

RADIAL FORGING MACHINE. TECHNOLOGY FOR AXLE TYPE PARTS

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ABSTRACT

This paper presents three types of radial forging machines to produce the axle type pieces. The new types of radial forging machines are presented cinematically. The movement of the deformation tools at these types of machines is compared with the motion at the existing machines.

KEYWORDS: hot plastic deformation, radial forging, axle type parts

1. Classical forging on machines with two tools used in parallel

When forging blanks of round section between plain tools, when the hammer or press ram reaches the blank, it does not result a contact surface as in the case of the extent of semi-square-section, but a contact line whose length is equal to the gripping length.

As the ram goes down, the deformation of the blank takes place on both sides of the contact line, at the same time, the contact line changing into contact surface. Once the top and bottom surfaces occur, the zones with difficult deformation occur too, which, together with the contact surfaces increase as the ram goes down. In contrast to the square section blanks forging, where in the zones with difficult deformation the material pervades in a non-deformed state, when forging round section blanks the zones with difficult deformation are formed on the account

of the volume of metal that was previously subject to plastic deformation.

The outside friction between the tools and the deforming material has an influence in this case too as it has when forging square section blanks, only this time the plastic deformation occurs before the forming of the difficult deformation zone.

It should also be noted that while forging blanks of square cross section the material deformed is entirely under the influence of tools (Figure 1), at the forging of round blanks only a part of the deformed material is under the direct influence of the tools, that is the shaded area (Figure 1 b). The escape of a portion of the workpiece from the influence of tools changes substantially the stress state scheme.

In the case of round section blanks forging, the plastic deformation zones, the non-uniformity of deformation and the plastic deformation stress depend to a great extent on the tools type, which can be plain or profiled, and on the degree of unitary deformation.

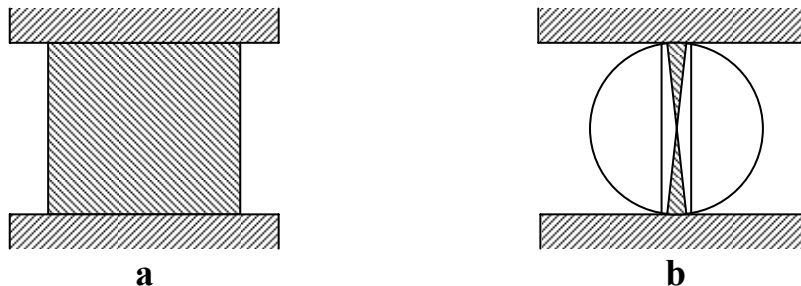


Fig 1. Deformation zones that were produced under the direct influence of tools at the forging of square and round section blanks

In Figure 2 are shown the plastic deformation zones which are formed during forging round section

blanks between plain tools, with small degrees of unitary deformation, under 3%. [1]

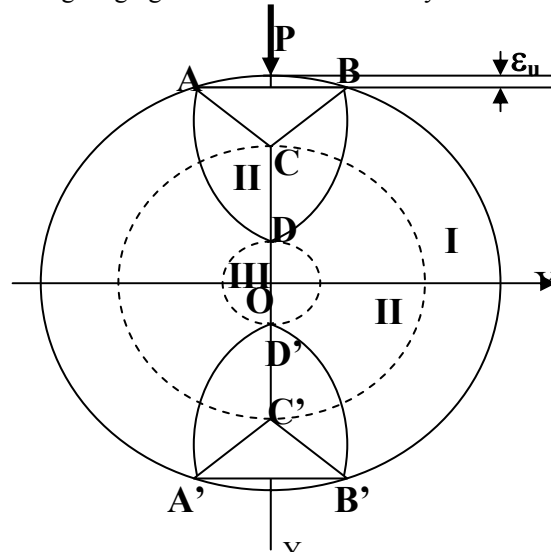


Fig. 2. The plastic deformation zones which are formed during forging round section blanks between plain and

As the difference between the extreme tensions is much higher in zone II than in the difficult deformation zone, the plastic deformation zone is more easily produced in zone II. When rotating the blank, Zone II expands and forms the ring between the OD radius circle and the maximum radius circle, overlapping zone I in the exterior zone of this ring. It results that the maximum and minimum deformation zones are overlapping and in the interior ring situated between the OD and OC radius circles, the plastic deformation takes place only at maximum intensity.

In zone III, that is inside the OD radius circle, the plastic deformation takes place at medium intensity, but under the influence of tensile stress.

