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APPARATUS FOR TESTING THE EFFECTIVENESS OF TUBE ROLLING

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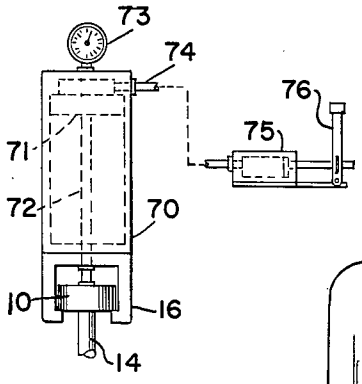


FIG. 4

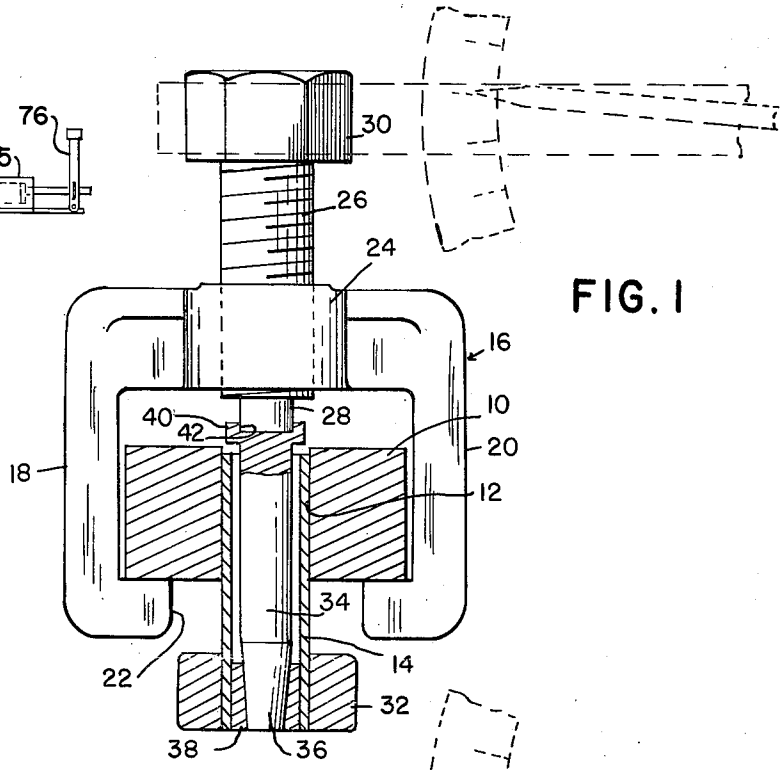
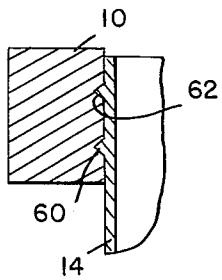


FIG. 1

FIG. 3.



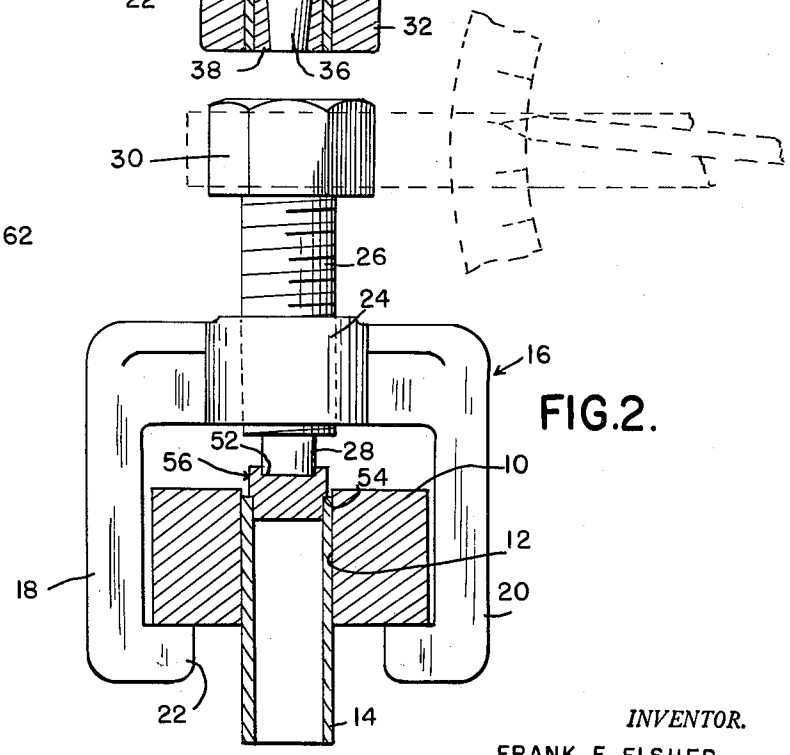


FIG. 2.

