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IRREGULAR BENDING APPARATUS

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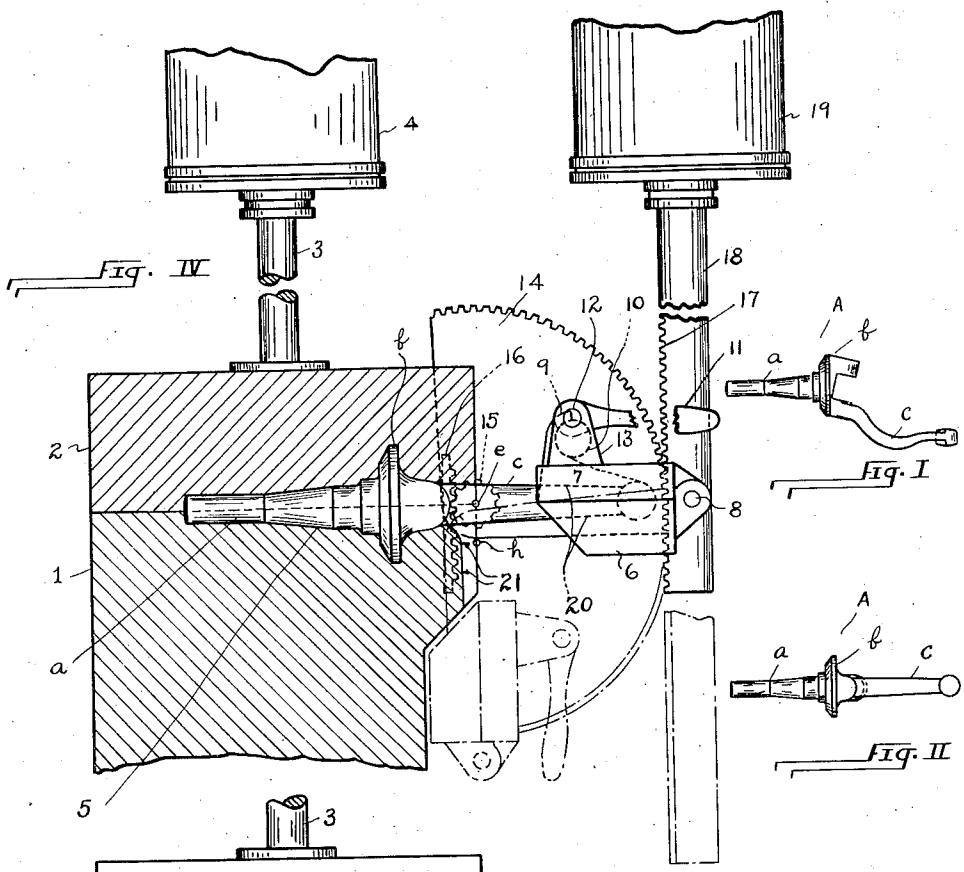


Fig. IV

Fig. I

Fig. II

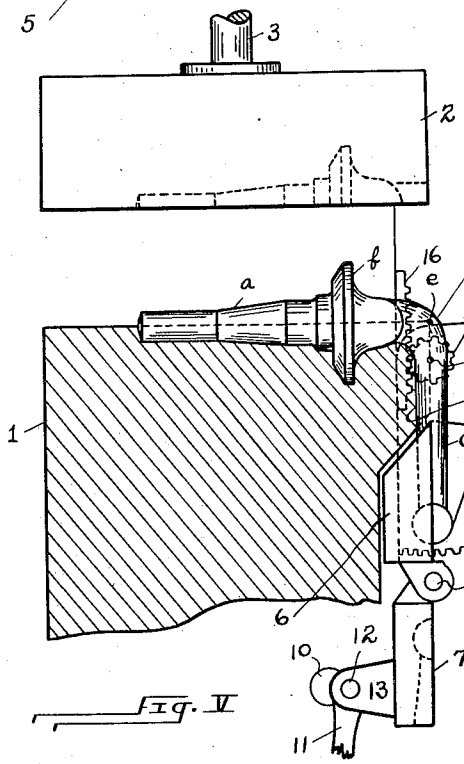


Fig. V

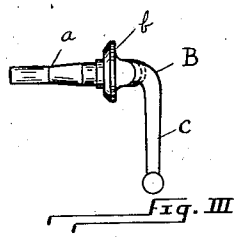


Fig. III

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IRREGULAR BENDING APPARATUS

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10 Claims. (Cl. 153—40)

Our invention relates to bending and shaping machines, and, by way of illustration and not limitation, we shall describe the invention as it is embodied in a machine for bending and shaping the steering arms of automobile spindles.

