Sept. 29, 1936. R. K. HOPKINS 2,055,534

HEADER

Original Filed Feb. 8, 1933 3 Sheets-Sheet 1

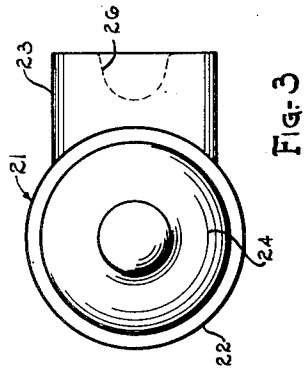


FIG. 3

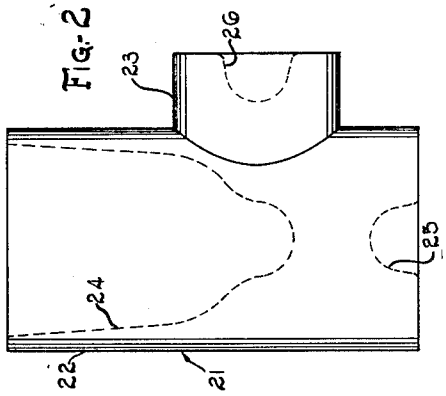


FIG. 2

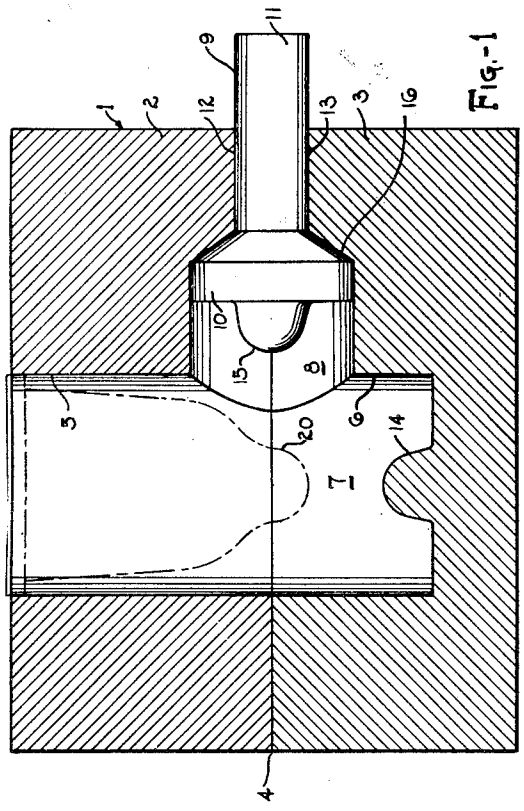


FIG. 1

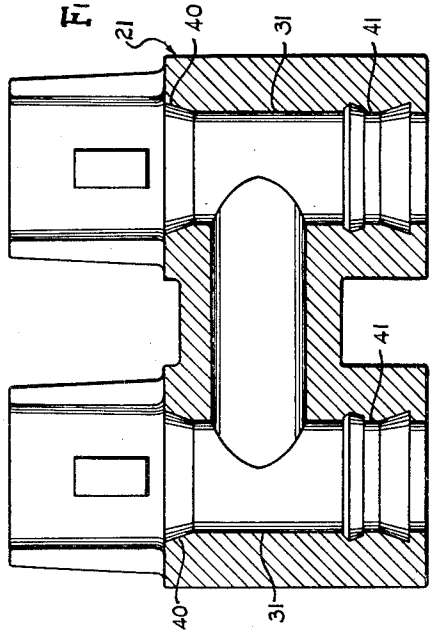


FIG. 8

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HEADER

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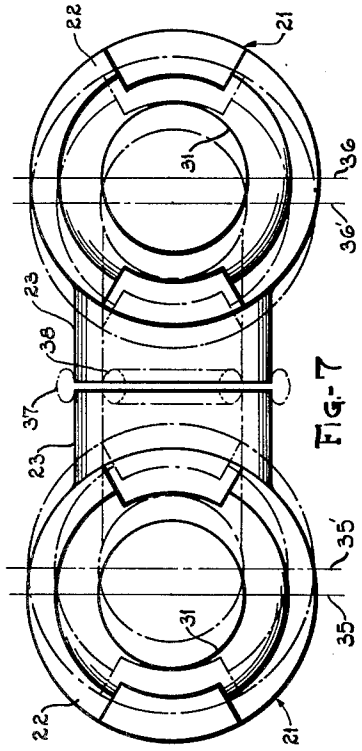


