

Jan. 10, 1950

J. L. HOLMQUIST ET AL.
METHOD OF INCREASING THE AXIAL TENSILE
STRENGTH OF THREADED JOINTS

2,494,128

Filed Nov. 14, 1945

3 Sheets-Sheet 1

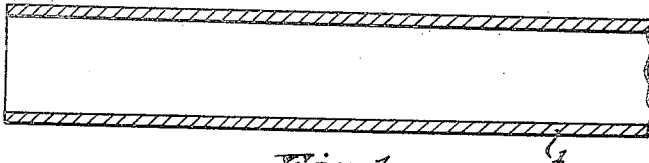


Fig. 1.

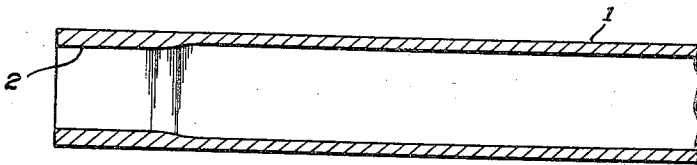


Fig. 2.

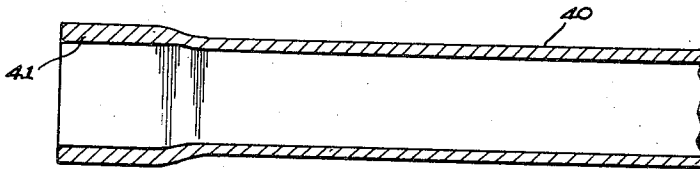


Fig. 3.

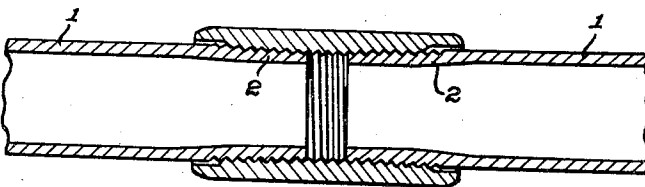


Fig. 4.

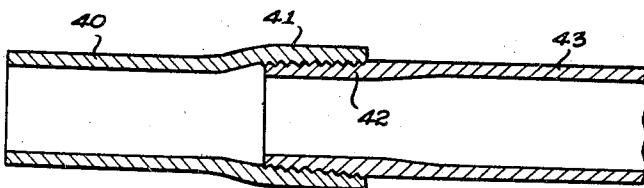


Fig. 5.

WITNESSES:
E. J. Maloney.

INVENTORS.
John J. Holmquist
Paul W. Phares
BY
Brown, Cottle & Fish
their ATTORNEYS.

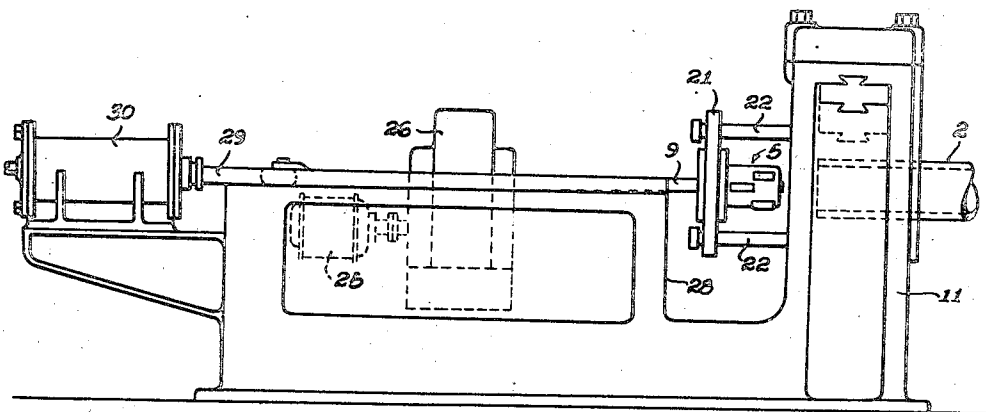
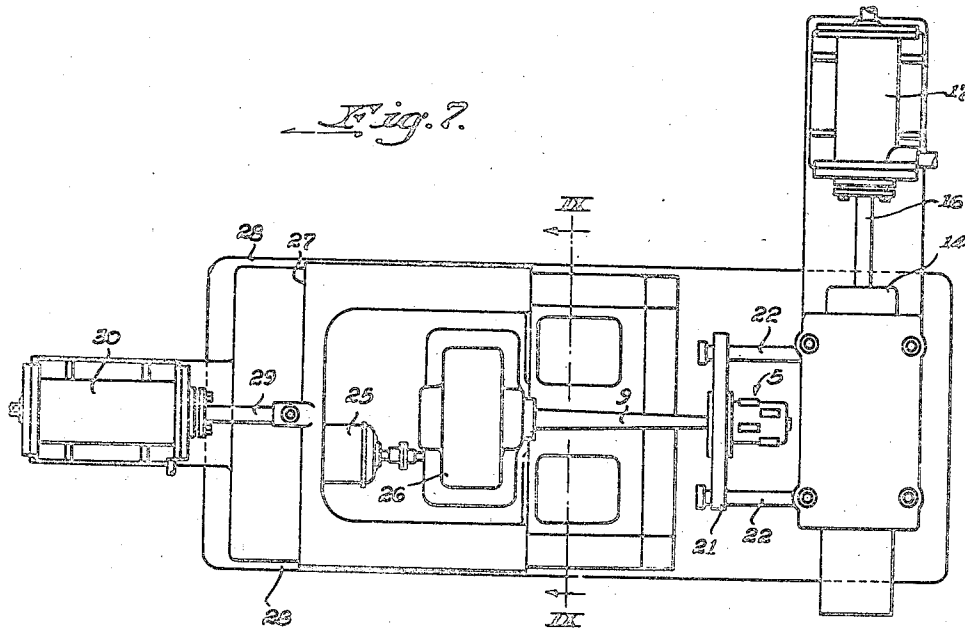
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WITNESSES:
E. J. Maloney.

