

[54] **SWAGING TOOL**
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 [58] Field of Search 72/399, 402, 407, 415; 29/237, 517; 279/41

[57] **ABSTRACT**

A swaging tool comprising a duality of axially slotted, radially compressible, opposed dies having adjacent generally cylindrical surfaces defining an opening for receiving a workpiece, and outer surfaces including laterally flared side portions, said dies being movable toward each other and including recesses having outwardly flared side portions which urge the side portions of the dies inwardly as such movement takes place so that all portions of the dies are compressed equally, one of the die-carrying members being removable to allow independent association with a workpiece to be swaged.

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13 Claims, 6 Drawing Figures

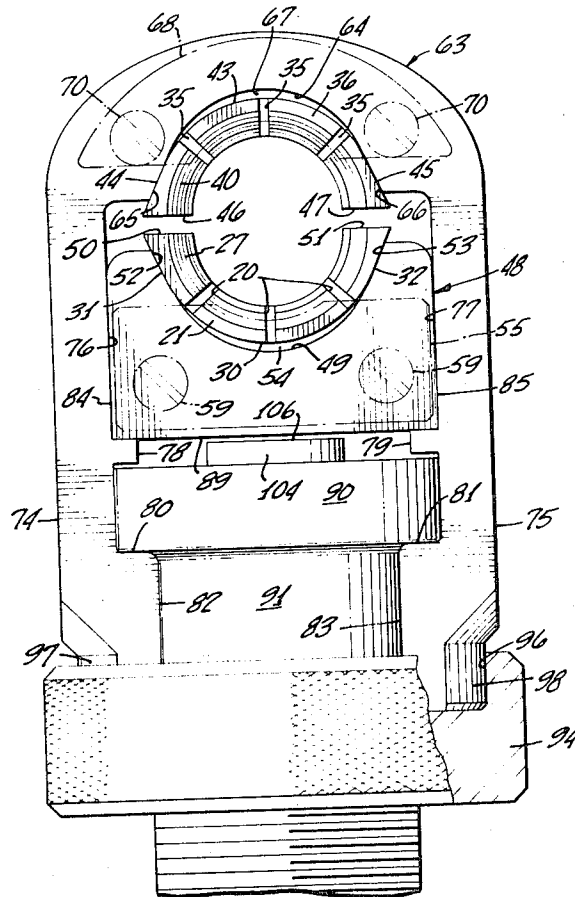


FIG. 2

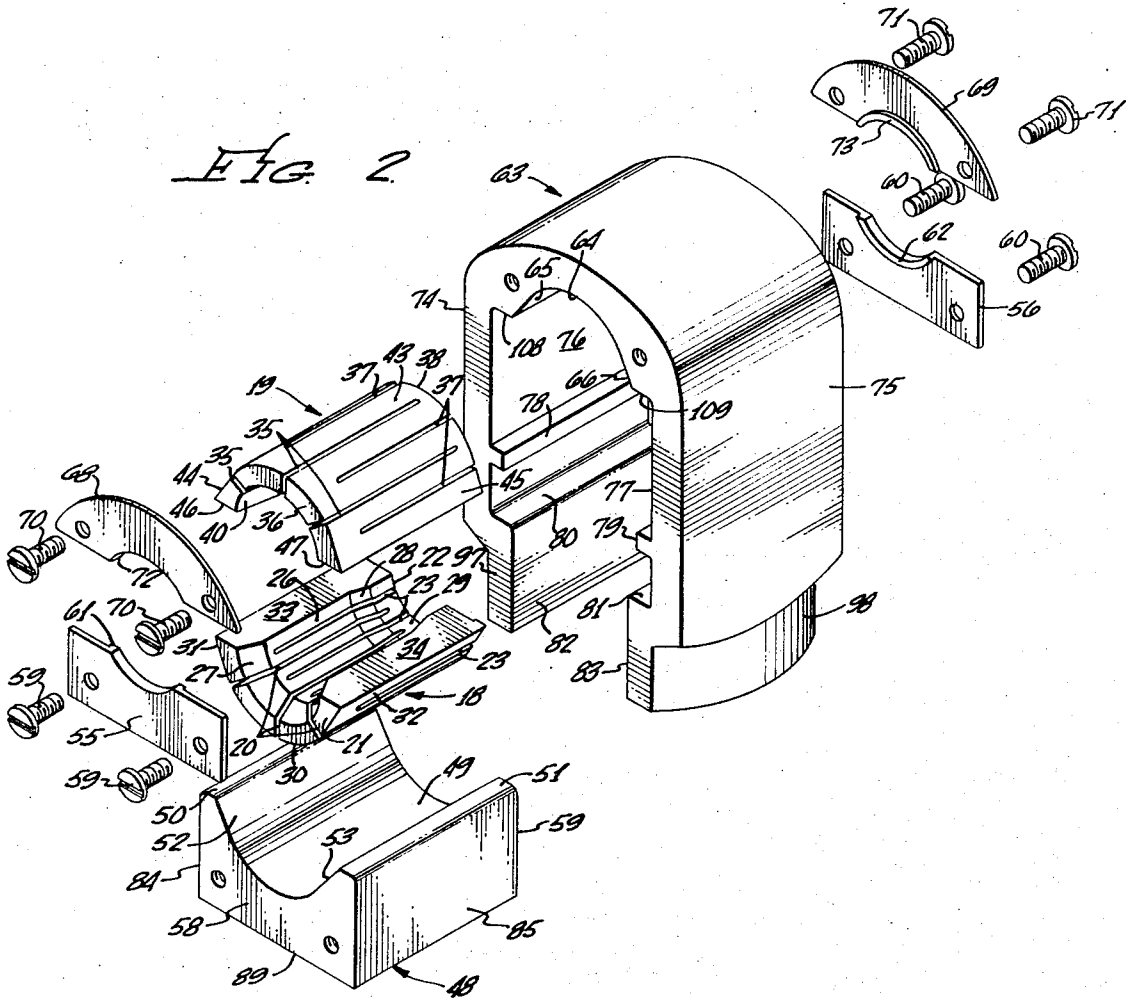


FIG. 1

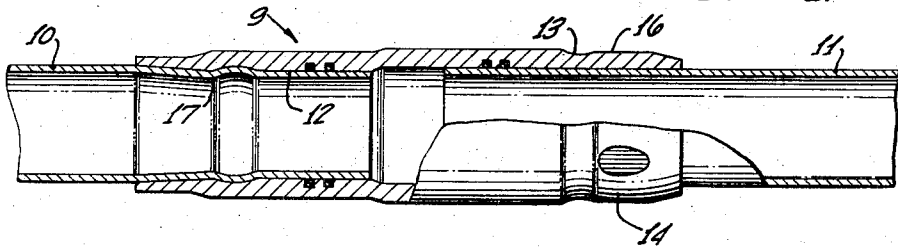


FIG. 3

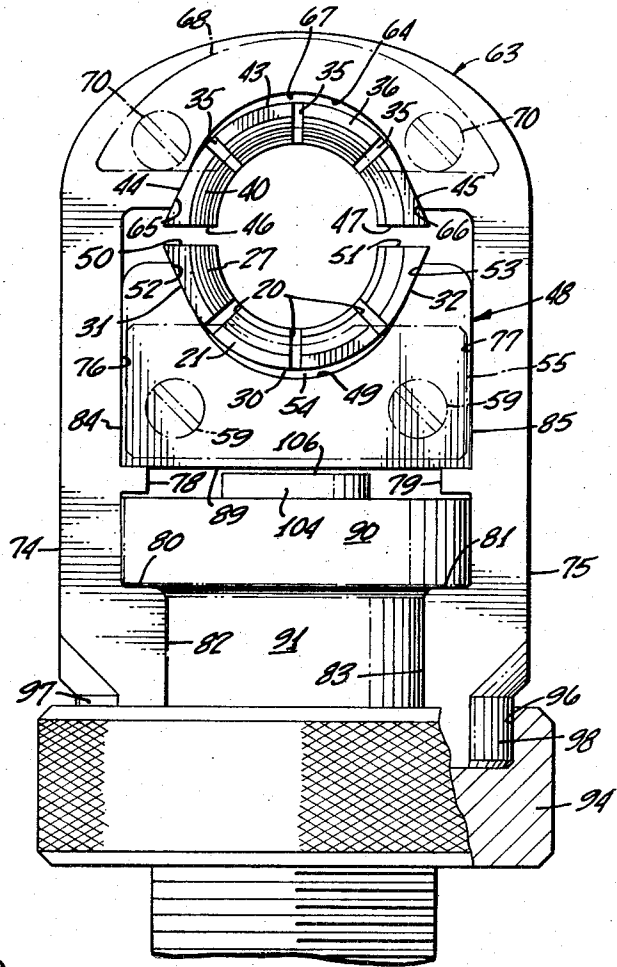
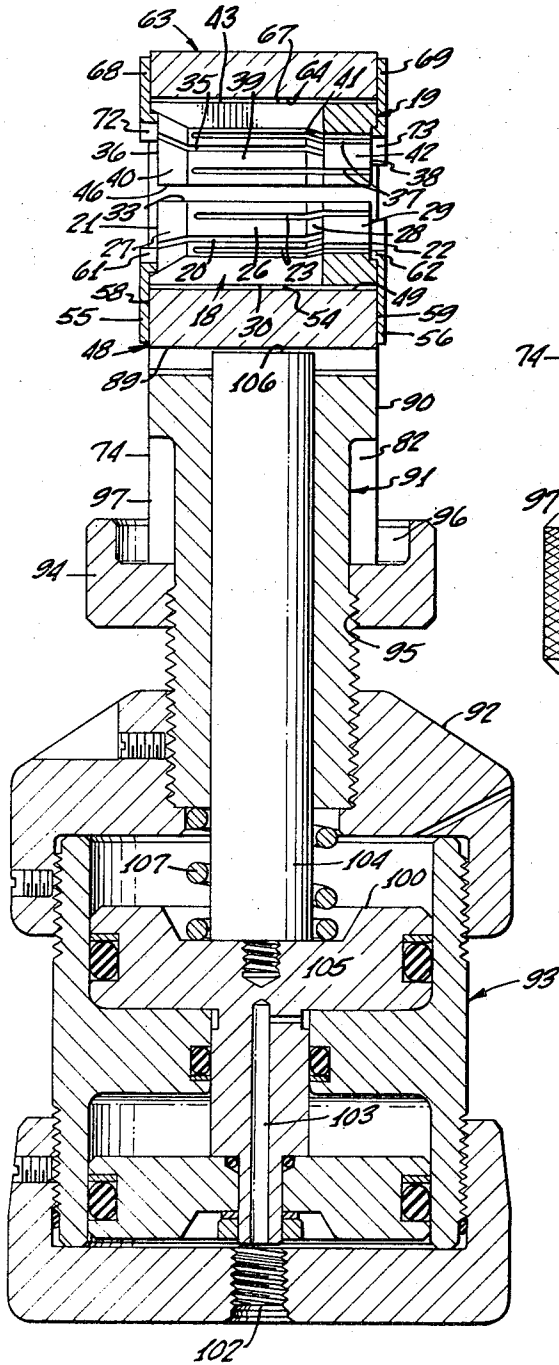


