Oct. 12, 1971 EIJIRO ODAGAKI 3,611,768

BULGING APPARATUS OF METALLIC PIPES

Filed June 13, 1969

FIG. 1

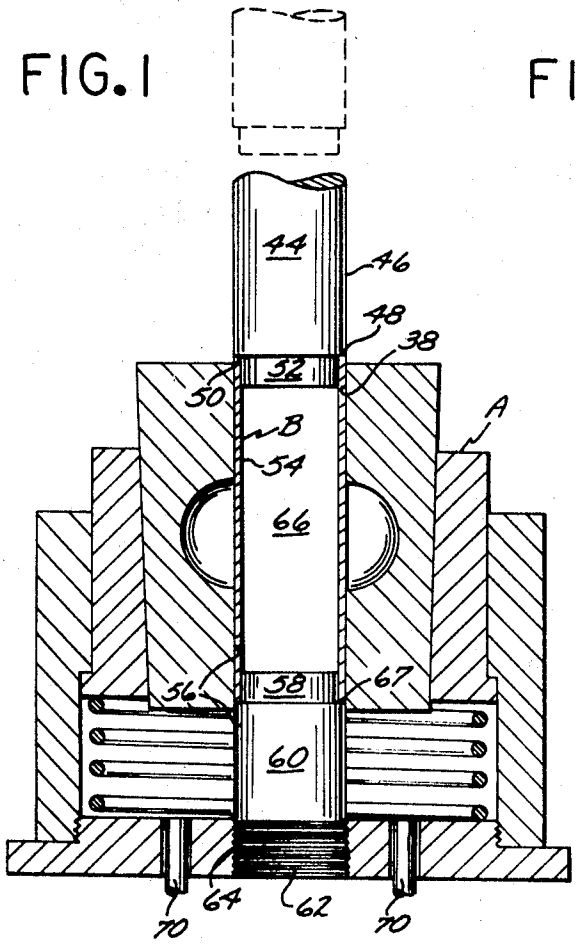


FIG. 2

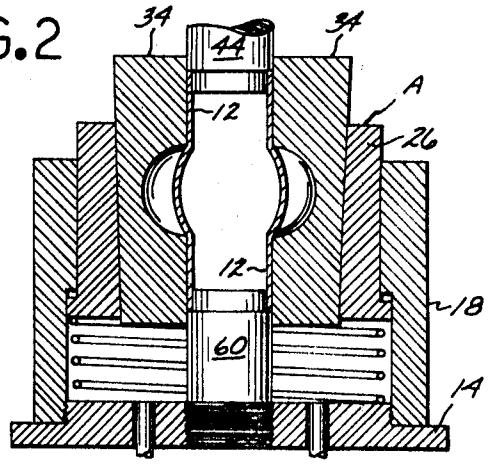


FIG. 3

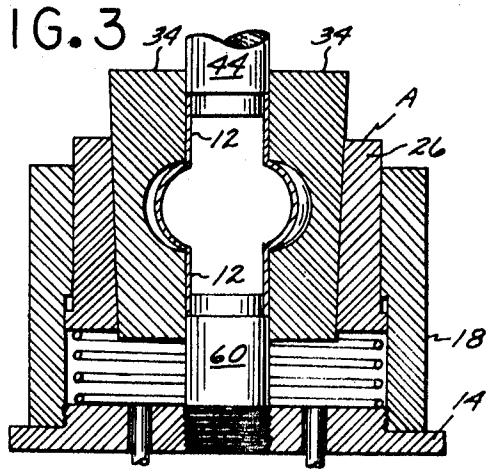


FIG. 5

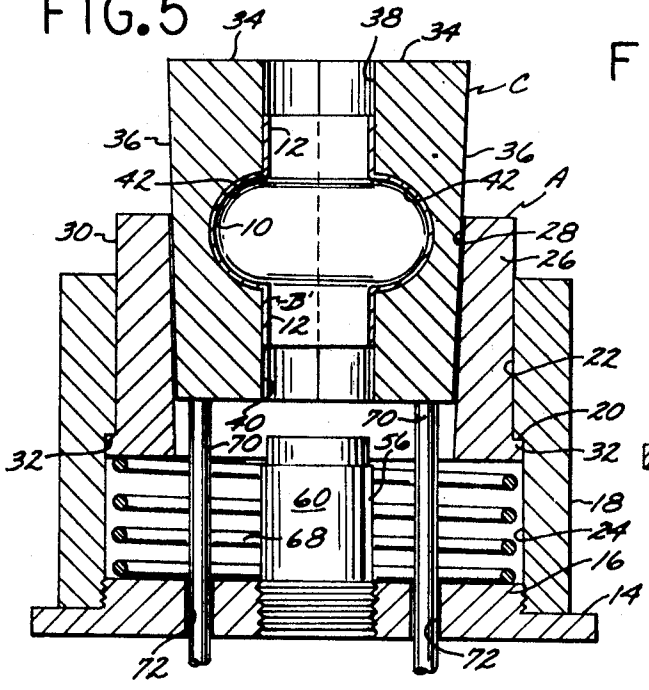
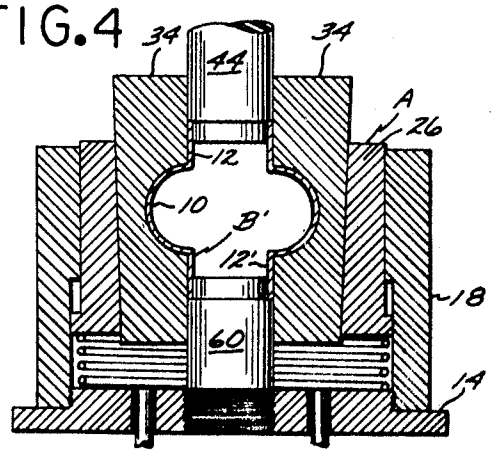


FIG. 4



INVENTOR.
EIJIRO ODAGAKI
BY
William G. Babcock
ATTORNEY

United States Patent Office 3,611,768 Patented Oct. 12, 1971

3,611,768

BULGING APPARATUS OF METALLIC PIPES

Eijiro Odagaki, Sakaishi, Osaka, Japan, assignor to Otsuya Tekko Kabushiki Kaisha, Sakaishi, Osaka, Japan

Filed June 30, 1969, Ser. No. 837,384
Int. Cl. B21d 15/10
U.S. Cl. 72—58 8 Claims

ABSTRACT OF THE DISCLOSURE

An apparatus and method of using same for transforming a tubular blank into a shortened tubular member having a circumferentially extending section of a desired configuration and expanded diameter. The section of expanded diameter has substantially the same wall thickness as the balance of the tubular member after the forming operation is completed.

BACKGROUND OF THE INVENTION

Field of the invention

An apparatus and method of using same for transforming a tubular metallic blank into a seamless tubular member having a circumferentially extending section therein of an expanded diameter, and the wall thickness of the section being substantially the same as the balance of the tubular member in which it is defined.

Description of the prior art

In present day industry there is a demand for tubular metallic members that have circumferentially extending sections therein of expanded diameter and of desired configurations. Prior to the present invention there has existed no equipment that was simple and easy to use in transforming tubular metallic blanks into tubular members having enlarged sections of desired configurations defined therein.

The present invention provides an apparatus of relatively simple structure and method of using same for transforming tubular blanks into tubular members having expanded sections therein.

SUMMARY OF THE INVENTION

An apparatus and method of using the same in which a metallic tubular blank is filled with a flowable material that remains at a substantially constant volume when subjected to a high pressure, with the blank and material being concurrently subjected to axially directed forces when within the confines of a split mold, and the blank as a result of the compressive forces applied to it and said material being permanently deformed to a tubular member having a circumferentially extending section of enlarged cross section formed therein.

