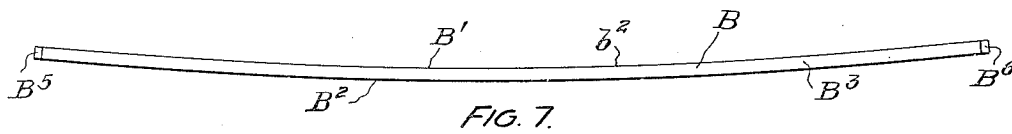
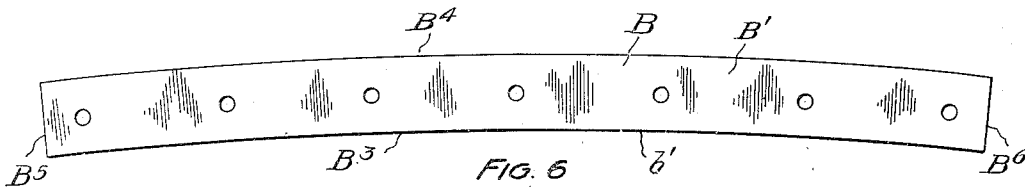
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4 Sheets-Sheet 4



INVENTOR:
LAD L. HERCIK
BY *Herman Eisele*
ATTORNEY.

UNITED STATES PATENT OFFICE

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METHOD OF AND APPARATUS FOR RECTIFYING DISTORTION IN METAL BODIES

Lad L. Hercik, Lakewood, Ohio

Application February 27, 1948, Serial No. 11,606

19 Claims. (Cl. 153—32)

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This invention relates generally to metal working tools and particularly to metal working tools for progressively changing the conformation of metal bodies.

More particularly, this invention is directed to methods of an apparatus for eliminating deformations in and returning to their original conformation and/or truing the conformation of metallic machine parts which have been distorted during the steps incident to heat treatment and/or hardening of the parts.

Among the machine parts for the treatment of which this invention is especially well adapted, are elongated hardened tool steel bars, such as shear blades, and hardened curved bars or endless members, such as tires, rings for relatively large dies, and the like.

As is well known, hardened steel parts are made of rolled, forged or cast alloy steel materials, having various compositions which are known to be capable of acquiring the hardness, toughness and other properties desired in the finished part. In the fabrication of hardened steel parts, the materials are first rough machined approximately to the desired conformation, after which machining the parts are heat treated. When the parts are to be hardened, this heat treating includes a heating according to a prescribed procedure to a relatively high temperature followed by a quenching in liquid or air. Following this quenching, in most cases, these parts are again heated to a relatively lower temperature to draw or reduce the hardness and brittleness and/or otherwise change the properties to suit the service for which the parts are intended. After the steel parts have thus been heat treated, they are usually accurately ground with suitable grinding equipment to the exact size and conformation desired.

It is also well known that, as a result of these heat treating and quenching steps, the rough machined parts usually deform from their original shape and distort or warp, this deformation or distortion being caused by a releasing of initial strain in the original materials, unequal heating, unequal cooling, and the like.

Due to this distortion and due to the uncertainty regarding the extent and character of this distortion, it is necessary to allow considerable grinding stock on the rough-machined parts in order to insure sufficient stock to enable the grinding equipment operator to produce a piece having the desired final dimensions. The alloy tool steel of which these parts are made is usually relatively very expensive and it is therefore

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desirable to reduce the excess allowance for grinding to a minimum. This reduction of the excess steel is desirable not only to reduce the amount of steel initially to be provided for a given piece but also because grinding operations are relatively time consuming and expensive.

It has heretofore been extremely difficult if not impossible to change the conformation of a hardened tool steel part or to return it to the conformation which it had prior to distortion, by any means which are economically feasible and satisfactory, even tho it has long been evident that such a correction of the distortions in conformation would have the very important economical advantages pointed out.

It is accordingly a prime general object of the present invention to produce a method and apparatus adapted to rectify or true the shape of metallic bodies or to contour the bodies to a predetermined form.

It is a further object of this invention to produce a method and apparatus particularly adapted to return the conformation of distorted or deformed hardened steel parts to the original conformation which they had prior to the heat treating process.

It is a further object of this invention to produce apparatus which will change the conformation of hardened steel parts accurately and with a minimum of manual labor.

It is a further object of this invention to provide apparatus readily adapted to support and guide the hardened parts in a manner which will permit the corrective action to be progressively applied accurately to selected areas of the parts at any point on the part where the corrective treatment is required.