Fig. 6.

INVENTORS.
John L. Holmquist
Paul W. Phares
BY
Brown, Citchlow & Fitch
ATTORNEYS.

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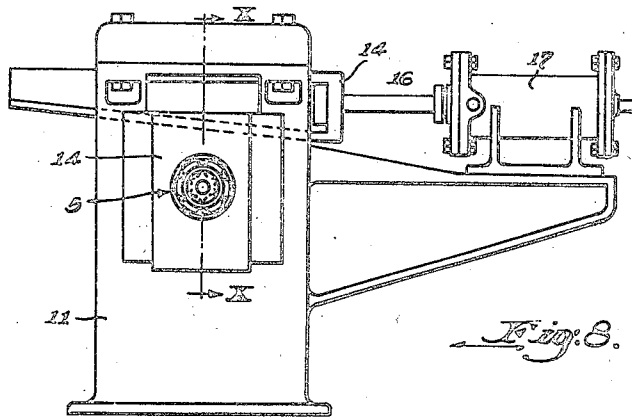


Fig. 8.

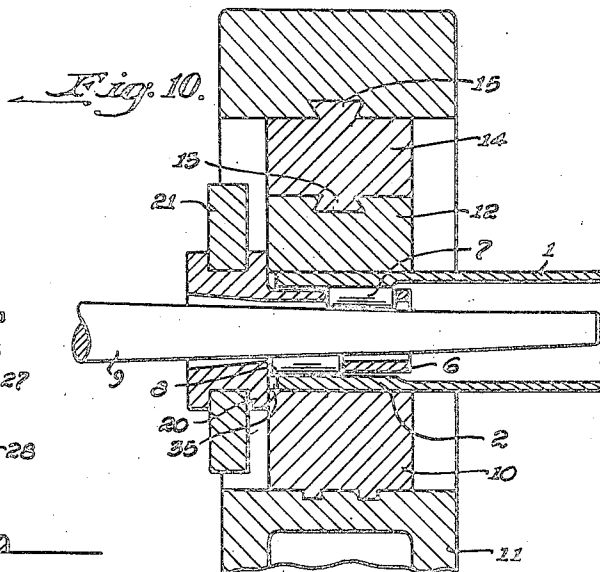


Fig. 10.

Fig. 9.

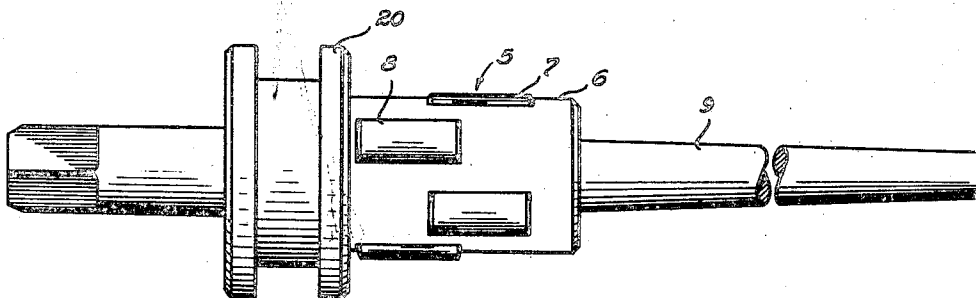
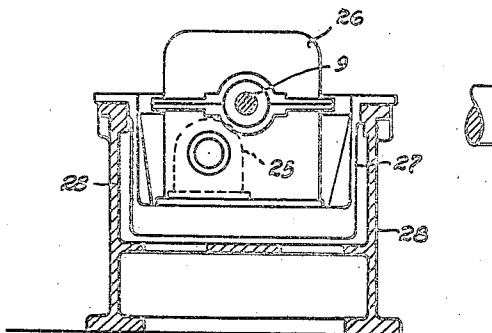


Fig. 11.