The tubular blank during the above described operation is shortened, with the extent of the shortening being dependent on the degree to which the circumferentially extending section therein is enlarged. The wall thickness of the enlarged section is substantially the same as the wall thickness of the balance of the blank in which it is formed, for as the section is radially expanded the portion of the blank to which the compressive force is applied moves longitudinally in the mold to supply additional stock for the expanded section.

As the portion of the blank to which the compressive force is applied moves longitudinally in the mold, the flowable material in the blank is likewise subjected to a compressive force that results in the material exerting a radially directed force on the interior surface of the blank. The radially directed force exerted by the flowable material on the interior surface of the blank in cooperation with the axially directed compressive force on the blank results in the blank being transformed to a tubular member having the configuration of the interior of the mold, and the transforming operation being completed without leaving any substantial residual stresses in the transformed tubular member.

A major object of the present invention is to provide an apparatus and method of using the same in which a tubular metallic blank filled with a flowable material that does not appreciably contract in volume when subjected to a high pressure is transformed by axially applied compressive forces concurrently applied to the blank and material into a shortened tubular member having a circumferentially extending section of expanded diameter and desired configuration.

Another object of the invention is to supply an apparatus and method of using the same in which the transformed tubular member is substantially free from residual stresses, and one in which the wall thickness of the expanded section is substantially the same as that of the balance of the tubular member.

A still further object of the invention is to furnish an apparatus for transforming tubular blanks into tubular members having expanded sections therein, with the apparatus being of relatively simple structure, easy to use and operate, and one that requires a minimum of maintenance attention.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a longitudinal cross sectional view of the apparatus, with a tubular blank disposed within a split mold that has a circumferentially extending cavity therein;

FIG. 2 is the same view as shown in FIG. 1, but with a ram starting to move downwardly in the mold to concurently exert axially directed forces on the upper portions of the blank and a flowable material that fills the blank, with the blank as a result of said forces starting to expand radially into said cavity;

FIG. 3 is the same view as shown in FIG. 2, but with the ram having moved downwardly further in the mold, and the blank having deformed further radially into the cavity;

FIG. 4 is the same view as shown in FIG. 3, but after the transforming operation is completed; and

FIG. 5 is the same view as shown in FIG. 4, but after the split mold has been forced upwardly to a position where it may be separated and the transformed tubular member removed therefrom.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The apparatus A shown in FIG. 1 is capable of transforming a tubular metallic blank B to a shortened tubular member B having a circumferentially extending section **10** of increased diameter positioned intermediate the ends thereof as illustrated in FIGS. 4 and 5. The section **10** is of substantially the same wall thickness as the parts **12** of the tubular member on each side thereof. Blank B is formed from a metallic material that cold flows and permanently deforms when subjected to greater than a predetermined compressive force.

Apparatus A, as may best be seen in FIG. 1, includes a stationary base **14** having a raised exteriorly threaded cylindrical section **16**. A cylindrical guide **18** is threadedly secured to section **16** and extends upwardly therefrom. A circumferentially extending body shoulder **20** is provided on the interior of guide **18** which acts as a stop. Body shoulder **20** divides the interior of guide **18** into upper and lower portions **22** and **24**, respectively.

A mold holder **26** in the form of a shell is provided, the interior cylindrical surface **28** of which tapers down-

wardly and inwardly at a slight angle. The mold holder **26** has an external cylindrical surface **30** of such diameter that it snugly and slidably engages upper portion **22**. The lower exterior part of holder **26** develops into a circumferentially extending flange **32** disposed within the confines of the lower portion **24**. Flange **32** limits the upward movement of mold holder **26** relative to guide **18** by contacting stop **20**, as may best be seen in FIG. 5.

