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[54] FORGING MACHINE

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[58] **Field of Search** 72/399, 402, 453, 452, 463

[56] **References Cited**

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[57] **ABSTRACT**

A forging machine is disclosed for reducing the cross sectional area of a workpiece which is positioned on a forging axis of the machine, i.e. the direction of travel of the workpiece through the machine. At least three forging saddles are arranged at intervals around the forging axis for applying a lateral thrust generally towards the forging axis. Each forging saddle has associated with it a driving mechanism for imparting a thrust to the saddle and an axially guided sliding plunger which transmits the thrust from the driving mechanism to the saddle and which has its axis inclined to the axis of the saddle.

5 Claims, 2 Drawing Figures

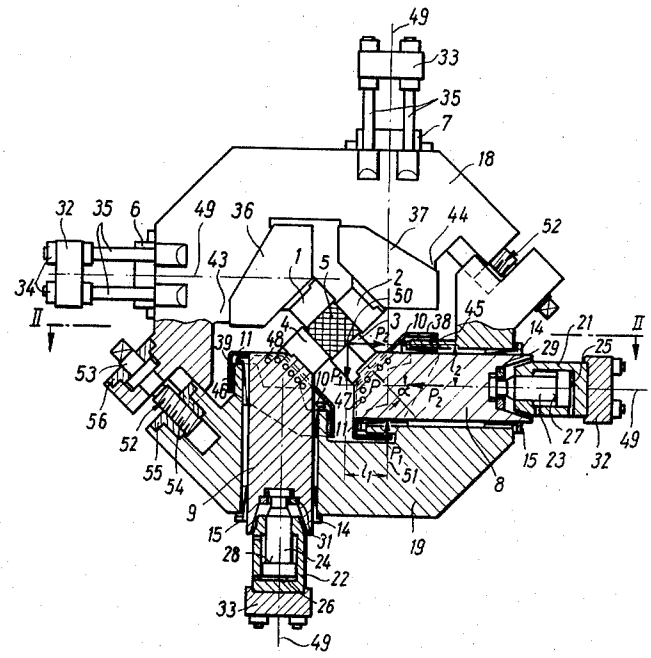


Fig. 1

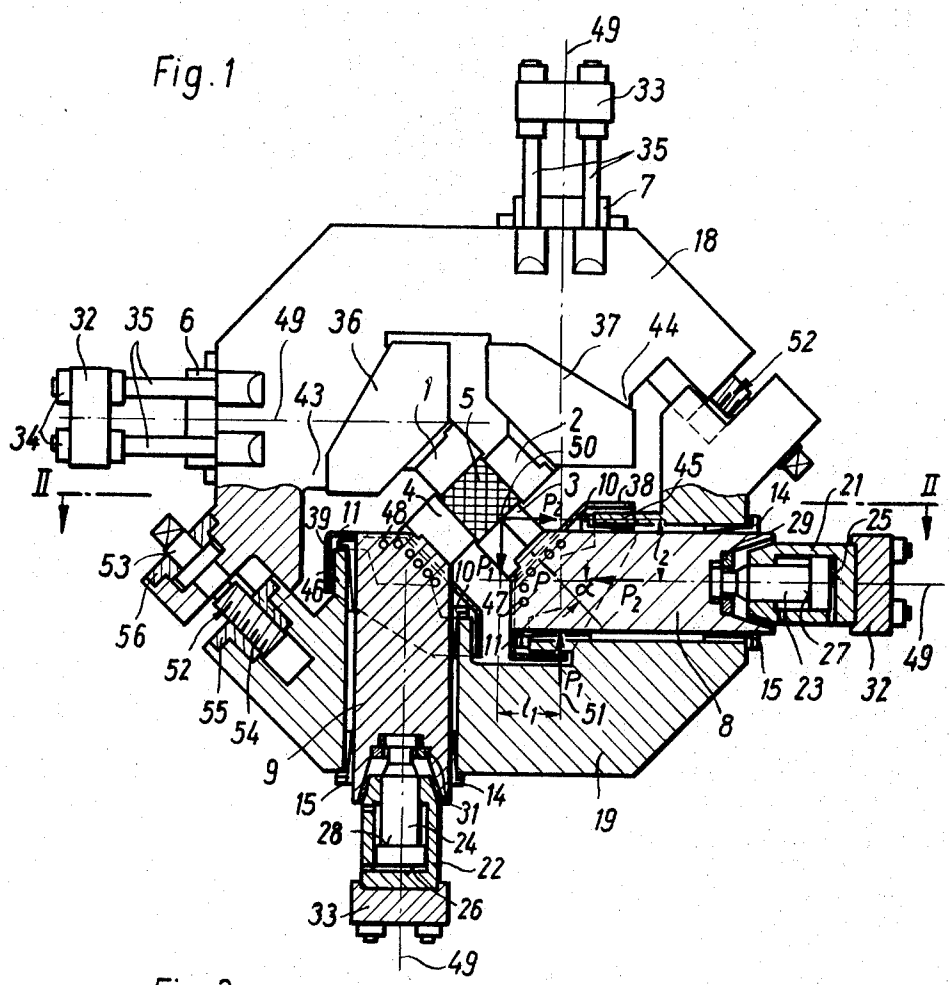
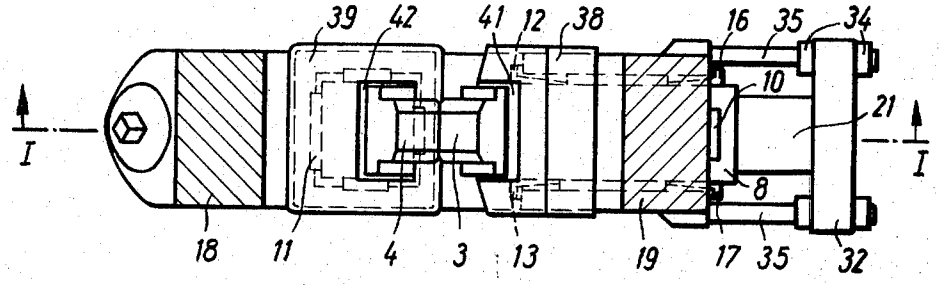