An automobile spindle, or, as usually termed in the art, a spindle unit, is an integral steel forging comprising a yoke portion, a spindle portion, and an angularly extending arm. In service the yoke portion, in cooperation with a king-pin, provides the means for pivotally securing the spindle unit to the front axle of a motor car; the spindle portion of the unit affords the mounting for one of the front wheels of the car; and the arm, extending substantially at right angle to the aligned spindle and yoke portions, is connected to the steering gear of the car.

In manufacturing a spindle unit, a steel blank is forged, and the forging is trimmed, providing a unit in which the spindle portion, yoke portion, and steering arm extend substantially in common plane. Then the steering arm is bent into the position of required angularity with respect to the aligned spindle and yoke portions, and the article thus fashioned is subjected to the usual machining and finishing operations. Our invention concerns the bending and shaping of the steering arm of the initially forged and trimmed article.

As viewed in plan the steering arm of the forged unit is of irregularly curved extent; the arm is integrated with and projects outward from one leg of the yoke portion of the unit, while the spindle portion thereof extends in opposite direction from the central body portion of the yoke. Keeping in mind that all portions of the spindle unit, as it is initially forged, extend substantially in common plane, it should be further explained that in such plane the general direction of extent of the steering arm is inclined to the axis of the spindle portion. Thus, it may be perceived that the bending of the steering arm, as it is so shaped and organized in the initially forged unit, into a standardized position of angularity with respect to the spindle and yoke portions of the unit involves many considerations, particularly when such operation is adapted, as it must be, for the mass production methods employed today. The requirements for standardization and precise uniformity of product only add to the problems involved. There is still another consideration: The bend in the steering arm is a complex bend—not a simple bend which may be formed by swinging the distal end of the arm about a fixed center—but a bend that is resolved by swinging the arm about a center that progressively shifts or varies during the course of the bending operation. It is our aim to provide means which are particularly effective to this end.

In the accompanying drawing Fig. I is a view in plan of a typical spindle unit, as it comes from the forging and trimming dies; Fig. II is a view of the same in side elevation, showing how the spindle, yoke, and arm portions of the spindle unit, as initially forged, extend in common plane; Fig. III is a view comparable with Fig. II, showing the arm of the spindle unit bent from the common plane of the yoke and spindle portions, and extending (as viewed in Fig. III) substantially at ninety degrees to the axis of the spindle portion; Fig. IV is a fragmentary view, showing partly in vertical section and partly in front elevation a machine for bending and shaping the arms of spindle units in accordance with our invention; and Fig. V is a view similar to Fig. IV, showing the movable elements of the machine in alternate positions of operation.

The machine of the invention includes two work-securing devices that are spaced apart, in this case spaced apart in the horizontal; one device is adapted to clamp and secure the spindle and yoke portions *a* and *b* of a forged unit A, while the other positively engages the arm portion *c* of the unit; and means are provided for effecting the relative angular or arcuate movement of the two work-securing devices about a travelling center of rotation, in such manner as to bend the steering arm *c* of the unit from the common plane of the spindle and yoke portions *a* and *b* (Fig. II) to its ultimate position of angularity with respect to such plane (Fig. III), and in so doing to provide in the arm the required specialized curvature and shape at the bend.

One of the work-securing devices operates under power in securing the spindle and yoke portions of a forged unit A in fixed position, while the companion work-securing device is adapted to be locked by hand in engagement with the arm *c* of the unit. The first-mentioned device consists in a stationary bed-block 1 and a cooperating head 2. The head 2 is carried by the vertically reciprocable plunger rod 3 of a power cylinder 4, and steam or compressed air affords the medium for powerfully reciprocating the plunger rod, to move the head 2 into position of engagement with the bed-block 1, and, alternately, to elevate the head from such position. The operating medium for the power cylinder is subject to the control of a suitable valve (not shown)—advantageously, a manually controlled valve is

used, whereby the powerful movement of the head 2 may be readily effected at the will of the attendant.

The bodies of the bed-block and head are recessed within their meeting faces, providing a matrix 5 (Fig. IV) in the form of the spindle and yoke portions *a* and *b* of the forged unit A.