A split mold C is provided that is defined by a number of elongate sections **34** that are in abutting contact with the sections having exterior surfaces **36** that taper downwardly and inwardly at the same angle as the surface **28**. When sections **34** are in abutting contact, as shown in FIG. 1, cooperatively define two axially aligned bores **38** and **40** which communicate with a circumferentially extending cavity **42** situated therebetween. The shape of the cavity **42** determines the size and configuration of the expanded section **10**. Bores **38** and **40** are of such transverse cross section that blank B is snugly, but slidably engaged thereby, as shown in FIG. 1.

A first elongate compressive force-exerting body **44**, preferably a hydraulically operated ram, is provided that is in axial alignment with bore **38**. The external cylindrical surface **46** of first body **44** is of such diameter that the body **44** may move longitudinally in bore **38**. Surface **46** terminates at the lower end thereof in an inwardly extending ring **48** which abuts against the upper end **50** of blank B as shown in FIG. 1. A short cylindrical portion **52** extends downwardly from body **44** below ring **48** that slidably and sealingly engages the upper part of a bore **54** defined in the blank B.

A second cylindrical body **56** is provided that has a short upper section **58** that slidably and sealingly engages the lower portion of bore **52** as best seen in FIG. 1. Second body **56** is axially aligned with first body **44**. The second body **56** includes a lower portion **60** that has threads **62** formed thereon that engage a tapped bore **64** formed in the base **14** as shown in FIG. 1. Upper portion **58** and lower portion **60** are separated by a ring shaped surface **67** against which the lower end of blank B abuts as may best be seen in FIG. 1. The blank B when disposed in the mold C as shown in FIG. 1 has a flowable material **66** therein that does not appreciably contact in volume when subjected to a high pressure. The material **66** may be either a liquid or a solid such as rubber that remains at a substantially constant volume when deformed.

The mold holder **26**, as may best be seen in FIG. 1, is at all times urged upwardly by a stiff helical spring **68** or other resilient means. The spring **68** is situated within the lower portion **24** of guide **18**, with the upper end of the spring abutting against the lower surface of the mold holder **26** and the lower end of the spring resting on the upper surface of section **16** of the base **14**, as best seen in FIG. 5. Each of the mold sections **34** (FIG. 5) may be contacted by a power operated rod **70** that is slidably movable in a bore **72** formed in base **14**. When rods **70** are concurrently moved upwardly, they separate the mold C from the mold holder **26** to permit the sections **34** to be removed from an encircling position about the formed tubular member B'.

In use, operation of the apparatus A is most simple. The first body **44** is raised from the position shown in split line in FIG. 1 to the position illustrated in phantom line in the same figure to permit a tubular blank B to be inserted within the confines of the mold C. The lower end of the blank B sealingly engages the section **58** and ring-shaped surface **67**.

Either prior to, or after insertion within the mold C, the flowable material is disposed in blank B. The first body **44** is then moved downwardly to the extent that the portion **52** thereof slidably and sealingly engages the upper interior part of the blank B, with the portion **52** and ring **48** sealingly engaging the upper part of the blank B. Force is then applied to the first body **44** to move the same downwardly in the bore **38** as illustrated in FIG. 2, and as such movement takes place, an axial compressive force is applied to the blank B as well as the flowable material **66** contained therein.

Due to the force exerted on the blank B by downward movement of the first body **44**, the blank B is shortened, and the part thereof adjacent the cavity **42** is radially expanded therein. In FIG. 3 it will be seen that as downward movement of the first body **44** takes place relative to the mold C, the flowable material **66** expands radially to a greater degree, with the radial flow of the material **66** terminating when portions of the blank B has been radially expanded to the etxent that the section **10** is fully formed in the blank, as shown in FIG. 4.

As the material defining the section **10** flows radially into the cavity **42**, additional stock in the blank B slides downwardly into the bore **38** to ultimately pass outwardly into the cavity to define the section **10** without lessening the wall thickness of the seltion **10** relative to the parts **12** of the tubular member B' that is being formed. After completion of the forming operation just described, the rods **70** are forced upwardly to separate the mold section **34** from the mold holder **26**, whereby the sections may be removed from the encircling position about the formed tubular member B'. After completion of the above described operation, the rods **70** are lowered to the position shown in FIG. 1 and the operation may be repeated.

