APPARATUS FOR HEAT SETTING METAL
5 Claims, 5 Drawing Figs.

UNITED STATES PATENTS

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Primary Examiner—Lowell A. Larson
Attorney—Abraham A. Saffitz

ABSTRACT: A method and apparatus for heat setting metal plate particularly, although not exclusively, for use in a leaf spring, in which a hot metal plate is bent to a predetermined shape between a pair of relatively movable dies, whereafter the plate and dies are moved together into a bath of quenching oil medium to heat set the metal in the predetermined shape. The dies each comprise a pack of relatively movable die plates which can be clamped together by fluid-operated means to prevent relative movement of the die plates while the hot plate is held in the dies. The dies are movable together while holding the hot metal plate in the predetermined shape towards and into a bath of quenching oil medium to heat set the plate in the predetermined shape and means are provided to circulate and cool the quenching oil medium.
APPARATUS FOR HEAT SETTING METAL

This invention relates to a method of and apparatus for use in heat setting metal plate.

According to one aspect of the present invention, there is provided a method of heat setting metal plate comprising the steps of bending the metal plate, when hot, to a predetermined shape between two relatively movable dies and quenching the hot metal plate whilst the same is still held between the dies to heat set said metal plate to said predetermined shape.

Preferably, while still holding the metal plate in said predetermined shape the dies are moved, together with the plate, into a bath of quenching medium to effect the quenching step.

The quenching medium is preferably oil.

The dies may be moved relatively to bend the plate by means of hydraulic or pneumatic rams. The movement of the dies into the quenching medium may also be by means of hydraulic or pneumatic rams.

According to a second aspect of the present invention, there is provided apparatus for use in heat setting hot metal plate, comprising two dies which are movable relatively towards one another to bend the hot metal plate into a predetermined shape, and a tank or reservoir for quenching medium, the dies being movable, while holding the hot metal plate in the predetermined shape, into the tank or reservoir so that the hot plate can be quenched while still in said predetermined shape.

Preferably, the dies are so mounted that the direction of the possible relative movement between them to bend the metal plate is substantially horizontal and such dies are moveable together downwardly into the quenching tank or reservoir which is located below the dies.

The dies may be moved relatively to one another by jacking hydraulic or pneumatic ram means, and the dies may be moved into the quenching tank or reservoir by means of quenching hydraulic or pneumatic ram means.

Each die preferably comprises a pack of metal die plates of which the profile defined by one set of adjacent parallel edges of the die plates defines the surface which engages the hot metal plate, and which can be moved relatively to one another in the direction of their planes so that the shape of the profile and hence the predetermined shape of the hot metal plate can be varied, and there is a clamp means to hold the die plates firmly clamped together to prevent relative movement between the die plates during bending of the hot plate.

The clamping means may comprise clamping hydraulic or pneumatic rams acting in a direction normal to the planes of the die plates to press the die plates together during bending of the hot plate.

When the apparatus is used for imparting a predetermined radius of curvature to a hot metal plate strip to form a leaf spring such as are used in vehicle suspensions, the center die plate of one pack of die plates has a dimple recess forming tool, while the opposite die plate in the other pack of die plates has a protruding dimple-forming tool, which dimple and recess tools can be moved by dimpling rams to cooperate and produce a dimple in such strip.

A loading means may be provided for the hot metal plate which can receive the plate and lower the same into position between the dies prior to bending and which can raise the heat-set plate out of the dies when the dies are again opened after quenching.

One of the dies may be movable towards the other to effect the bending of the plate whilst said other die is fixed.

The dies may be mounted on a crossbeam which can be moved into said tank or reservoir.

There may also be circulating means for circulating cool quenching medium through the tank or reservoir.

The circulating means preferably is arranged to direct the cool quenching medium onto the dies when the latter are in the tank or reservoir.

An embodiment of the invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

FIG. 1 is a diagrammatic sectional view of the dies used in bending the metal plate according to the method of the embodiment of the invention, and in the left-hand side of the figure, the dies are shown in the open position prior to the insertion of the hot metal plate, while in the right-hand side of the figure, the dies are shown in the closed position after the hot plate has been inserted between the dies and bent; the metal plate has been omitted for the sake of clarity;

FIGS. 2A, 2B and 2C are detailed sectional plan views corresponding to FIG. 1, the three drawings being placed together, side by side to form a complete plan view of the apparatus;

FIG. 3 is a sectional elevation of the apparatus according to the embodiment of the invention, which elevation is taken on the line III-III of FIG. 1.