Fig. 2



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FORGING MACHINE

This invention relates to forging machines for reducing the cross sectional area of a workpiece which is positioned on the forging axis of the machine, i.e. the path taken by the workpiece through the machine, having at least three forging saddles which are arranged at intervals around the forging axis and are arranged to apply lateral thrust towards the forging axis.

In a known forging machine of this kind each forging saddle is directly but flexibly coupled to a guiding arm which is inclined at an angle to the forging saddle and is pivoted on an axle pin extending parallel to the forging axis. A driving mechanism is arranged to impart a thrust to the forging saddle in a substantially perpendicular direction through the connection of the saddle to the guiding arm. In such a forging machine containing four forging saddles and arranged to produce forged bars of square cross section, each guiding arm forms an angle of approximately 45° with the direction of forging thrust applied to and by the forging saddle. If the pivot axles for the guiding arms are adjustable in position transversely with respect to the forging axis, the machine can be adjusted to produce forged bars not only of square cross section but of rectangular cross section of different side ratios as desired. By suitably choosing the number and construction of the forging saddles it is also possible to produce forged bars with substantially round cross sections and forged bars of other polygonal cross sections.

Although forging machines of this kind operate quite satisfactorily, they are excessively bulky, and costly to construct. The width of such machines is approximately 18 times the width of the bar of greatest cross section which can be forged by the machine.

With the aim of providing a forging machine which will perform the same function as that described above but which is considerably more compact and also simpler in construction, according to the present invention, in a machine of the kind described each forging saddle has associated with it a driving mechanism for imparting a thrust to the saddle and an axially guided sliding plunger which transmits the thrust from the driving mechanism to the saddle and which has its axis inclined to the axis of the saddle. Such a machine can be constructed in which the ratio of the width of the largest raw bar which can be fed to the machine, to the width of the forging machine stand or frame is only approximately 1 : 9. This machine is therefore only half as wide as the known machine mentioned earlier, but nevertheless functions just as well. There is obtained not only a considerable economy in metal in the manufacture of the machine, but the manufacture is also simpler.

Preferably each driving mechanism is arranged to apply its thrust along the axis of the associated sliding plunger.

Each sliding plunger is preferably guided to slide in a passage in the frame of the machine by forward guiding devices at the saddle end of the passage and rear guiding devices at the other end of the passage adjacent the driving mechanism, and preferably each sliding plunger and its forward guiding devices are arranged so that one of the forward guiding devices provides the reaction against the component of the reaction force exerted in use by the workpiece on the forging saddle in a direction perpendicular to the axis of the sliding plunger, this guiding device being arranged so that the moment of the component of the workpiece reaction perpendicular to the sliding plunger axis about the point of reaction by this guiding device always balances the moment of the component of the workpiece reaction parallel to the axis of the sliding plunger about this axis. Consequently these two opposite moments cancel each other out and no undesired tilting torque is applied to the sliding plunger. The resulting effect is that, in the case of each sliding plunger, only one of the forward guiding devices is loaded, by the application of the reaction component perpendicular to the plunger axis, while the other guiding devices remain substantially unloaded.

The guiding devices for each sliding plunger are preferably adjustable in position, allowing a certain minimal working gap to be retained between the working face of each forging saddle and the side face of the neighboring forging saddle.