INVENTOR.

FRANK F. FISHER

BY Whittemore, Hulbert & Belknap

ATTORNEYS

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APPARATUS FOR TESTING THE EFFECTIVENESS OF TUBE ROLLING

Frank F. Fisher, Detroit, Mich., assignor to The Airetool Manufacturing Company, Springfield, Ohio, a corporation of Ohio

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12 Claims. (Cl. 73—88)

The present invention relates to apparatus for testing the effectiveness of tube rolling.

At the present time tube rolling equipment is available for expanding the ends of tubes into openings in tube sheets or headers and this equipment may be associated with control mechanism for insuring uniformity of tube rolling. A typical example of tube rolling equipment and a control system therefor is shown in my prior Patent No. 2,355,852, wherein means are provided responsive to current supplied to a motor for actuating the tube rolling equipment, adapted to terminate the tube rolling operation when the current reaches a predetermined value.

Thus, in effect, the tube rolling operation is controlled automatically so as to produce substantially identical results on each tube as its end is expanded into interlocking engagement in the hole in the tube sheet. Moreover, the control instrumentality is adjustable so that it may be set to produce the optimum holding strength and stability of the rolled joint. It will be understood that tube joint strength will decrease if tube expansion is either increased or decreased from its optimum value.

When employing equipment of this sort it is of course desirable to check the results of the tube rolling operation so as to insure proper setting of the control instrumentality so as to produce optimum results.

It is an object of the present invention to provide apparatus, and more particularly, simple hand operated apparatus, for checking the effectiveness of a tube rolling operation. Thus, in setting the control instrumentality for the tube rolling equipment, sample tubes are rolled into a test block and the results checked and measured to be sure that the setting of the control instrumentality is such as to produce optimum results.

More specifically, it is an object of the present invention to produce simple and easily operated apparatus designed to check the amount of force required to remove an expanded tube end from a hole in a test block.

It is a further object of the present invention to provide apparatus effective to produce a direct indication of the effectiveness of a tube rolling operation in expanding the metal of a tube end into annular grooves provided in a hole in a test block.

It is a further object of the present invention to provide apparatus for testing the effectiveness of a tube rolling operation which comprises a two-piece test block having an annular groove provided in a hole therein to permit separation of the pieces of the test block to permit inspection of the rib produced on a tube by the groove in the test block.

Other objects and features of the invention will become apparent as the description proceeds, especially when taken in conjunction with the accompanying drawings, wherein:

Figure 1 is an elevational view, partly in section, showing apparatus for testing the strength of a joint produced by expanding the end of a tube in a test block.

Figure 2 is a view similar to Figure 1, illustrating a variation of the apparatus illustrated in Figure 1.

Figure 3 is a fragmentary sectional view illustrating the use of an annular groove in the test block to produce corresponding ribs in the expanded end of the tube.

Figure 4 is an elevational view of testing apparatus similar to that illustrated in Figures 1 and 2, used in conjunction with a hydraulic cylinder.

Referring now to Figure 1, there is illustrated a test block 10 having a cylindrical opening 12 extending therethrough. The test block is designed for use with a portion of a tube 14 which is used in the test. In completing the test the end of the tube 14 is inserted into the opening 12 of the block 10 and is expanded into contact with the interior surface of the hole or opening 12 by suitable tube rolling equipment.

In order to test the effectiveness of the tube rolling operation there is provided a supporting yoke 16 having arms 18 and 20 which terminate in inwardly extending portions 22 adapted to underlie and support the test block 10. The support yoke 16 is provided with an enlarged boss 24 which is internally threaded to receive a screw 26. The lower end of the screw 26 is reduced as indicated at 28, and its upper end is provided with a suitable head 30 by means of which the screw may be turned with a torque wrench or similar measuring means.