FIG.-7

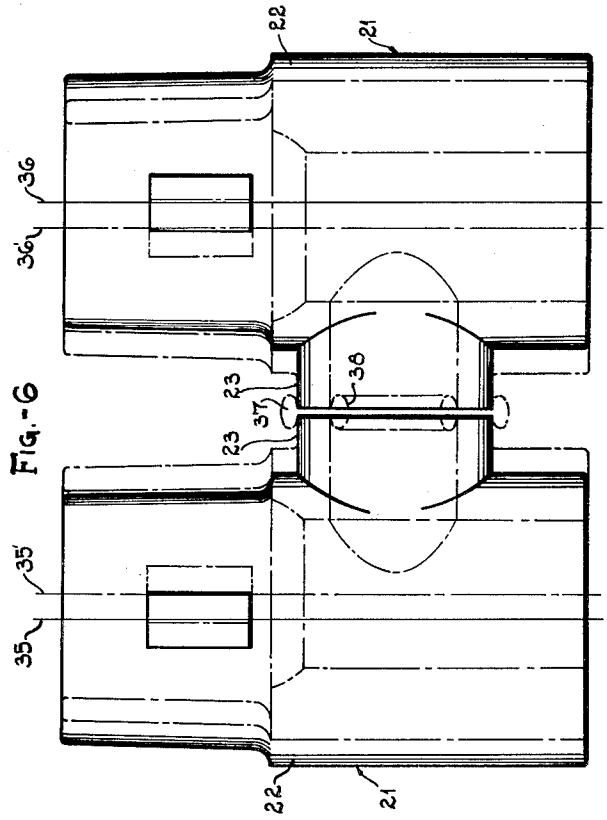


FIG.-6

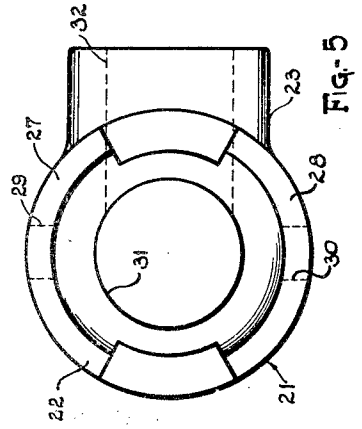


FIG.-5

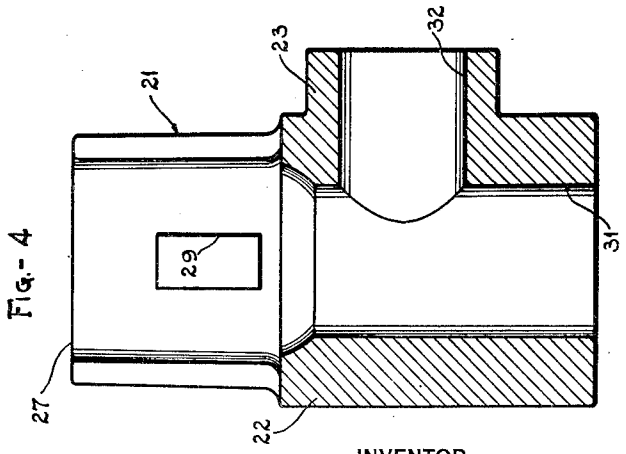


FIG.-4

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HEADER

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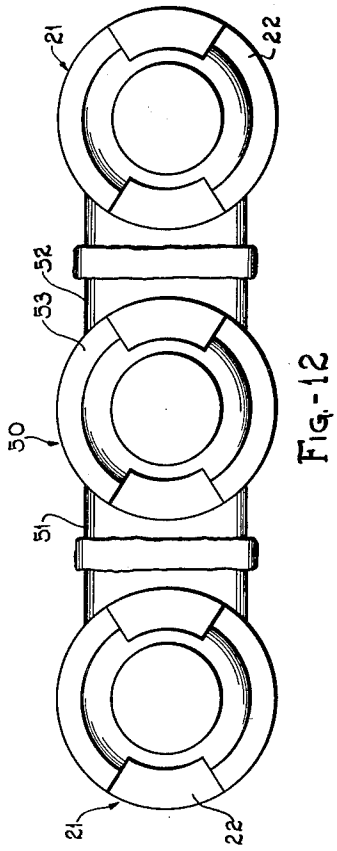