It is a further object of this invention to provide power means for effecting the treating of the hardened steel parts and power means for advancing the parts for progressive treatment along selected portions of the part to be treated.

It is a further and more specific object of this invention to produce satisfactory apparatus adapted to mount and apply a high speed impact tool to effect the rectifying of distortions in hardened steel parts.

It is a further specific object of this invention to provide a novel method of and apparatus for progressively flexing the hardened part in the area where it is being correctively treated for the purpose of expediting the corrective action.

It is a further specific object of this invention to provide apparatus for varying the intensity of the power impact means for treating the hard-

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ened steel parts and for varying the degree of flexure in the hardened steel parts in proportion to the requirement of the corrective action.

A further understanding of the construction and operation and of the manner in which the novel features of this invention effect the above and further objects, will be acquired from the following detailed description and the annexed drawings, which set forth certain means embodying this invention, such disclosed means constituting, however, but one of the forms in which the principle of this invention may be applied.

Referring to the annexed drawings:

Fig. 1 is a front elevation of one form of apparatus embodying this invention, this view disclosing apparatus adapted for truing elongated hardened steel parts, such as hardened shear blades or the like, certain portions of the apparatus being partially broken away to more clearly illustrate the construction.

Fig. 2 is a right side elevation of the apparatus shown in Fig. 1, this view being partly broken away on a vertical plane passing, in a direction from front to rear, approximately thru the center line of the machine.

Fig. 3 is a fragmentary vertical section, this view being taken on the plane indicated by line 3, 3 in Figures 2 and 4.

Fig. 4 is a horizontal sectional view, taken in the broken plane indicated by lines 4, 4 in Fig. 1.

Fig. 5 is another horizontal sectional view taken in a plane indicated by lines 5, 5 in Fig. 1.

Fig. 6 is a plan view of a hardened shear blade such as that shown in the apparatus in Figures 1, 2, 4 and 5, this blade being shown in a distorted condition into which it has been presumed to have been deformed as a result of heat treatment, the deformation being considerably exaggerated in this view for the sake of illustration.

Fig. 7 is an edge view of the blade shown in Fig. 6, this blade being shown with a distortion in a vertical plane, also presumed to have been acquired by the blade as a result of heat treatment, the distortion here too being somewhat exaggerated.

Fig. 8 is a view showing certain elements of the apparatus illustrated in Figures 1 to 5, detached from the apparatus, in order to more clearly illustrate the principle of operation of the machine, these elements being shown operating on a metallic body of the character illustrated in Figures 6 and 7.

Fig. 9 is a view similar to Fig. 8 showing, however, a slight modification of the apparatus required to adapt the parts thereof for treating a hardened steel ring.

The apparatus illustrated for the purpose of disclosing the present invention includes a rotatable anvil upon which an elongated hardened metallic body is to be supported, and includes power means for rotating the anvil and advancing the body in the direction of its length. The apparatus further includes preferably high speed impact means having the characteristics of an air hammer and capable of delivering power blows in rapid succession, this impact means being located vertically above and in the plane with the axis of the rotatable anvil, and having provisions for varying the intensity of the blows. This apparatus further includes manually adjustable means for selectively adjusting the position of the body transversely of its longitudinal dimension with reference to the location of the impact means. This apparatus further includes

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means for flexing the body about the top of the anvil, these flexing means including controls adapted to vary both the degree and the intensity of the force of the flexing means. This apparatus further includes means for conveniently supporting that portion of the body which is not supported by the anvil.

The parts of this apparatus will be described in the relative position which they occupy as illustrated in the drawings, and terms such as "upper," "lower" and the like are used for convenience of description only as this apparatus and its elements may, with slight modifications, be inverted or mounted in a horizontal position, as will be understood.

Referring first to the form of the invention illustrated in Figures 1 thru 8 of the drawings, the frame of the machine is indicated at 10 and includes a base 11, a lower housing 12 and upwardly extending housing 13. The lower housing 12 is formed with side walls 14, 14 and front and rear walls 15 and 16, respectively. The upwardly extending housing 13 is formed of a right side wall 17 and a left side wall 18 and a rear wall 19, the walls 17, 18 and 19 extending to and being mounted on the base 11 and the walls 17 and 18 being integrally connected with the rear wall 16. The walls 17 and 18 are formed above the housing 12 with forwardly extending wall portions 20 and 21 respectively, these wall portions partially overhanging the lower housing 12. As will appear from Figures 1, 4 and 5, the overhanging portion of the housing 13 between the wall portions 20 and 21 is normally open toward the front.