In the embodiment of the invention illustrated in Figure 1 means are provided connecting the screw 26 to the tube 14 so as to pull the tube out of the test block 10. This means comprises a stiffening ring 32 which surrounds the lower end of the tube 14. A plunger 34 is provided adapted to extend through the tube 14 and having at its lower end a tapered portion 36. Intermediate the tapered portion 36 of the plunger 34 and the inner surface of the tube 14 is a split expanding ring 38, the inner surface of which is tapered in conformity with the tapered portion 36 of the plunger 34. The upper end of the plunger 34 is provided with a head 40 recessed as indicated at 42, for the reception of the lower end portion 28 of the screw 26.

In use, a torque wrench is provided with means associated therewith for measuring the torque applied when the wrench is applied to the head 30, and the screw 26 is rotated in a direction tending to move the plunger 34 downwardly. Downward movement of the plunger 34 cams the sections of the split ring 38 outwardly, thus gripping the lower end of the tube 14. At the same time, a downward pull is applied to the tube 14 tending to pull the tube out of the hole 12 in the test block 10. When sufficient torque has been applied to the screw to build up the force necessary ot break the joint between the expanded tube end and the test block 10, the reading on the torque wrench indicator will give an indication of the force which was required to break the joint. Similar tests may be run on other tube sections in which different adjustments have been made in the control apparatus for the tube rolling equipment and thus the optimum setting of the control instrumentality arrived at.

In Figure 2 there is illustrated a similar arrangement employing many of the same parts illustrated in Figure 1, and these parts will not again be described in detail. In this illustrated embodiment of the invention means are provided for connecting the lower end 28 of the screw 26 in such a manner as to push the tube 14 downwardly so as to break the joint between the tube and the test block 10. For this purpose an abutment member 56 is provided having a recess 52 at its upper end for receiving the reduced end 28 of the screw 26. The abutment member is provided with a shoulder 54 adapted to rest upon the upper end of the tube 14 and the abutment member is dimensioned so as to permit its entry into the upper end of the hole 12 provided in the block 10.

The operation of this embodiment of the invention is identical with that above, the only difference being that

the force developed by the screw **26** tending to move the tube **14** longitudinally of the opening **12** in the block **10** is applied as a push to the upper end of the tube **14**, rather than as a pull to the lower end thereof.

Preferably, the interior of the hole **12** is a smooth cylindrical hole even though the rolling equipment is being tested for its effectiveness in carrying out a tube expanding operation in conjunction with an internally grooved hole. It is found that up to and including the optimum degree of expanding a substantially definite and invariable relationship exists between the force required to remove an expanded tube end from a smooth hole and a similarly expanded tube end from a hole provided with grooves of definite shape and number. However, it is possible, if desired, to provide internal grooves in the hole **12** of the block **10** in order to obtain the actual strength of joints thus equipped.

As seen in Figure 3, the block **10** may be provided with one or more (and preferably two) grooves **60**, into which the material of the tube **14** is expanded to produce ribs **62**. Obviously, the presence of the rib **62** requires a substantially greater force to move the expanded tube out of the test block, but as indicated above, this force bears a substantially constant relationship to the force required to move the tube out of a smooth hole, assuming an identical expanding or tube rolling operation.

In Figure 3 the grooves **60** are indicated as of generally V-shape in cross-section. It will be appreciated however that grooves of different cross-section may be provided in conformity with the types of grooves which will be encountered in the actual production tube rolling. Thus, grooves of rectangular cross-section or semi-circular cross-section may be provided in the test block as required, the rectangular shape being used more than others.

In the embodiment of the invention illustrated in Figures 1 and 2, the force for moving the expanded tube out of the test block is developed by a torque measuring wrench applied to the screw **26**. However, in some cases it is preferable to employ a different power means for moving the tube.

In Figure 4 there is illustrated an arrangement in which the supporting yoke **16** has secured thereto a power cylinder **70** containing a piston **71** connected to a piston rod **72**. The test block **10** is supported in the yoke in the same manner as illustrated in Figures 1 and 2 and a force is applied to the tube **14** tending to move it longitudinally of the hole in the test block in the same manner as illustrated in Figures 1 and 2. Thus the lower end of the piston rod **72** may fit within a recess provided in a plunger such as illustrated at **34**, associated with the expanding sectional ring **38** and the stiffening ring **32**. Alternately, the lower end of the piston rod **72** may cooperate with an abutment member such as illustrated at **56** in Figure 2.