FIG.-12

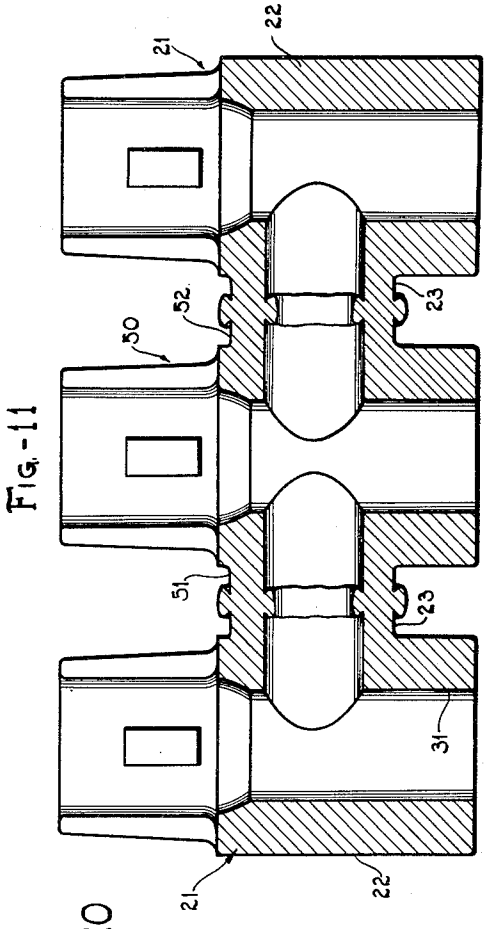


FIG.-11

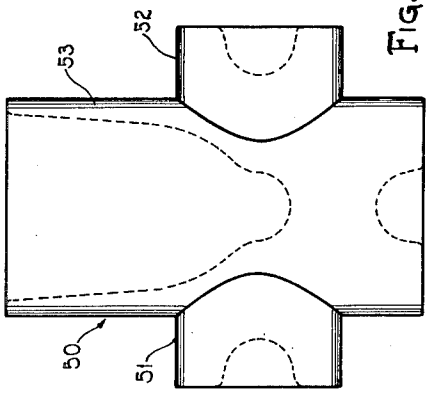


FIG.-9

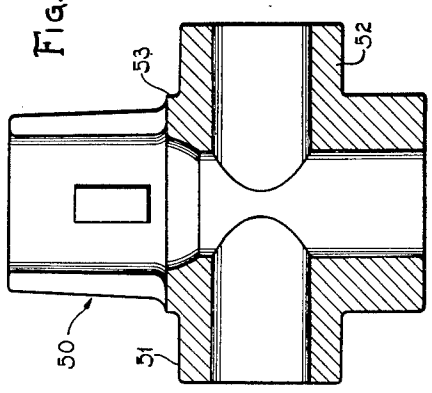


FIG.-10

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UNITED STATES PATENT OFFICE

2,055,534

HEADER

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Original application February 8, 1933, Serial No. 655,719. Divided and this application January 27, 1934, Serial No. 708,597

8 Claims. (Cl. 78—60)

This invention relates to headers or return bends for interconnecting the adjacent ends of two or more parallel tubes and is a division of application Serial No. 655,719 filed February 8, 1933.

Headers or return bends of this type are particularly adapted for use in connection with cracking coils and similar oil refining equipment, although their utility is not limited to this type of apparatus. The complicated shape of such headers or return benders renders it impracticable to produce them commercially by forging in a single piece. Cast headers or return bends have therefore been employed in spite of the recognized superior strength of forgings as compared with castings. The superiority of forgings over castings makes the use of forged headers or return bends very desirable in cracking coils because of the extremely high pressures and temperatures frequently encountered and the subsequent strain upon the equipment.

The primary object of the present invention is to provide unitary headers or return bends of the foregoing type constructed of forged steel.

A further object of the invention is to provide a method of fabricating unitary headers or return bends from forged steel, whereby the obstacles heretofore encountered in forging such articles are overcome and unitary headers or return bends may be produced from forged steel in a simple and economical manner.