The walls 15 and 16 are provided at the center of the housing 12, and substantially half way between the top and bottom edges of these walls, with aligned bearings 22 and 23, Fig. 2. The wall 19 is likewise formed with a bearing 24 aligned with the bearings 22 and 23. These bearings are adapted to rotatably support an anvil shaft 25 to which is fixed a relatively heavy cylindrical anvil 26 disposed within the housing 12 and intermediate the bearings 22 and 23.

Fixedly secured to the shaft 25 rearwardly of the frame 12 and between the bearings 23 and 24 is a worm gear 27. This worm gear is actuated by means of a worm 28 mounted within the housing 13 and fixed on a shaft 29, supported in spaced bearings in the side walls 17 and 18, as best appears in Fig. 3. The worm shaft 29 extends outwardly to the left of the side wall 18, as shown in Figures 3, 4, and 5, to which extension a spur gear 30 is fixed. This spur gear is operatively engaged by a spur pinion 31, which is, in turn, fixed to the shaft of an electric motor 32, this motor being supported on a bracket 33 extending outwardly from the side wall 18. The motor 32 is actuated by an electric rheostat or controller indicated at 34, Fig. 1, and which is adapted to variably control the speed of the motor in either direction.

As will be understood, the actuation of the motor will cause the worm gear 27 and shaft 25 to rotate, and thus rotate the anvil 26 about the fore and aft axis of the anvil shaft 25, and it will further be understood that the anvil may be rotated so that the top moves either to the right or to the left, as the operator may desire.

It will also be apparent that a bar, shear blade or the like, such as indicated at B, in Figures 1, 2, 4 and 5, can conveniently be supported on the top of the cylindrical anvil in a position with its thinnest dimension in a vertical direction and

with its longer dimension extending crosswise with reference to the axis of the anvil, that is, parallel to the direction of movement of the periphery of the anvil.

In order to provide a support for that portion of the bar B which extends beyond the anvil, auxiliary supports indicated generally at 33, 35 are provided, these supports consisting of vertical posts 36, 36, and front and rear horizontally spaced bars 37 and 38 respectively, these bars being supported at one end on the posts 36 and at the other end on the housing 12. Supported in these bars are a plurality of rolls 39 preferably mounted in anti-friction bearings. The upper surface of these rolls is disposed slightly below the level of the top of the anvil 26. The supports desirably extend laterally from the axis of the anvil, for a distance sufficient to support the projecting portion of the longest bar ordinarily treated on the apparatus.

Exteriorly of the side walls 17 and 18 are provided a pair of front guide bars 40, 40, and rear guide bars 41, 41, each pair of guide bars being spaced apart sufficiently to form slide ways for a vertically reciprocable channel frame structure 42. This frame structure 42 comprises channels 43, 43 engaging opposite outer faces of the side walls 17 and 18 and each guided by a pair of bars 40, 41. The channels 43, 43 are integrally secured together at their upper ends by a pair of spaced cross bars 44, 44, as shown in Figures 1 and 2. Secured in each of the side walls 17 and 18, intermediate the guide bars 40 and 41, are a plurality of vertically spaced cap screws 45, each extending thru one of a plurality of vertically spaced vertically extending slots 46, formed centrally in the webs of the channels 43, 43, the head of each screw 45 being spaced from the side wall 17 or 18 a distance slightly greater than the thickness of the web of the channels 43, 43, whereby the channels and hence the channel frame 42, may slide freely vertically and be held in sliding engagement with the adjacent side walls 17 and 18. As will appear from the drawings, the centers of the slots 46 are located at the same center to center spacing as the cap screws 45. The channels 43, 43 are preferably so located on the housing 13, that a plane passing thru the centers of the channels intersects the axis of the anvil 26 at right angles, and approximately midway between its front and rear edges.

Preferably rigidly secured to the upper ends of the walls 17 and 18 of the housing 13 by means of a plurality of vertical supports 48 extending upwardly from the housing 13, is a platform 47. Supported on the platform 47, is a pneumatic cylinder 49. Movably mounted in the cylinder 49 is a piston (not shown) actuating a piston rod 50. The piston rod 50 is secured by a pin 51 to the cross bar 44 at the upper end of the channel frame 42. The pneumatic cylinder 47 is controlled by air under pressure passing thru conduits 52 and 53. A suitable manually actuatable four way control valve 54 receives air from a pressure supply line 55, controlled by a pressure regulating valve 56, and is adapted to control the passage of the air under pressure into the head end of the cylinder and out of the piston rod end of the cylinder, or vice versa, depending upon whether the operator desires to move the piston downwardly or upwardly.