It has been found advantageous if part of each passage which houses a sliding plunger is formed by an annular flange projecting inwards from the machine frame, i.e. towards the corresponding forging saddle. As a consequence the inner end of each flange may be covered by a protective cap which has an opening for the end of the sliding plunger adjacent the forging saddle. This provides an easy way of protecting the guiding devices from scale resulting from the forging.

In order to allow forged bars with cross sections having different ratios to be produced, the forging saddles are arranged in neighboring pairs each of which is adjustable in position transversely with respect to the forging axis, that is to say across the direction of advance of the workpiece. When there are two neighboring pairs of forging saddles the machine frame is preferably split into two parts, each part housing the sliding plungers of one pair of forging saddles, and the two parts of the machine frame being adjustable in position relative to each other, thereby making the positions of the pairs of forging saddles adjustable. The two parts of the machine frame may be adjustable in position with respect to each other by known adjustment devices, for example by means of screw threaded spindles which connect the two parts, the opposite ends of each spindle being in different machine parts from each other and having threads of opposite hand.

An example of a forging machine in accordance with the invention will now be described with reference to the accompanying drawings, in which:

FIG. **1** is a partly sectioned front view of the forging machine, the section being taken along the line I—I in FIG. **2**; and

FIG. **2** is a section taken along the line II—II in FIG. **1**.

The drawing is limited to showing only those parts which are necessary for explaining the invention. Other parts of the machine, for example the means for advancing the workpiece, and the supply ducts for the hydraulic fluid, have been omitted for greater clarity.

The forging machine represented in the drawing is intended for forging bars having a rectangular cross section. However, it is obvious that by suitably choosing the number and construction of the forging saddles, bars with other polygonal cross sections can be forged.

The forging machine shown has four forging saddles **1,2,3,4** positioned at 90° intervals around the path followed through the machine by a workpiece **5**. This path is known as the forging axis. In use, the four forging saddles **1,2,3,4** act somewhat as a forging gauge entirely surrounding the workpiece **5**. Each forging saddle **1,2,3,4** is attached at an angle to the inner end of a sliding plunger **6,7,8,9** which slides axially in one or other of two parts **18, 19** of the machine frame. That is, the direction of the forging thrust of each forging saddle is inclined to the axis of its associated sliding plunger. Each sliding plunger **6,7,8,9** is guided in the machine frame at its inner end by forward guiding devices **10, 11, 12, 13** and at its outer end by rear guiding devices **14,15,16,17**.

Each forging saddle **1,2,3,4**, and its associated sliding plunger **6,7,8,9**, is provided with a drive comprising a piston in a hydraulic cylinder. Each hydraulic cylinder, for example **21, 22**, contains a differential piston **23, 24**, and the thrust for the forging saddle is obtained by applying hydraulic pressure to the main working faces **25, 26** of the pistons **23, 24**. Retraction of the pistons is obtained by applying hydraulic fluid to the annular surface **27, 28** of each piston **23, 24**. Each forging piston **23, 24** is connected at its inner end to its sliding plunger through a two-piece retainer disc **29, 31** and the thrust from the piston is transmitted through the plunger to the forging saddle. At its outer end each cylinder **21, 22** is anchored to the machine frame **18, 19** by means of a crosshead **32, 33** and tie rods **35** secured to the crosshead by retainer nuts **34**.

The forward guiding devices **10,11,12,13** need to be protected from scale coming from the workpiece **5**. For this purpose the inner end of each sliding plunger **6,7,8,9** is covered over by a protective cap **36, 37, 38, 39**, each of which has an opening **41, 42** for accommodating the outer end of the associated forging saddle. Each protective cap **36,37,38,39** has side walls which house a guiding flange **43,44,45,46** projecting from one or other of the two halves **18,19** of the machine frame. Each projecting flange **43,44,45,46** houses one of the sliding plungers **6,7,8,9**. In use, a considerable amount of heat is generated from the forging process and this is transmitted from the forging saddles **1,2,3,4** to the guiding devices of the sliding plungers **6,7,8,9**. Consequently the sliding plungers need to be cooled and for this purpose the inner end of each sliding plunger **6,7,8,9** contains transverse drillings **47,48** through which there flows a stream of cooling medium.

In the forging machine in accordance with the invention the direction of the deformation resistance offered by the workpiece and acting on each forging saddle does not coincide with the direction of application of the thrust from the forging piston and acting along the axis of the sliding plunger. Consequently, comparatively high thrusts are applied to the guiding devices supporting the plunger. In the forging machine represented in the drawing, with four forging saddles **1,2,3,4**, the direction of action of the deformation resistance P can be divided into two force components P_1, P_2 at right angles to each other, and it is desirable to prevent these force components as far as possible from acting on the guiding devices **10** to **17**. For this purpose the position of the axis **49** of each sliding plunger **6,7,8,9**, and the length of each forward guiding device **11**, and therefore the position of the force line **51** of the force component P_1, are chosen so that the torques applied by the force components P_1 and P_2 over their lever arms l_1 and l_2 are equal and opposite to each other. Consequently only the forward guiding device **11** is subjected to the action of the force component P_1, and other guiding devices remain largely unloaded.