Referring to the drawings, and firstly to FIGS. 1, 2A, 2B and 2C, a pair of dies indicated generally by reference numerals 10 and 12 are for bending hot metal plate, in this example a metal strip for a leaf spring, inserted therebetween into an accuate form, and each die comprises a pack of rectangular die plates 14 which lie side by side in substantially vertical parallel planes. The two packs of plates 14 lie at the same height and the opposed sets of edges of the die plates define the profile to which the plate is to be bent. The dies 10 and 12 are moveable towards and away from each other in a substantially horizontal direction as indicated by arrows 16, 18 and in the example the die 10 is fixed while the die 12 is moveable substantially horizontally as indicated by arrows 16, 18, by means of two fluid pressure rams 20 respectively located at the ends of the dies 10, 12. The cylinders 22 of rams 20 are fixed to a frame 24 on which the plates 14 of die 10 rest while the pistons 26 are connected to a crossbeam 28 on which the plates 14 of die 12 rest. The crossbeam 28 is slidably mounted on transverse frames 30 of frame 24.

The plates 14 of each die 10, 12 are movable relatively to one another in their own planes so as to vary the profile to which the plate is to be bent, and eventually heat set, and when the plates 14 have been so adjusted, they are held clamped in such position by means of fluid pressure operated clamping rams 32 mounted to press the plates 14 together in a direction normal to their planes.

The center plate 14A of each pack of plates 14 is thicker than the other plates of the pack and in each such plate there is a fluid pressure operated ram 14B which is for use in producing a dimple in the center of the metal plate strip. As best seen in FIG. 3, the end of the piston rod of ram 14B which is in die 10, has a male dimpling tool head 34 of heat-resistant material while the other ram 14B has at the end of its piston a female dimpling tool head 36 also of heat-resistant material.

The edges of the die plates defining the profile and the die plates are provided with strips, 38, of heat-resistant material which are profiled as shown in FIGS. 1 and 2 to give line contact with the metal strip. By this means, there are provided spaces between the contact lines of such strips 38 and the metal plate so that, during the subsequent quenching step, the quenching medium can flow through such spaces to cool the strip.

In bending a strip of metal with the dies as described above, the strip, when flat and hot, is placed between the dies 10 and 12 when they are in the position shown in the left-hand side of FIG. 1, and FIGS. 2A and 2B, and when clamping rams 32 are moved to clamp the packs of plates 14, the dies 10 and 12 are moved to the position shown in the right-hand side of the FIG. 1, so that the strip is bent by the dies into the predetermined shape. The rams 14B are then moved to produce the central dimple in the strip. The pressure in rams 14B is relieved before the strip is quenched and the dimpling tools 34 and 36 move away from one another under spring pressure. The dimpling rams 14B are associated with adjustable dead stops so that the stroke of the rams, and hence the size of dimple produced can be varied.

Referring now to FIG. 3 in detail, the dies 10 and 12 are located above a quenching tank or reservoir 40 containing quenching medium, in this case oil, and being defined by metal plate sidewalks 42 and a bottom 44. The dies 10, 12 and their associated parts form part of an assembly which is bodily
movable downwards into and immersible in the quenching oil by means of fluid pressure operated rams 46. The assembly is guided in its downward movement into the quenching medium and also when it is raised from the medium by rollers 48 which run on vertical guide rails 50 which extend vertically upwards from the bottom of the tank 40.

The assembly is also provided with loading means which is for use in loading the strip metal into position between the dies 10, 12 and also for use in unloading the metal strip after bending and heat setting. Such loading means comprises a pair of forks 52 between the fingers of which the metal strip is located. The forks 52 are movable by means of fluid pressure operated loading rams 54 such that the forks 52 are raised above the dies 10, 12 to accept the metal strip, are lowered to position the strip between the dies 10, 12 and after bending and quenching of the metal strip and when the dies 10, 12 are again opened the forks 52 are again raised by the rams to eject the heat-set strip. When the forks 52 are raised to the up position by rams 54, they are pivoted to an angle of 45° to the vertical to enable easy ejection and loading.