Compared with the tension and deformation state at the forging of square section blanks, at forging round blanks between plain tools, the non-uniformity of the deformation $\epsilon \Delta$ is lower in value, but the heterogeneity of plastic deformation is more obvious. When forging round section blanks is done with small degrees of deformation, the central area is deformed by stretching and the amount of mechanical characteristics is reduced. This explains why in many cases the values of the mechanical characteristics of the parts and semi-products forged after the scheme square - rectangle - square are better than in the case of forging on the scheme round - round.

After forging, for the purpose of decreasing the diameter and increasing the length of the disk, the dimensional change of the pins and of their holes took place in a different way. Thus, while the peripheral pin has reduced its diameter and become elongated, the central pin has not undergone any change and its hole widened and shortened. The intermediate pins

underwent different changes. Increasing the central pin hole diameter, while the disc diameter decreased, confirms the presence of radial tensile stresses in this area. Shortening the length of the disk in the axial zone and its elongation in the peripheral zone proves the presence of longitudinal tensile stress in the center.

The way in which the radial tensile stress is formed is presented in Figure 3, which shows the decomposition and composition of the forces acting on the round blank during forging between plain tools. [1].

In the ABC difficult deformation zone, which is formed under the influence of external friction forces T , the tension state is space compression $S1$ and the difference between the extreme voltages is minimal, virtually negligible. Due to the reduced difference between σ_3 and σ_1 , the material in the ABC zone does not deform. Due to lack of material deformation of the ABC, the plastic deformation force is transmitted to the blank through this area that enters the material just like a ripping spike.

In the case of forging round blanks between flat tools to reduce tension stress and cracking or fracture tendency, as well as to improve the mechanical characteristics, forging must be run with deformation degrees higher or at least equal to 8%. Increasing uniform deformation over 8% makes difficult the forging operations in order to maintain the round shape of the blank section.

This is why in the case of forging round blanks from metals and alloys with low plasticity it is recommended using profiled tools or at least combined tools.

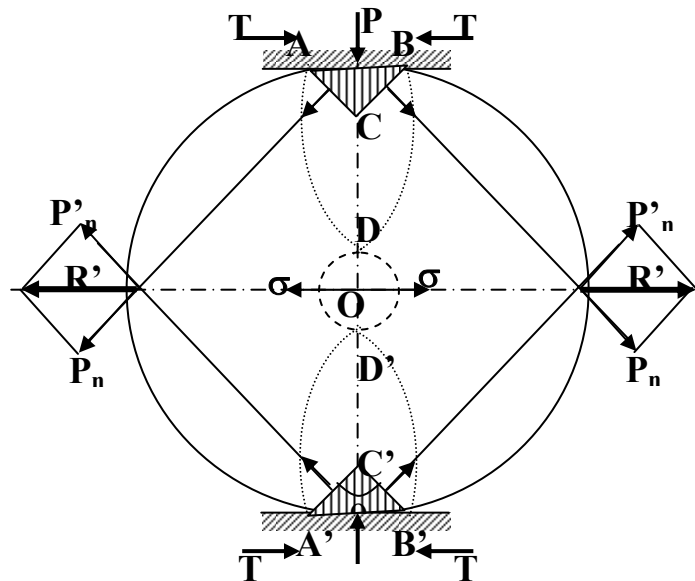


Fig. 3. Scheme and the tension forces during forging blanks between tools round flat

2. Radial forging - working principle of classic machine

Radial forging is the operation of stretching by forging in which the deformation forces, of the same size, acts on the blank simultaneously from two or more diametrically opposed directions. In the moments of pause, when the forming tools (hammer pairs) are executing the withdrawal motion, the blank

runs an advance and rotation movement (Figure 4). Radial forging is currently an advanced process for the series manufacturing of cylindrical, conical or mixed step axis, made of semi-round, square or hollow blanks, both hot and cold. Pieces like: rods for steering rods, axes from gear boxes and differentials, tube axles for serial production of cars, wagon axles, connecting sleeves for the oil industry, hard rolling special steel bars, are executed by radial forging with good results.

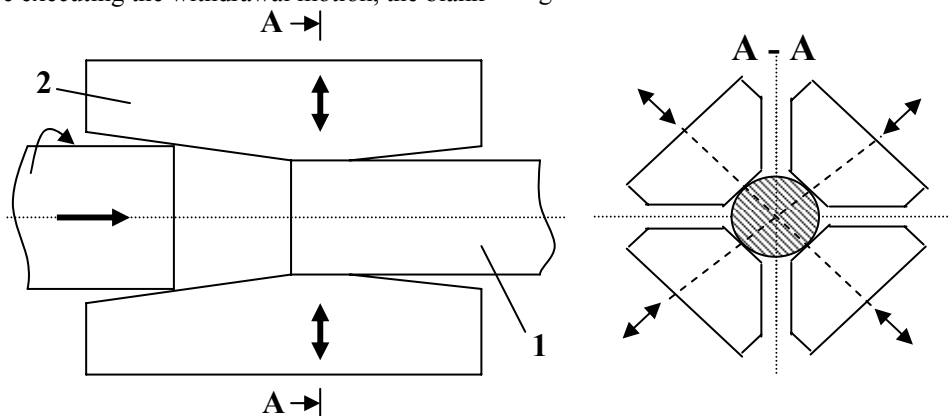


Fig. 4. Scheme of radial forging of round blanks with two pairs of tools: 1 – blank; 2 – sledge