The cylinder **70** has connected thereto a pressure gauge **73** giving a direct indication of the pressure prevailing within the cylinder **70** above the piston **71**. Connected to the upper end of the cylinder **70** by a conduit indicated at **74** is a pump **75** provided with a manual operating handle **76** so that the operator may by manipulation of the handle **76**, build up sufficient pressure within the cylinder **70** to break the expanded tube loose from the test block **10**. It is only necessary for the operator to watch the gauge **73** as the pressure is increased to determine the pressure prevailing when the tubes moves with respect to the test block.

It will be appreciated that in tube rolling optimum results are obtained at an intermediate setting of the control instrumentality, and accordingly, it is of the utmost importance to be able to determine by actual tests or inspection when the optimum result is obtained.

The present testing apparatus permits ready testing of the expanded joint on the job and permits the necessary number of tests to be run to determine the optimum setting of the control instrumentality.

The drawings and the foregoing specification constitute a description of the improved apparatus for testing the effectiveness of tube rolling in such full, clear, concise and exact terms as to enable any person skilled in the art to practice the invention, the scope of which is indicated by the appended claims.

What I claim as my invention is:

1. Testing apparatus for testing the effectiveness of tube rolling comprising a test block having a hole extending therethrough from end to end in which a tube is rolled, a support for said block extending across one end of said block and including means engaging the opposite end thereof, means on the portion of said support extending across said one end thereof and including a member extending into and movable axially of the hole in said block, means for connecting said member to a tube rolled in the hole in said block at a point beyond said block from said one end thereof to apply a pull to the rolled connection, actuating means for moving said member axially of the hole to free the tube from said block, and means for measuring the force required to move the tube longitudinally of the hole in said block.

2. Testing apparatus as defined in claim 1 in which the means for connecting said member to the tube comprises a shouldered abutment element received in the end of the tube adjacent said member, the shoulder thereon being shaped to engage the end of the tube and to be receivable within the hole in said block.

3. Testing apparatus as defined in claim 1 in which the means for connecting said member to the tube comprises a stiffening ring surrounding the tube at the opposite side of said block from said member, said member including a tapered portion movable longitudinally of the tube, and a sectional expansion ring having a tapered inner surface received in the tube opposite said stiffening ring cooperable with the tapered portion of said plunger.

4. Testing apparatus as defined in claim 1 in which the actuating means comprises a screw threaded to said support axially of the hole in said block and means for operatively connecting said screw to said member.

5. Testing apparatus as defined in claim 4 which comprises means for rotating said screw, and means for measuring the torque to said screw.

6. Testing apparatus as defined in claim 5 in which the means for rotating the screw and measuring the torque comprises a torque wrench including torque indicating means.

7. Testing apparatus as defined in claim 1 in which the actuating means comprises a power cylinder, a piston therein, a piston rod for moving said member, means for forcing fluid into said cylinder, and a gauge for indicating pressure of fluid in said cylinder.

8. Testing apparatus as defined in claim 1, the interior of said hole being smooth.

9. Testing apparatus as defined in claim 1, the interior of said hole having an annular groove therein.

10. Testing apparatus for testing the effectiveness of tube rolling comprising a test block having a hole therein provided with an internal annular groove into which a tube is expanded by rolling, and means for determining the effectiveness of the rolling operation in producing ribs conforming to said grooves comprising means for forcing the tube out of said block and means for measuring the force required to free the tube from said block.

11. Testing apparatus for testing the effectiveness of tube rolling comprising a test block having a hole extending therethrough from end to end in which a tube is rolled, a support for said block extending across one end of the block and including means engaging the opposite end thereof, means on said support including a threaded member movable axially of the hole in said block upon rotation thereof, means extending at least in part into the tube for connecting said threaded member to the tube in said test block, and a torque wrench for rotating said threaded member.

12. Testing apparatus as defined in claim 11 in which

said means comprises a headed element having a shoulder engageable with the end of said tube and a seat for receiving the end of said threaded member to apply forces tending to push the tube out of said block upon rotation of said threaded member.

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