The tank or reservoir 40 is provided with removable lid members 55 which extend over the assembly including the dies 10, 12. The members 55 are spaced to define an access aperture 56 to allow access into the interior of the tank or reservoir and to the dies 10, 12. Located above the aperture is a hood (not shown) having an extractor fan associated therewith for the removal of vapors given off during quenching. The hood and fan are carried by tie bolts 58 attached to the die assembly.

The various fluid-pressure rams are preferably hydraulically operated, but could be pneumatically operated if desired, and are automatically controlled by means of a suitable control system so that the operations take place automatically and in timed sequence. By this means therefore the heated flat strips can be presented to the apparatus and heat set thereby in turn.

The quenching tank or reservoir 40 has inlet and outlet means so that the hot quenching medium may be withdrawn from the tank, cooled and filtered and returned to the tank or reservoir by recirculating means. The inlet means comprise pipes which in use, direct cool incoming quenching oil onto the metal plate being set so that the cool oil flows between the strips 38 to effectively cool said metal plate when the latter and the dies are submerged in the quenching oil. The cool oil is fed to the plate being quenched by means of propeller agitators located under the inlet pipes. Such agitators ensure maximum circulation of the quenching oil.

The circulating means includes a duplex pump and filter system in both the inlet side and the outlet side of the tank or reservoir, and also provided are suitable valves to enable the oil circulation to be terminated or the tank emptied. There may be standby circulating means which operate automatically if there is a failure in the primary circulating means.

To cool the oil during circulation there is preferably an open tray cooler fitted with an enlarged base tank to accommodate 1,000 gallons of quench oil in excess of normal requirements. Such cooler has a motor-driven cooling fan and exhaust ducting.

The above-described embodiment of the invention is given by way of example only and it is to be appreciated that the invention may be applied to the heat setting of metal plate for purposes other than leaf springs. Also, the above-described embodiment may be modified without departing from the scope of the invention as defined in the appended claims. Thus, as examples of possible modifications the various rams may be replaced by drive linkages and gearing, the cooler may be of another form, and the dies may be mounted in a manner other than that shown in the drawings.

It is claimed:

1. Apparatus for use in heat setting metal plate comprising two dies, one of which is movable relatively towards the other by fluid pressure to bend the hot metal plate into a predetermined shape, each die comprising a pack of metal die plates of which the profile defined by a set of adjacent parallel edges of the die plates defines the surface which engages the hot metal plate, and which can be moved relatively to one another in the direction of their planes so that the shape of the hot metal plate can be varied; clamp means acting in a direction normal to the planes of the die plates being provided to hold the die plates firmly clamped together to prevent relative movement between the die plates during bending of the hot metal plate; a center die plate of each pack of die plates being thicker than the other plates of the packs; a fluid pressure operated ram in each of said center die plates, one of said fluid pressure operated rams having a male dimpling tool head and the other of said fluid pressure operated rams having a female dimpling tool head; means for moving said male and female dimpling tool heads to produce a dimple in said hot metal plate; a tank for oil-quenching medium; means for holding the hot metal plate in said predetermined shape; and means for moving said dies and said hot metal plate together into said quenching medium so that the hot metal plate can be quenched while still in said predetermined shape between said dies.

2. Apparatus as claimed in claim 1, wherein the parallel edges of the die plates which define the profile in which the hot metal plate is to be set are shaped so as to have line contact with the plate with spaces between the lines of contact such that the quenching medium can flow in said spaces and in contact with the metal plate.

3. Apparatus as claimed in claim 1, wherein said clamp means comprise fluid pressure operated clamping rams mounted to press the die plates together in a direction normal to the planes of said plates.

4. Apparatus as claimed in claim 1, including a loading means for the hot metal plate, said loading means comprising a pair of forks which are movable by fluid pressure operated loading rams to receive the hot metal plate, to lower the same into position between the dies prior to the bending of the hot metal plate, and to raise the heat-set metal plate out of the dies when the dies are opened after quenching.

5. Apparatus as claimed in claim 1, including means for cooling, filtering and recirculating said quenching medium.