The radial forging process is performed on vertical or horizontal machines. Because the vertical stroke is limited by the size of the machine, vertical radial forging machines can forge blanks and parts with lengths up to 2 ... 3 m. Horizontal machines can get parts or elements up to 12 m. The most known radial forging machines worldwide are manufactured

by GFM (Austria). Radial forging machines for executing long bars are equipped with two manipulators supporting the blank at both ends. In both cases, the forward movements of the manipulator and the rotating movements of the clamp that holds the blank are synchronized with the plastic

deformation. In forging square, rectangular or hexagonal profiles, the manipulator or the grip head achieves only an advance movement without turning the blank.

The machine has the advantage of rapid deformation (within one minute / cycle), which permits to maintain the temperature of the piece almost constant during plastic deformation.

The main disadvantage of the conventional radial forging machines is that for parts with small diameter, it is necessary that the forming tools to be changed for each size.

3. Working principle of new radial forging machine and construction variants

Reducing the section of the material takes place due to the simultaneous movement of the four forming tools driven two by two by two hydraulic cylinders.

The tool movement during contact with the material actually consists of two movements that occur at the same time: one perpendicular on the direction of the main deformation and the other parallel and in the same direction with it. This last movement has the effect of the automatic advance of the forged blank. Material deformation is made without limitation of widening, requiring small capacity of installed power and forces (Figura 5).

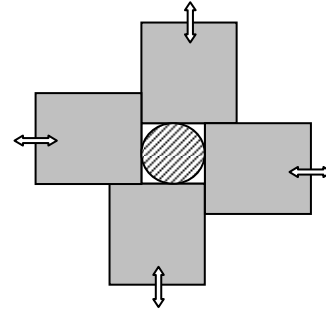


Fig. 5. Working principle of radial forging machine

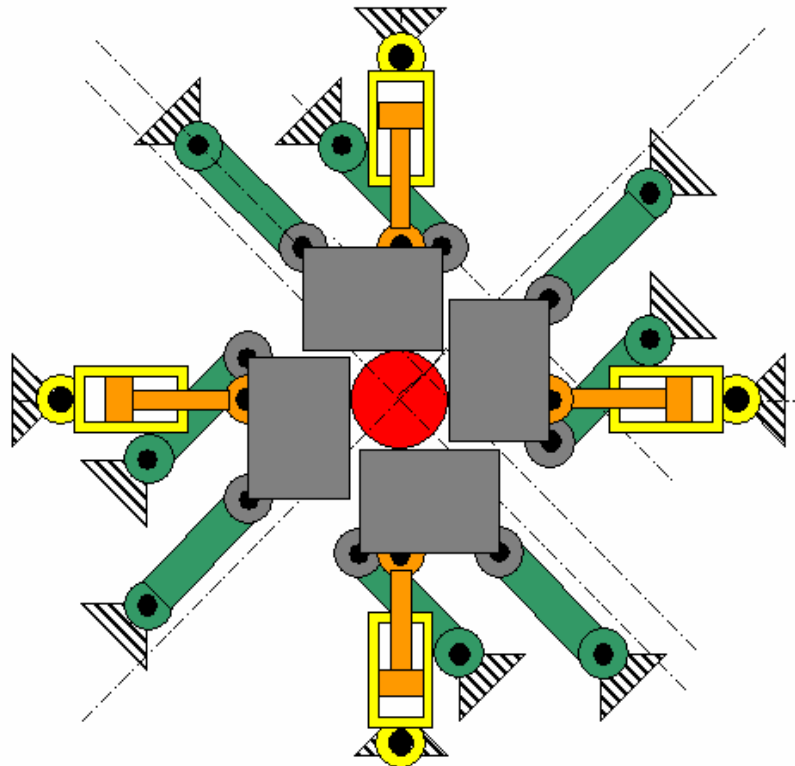


Fig. 6. Kinematic scheme of new radial forging press (Option 1)