The other work-securing device includes a basal block 6 and a cover block 7; the two blocks are pivotally interconnected at 8, and means are provided for locking the blocks in the closed, face-to-face position shown in Fig. IV. Any well-known form of hand actuated locking device may be employed. In exemplary way, we show a hook element 9 projecting upward from the basal block 6 and adapted to be engaged within the hook by a cylindrical catch 10. The cylindrical catch is integrated with the inner end of a handle 11 which is pivotally mounted on a pin 12 secured in a lug or bracket 13 on the cover block 7. The cylindrical catch 10 is arranged eccentrically of the pin 12, whereby, by throwing the handle counter-clockwise (Fig. IV), the catch is swung from beneath the hook portion of element 9, and the cover block 7 is released to swing into open position (Fig. V). Alternately, upon closing the cover block 7 upon the basal block 6, the handle 11 is thrown clockwise, and the cylindrical catch is thereby forced into secure engagement with the hook element 9, providing a secure locking of the two blocks 6 and 7 in closed position.

The two blocks 6 and 7 are complementarily recessed within their meeting faces, providing, when the blocks are locked together, a matrix 20 in which to secure the terminal portion of the arm *c* of a forged unit A.

The means, above alluded to, for effecting the relative angular or arcuate movement of the two work-securing devices 1, 2 and 6, 7 advantageously include a segmental gear 14, upon which the basal block 6 of the work-securing device 6, 7 is rigidly mounted. A gear pinion 15 is secured to the segmental gear concentrically of the center about which it is rotatable, and such pinion meshes with the teeth of a vertically extending gear rack 16 borne by the bed-block 1. The teeth of segmental gear 14 mesh with teeth 17 formed in the side of a vertically reciprocable plunger rod 18 of a cylinder and plunger unit 19. Conveniently, the unit 19 is supplied with the same power medium as operates the unit 3, 4, and the operation of the unit 19, in effecting the powerful rise and descent of the rod 18, is subject to the control of a hand valve (not shown).

Preparatory to an arm-bending and forming operation, the attendant (by manipulation of the above-mentioned controlling valve) moves the plunger rod 18 into its elevated position; when the plunger rod is elevated, the segmental gear 14 rests in the position in which it is shown in Fig. IV, with the meeting faces of the blocks 6 and 7 lying in common horizontal plane with the upper face of the bed-block 1; then the attendant swings the handle 11 into release position, and throws back the cover block 7, uncovering the face of basal block 6; next he effects the rise of plunger rod 3, thereby elevating the head 2 and exposing the recessed face of bed-block 1; and then he lays a spindle unit A across the two blocks 1 and 6, the spindle unit being preheated to a cherry red. Considering Fig. I (in conjunction with Fig. IV), the position of the spindle unit may be clearly visualized; that is, as it appears in plan upon the exposed faces of the two blocks 1 and 6. The spindle and yoke portions *a* and *b* of the spindle unit nested in the recess (5) of bed-block 1, and the distal end portion of arm *c* is lodged in the recess (20) in basal block 6.

While the parts are so positioned, the cover block 7 is swung into closed position upon the block 6 and locked, and the head 2 is moved downward into forceful engagement with the bed-block 1. Thus, as illustrated in Fig. IV, the spindle and yoke portions *a* and *b* of the spindle unit are securely engaged and supported within matrix 5, and the distal portion of the arm *c* is securely engaged within the matrix 20.

The attendant then effects the descent of the plunger rod 18. In consequence, the segmental gear rotates clockwise, swinging the arm-securing device 6, 7 and progressively bending the arm in the region of its integration with the yoke portion *b*. In this case, the range of rotation of the segmental gear is ninety degrees, whereby the arm *c* is swung from the horizontal position, shown in Fig. IV, to the vertical position, shown in Fig. V. While keeping in mind that in plan (Fig. I) the arm *c* extends angularly to the axis of spindle portion *a*, it will be understood that the arcuate movement of arm-securing device 6, 7 (and, in consequence, the movement of the engaged distal end of the arm, as viewed in Fig. IV) is in a vertical plane that is spaced or offset from the axis of the spindle portion *a*. In this case such vertical plane extends in parallelism with a vertical plane extending through the axis of the spindle portion. These features of structure and operation lend themselves to the provision of the desired bend at the junction of the arm and yoke portions of the spindle unit.