WITNESSES:
E. J. Maloney

INVENTORS.
John L. Holmquist
Paul W. Phleger
BY
Brown, Critchlow & Fitch
ATTORNEYS.

UNITED STATES PATENT OFFICE

2,494,128

METHOD OF INCREASING THE AXIAL TENSILE STRENGTH OF THREADED JOINTS

John L. Holmquist, Alliquippa, Pa., and Paul W. Pheneger, Ypsilanti, Mich., assignors to The National Supply Company, Pittsburgh, Pa., a corporation of Pennsylvania

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2 Claims. (Cl. 29—148.2)

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The invention relates to threaded well casing joints that are composed of interiorly and exteriorly threaded metal tubular members made of steel.

The casing of an oil well is hung vertically in the well in such a manner that the threaded joints of the upper lengths of pipe sustain all, or substantially all, of the weight of the casing in tension. Because of this the greater the depth of wells the greater becomes the necessity of increasing the axial tensile strength of the threaded casing joints.

In some cases an increase in the strength of well casing joints has been obtained by upsetting the ends of pipe to increase their wall thickness so that stronger threads can be cut without weakening the threaded ends excessively in comparison with the strength of the main bodies of the pipe. The effect of such upsetting is to increase the outside diameter of a casing joint if the upset is external or to decrease its inside diameter if the upset is internal. Due to the necessity of maintaining a small outside diameter for clearance of casing in a drilled hole and the necessity of maintaining a large inside diameter for clearance in the telescoping of smaller diameter casing as the hole deepens, limitations are imposed upon the amount of upsetting that can be done, and in consequence thereof limitations are placed upon the amount of the increase in the strength of joints that can be effected by upsetting the ends of casing pipe.

In other cases an increase in strength of joints has been obtained by first laterally expanding upset ends of casing pipe and then cold working the expanded ends by compressing them radially to reduce their diameter. However, the thickness of cold worked metal required for strength, combined with the limitations on such thickness imposed by clearance considerations, results in defining for a given casing pipe, the inside diameter through the upset to a permissible range of variation too narrow to be maintained in practical manufacturing operations, by the upsetting, expanding, and radial compressing alone. Consequently it has been found necessary, after the radial compression operation, to bore the pipe ends, which adds materially to the cost of manufacture.

The object of this invention is to provide a simple and economical method of increasing the axial tensile strength of a threaded joint to any desired extent without increasing its outside diameter or decreasing its inside diameter beyond the clear-

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ance requirements of service, and without the necessity of final boring.

In the practice of this invention in its applicability to coupling joints that are formed by exteriorly threading the adjacent ends of pipe which are connected to each other by sleeve couplings whose ends are interiorly threaded, the adjacent ends of the pipe are first interiorly upset while at a hot working temperature, the amount of increase in wall thickness effected by the upsetting being dependent upon service requirements. After such upsetting the pipe is preferably normalized to unify its physical characteristics at the desired strength of the main body of the pipe. When at a cold working temperature, the upset end of each pipe is rigidly confined exteriorly to prevent expansion or enlargement of its outside diameter during the next step of the procedure. Preferably the exterior face of the upset end is so confined by a multiple part die adapted to be closed upon the end. While the upset end is so confined against expansion, its wall thickness is progressively cold reduced by applying rolling pressure to the interior face of the upset. It is unnecessary subsequently to bore the upset because in the cold reducing operation the inside diameter through the upset is established to the necessary precision for clearance requirements. In the cold reducing operation the metal of the upset end flows axially of the pipe and increases its length in proportion to the amount of reduction in wall thickness. This axial plastic flow of the metal increases its axial tensile strength in proportion to the amount of cold reduction of the wall thickness that is effected. Thereafter the cold reducing end of the pipe is exteriorly threaded to be received by an interiorly threaded sleeve coupling.