According to my invention, a unitary forged steel header or return bend is produced by forging the header or return bend in separate sections, each of which may be forged in a convenient and economical manner, and subsequently joining these sections by welding in such manner as to insure accurate dimensioning of the finished article. Fabricated in this manner, the header or return bend, while not forged as a complete unit, has all of the desirable characteristics of a single forging, and it is generally more satisfactory than a cast steel header or return bend, both in point of service and in point of safety.

More specifically, each individual forging has a body portion adapted to accommodate a tube and a boss extending laterally from the body portion and adapted to form a cross-over connection to the next tube. A forging of this character may be conveniently and economically made by press forging as disclosed hereinafter. The bosses of two such forgings are then joined together by welding to form a double header or return bend. Where a multiple tube header is to be made, forgings as just described are used at the ends of the header, and intermediate forgings having two oppositely disposed lateral bosses are welded therebetween. As is well understood by those skilled in this art, it is essential in such headers or return bends to have the centers of the tube bores at a specified distance apart, and my invention accomplishes this in a simple and expeditious manner.

My invention may be more clearly understood by reference to the following description and to the accompanying drawings, which form a part of this specification, and in which:

Fig. 1 is a central vertical section through a die for press forging one of the individual sections, the plunger of the press being shown in broken lines;

Fig. 2 is a side elevation of a forging made in the die shown in Fig. 1;

Fig. 3 is a top plan view of the forging shown in Fig. 2;

Fig. 4 is a central vertical section through the forging shown in Figs. 2 and 3 after drilling and cutting;

Fig. 5 is a top plan view of the drilled and cut forging shown in Fig. 4;

Fig. 6 is a side elevation showing in full lines two of the drilled and cut forgings in position for welding to produce a double header, and in broken lines the positions of the forgings after the welding operation is completed;

Fig. 7 is a top plan view of the parts shown in Fig. 6;

Fig. 8 is a central vertical section through the finished double header after machining;

Fig. 9 is a side elevation of a modified forging for use in the production of multiple headers;

Fig. 10 is a central vertical section through the forging shown in Fig. 9 after drilling and cutting;

Fig. 11 is a central vertical section through a multiple header after the welding operation; and

Fig. 12 is a plan view of the header shown in Fig. 11.

Referring more particularly to the drawings, the die 1 shown in Fig. 1 comprises an upper member 2 and a lower member 3 meeting in a horizontal plane at 4. A cylindrical opening 5 extends vertically through the upper member 2 and registers with a cylindrical opening 6 extending part way into the lower member 3 to form a vertical cylindrical recess 7. The vertical cylindrical recess 7 shapes the main body portion of the forging. The members 2 and 3 are also cut away as shown to form a cylindrical

recess 8 extending laterally from the vertical cylindrical recess 7. The lateral recess 8 forms a cylindrical laterally extending boss on the forging, and the plane 4 bisects the recess 8 to permit subsequent removal of the forging from the die.

A removable plug 9 has a head 10 fitting snugly in the outer end of the lateral recess 8 and has a cylindrical handle 11 fitting snugly in semi-cylindrical recesses 12 and 13 in members 2 and 3, respectively. The lower member 3 and the plug 9 are preferably provided with substantially hemispherical protuberances 14 and 15 located centrally of the closed ends of the vertical cylindrical recess 7 and the lateral cylindrical recess 8, respectively. The protuberance 14 is shown as integral with the lower member 3, but it may if desired be formed by a plug inserted in the member 3. The rear face 16 of the head 10 and the corresponding end of the recess 8 are preferably shaped like a frustrum of a cone, as illustrated, in order to facilitate separation of the die members from the plug 9 after the forging operation.

A plurality of plugs 9 having heads 10 of different thicknesses may be provided, so that a single die 1 may be used to make forgings having side bosses of different lengths, depending upon the tube center to center distance desired in the finished header.

In use, the two members of the die 1 are locked together in a suitable forging press with a plug 9 of suitable dimensions in place, and a heated billet, preferably a short piece of round bar steel stock, is dropped into the vertical recess 7. A plunger 20, shown in broken lines in Fig. 1, is then forced downwardly into the vertical recess 7 of the die, thus forcing the hot metal to occupy all of the recesses 7 and 8 of the die. The plunger is then raised, the die unlocked and the upper member 2 is raised, leaving the hot forging and the plug 9 resting upon the lower member 3. The forging is now lifted by means of tongs or other suitable implement, carrying with it the inner end of the plug 9 for a short distance until the plug drops out or is extracted laterally.