It will accordingly be evident that by means of the manual actuation of the valve 54, the frame 42 may be moved in a vertical direction at the will of the operator, and that the pressure ex-

erted by the cylinder will be controllable and proportionate to the pressure in the supply line 55.

Formed as extensions to the flanges at the lower ends of each of the channel members 43 are a pair of enlarged flanges 57, 57, these flanges being spaced apart a distance substantially equal to the width of the channel members. Interposed between each pair of flanges 57, 57 are two rollers 58, 59. The rollers 58 are preferably slightly smaller than the rollers 59, and are located inwardly of the channel frames 43, and also inwardly of the walls 17 and 18, that is in a direction toward a vertical plane passing thru the axis of the anvil shaft 25. The rollers 58 are rotatably mounted on pins fixed in the flanges 57, 57. The relatively larger rollers 59, 59 are located outwardly of the wall members 17 and 18, that is in a direction away from a vertical plane passing thru the axis of the anvil shaft 25 and are mounted on pins 60 which are vertically adjustable in slots in the flanges 57, 57, adjusting screws 61 being provided to resist the upward thrust of these rollers and to provide for vertical adjustment of the rollers.

It will accordingly be evident that a downward thrust of the piston in the cylinder 49 will exert a corresponding downward thrust on the rollers 58 and 59. It will also be evident that a variation in the pressure of the air being supplied to the cylinder 49 will produce a corresponding variation in the downward pressure of the rollers. It will further be clear that a shear blade or bar such as that shown at B, supported at the center or high point of the anvil 26 can be deflected downwardly by the pressure of the rollers 58 and 59, to form a convex flexure about the top of the anvil, substantially as shown in Figures 1 and 8. It will further be understood that a greater or less flexure may be obtained by suitably vertically adjusting the rollers 59 with relation to the rollers 58, and by forcing these rollers downward more or less.

Integrally formed with the side walls 17 and 18 of the housing 13, and preferably in vertical alignment with a plane passing transversely thru the fore and aft center of the anvil 26 are a pair of inwardly projecting vertical guide bars 62, Figures 1 and 4. Mounted for vertical reciprocation on these guide bars is a relatively heavy block 63 formed with a central generally cylindrical aperture 64. Mounted in the aperture 64 is a power hammer 65 capable of producing blows, the source of power preferably being air under pressure. This pneumatic hammer 65 is formed with a flange 66 adjacent its lower end, fixedly secured to the block 63 in any desired manner.

The block 63 is provided at its upper end and substantially centrally thereof with an eye screw 67 to which is connected the lower end of a steel cable 68. The steel cable passes over an idler pulley 69 and is wound on a drum 70, this drum being rotatably supported by means of a shaft 71. Fixedly secured to one end of the drum is a worm gear 72. This worm gear is in turn engaged by a worm 73 fixed to a shaft 74 mounted in suitable bearings 75 on the side wall 17. The forward end of the shaft extends forwardly of the side wall 17 and on this extension is fixed a hand wheel 76.

As will be evident, a rotation of the hand wheel in the proper direction will cause the worm and hence the worm gear and drum 70 to rotate. The rotation of the drum will wind or unwind the cable 68 depending on the direction of rotation

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and this winding or unwinding of the cable, in turn, will raise or lower the block 63. It will also be evident that the worm and worm gear due to its relatively high ratio will permit an easy and sensitive vertical movement of the block 63 and it will also be evident that due to the locking action of the worm on the worm gear, the block will remain in the adjusted position.

The pneumatic hammer 65 is provided with a downwardly projecting plunger 77 preferably tipped with a hardened steel ball 78, the ball being preferably centrally positioned, fore and aft, with respect to the convex face of the anvil 26. Air is supplied to the hammer thru a conduit 79, controlled by a suitable valve 80, receiving its air from a conduit 81 which is, in turn, supplied by air passing thru a regulating valve 82.

It will be evident that by means disclosed, the impact of the air hammer can readily be delivered to the shear blade or bar B in line with the extreme top of the convex face of the anvil and at the top of the convex curvature of the blade B, and that the intensity of this impact can be regulated by suitable vertical positioning of the block 63, and by suitable control of the pressure of air being supplied to the air hammer.