In the practice of this invention in its applicability to bell and spigot threaded joints for connecting tubes to each other directly, the spigot end of a pipe is interiorly upset and then cold worked by reducing its wall thickness in the manner explained above with reference to the upset ends of pipes for coupling joints. In a similar manner the end of the adjacent pipe is expanded radially to form a bell and is upset to increase the wall thickness of the bell. Thereafter the wall of the bell is cold reduced by applying rolling pressure to its interior face in the manner explained above.

The invention will be further explained with reference to the accompanying drawings in which Fig. 1 is a longitudinal central sectional view through a portion of a plain pipe which may be either seamless or welded; Fig. 2 a similar view

through the pipe after its end has been upset interiorly; Fig. 3 a similar view of a pipe after its end has been both upset and expanded to form a bell; Fig. 4 a longitudinal central sectional view through a completed coupling joint; Fig. 5 a view similar to Fig. 4 through a completed bell and spigot joint; Fig. 6 a side view of a machine that may advantageously be used for cold reducing pipe ends, although in the practice of the invention other mechanism may be used for this purpose; Figs. 7 and 8 plan and right end views, respectively, of the machine shown in Fig. 6; Fig. 9 a transverse sectional view of the machine taken on the line IX—IX of Fig. 7; Fig. 10 a vertical sectional view to enlarged scale taken on the line X—X of Fig. 8; and Fig. 11 a side view to enlarged scale of the tube expanding tool of the machine.

In the forming of a threaded coupling joint such as shown in Fig. 4, each of the adjacent ends of plain pipe 1 is provided with an interior upset 2 which is somewhat greater in length than the external threads to be later cut on it, and which merges gradually with the portion of pipe that is not upset. The upsetting is done while the ends of the pipe are at a hot working temperature, and in the upsetting operation the wall thickness of the pipe ends is preferably increased to about one and one-half times that of the normal wall thickness of the pipe, although this may be varied depending upon the requirements of service. As has been stated, after the upsetting operation, the pipe is preferably normalized.

The cold work reduction of the wall thickness of each upset is preferably done by a tube expander of the type comprising a cylindrical roller cage and a tapered rotatable mandrel within it, the mandrel forming a backing support for rollers which lie in axially disposed slots in the cage and project beyond its outer face. If the expander is of the self-feeding type the roll-positioning slots in the cage are inclined slightly to the axis of the mandrel. In the tube expander 5 shown particularly in Figs. 10 and 11, a cylindrical cage 6 is provided with slots that extend parallel to the axis of the cage for receiving two annular series of equally spaced rolls 7 and 8 whose adjacent ends overlap to preclude the formation of ridges on inner faces of cold reduced upsets, there being three rolls in each series angularly spaced 120° from each other. Extending through cage 6 there is a tapered mandrel 9 against which the inner faces of rollers 7 and 8 bear, the rollers being tapered one-half the over-all taper of the mandrel so that the outer working faces of the rollers form a cylindrical inner face on the upset end of a pipe.

During the cold reduction of the upset end of a pipe its outer face is rigidly confined between a two-part die having a lower block 10 which rests upon an end portion 11 of the frame of the cold reducing machine shown in the drawings, and having a vertically movable upper block 12 whose upper face is provided with an inclined dovetail groove 13 formed to receive a dovetail projection on a laterally slidable wedge 14 whose upper face has a horizontal dovetail connection 15 with the top of the frame. Wedge 14 is connected to a piston rod 16 of a pressure fluid cylinder 17 for reciprocating the wedge horizontally to raise and lower upper die block 12.

At its outer end cage 6 of expander 5 is connected to a collar 20 adapted to bear against the faces of die blocks 10 and 12 properly to position

the expander within the upset end of a pipe, and this collar is provided with a groove which receives a carrier plate 21 that is slidably mounted on a plurality of rods 22 connected to and extending outwardly from the frame of the machine. In positioning a pipe within the die a substantial space, indicated at 35 in Fig. 10, is left between the end of the pipe and the adjacent face of collar 20 for the endwise plastic flow of metal during the cold reducing operation.