The forging 21 so produced will have the shape shown in Figs. 2 and 3 and will comprise a main cylindrical body portion 22 and a cylindrical side boss 23. The length of the boss 23 will depend upon the thickness of the head 10 of the particular plug 3 chosen. The upper end of the body portion 22 will have a depression 24 corresponding in shape to the plunger 20. The lower end of the body portion 22 and the end of the boss 23 will have depressions 25 and 26, corresponding respectively to the protuberances 14 and 15 of the die member 3 and the plug 9.

Portions of the body 22 of the forging 21 are then cut away, preferably by means of an acetylene cutting torch, to form the ears 27 and 28 having slots 29 and 30, respectively, as shown in Figs. 4 and 5. These ears and slots are for the purpose of supporting the customary holding yokes for the closure plugs ordinarily employed in equipment of this kind for sealing the outer ends of the tube bores. It will be understood that the present invention is not concerned with the particular form of closure devices utilized, and that provision might be made for any desired form of such closures. The forging 21 is next drilled to form the tube bore 31 in the body portion 22 and the cross-over connection 32 in the boss 23, as likewise shown in Figs. 4 and 5.

To make a double header, two of the drilled and cut forgings 21 are placed with their bosses 23 facing one another as shown in full lines in Figs. 6 and 7. The ends of the bosses 23 may be then joined together by welding in any desired manner. As stated above, all headers or return bends are made for a definite spacing of the tube centers. The bosses 23 must therefore be of such length that the required distance between the center lines of the tube bores 31 is obtained after the welding operation is completed. If ordinary electric arc welding utilizing a fusible welding rod electrode is to be employed, the ends of the bosses 23 are preferably chamfered so as to form the usual welding groove.

Although electric arc welding may be employed as above described, in the preferred embodiment of my invention I join the two forgings by resistance flash welding. With this type of welding, I make the bosses 23 sufficiently long so that the distance between the center lines of the tube bore 31 is greater at the commencement of the welding operation than is desired in the finished header. Thus, the full lines 35 and 36 in Fig. 7 show the spacing of the center lines of the tube bores 31 prior to welding, and the broken lines 35' and 36' show the spacing of these same center lines after the resistance flash welding operation is completed.

In this resistance flash welding, the welding current is passed directly through the two forgings, and an arc is established between the meeting faces of the bosses 23 by making contact between the two bosses and then separating them slightly. The arc thus established heats the metal at the ends of the bosses, and after a short time this metal begins to melt. The two forgings are then fed slowly towards each other until the distance between the tube bore center lines is a predetermined amount greater than that desired in the finished header. When this predetermined point is reached, the two forgings are pushed rapidly and firmly together until a definite pressure is exerted between them. This last step extinguishes the arc, and the current is cut off after the arc has been extinguished. The extra distance allowed and the pressure to be exerted depend upon the size of the forgings and the welding conditions, and should be determined by experimentation in advance of quantity manufacture. When these factors are properly chosen, the distance between the tube bore center lines of the welded forgings will be within the allowable limits of tolerance.

After the welding operation, the final machining of the header or return bend is performed. The pressure of the two forgings together produces flashes or upsets 37 and 38 at the inside and outside edges of the bosses 23, as shown in broken lines in Figs. 6 and 7. These flashes or upsets may be seen somewhat more clearly in Figs. 11 and 12. The upsets 37 and 39 may be removed partially or wholly as shown in Fig. 8, the outer upset 37 being removed by chipping or otherwise, and the inner upset 38 by the use of an appropriate broaching tool. At the top of the header, the seats 40 are machined very accurately to accommodate the customary closure plugs (not shown) and the tube seats 41 are also machined accurately not only as to their internal dimensions, but so as to maintain the center to center distances of the tube bores within the required tolerance.