FIG. 4

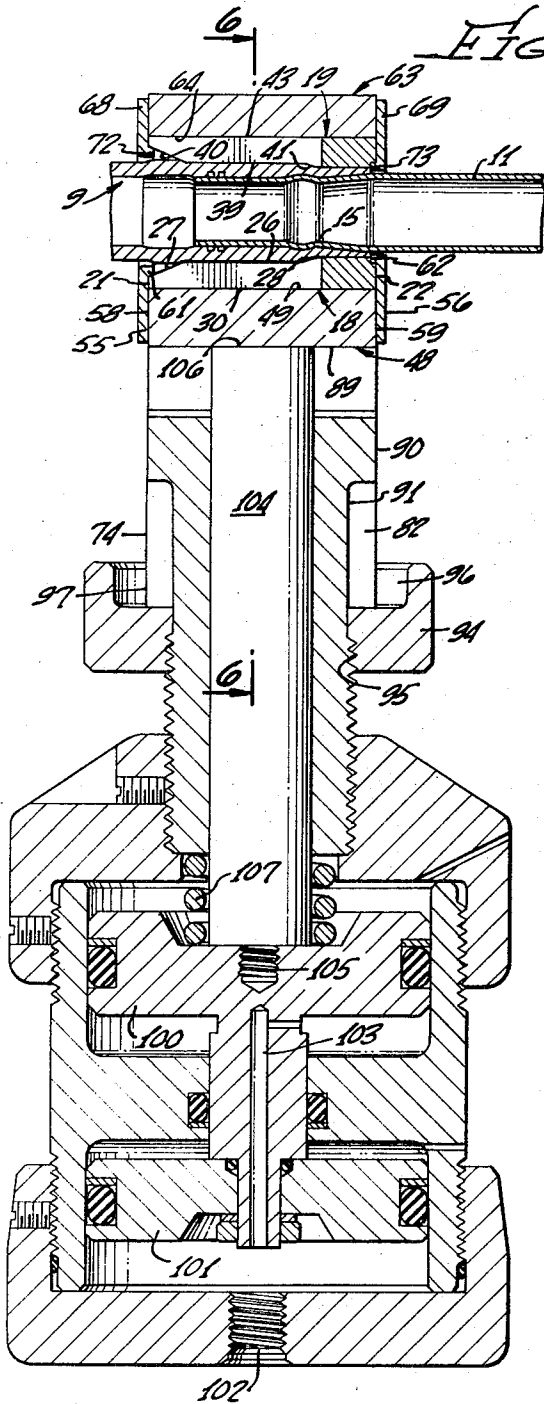


FIG. 5

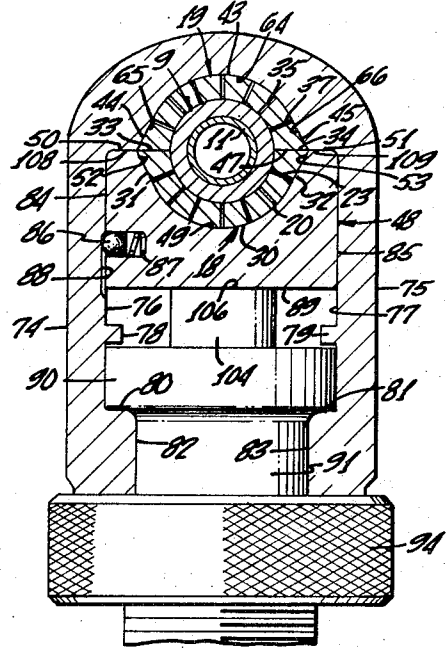


FIG. 6

SWAGING TOOL

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention pertains to a swaging tool.

2. Description of Prior Art

There is an increasing use of swaged hydraulic fittings in hydraulic systems, particularly those in aircraft. Some swaged fittings result in simplified connections to the tube, avoiding brazing, threading or the use of other connecting means. A fitting of this type is shown in U.S. Pat. No. 3,572,779 in which the fitting is a sleeve which fits over the end of the tube, the sleeve having one or more annular ridges on its exterior. The fitting is attached to the tube by compressing the ridges inwardly to flatten them along the outer surface of the fitting, which transfers the contours of the ridges to the inner surface of the fitting. This, in turn, causes indentations in the tube and effects an attachment to the tube. In accomplishing this, it is important that uniform compression be provided around the entire circumference of the fitting. This is necessary to secure a fluid-tight joint and also to enhance the strength of the attachment.

The swaging operation is made more difficult by the cramped quarters within which the swaging operation often must take place. This is particularly true in aircraft hydraulic systems. It may be quite difficult to gain access to the tube, and there may be very little room around it within which to accomplish the swaging operation. Therefore, a satisfactory swaging tool must be compact and should be capable of association with a tube, irrespective of space limitations. Prior-art compression tools, such as those found in U.S. Pat. Nos. 2,182,663, 2,566,000, 3,064,706 and 3,575,036 possess shortcomings such as those discussed above and are not satisfactory in swaging fittings of the type discussed above.

SUMMARY OF THE INVENTION

The present invention provides a simplified tool which will provide uniform compression around the fitting, yet which can be associated with the fitting in almost any limited space application. The tool of this invention includes a pair of dies which together define a substantially cylindrical surface for engaging the exterior of the fitting. These dies are compressible radially by virtue of having longitudinal slots through their walls, extending inwardly from opposite ends. The result is a unitary die member which can be compressed radially by bending the elongated sections defined by the slots.

The exteriors of the dies have central cylindrical portions and flat side portions tangent to the central parts and flaring outwardly therefrom. The outer surfaces of the dies are received by carrying members. The latter include central cylindrical portions of smaller radius than the die surfaces adjacent to them, and flat side surfaces tangent to their central surfaces and complementarily engaging the flat surfaces of the dies.

As a result of this construction, when one member is moved toward the other, the side portions are compressed inwardly an adequate amount, because of the outwardly flaring side surfaces of the dies and the carrier members, to force the sides inwardly against the fitting. The central parts also are compressed to become complementary to the central parts of the carrier members. This produces uniform compression around

the fitting to produce a superior swaged connection, despite the fact that die movement is in only one direction.

One of the die carriers is actuated by the rod of a power cylinder and is movable. The other is a stationary element connected to the body of the power cylinder. The stationary member is in the form of a yoke having a slot at one end receiving a flange on a post extending from the head of the power cylinder. A nut on the post engages the yoke to retain the flange in the slot. This allows the yoke to be removed by loosening the nut. The separated yoke may be placed around a fitting in very cramped quarters, and then rotated as necessary for subsequent attachment to the tool, thereby allowing the tool to be associated with fittings where space is quite limited. This also allows rapid removal of the tool from the fitting once the swaging operation is complete. The construction of the tool also is simple in design so as to be reliable and capable of manufacture at a relatively low cost.