Suitable means are provided for shifting the blade or bar B in a fore and aft direction with reference to the pneumatic hammer in order that the point at which the hammer applies its blows may be applied to selected areas across the face of the blade, by the operator. These shifting means are best shown in Figures 1, 2, 4 and 5, from which it will appear that a pair of shafts 83, 84 pass thru and are mounted in suitable bearings in the walls 15 and 16 of the housing 12. These shafts 83 and 84 are each formed with right hand threads 85 intermediate the walls 15 and 16 adjacent their rear ends. Having threaded engagement with the threads on the shafts 83 and 84 is an elongated guide bar 86. The under side of the central portion of this bar is substantially tangent to the top of the anvil 26 at its center and the ends of the bar are formed with depending bosses 87, 87 formed with threaded apertures engaging the threads 85. Fixedly mounted on the forward ends of each of these shafts 83 and 84 are similar sprockets 88, 88. These sprockets are operatively connected by a chain 89. Mounted on the front end of the shaft 84 is a hand wheel 90. A rotation of the hand wheel 90, as will be evident, will cause both shafts 83 and 84 to rotate simultaneously thus causing the bar 86 to shift either forwardly or rearwardly, in parallel relation, depending on the direction of rotation.

Also passing thru and mounted in suitable bearings in the front and rear walls 15 and 16 are shafts 91 and 92, formed intermediate the walls 15 and 16 and adjacent the front with left hand threads 93. Having threaded engagement with the threads 93 on the shafts 91 and 92 is an elongated guide bar 94 similar to the bar 86. The under side of the central portion of this bar is substantially tangent to the top of the anvil 26 at its center and is formed adjacent its ends with depending bosses 95, formed with threaded openings to receive the threads 93. Fixedly mounted at the forward end of the shafts 91 and 92 are similar sprockets 96 which are operatively connected by means of a chain 97. Mounted on the forward end of the shaft 91 is a hand wheel 98. It will accordingly be understood that the turning of the hand wheel 98 will also cause both shafts 91 and 92 to rotate simultaneously

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causing the bar 94 to move forwardly or rearwardly, in parallel relation, depending upon the direction of rotation of the hand wheel.

Operation

The operation of the apparatus illustrated in Figures 1 to 5 and 8 will be described when used for rectifying distortion in a deformed hardened steel blade B such as that shown in Figures 6 and 7. The blade or bar is generally elongated in form and may be defined for convenience of description, as being formed with upper and lower faces or sides B¹ and B² respectively, front and rear edges B³ and B⁴ respectively, and left and right ends B⁵ and B⁶ respectively.

The blade B illustrated in these figures is presumed to have been straight in its rough machined condition and is presumed to have assumed the distorted conformation shown in Figures 6 and 7, as a result of heat treatment. It is likewise presumed that this shear blade is intended to be straight in its finished state. This blade as illustrated in these figures is shown distorted in two directions, the degree of distortion being considerably greater than any distortion which would normally occur in practice. In any event, however, some distortion always occurs and unless some provision is made for eliminating the distortion and correcting the conformation of the blade, considerable material will have to be ground off before a straight usable blade is obtained.

Prior to the treatment of the blade in the hereinbefore described apparatus and after the heat treating and/or hardening operation on the blade is complete, the operator ascertains the location of and extent of the distortion from the desired final conformation. In case the hardened machined part is intended to be straightened, this checking may be done by means of a straight edge or gage, and thereupon, a skilled operator can determine the character of corrective action required.

In order to correct a distortion of the nature illustrated in Fig. 6, it is evident that the blade must be stretched or elongated in the zone adjacent to its concave edge b' (Fig. 6). If the concave curvature of the blade is not uniform, it will also be clear that a greater amount of stretching or elongation will be required adjacent the edge having the smaller radius of curvature.

I have discovered that a hardened steel piece may be readily stretched or elongated locally by convexly flexing the area to be stretched and applying to the convexly flexed face relatively light blows of high frequency, such as those delivered by an air hammer or the like. I have also discovered that a blade having a distortion of the nature illustrated in Fig. 6 in one plane only (that is without any considerable distortion of the character shown in Fig. 7) requires the convex flexing and application of the high frequency blows first to one flat side of the blade and then to the other flat side, in order that the hammering may not produce any additional undesired distortion in the blade.

In the event that the blade has only a concave distortion in a vertical direction as shown at b² in Fig. 7, for instance, I have found that a flexing in a direction opposed to the distorted flexure and the application of high frequency blows to the flexed area (upper surface, Fig. 1) will progressively cause the surface to stretch, and will progressively straighten the blade to its desired rectilinear form. In this event the blows

must be applied uniformly over the entire concave face of the blade. If the distortion curvature is not uniform, a greater intensity or a prolonged hammering must be applied to the areas having the smallest radius of concave curvature prior to the treatment.