When it is desired to manufacture headers or return bends having provision for more than two tubes, forgings 50 such as shown in Fig. 9, are employed in addition to the forgings 21. The forging 50 may be made in a die similar to that

shown in Fig. 1 except that recesses are formed on each side of the vertical cylindrical recesses of the die so that the forging 50 will have bosses 51 and 52 on each side of the body portions 53. The forging 50 is then drilled and cut in a manner similar to the forging 21, as shown in detail in Fig. 10. To make a three tube header, one forging 50 is placed between two forgings 21 and the whole welded together as shown in Figs. 11 and 12. The welding operation may be performed in stages, by first welding one end forging 21 to the central forging 50, and then welding the other end forging 21 to the central forging 50, or the two welding operations may be performed simultaneously if desired. It will be obvious that headers for any desired number of tubes may be made simply by inserting additional forgings 50 between the end forgings 21. The welded forgings shown in Figs. 11 and 12 should, of course, be machined subsequently to the welding operation similarly to the machined header shown in Fig. 8.

It will be apparent that my invention permits the manufacture of headers or return bends accommodating any desired number of tubes from a plurality of individual forgings each of which may be made in an economical and expeditious manner. Furthermore, my invention permits the welding of these forgings in such manner that accurate centering of the respective forgings is obtained. The resistance welded joint of the preferred modification of my invention is formed wholly from the original forged steel of the forging, and hence the welded joint has a strength substantially the same as that of the other portions of the finished header. A further advantage of my invention is that headers of varying tube center distances may be made from the same original forgings, within reasonable limits, and where extreme variations are desired, this may be accomplished with the same die merely by changing the size of the removable plug used during the forging operation.

It will be obvious that various modifications may be made in my invention without departing from the spirit thereof, and I desire to be limited therefore only by the prior art and the scope of the appended claims.

I claim:

1. In combination, a press forging die having a bore therein one end of which opens to the outside of said die, a second bore entirely surrounded by the body of said die intersecting said first bore at right angles, said second bore having a tapered end, a third bore of reduced diameter coaxial with said second bore and connecting the tapered end of said second bore with the outside of said die, said die being split in a plane that includes the axis of said second and third bores, and a plug adapted to fit in the tapered end of said second bore on a shank adapted to fit in said third bore, said plug being positioned in said tapered end to determine the effective length of said second bore.

2. A press forging die, a bore therein having one end in communication with the outside of said die, a second bore entirely surrounded by the body of said die and intersecting said first bore at right angles, a third bore of reduced diameter coaxial with said second bore and connecting one end of said second bore with the outside of said die, there being a shoulder between the communicating ends of said second and third bores and a plug adapted to determine the effective length of said second bore insertable in said second and third bores and adapted to be fixed against movement in one direction by said shoulder, said plug and the bottom of said first bore including work hollowing protuberances.

3. A press forging die, a bore therein having one end open to the outside of said die, a second bore having one end opening into said first bore and having a shoulder at the other end thereof, and a plug insertable in said second bore against said shoulder to close said end of said bore and to determine the effective length thereof said die being split in a plane that includes the axis of said second bore.

4. A press forging die, a bore therein having one end open to the outside of said die, a second bore entirely surrounded by the body of said die intersecting said first bore at right angles, a third bore of smaller cross section than said second bore connecting the end of said second bore with the outside of said die, there being a shoulder between the communicating ends of said second and third bores, and a plug having a head of cross section substantially equal to that of said second bore and a shank of cross section substantially equal to that of said third bore, said plug being insertable in said second and third bores with said head against said shoulder to determine the effective length of said second bore.

5. In a forging machine, in combination, a pair of relatively movable dies forming an impression when in closed position, having bores extending exteriorly thereof, a mandrel having a displacement nose projecting into one of said bores, an enlargement on said mandrel, recesses in said die elements adapted to engage said enlargement thereby locking the mandrel in place and closing the end of the impression, a piercing tool carried by a header slide and having a displacement nose adapted to enter the other end of said impression.

6. A press forging die, a bore therein having one end in communication with the outside of said die, a second bore in said die having one end opening into said first bore, a work shaping mandrel positioned in said second bore against the other end thereof, the sides and other end of said second bore fixing said mandrel against movement in one direction.

7. A press forging die, a bore therein having one end in communication with the outside of said die, a second bore in said die of substantially uniform cross section having one end opening into said first bore, a work shaping mandrel positioned in said second bore against the other end thereof, the sides and other end of said second bore fixing said mandrel against movement in one direction.

8. A press forging die, a bore therein having one end in communication with the outside of said die, a second bore in said die of substantially uniform cross section having one end opening into said first bore, a work shaping mandrel positioned in said second bore against the other end thereof, the sides and other end of said second bore fixing said mandrel against movement in one direction, said die being split in a plane that includes the axis of said second bore.

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