Brief Description of the Drawing:

FIG. 1 is a longitudinal sectional view showing a fitting and associated tubing for swaging by the tool of this invention;

FIG. 2 is an exploded perspective view of the dies and associated portions of the tool;

FIG. 3 is a longitudinal sectional view of the tool with the mechanism retracted;

FIG. 4 is an enlarged end elevational view of the portion of the tool that includes the dies and associated parts, with the die retainer plates removed (but indicated in phantom) for clarity;

FIG. 5 is a longitudinal sectional view of the tool, similar to FIG. 3, but with the power cylinder extended for swaging a fitting; and

FIG. 6 is a sectional view taken along line 6-6 of FIG. 5.

Description of the Preferred Embodiment:

The swaging tool of this invention is particularly adapted for swaging a coupling fitting of the type illustrated in FIG. 1. The fitting 9 is a sleeve which receives the ends of tubes 10 and 11, acting as a union to join the two tubes together. Prior to the swaging operation, as indicated in the right-hand portion of FIG. 1, the interior wall 12 of the fitting 9 is cylindrical. The exterior wall, however, is irregular, having an annular part 13 of reduced diameter adjacent the end, beyond which are an annular ridge or bump 14 and an outwardly tapering part 15 that extends to the end. Flat surfaces 16 are provided around the bump 14, preventing relative rotation of the tube and fitting after the swaging is complete. In the swaging operation, the fitting 9 is compressed inwardly so that it is given an irregular interior configuration and grips the tube tightly. The left-hand portion of FIG. 1 illustrates the fitting following the completion of the swaging operation, with the exterior bump forced inwardly and indentation 17 formed on the inside wall of the fitting 9. The tube 11 is swaged to a configuration complementary to the interior of the fitting, thereby providing a coupling between the fitting and the tubing. When both sides of the fitting 9 are swaged properly, there is a permanent leakproof coupling of the tubing sections 10 and 11.

The swaging tool of this invention includes a pair of identical dies 18 and 19, illustrated in perspective in

the exploded view of FIG. 2. These are unitary members having slots extending inwardly from either end to allow compression of the dies. The die 18 includes three parallel longitudinal slots 20 through its wall, extending inwardly from the end 21, which is positioned at the left in the illustration of FIG. 2. The central slot 20 is at the middle of the die 18, and the outer slots 20 are equally spaced from it. The slots 20 pass through the wall of the die radially, and extend to a location adjacent the opposite end 22.

There are additional and similar parallel longitudinal slots 23 through the wall of the die 18, extending inwardly from the right-hand end 22. There are four of the slots 23, which are equally spaced and positioned on either side of the other longitudinal slots 20. The slots 23 stop short of the end 21 of the die. By virtue of the two sets of slots 20 and 23 extending inwardly from opposite ends of the die 18, the die is made up of parallel, elongated bendable elements and so is compressible in the radial direction.

The inner surface of the die 18 is recessed, including an elongated central portion 26 of cylindrical shape. One end of the central portion 26 connects to a relatively short frustoconical part 27 that extends to the end 21. At the opposite end of the die, there is a frustoconical portion 28 that leads to a short cylindrical section 29 of smaller diameter than the portion 26. The cylindrical portion 29 connects to the end 22.

The outer surface of the die 18 is convex, including a central portion 30 which is of cylindrical contour, having the same axis as that of the central portion 26 of the inner surface. Adjacent the longitudinal side edges, however, are exterior surfaces 31 and 32 which are flat and tangent to the central cylindrical exterior surface 30. This means that the surfaces 31 and 32 flare outwardly from a cylindrical contour, increasing the wall thickness of the die adjacent its longitudinal side edges 33 and 34.

In a similar manner, the die 19 includes three longitudinal slots 35 extending inwardly from the left-hand end 36 and four longitudinal slots 37 extending inwardly from the opposite end 38. The slots 35 stop just short of the end 38, while the other slots 37 do not reach the end 36. The interior of the die 19 includes a central cylindrical portion 39 at the left-hand end of which, as illustrated in FIG. 3, is a beveled portion 40 that flares outwardly to its intersection with the end 36. At the opposite end of the central portion is a bevel or frustoconical portion 41 that extends to a short cylindrical section 42 of smaller diameter that interconnects with the right-hand end 38. The exterior of the upper die 19 has a central portion 43 defined by a cylindrical segment, and flat sides 44 and 45, tangent to the central portions 43, which extend to the longitudinal side edges 46 and 47.