In the event that the distortion is compound, such as the distortion actually illustrated in the blade represented in Figures 6 and 7, a combination of the hammering treatments just set forth will be required.

The actual operation of the apparatus on a blade having a compound distortion is as follows:

After the operator has ascertained the nature of the distortion and determined the nature of the corrective action required, he raises the channel frame 42 and raises the block 53 and positions the blade B on the top of the anvil 26. Thereupon the operator lowers the block 53 until the ball 78 at the lower end of the hammer plunger 77, is adjacent the face or side of the blade. The operator then locates the blade in the desired fore and aft position with reference to the air hammer plunger by bringing the rear guide bar 86 forwardly against the rear edge of the blade B and bringing the forward guide bar 94 against the front edge of the blade, as clearly shown in Fig. 5, the adjustment of these guide bars being effected by suitably turning the hand wheels 90 and 98. The operator then brings down the frame 42 by properly manipulating the valve 54 causing the rollers 58 and 59 to engage the top of the blade on each side of the center line of the anvil 26 and flexing it in a direction counter to the distorted curvature, which flexing may amount to a convex flexing as shown in Figures 1 and 8, if the distorted curvature is not pronounced. As will be understood, a greater or less flexing can be obtained by increasing or decreasing the pressure in the air cylinder 49. The degree of flexure can also be regulated by means of the vertical adjustment of the rollers 59, as hereinbefore pointed out. The operator then manipulates the electric switch 34 to cause the anvil to rotate in the desired direction and at desired speed, which rotation of the anvil causes the blade to travel endwise to the left or to the right, as the case may be, and the engagement of the rollers 58 and 59 with the top surface of the advancing blade causes the blade to flex over the top of the anvil progressively, as the blade moves longitudinally. The operator then lowers the block 53 by turning the hand wheel 76 until the ball 78 at the bottom of the plunger hammer suitably engages the flexed area of the blade B, whereupon the operator initiates the hammering action of the hammer by suitably manipulating the valve 80.

After the operator has thus fed the blade the desired distance longitudinally, he reverses the feed and repeats this reversal of travel until he has sufficiently peened the area which he is treating. The operator then moves the blade forwardly or rearwardly with reference to the hammer by manipulating the hand wheels 90 and 98 and repeats the peening and feeding until he has treated the full length and the full width of the area of the blade which requires treatment. If necessary, the blade may be inverted and the lower face treated in a similar manner to the extent and for the length of time required to produce a straight blade.

It is to be noted that the pneumatic cylinder 49 exerts a predetermined pressure to flex the blade. And if any section of the blade offers

greater resisting to flexing than adjacent sections, the pneumatic cylinder will yield slightly and the stronger section of the blade will not be deflected to the same extent as the weaker section of the blade, all to the end that no area of the blade may be flexed to an extent beyond a safe amount, whereby the danger of fracture of the blade is eliminated. The rollers 53 are provided in close proximity to the hammer plunger in order that the blade may be flexed and the treatment extended to areas close to the ends of the blades, the rollers 58 preventing the end of the blade from jumping up after such end has travelled longitudinally past the relatively larger roller 59 in a direction toward the pneumatic hammer.

The principle of this invention is well adapted for correcting distortion in machine parts other than straight or rectilinear parts and the hereinbefore described apparatus, with slight modifications, can readily be adapted to rectify parts having curved or other conformations. One illustration of the adaptation of this machine for treating parts other than rectilinear in conformation is shown in Fig. 9.

In this figure, the body being treated in the apparatus is illustrated to be generally of arcuate conformation and is specifically shown as an endless ring R. The extent and character of the disclosure in Fig. 9 is substantially the same as the disclosure in Fig. 8 and only so much of the apparatus is shown as is necessary for an understanding of the adaptation of the principle of the previously described apparatus for treating a body arcuate in conformation.

In Fig. 9, the anvil 26, pneumatic hammer 77, channel frames 42 and roller 58 are identical with the corresponding parts used for rectifying a generally straight bar. For the purpose of rectifying an arcuate member, however, slightly larger rollers 59^a, 59^a are substituted for the rollers 59, 59. These rollers are mounted on pins 60^a, 60^a which are vertically adjustable in slots formed in the flanges 57^a, 57^a, adjusting screws 61, 61 being provided to permit the vertical adjustment of and to resist the upward thrust of these rollers. The lowest points in the peripheries of the rollers 59^a, 59^a in a machine adapted for truing parts having upward convexity are considerably lower than the lowest points in the periphery of rollers 58.