Mandrel 9 is adapted to be rotated by a motor 25 through a reducing gear 26 to which the outer end of the mandrel is connected, the mandrel driving and supporting mechanism being borne by a carriage 27 that is supported by side rails 28 of the machine frame for movements towards and from the pipe-clamping die. The rear end of the carriage is connected to a piston rod 29 of a fluid pressure cylinder 30 for so moving the carriage. While the pipe end is being clamped in the die, mandrel carriage 27 and tube expander 5 are in the position shown in Figs. 6 and 7. Carriage 27 is then moved forwardly by actuating pressure cylinder 30, and the expander 5 is simultaneously moved within the pipe until its shoulder 20 bears against the vertical face of the die. In such position the inner ends of rollers 7 project beyond the inner end of upset 2 so that during the rolling operation the full length of the upset is reduced. Motor 25 is then driven to rotate the mandrel while the mandrel carriage is fed forwardly progressively to move rollers 7 and 8 radially upwardly. The rotation of the mandrel rotates these rollers, and, by their engagement with the inner face of the upset, they in turn rotate cage 6 so that the wall of the upset is gradually and uniformly cold rolled to reduce its thickness the desired amount which is determined by the extent of longitudinal feed of the mandrel within the cage. The inner rolled face of the upset is smooth and of true cylindrical form from end to end. At the completion of the cold reducing operation, wedge 14 is moved outwardly by pressure cylinder 17 to elevate die block 12 to release the pipe, and carriage 27 is moved to the left sufficiently to cause the mandrel to release rollers 7 and 8 from their binding engagement with the inner face of the reduced upset. The tube expander may then be removed from the pipe by further moving the carriage 27 to the left and by sliding carrier plate 21 outwardly upon its supporting rods 22.

In making a bell and spigot joint like that shown in Fig. 5, a pipe 40 is first upset and expanded to form a bell 41 at its end, after which the bell is cold reduced in the manner fully explained with reference to the upset end 2 of pipe 1. The spigot end 42 of pipe 43 of the bell and spigot joint is in all respects formed the same as the upset end of pipe 1 for a coupling joint.

To effect a substantial increase in the axial tensile strength of a threaded joint, the wall thickness of the upset should be cold reduced to not less than five per cent, and in some cases may be cold reduced as much as twenty-five per cent. By a series of tests on well casing having an outside diameter of 5½ inches we have found that the percentage increase in tensile strength of coupling joints effected by the practice of our invention is substantially proportional to the percentage of cold work reduction of the wall thickness of internal upsets, the percentage increase in strength being about double the percentage reduction in wall thickness of the upset ends. By way of example and not of limitation, if it is de-

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sired to so increase the axial tensile strength of a coupled joint for well casing of seven inches outside diameter having a normal wall thickness of about .36 of an inch that it is equal to the longitudinal tensile breaking strength of the body of the casing, this may be done by interiorly upsetting the ends to a wall thickness of approximately 0.5 of an inch and then cold reducing the wall thickness of the upset ends approximately 11 per cent.

In addition to providing a simple and economical method of increasing the axial tensile strength of a threaded joint to any desired extent without increasing its outside diameter or decreasing its inside diameter beyond the clearance requirements of service, an important advantage of this invention is that the upsetting and cold reducing operations is so related and controlled that the completion of the cold reducing operation the inside diameters of the interior upsets are large enough for required clearance. This eliminates the expense of the final boring of interior upsets that has been found to be necessary to meet clearance requirements.

According to the provisions of the patent statutes, we have explained the principle and mode of operation of our invention, have described and illustrated what we now consider to be the best way of practicing it, and have given examples of how it may be practiced. However, we desire to have it understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically described and illustrated.

We claim:

1. The method of increasing the axial tensile strength of a threaded well casing joint composed of interiorly and exteriorly threaded metal tubular members, which comprises upsetting a tubular member, rigidly confining one face of the upset to prevent radial flow of the metal at such face and, while said face is so confined and while the metal of such member is at a cold working tem-

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perature, causing the metal of the member to flow axially of the member by progressively cold reducing the wall thickness of the upset not less than 5% and not more than about 25% by rolling pressure applied to the other face of the upset, thereby increasing the axial tensile strength of the metal about double the percentage of said reduction in wall thickness, and thereafter threading said confined face of the thus reduced upset.

2. The method of increasing the axial tensile strength of a threaded well casing joint composed of interiorly and exteriorly threaded metal tubular members, which comprises interiorly upsetting an end of a tube rigidly confining the exterior face of the upset end to prevent expansion thereof and, while said end is so confined and while the metal of the member is at a cold working temperature, causing the metal of the member to flow axially of the member by progressively cold reducing the wall thickness of the upset not less than 5% and not more than about 25% by rolling pressure applied to the interior face thereof, thereby increasing the axial strength of the metal about double the percentage of said reduction in wall thickness thereof, and thereafter threading the exterior face of the cold reduced end.

JOHN L. HOLMQUIST.
PAUL W. PHENEGER.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,318,962	Brinkman	Oct. 14, 1919
1,325,073	Boyd et al.	Dec. 16, 1919
2,089,790	Halpern	Aug. 10, 1937
2,219,784	Maupin	Oct. 29, 1940
2,261,056	Dunn	Oct. 28, 1941