The lower die 18 is received within a die holder 48. This member includes an upper surface having a central portion 49 which is contoured as a cylindrical segment having a radius of curvature slightly less than that of the radius of curvature for the central portion 39 of the outer surface of the die 18. Adjacent the longitudinal edges 50 and 51 of the die holder 48 are flat surfaces 52 and 53 which are tangent to the central portion 49 of the upper surface of the die holder. The flat surfaces 52 and 53 are at the same angle as the exterior flat surfaces 31 and 32 of the die 18. Consequently, when the die 18 is positioned within the die holder 48,

there is complementary engagement between the flat surfaces 31 and 52, and 32 and 53 of the die and die holder, respectively. However, as appears in FIG. 4, there is a clearance space 54 between the central exterior portion 30 of the die 18 and the central portion 49 of the upper surface of the die holder 48.

The die 18 is held to the die holder 48 by means of flat plates 55 and 56 which engage the opposite flat end walls 57 and 58 of the die holder, to which they are held by screws 59 and 60. The central upper edges of the plates 55 and 56 are recessed and provided with inwardly extending flanges 61 and 62 which overlap and fit within recessed portions at the ends of the die 18, assuring that the die 18 is retained by the die holder 48.

The upper die 19 fits within a yoke 63 which has an upper inside surface having a central portion 64 which is a cylindrical segment similar to the central portion 49 of the die holder 48. There are flat surfaces 65 and 66 tangent to the surface 64 of the yoke 63 and corresponding to the flat surfaces 52 and 53 of the die holder 48. Consequently, when the die 19 is received in the yoke 63, the side exterior flat surfaces 44 and 45 of the die complementarily engage the flat surfaces 65 and 66 of the yoke 63, while there is a gap 67 between the central exterior surface 43 of the die 19 and the central surface 64 of the yoke. Retainer plates 68 and 69, held to the yoke 63 by screws 70 and 71, are provided with short, central, inwardly directed flanges 72 and 73 which overlap the recessed ends of the die 19 and hold the die to the yoke.

The yoke 63 includes parallel sidewalls 74 and 75 having flat upper inner surface portions 76 and 77, near the lower ends of which are inwardly directed transverse flanges 78 and 79, respectively. The inner wall surfaces 76 and 77 terminate at their lower ends in inwardly directed longitudinal shoulders 80 and 81. Beneath these shoulders, the sidewalls 74 and 75 have flat, parallel inner surfaces 82 and 83, respectively, which are closer together than the surfaces 76 and 77.

The flat, parallel sidewalls 84 and 85 of the die carrier 48 fit substantially complementarily between the inner surfaces 76 and 77 of the sidewalls 74 and 75 of the yoke 63. The die carrier 48 is retained between the walls 74 and 75 by means of a ball 86 that fits within an opening in the die carrier, biased outwardly by a spring 87 into a groove 88 in the surface 76 of the wall 74, as seen in FIG. 6. The bottom surface 89 of the die carrier 48 engages the upper surfaces of the flanges 78 and 79 of the yoke 63 when the mechanism is in its retracted position, as shown in FIGS. 3 and 4. This positions the lower die 18 opposite from the upper die 19, with the dies then defining an opening between them which is slightly elongated in the vertical direction as shown.

Between the flange 78 and the shoulder 80 of the sidewall 74, and the flange 79 and shoulder 81 of the sidewall 75 is positioned a circular flange 90 which is at the upper end of a tubular post 91. The lower end of the post 91 is threaded into the head 92 of a power cylinder 93. A nut 94, knurled around its periphery, has a lower threaded part 95 of relatively small interior diameter threaded onto the intermediate portion of the post 91. At the upper end of the nut 94 is an axial recess 96, of larger diameter than the opening 95, which receives the lower ends 97 and 98 of the yoke sidewalls

74 and 75, respectively, which have arcuate outer surfaces complementary to the wall of the recess 96.

Typically, the power cylinder 93 is hydraulically operated and, in the embodiment illustrated, includes two pistons 100 and 101 for enhanced force. Fluid can enter the cylinder 93 through an inlet 102 adjacent the lower piston 101 and travel through a passageway 103 to the zone behind the upper piston 100.