The center of rotation of the segmental gear 14 is coincident with, or aligned with, the axis of the pinion 15, and, at the start of the arm-bending operation, such center of rotation lies in the horizontal mid-plane of the spindle unit, as indicated at *e* in Fig. IV. However, when the segmental gear begins its clockwise rotation, the pinion 15 rotates with it, and rolls downward along the stationary gear rack 16. Accordingly, the center of the pinion, that is, the center of rotation of the segmental gear, progressively moves downward in a vertical, linear path. It will be understood, therefore, that the work-securing device 6, 7 does not move merely through a simple arcuate or circular path, but moves through an arcuate path resolved by rotation about a progressively varying or shifting center. As has been mentioned, the rotary movement of the segmental gear is through ninety degrees; during such movement the center of rotation of the gear travels vertically downward from the point *e* to the point *h*. And it will be perceived that, as the arm *c* is progressively bent downward from its initial horizontal position (Fig. IV) to its ultimate position (Fig. V), the arm is subjected to both bending and tension stresses. Such is the nature of the operation which gives the bend B (Figs. III and V) its required shape and structure. It will be further observed that the right-hand face of the bed-block 1 may be recessed, as indicated at 21, to provide means for guiding and shaping the metal during the formation of the bend B in the above-described manner.

When the rod 18 reaches the bottom of its stroke and the work-securing device 6, 7 has been powerfully swung through the required arm-bending range, the head 2 is elevated, the

device 6, 7 is opened (Fig. V), and the spindle unit, completed so far as immediately concerns the invention, is removed. Then, the plunger 18 is elevated, and the parts are automatically restored to work-receiving position.

We claim as our invention:

1. A bending machine including two work-securing clamps, means including a rotary gear and a reciprocable member for effecting relative angular movement of said clamps about the center of rotation of said gear, and means for progressively shifting the center of said gear in linear path during its rotation.

2. A bending machine including two work-securing devices, means including a rotary gear for effecting relative angular movement of said devices about the center of rotation of said gear, and a pinion and rack cooperating with said gear, progressively to shift the center of the gear during its rotation.

3. A bending machine including two work-securing devices, means including a rotary gear for effecting relative angular movement of said devices, a power-actuated, reciprocable rack for rotating said gear, and means operating in coordination with the movement of said rack for positively shifting the center of rotation of said gear.

4. A bending machine including two work-securing devices, means including a rotary gear for effecting relative angular movement of said devices, a power-actuated rack reciprocable for moving said gear in alternate directions of rotation, and means operating in coordination with said rack for progressively shifting the center of rotation of said gear in alternate directions along a fixed path.

5. A bending machine including a power-actuated device and a hand-actuated device for securing the work, means including a gear and a rack meshing with the gear for arcuately moving the second device relatively to the first, means for powerfully reciprocating the rack and rotating said gear, and means cooperating with said last-mentioned means for progressively shifting the center about which said second device arcuately moves.

6. A bending machine including a power-actuated device and a hand-actuated device for securing the work, means including a gear and a rack meshing with the gear for arcuately moving the second device relatively to the first, means for powerfully reciprocating the rack and rotating said gear, and means including a second rack and a pinion integrated with said gear and meshing with said second rack for effecting the shifting of the center of said gear during its rotation.

7. A bending machine for forged articles including two work-securing devices, a motor, and means including a rotary member and a reciprocable member cooperating with said motor for powerfully effecting the relative angular movement of said devices, and means operating in coordination with the operation of said motor for shifting the center about which said relative angular movement is effected.

8. In a machine for shaping a forging that includes a spindle portion and an arm portion extending angularly therefrom, the combination of means for engaging said spindle portion, means for engaging said arm portion, means for angularly moving the second means relatively to the first in a plane offset from the axis of said spindle portion, and means for shifting the center about which said angular movement is effected in such plane.

9. In a machine for shaping a forging that includes a spindle portion and an arm portion extending angularly therefrom, the combination of means for engaging said spindle portion, means for engaging said arm portion, means for angularly moving the second means relatively to the first in a plane offset from and parallel to the axis of said spindle portion, and means for shifting the center about which said angular movement is effected in such plane.

10. In a machine for shaping an article that includes a body portion and a member extending angularly therefrom, the combination of means for engaging said body portion, means for securing said angularly extending member, means for angularly moving said second means relatively to the first in a plane offset from the center line of said body portion, and means for shifting the center about which said angular movement is effected in such plane.

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