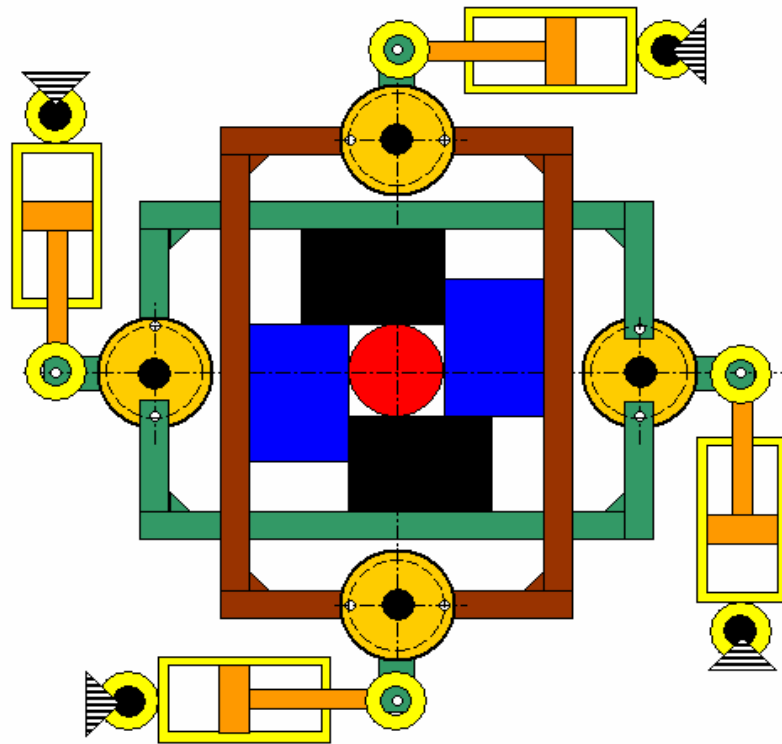


Fig. 7. Kinematic scheme of new radial forging press (Option 2)

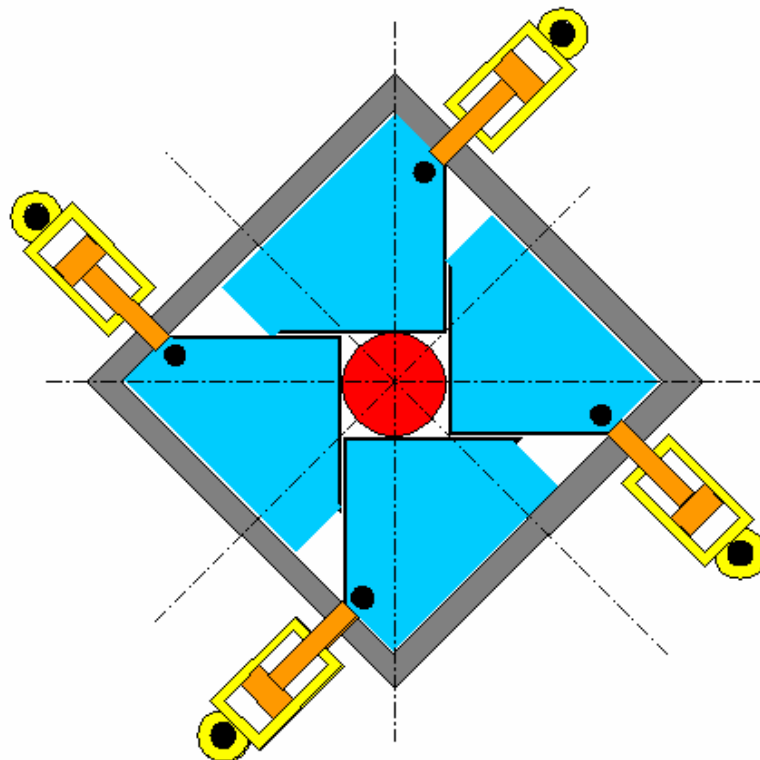


Fig. 8. Kinematic scheme of new radial forging press (Option 3)



4. Conclusion

1. The number of presses in the case of radial forging is considerably smaller than in the case of forging between two plain tools (63 to 400) because in the case of radial forging there is no widening and a higher degree of deformation per pass is possible.

2. The small number of presses involves a higher productivity and a reduced duration of the operation. In this way the number of reheating operations reduces, so there are heat savings too.

3. The possibility of using a higher degree of deformation per pass involves a smaller number of passes.

4. The lack of widening creates a state of tension and triaxial deformation, state in which there is no stress tension, only compression tension. As there is no tensile stress, there is no central cracking either, as it is found in most cases of forging round section blanks between two parallel plane tools.

5. To forge with high degrees of deformation

per pass for radial forging machines, forming tools present an angle of adjustment to avoid overlapping.

6. The radial forging machine model presented in this paper has the advantage that, unlike other types of radial forging machines, allows extension of semi-round or polygonal blanks in a wide range of diameters without having to change the forming tools.

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