A rod 104 has a threaded lower end 105 of reduced diameter, which is received in a threaded opening in the upper piston 100 so that the rod will move with the two pistons. The rod 104 extends generally complementarily through the tubular post 91, with its upper end 106 being positioned immediately below the lower surface 89 of the die holder 48. A return spring 107 circumscribes the lower end portion of the rod 104, bearing against the lower end of the post 91 and the upper side of the piston 100 to force the pistons to their retracted positions in the absence of fluid pressure within the power cylinder.

In operation of the device, a fitting to be swaged is placed between the dies 18 and 19, with the mechanism in the retracted position. The flanges 62 and 73 of the die retainer plates 56 and 69 have corners extending into the die opening (see FIG. 5) which are engaged by the end of the fitting 9. Thus, the plates 56 and 69 act as stops that locate the fitting in the proper position axially relative to the dies 18 and 19.

Pressurized fluid then is admitted to the power cylinder 93, forcing the piston rod 104 upwardly against the die holder 48. This moves the die 18 toward the die 19 until the side edges 50 and 51 of the die carrier 48 engage lateral surfaces 108 and 109, respectively, of the yoke 63 adjacent the recess for the die 19, which terminates the swaging stroke. The dies are compressed as this takes place, reducing the radius of curvature of the opening they define, which swages the fitting 9 and attaches it to the tubing received within it. The outward force on the dies is absorbed by the flange 90 at the end of the post 91, through its engagement with the shoulders 80 and 81 of the yoke, these abutments thereby holding the yoke 63 to the power cylinder 93. The wall of the recess 96 in the nut 94 prevents the sidewalls 74 and 75 of the yoke from spreading outwardly when the force is applied. When the fluid pressure is released and the return spring moves the pistons to their retracted positions, the fitting may be removed from the tool and the swaging operation is complete.

Even though the tool of this invention is uncomplicated and compact, operating with only two dies and through motion in only one direction, the fitting 9 is compressed evenly around its entire circumference as the swaging takes place. This provides an improved joint between the fitting and tube, with more assurance of a fluid-tight connection and greater strength.

The uniformity in swaging occurs because of the construction of the dies 18 and 19 and the contours of their outer surfaces, as well as the surfaces of the die holder 48 and the yoke 63 that engage them. Because the side parts of the die exteriors and the corresponding surfaces of their adjacent holding members flare outwardly from the central cylindrical portions, the dies compress inwardly at their longitudinal side edges, irrespective of the fact that the only die movement is perpendicular to the transverse plane between the dies. Thus, as the die holder 48 moves upwardly, its flat surfaces 52 and 53, bearing against the flat surfaces 31 and

32 on the exterior of the die 18, respectively, cause the longitudinal side portions of the die 18 to move inwardly toward the axis of the die. A similar effect occurs from the engagement of the flat surfaces 65 and 66 of the yoke 63 with the flat surfaces 44 and 45 on the exterior of the die 19.

When the piston rod 104 is at the upper end of its stroke, and the longitudinal side edges 33 and 34 of the die 18 and the side edges 46 and 47 of the die 19, respectively, are brought into engagement, as shown in FIG. 6, the central parts of the dies are compressed as the central cylindrical exterior surfaces of the dies are caused to assume the contours of the cylindrical portions of their holding members. In other words, the cylindrical exterior part 30 of the die 18 is compressed to fit within the cylindrical surface 49 of the die holder 48. Also, the central cylindrical portion 43 of the die 19 is compressed to assume the smaller configuration of the cylindrical surface 64 of the yoke 63. The slotted construction of the dies allows the contraction to take place as the segments of the dies bend and the slots close up.

The combined effects of the side and central surfaces of the dies and die holders produce the uniform swaging around the circumference of the fitting.

Another advantage to the swaging tool of this invention arises from the ready removability of the yoke 63. Upon loosening the nut 94, the yoke 63 may be slid off the flange 90 of the post 91, allowing the yoke to be separated from the remainder of the tool for initial association with a fitting to be swaged. The nut 94, being knurled and large in diameter, is easily and rapidly loosened from the threads of the post 91. When there is limited access to the fitting to be swaged, such as may occur in swaging fittings on aircraft, the separated yoke 63 can be turned in any direction in order to enable it to be placed around the tubing prior to the attachment of the remainder of the tool. Then, the yoke 63 may be rotated as necessary before the tool is reassembled as the nut 94 is tightened onto the threads of the post 91. Of course, after the swaging is complete, the yoke again is removed to allow the tool to be separated from the tubing. The rapid assembly and disassembly of the yoke with the remainder of the tool greatly enhance the versatility and practicality of the tool of this invention.