It will be understood that guide bars similar to the previously described guide bars 86 and 94 and adjusted by screw shafts 83, 84, and 91, 92 respectively, are provided for the purpose of shifting the work transversely with reference to the pneumatic hammer plunger.

When the work consists of an endless ring of the type shown at R, it will be understood that the front wall 15 of the lower housing 12 must be temporarily removable or other changes made in the housing or support of the anvil to make it possible to mount the endless ring on the anvil and remove the ring from the anvil. It will also be evident that the position of the rollers 39, 39 for supporting the ends of the work will have to be re-located to suit the approximate curvature of the work or omitted entirely as unnecessary when the work consists of an endless ring as shown.

The procedure in the use of this apparatus for truing arcuate metallic bodies is substantially the same as that used for truing generally straight bodies, the operator first determining which areas in the arcuate bodies should be elongated to true

the body to the desired conformation and then proceeding to simultaneously apply hammer blows and advance the ring in a direction parallel to its periphery until the desired result is obtained.

While this specification describes this invention as being applied to the treatment of hardened steel bodies, it will be understood that this invention may equally well be applied to treating bodies of soft steel and other materials.

It will be apparent to those skilled in the art that the embodiment herein described may be variously changed and modified without departing from the spirit of the invention, and that the invention is capable of uses and has advantages not herein specifically described, and that many modifications of this invention and its application in addition to those shown will occur to those skilled in this art. It will accordingly be appreciated that the herein disclosed embodiment is typical only and that my invention is not limited to the exact constructions shown and described.

What I claim is:

1. The method of rectifying distortion in a metallic body, comprising: flexing said body in the area of distortion counter to the direction of said distortion, and delivering a succession of blows against said body over said counterflexed area.

2. The method of rectifying distortion in a metallic body, comprising: variably flexing selected areas of said body to different extents in the areas of distortion and counter thereto, and hammering the body at the areas while in flexed condition.

3. The method of rectifying distortion in a metallic body, which comprises: progressively flexing adjacent distorted areas of said body, selectively varying the extent of flexure of the body at the distorted areas, and subjecting the progressively flexed areas of said body to blows of selectively varying intensity while the areas are flexed.

4. The method of rectifying distortion in a metallic body by means of hammer blows, comprising: moving the body with reference to the point of application of the blows, progressively flexing said body only in the area of distortion, delivering a succession of blows at selected flexed distorted locations upon said body while said body is moving and selectively varying the intensity of the blows.

5. The method of rectifying deformation of a metallic body of generally longitudinal conformation by means of hammer blows, comprising: moving the body lengthwise with reference to the point of application of the blows, progressively flexing predetermined longitudinally adjacent areas of said body, and selectively playing the hammer blows over said flexed areas simultaneously with the movement of the body.

6. The method of rectifying deformations of a metallic body generally longitudinal in conformation, comprising: flexing predetermined longitudinally spaced areas of said body counter to the direction of the deformation, playing a succession of hammer blows over said counterflexed area, and moving said body lengthwise and transversely with reference to the point of application of the hammer blows, simultaneously with the application of the blows.

7. The method of straightening a hardened steel bar with a distorted portion having a face concavely flexed from a rectilinear conformation comprising: counterflexing the concavely flexed

portion of the bar until the concave face assumes a convex conformation, holding the bar in the counterflexed condition and simultaneously peening the convex face of the bar.

8. A method of straightening a hardened steel bar with a distorted portion having a face concavely flexed from a rectilinear conformation comprising: counterflexing the distorted portion of the bar until the concave face assumes a convex conformation, holding the bar in the counterflexed position and moving said bar longitudinally in said counterflexed condition whereby adjacent areas are progressively flexed, and simultaneously peening the convex face of the bar.

9. In apparatus of the character described, a convex anvil, means for flexing a metallic body about the anvil, means for shifting said metallic body while flexed, relatively to the anvil, whereby adjacent areas may be successively flexed, and power means for subjecting the flexed area of the metallic body to hammer blows.

10. In apparatus of the character described, a convex anvil, means for flexing a metallic body about the anvil, means for varying the extent of flexing, power blow producing means for subjecting said metallic body while flexed to a succession of blows, and means for changing the relative location of said body and said blow producing means while said body is in flexed condition.

11. In apparatus of the class described, the combination of a convex anvil adapted to accommodate a metallic body having distorted areas for movement thereover, flexing means cooperable with said anvil on opposite sides thereof to flex said distorted areas and to hold said metallic body in flexed conformation against said anvil as it is fed across the same, and automatic hammer means for delivering blows to said flexed distorted areas of said flexed metallic body as it is moved across said anvil.