In order to be able to produce a forged bar with a rectangular cross section instead of square, neighboring pairs of forging saddles must be adjustable in position transversely with respect to the forging axis, that is to say transversely of the direction of advance of the workpiece **5**. In the example shown in the drawing this is obtained by joining together the two parts **18** and **19** of the machine frame by means of adjustment spindles **52**, each of which has an external thread which works in an internally threaded bush or nut **55**. The outer end **53** of each spindle rotates in a bush **56** fixed to the machine frame part **18, 19** opposite to that in which the bush **55** is fitted.

If the forging thrust is applied hydraulically, the two working cylinders **21, 22** for neighboring forging saddles in the same machine part **18, 19** may, if desired, be fed with hydraulic fluid from separate pumps. In this case the quantities of hydraulic fluid fed to the two cylinders can be precisely metered, or if desired a hydraulic synchronization control system can be used. Alternatively, if desired, instead of the hydraulic drive, a mechanical driving system, for example using eccentrics or screw threaded spindles, may be used.

We claim:

1. A forging machine for reducing the cross sectional area of a workpiece, said machine comprising a support frame, means defining a predetermined path for the workpiece to travel through said machine, said path being called the forging axis, at least three forging saddles positioned at intervals around said forging axis for applying lateral thrust generally towards said forging axis, a sliding plunger for operating with each forging saddle, means in said support frame defining a slide passage for each sliding plunger, means for guiding each of said sliding plungers in its slide passage for axial sliding movement, the axis of each of said sliding plungers being inclined to the associated forging saddle, a driving mechanism acting on each of said sliding plungers for imparting a thrust through said sliding plunger to the associated forging saddle, means mounting said driving mechanisms on said support frame, each of said means for guiding a sliding plunger in its associated passage includes forward guiding devices at the forging saddle end of said passage and rear guiding devices at the other end of said passage adjacent the associated driving mechanism, and said forward and rear guiding devices are adjustable in position.

2. A forging machine for reducing the cross sectional area of a workpiece, said machine comprising a support frame, means defining a predetermined path for the workpiece to travel through said machine, said path being called the forging axis, at least three forging saddles positioned at intervals around said forging axis for applying lateral thrust generally towards said forging axis, a sliding plunger for operating with each forging saddle, means in said support frame defining a slide passage for each sliding plunger, means for guiding each of said sliding plungers in its slide passage for axial sliding movement, the axis of each of said sliding plungers being inclined to the associated forging saddle, a driving mechanism acting on each of said sliding plungers for imparting a thrust through said sliding plunger to the associated forging saddle, means mounting said driving mechanisms on said support frame, each of said means for guiding a sliding plunger in its associated passage includes forward guiding devices at the forging saddle end of said passage and rear guiding devices at the other end of said passage adjacent the associated driving mechanism, each slide passage is formed in part by an annular flange projecting inwards from said support frame generally towards the corresponding forging saddle, and a protective cap for each of said annular flanges, said cap covering the inner end of the associated flange and containing means defining an opening for accomodating the end of the associated sliding plunger.

3. A forging machine for reducing the cross sectional area of a workpiece, said machine comprising a support frame, means defining a predetermined path for the workpiece to travel through said machine, said path being called the forging axis, at least four forging saddles positioned at intervals around said forging axis for applying lateral thrust generally towards said forging axis and said forging saddles arranged in even numbers, a sliding plunger for operating with each forging saddle, means in said support frame defining a slide passage for each sliding plunger, means for guiding each of said sliding plungers in its slide passage for axial sliding movement, the axis of each of said sliding plungers being inclined to the associated forging saddle, a driving mechanism acting on each of said sliding plungers for imparting a thrust through said sliding plunger to the associated forging saddle, means mounting said driving mechanisms on said support frame, and said machine includes means grouping said forging saddles in neighboring pairs, and means for adjusting each of said neighboring pairs in position transversely with respect to said forging axis.

4. A forging machine as claimed in claim **3**, wherein there are two pairs of said forging saddles and said support frame comprises two parts, each of said two support frame parts having the sliding plungers associated with one pair of said forging saddles, and there being means for adjusting said two support frame parts in position relative to each other, thereby making the positions of said neighboring pairs of forging saddles adjustable relative to each other.

5. A forging machine as claimed in claim **4**, wherein said means for adjusting the position of said two machine parts relative to each other comprises a number of screw threaded adjustment spindles and means in each of said two machine frame parts cooperating with the opposite ends of said screw threaded spindles, each of said screw threaded spindles having threads of opposite hand at its opposite ends.

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