The ability to obtain uniform circumferential compression of the dies 18 and 19, despite movement only in one direction, allows the tool to be more compact and reliable than if auxiliary means were used to compress the side portions of the dies. The latter would require additional mechanism, with attendant increase in size and complexity. The ability to swage in areas of limited space would be lost.

The foregoing detailed description is to be clearly understood as given by way of illustration and example only, the spirit and scope of this invention being limited solely by the appended claims.

I claim:

1. A swaging tool comprising a duality of dies,

each of said dies including a plurality of substantially parallel elongated elements collectively having an inner surface defining a generally semi-cylindrical contour, and an outer surface having a central part made up of a plurality of said elements collectively defining a generally cylindrical

cal segment and side parts flatter than said central part and flaring outwardly therefrom, said elements of each of said dies being spaced apart so as to provide a means for permitting radial compression thereof so as to reduce the radius of curvature of said inner surface,

a member carrying each of said dies, each of said members including a surface adjacent said outer surface of the die carried thereby, said surface of each of said members including a central part defined by a generally cylindrical segment of smaller radius than that of said generally cylindrical segment of said central part of said outer surface of said die carried thereby, and having side parts flatter than said central part of said member and flaring outwardly therefrom, said side parts of said member engaging said side parts of said die carried thereby, said central part of each of said members being normally spaced from said central part of said die carried thereby,

and means for moving said members relatively toward each other for compressing said dies and swaging a workpiece therebetween.

2. A device as recited in claim 1 in which said side parts of said outer surfaces of said dies are substantially flat surfaces tangent to said central parts of said outer surfaces.

3. A device as recited in claim 2 in which said side parts of said members are substantially flat surfaces tangent to said central parts of said members, said substantially flat surfaces of each of said members being substantially in complementary engagement with said substantially flat surfaces of the die carried thereby.

4. A device as recited in claim 3 in which, for said means for spacing said elements apart and permitting radial compression of said dies, each of said dies is a unitary member provided with a plurality of longitudinal slots therethrough, said slots including a plurality of first slots extending axially inwardly from one end of said die and stopping short of the opposite end of said die, and a plurality of second slots extending inwardly from said opposite end of said die and stopping short of said one end of said die.

5. A device as recited in claim 4 in which said first slots are intermediate said second slots.

6. A device as recited in claim 5 in which, for said means for moving said members relatively toward each other, there is included

power means for moving one of said members toward the other of said members, and means for holding said other member stationary relative to said power means.

7. A device as recited in claim 6 in which said means for holding said other member stationary is removable for permitting said other member and said die carried thereby to be separated from said power means and independently associated with a workpiece to be swaged.

8. A device as recited in claim 6 in which said other member is a yoke carrying one of said dies in the intermediate portion thereof.

9. A device as recited in claim 8 in which said means for holding said other member stationary includes interengaging abutment surfaces on said yoke and said power means, said abutment surfaces being disengageable, and means for normally preventing disengagement of said abutment surfaces.

10. A device as recited in claim 8 in which, for said means for holding said other member stationary, said power means includes an elongated member having a flange thereon, said yoke having opposed sidewalls having shoulders thereon engageable with said flange, and including means for holding said flange between said sidewalls.

11. A device as recited in claim 10 in which said means for holding said flange between said sidewalls includes

a nut, said elongated member having threads thereon engaged by the threads of said nut, said nut having a recess receiving the ends of said yoke for preventing substantial lateral movement of said yoke relative to said elongated member.

12. A device as recited in claim 11 in which said elongated member is a hollow post, and in which said power means includes a power cylinder and a rod extending through said post for engagement with said one member remote from said intermediate portion of said yoke.

13. A swaging tool comprising a duality of dies,

each of said dies being a unitary member having a plurality of slots alternately extending inwardly from its opposite ends so as to provide a plurality of substantially parallel elongated elements, said elements collectively defining an arcuate inner surface, said elements collectively defining an outer surface with an arcuate central part made up of a plurality of said elements, and side parts flatter than said central part and flaring outwardly therefrom,

a carrying member for each of said dies, each of said carrying members including a surface adjacent said outer surface of the die carried thereby, said surface of each of said carrying members including an arcuate central part of greater curvature than that of said arcuate central part of said die carried thereby, and side parts flatter than said central part of said carrying member and flaring outwardly therefrom, said side parts of said carrying member engaging said side parts of said die carried thereby, said central part of each of said surfaces of said carrying members being normally spaced from said central part of said die carried thereby, and means for moving said carrying members relatively toward each other for compressing said dies and swaging a workpiece therebetween.

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