12. In apparatus of the character described, a convex oscillatable anvil adapted to accommodate a metallic body for movement thereon, power means for oscillating said anvil, flexing means cooperable with said anvil and adapted to hold said metallic body in flexed conformation against said anvil, said flexing means being adapted to maintain said metallic body in flexed condition during oscillation of said anvil, and an automatic hammer for delivering blows to the flexed metallic body on said anvil, said hammer being adjustable to vary the intensity of the blows delivered.

13. In apparatus of the class described, the combination of a convex oscillatable anvil movable about an axis and adapted to accommodate a metallic body having distorted areas for movement thereover, flexing means cooperable with said anvil on opposite sides of its axis to flex said distorted areas and to hold said metallic body in flexed conformation against said anvil as it is fed across the same by oscillation of said anvil, and automatic hammer means for delivering blows to said flexed distorted areas of said flexed metallic body as it is moved relatively to said hammer means.

14. In apparatus of the character described, a convex anvil, adapted to support an elongated metallic body and rotatable about an axis, means on opposite sides of said axis engageable with said body to flex the same about said anvil, power hammer means adapted to apply hammer blows to the convex side of the body in a direction toward said axis, and power means for rotating

the anvil to feed said body relatively to said anvil flexing means and hammer means.

15. In apparatus of the character described, a substantially cylindrical anvil rotatable about an axis and adapted to support and feed an elongated metallic body, means on opposite sides of said axis engageable with said body to flex the same about said anvil, power hammer means adapted to apply hammer blows to the side of the body in a direction toward said axis, speed controllable power means for rotating the anvil, to feed said body relatively to said hammer means while said hammer blows are being applied, and means for varying the intensity of the hammer blows.

16. In apparatus of the character described, a convex rotatable anvil adapted to support an elongated metallic body, roller means engageable with at least two points of said body on alternate sides of the top of the anvil and adapted to flex said body about the anvil, means adapted to advance the roller means toward the anvil, hammer means adapted to hammer the flexed body against said anvil in the area between said two points, power means for rotating the anvil, and means for shifting the body relatively to the hammer means.

17. In apparatus of the character described, an anvil having a convex portion adapted to support an elongated metallic body, hammer means adapted to apply hammer blows against the side of the body in a direction toward said convex portion, a slide mounted for movement toward the anvil, two pairs of rollers mounted on said slide adjacent the anvil, one pair on each side of a plane parallel to the direction of movement of the slide and passing thru the convex portion of the anvil, the rollers of each pair being spaced at different distances from said plane and one roller of each pair being adjustably mounted relatively to the anvil.

18. In apparatus of the character described, a convex anvil adapted to support an elongated metallic body, hammer means adapted to apply hammer blows against the side of the body in a direction toward said anvil, a slide perpendicularly movable relatively to the anvil, two pairs of rollers mounted on said slide adjacent the anvil, one pair located on each side of a perpendicular plane passing thru the anvil at its point of engagement with the body and adapted to engage the body, the rollers of each pair being spaced at different distances from said plane and one roller of each pair being vertically adjustably mounted, pressure means for engaging the pairs of rollers with the body, whereby flexure of the body about the anvil is produced, and means for shifting the body relatively to the hammer means while the roller pairs are in flexure producing engagement with the body.

19. In apparatus for rectifying distortions in a generally elongated metal body of the character described, a supporting frame, a cylindrical anvil rotatably mounted about an axis in the frame, power means for rotating the anvil, means for varying the direction and speed of rotation of the anvil, vertical guide means on the frame aligned with the axis of the anvil, a slide mounted in the guide means for vertical movement toward and from the anvil, two pairs of rollers mounted on the slide adapted to engage the body, one pair on each side of the axis of the anvil, the rollers of each pair being spaced different distances from the anvil, the body engaging face of the rollers farthest from the axis of the anvil being adjustable to a position lower than the body engaging face of the rollers nearest the axis, fluid pressure means for moving the roller carrying slide toward and from the anvil, weight means mounted for movement toward and from the anvil, means for adjustably positioning the weight means relatively to the anvil, a fluid actuated power hammer secured to the weight means having the direction of its impact stroke aligned with the axis of the anvil, spaced guide means adjustable relatively to each other and laterally adjustable relatively to the power hammer adapted to engage opposite edges of the body and shift the body laterally relatively to the power hammer.

LAD L. HERCIK.

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