What is claimed is:

1. A method of transforming a tubular metallic blank to a tubular member of shorter length having a circumferentially extending section of a desired configuration and increased diameter intermediate first and second end thereof, which method includes the steps of:

(a) filling said tubular blank prior to said transforming thereof with a material which flows when subjected to pressure;

(b) engaging said first and second ends with longitudinally aligned first and second bodies that seal therewith;

(c) encircling said tubular blank with a plurality of third rigid bodies which are in abutting contact with one another as well as the exterior surface of said blank, in which third bodies a plurality of circumferentially extending transversely aligned cavities are formed that are of the configuration it is desired to form said section;

(d) moving said first body towards said second body to concurrently axially compress said tubular member and said material to the extent that said material exerts a radially directed force on said blank of sufficient magnitude as to consecutively move adjoining longitudinal portions of said blank outwardly into said cavities without appreciable diminution of the wall thickness of said portions to define said section;

(e) movng said third bodies towards said second body at such a rate as to minimize any axial movement of said third bodies relative to the portion of said section that has expanded into said cavity during said transformation of said section;

(f) terminating movement of said first and third bodies towards said second body after said transformation of said blank;

(g) removing said first and third bodies from engagement with said blank after said blank has been transformed; and

(h) removing said flowable material from said blank after the latter has been transformed to said tubular member.

2. A method as defined in claim **1** wherein said material is a liquid.

3. A method as defined in claim **1** wherein said material comprises a resilient solid which deforms three-dimensionally when subjected to pressure.

4. An apparatus for use in transforming a tubular metallic blank filled with a flowable material into a tubular

member having a circumferentially extending section of a desired configuration and increased diameter intermediate first and second ends thereof, which apparatus comprises:

(a) a first body which sealingly engages a first end of said blank;

(b) a second stationary body in longitudinal alignment with said first body, with said second body being in sealing engagement with a second end of said blank;

(c) a plurality of third bodies in abutting contact with one another as well as the exterior surface of said blank, in which third bodies transversely aligned circumferentially extending cavities are formed which are of the configuration it is desired to form said section;

(d) holding means for maintaining said third bodies in said abutting contact;

(e) guide means for slidably engaging said holding means, which guide means is in a fixed position relative to said second body;

(f) power means for moving said first body towards said second body to concurrently exert a compressive force on said blank and said material contained therein to three-dimensionally deform said material, with said material due to said deformation forcing consecutive longitudinal portions of said blank outwardly into said cavities to define said section, and with said sections due to said compressive force thereon defining said section without any appreciable diminution in the wall thickness thereof;

(g) resilient means for causing said third bodies and holding means to move towards said second body at the same rate as said first body moves thereto to prevent longitudinal movement of said third bodies relative to said cavities; and

(h) power means for moving said third bodies and holding means in a position relative to said second body where said tubular member with said section formed therein can be separated from said third bodies.

5. An apparatus as defined in claim 4 wherein said holding means comprises a first cylindrical shell, the interior surface of which tapers inwardly towards said second body, and the exterior surfaces of said third bodies are tapered to conform with that of said interior surface of said first shell with which they are in contact.

6. An apparatus as defined in claim 5 which further includes:

(i) a base which supports said second body and guide means and said guide means comprises a second cylindrical shell.

7. An apparatus as defined in claim 6 wherein said resilient means comprises a compressed helical spring that abuts against said base and said first shell, with said spring being disposed within the confines of said second shell.

8. An apparatus as defined in claim 6 wherein said power means comprise a plurality of movable fingers which extend upwardly through openings formed in said base and can engage the ends of said third bodies most adjacent said second body.

References Cited

UNITED STATES PATENTS

788,119	4/1905	Pope	72—58
1,766,098	6/1930	Booth	72—58
2,592,867	4/1952	Cuq	72—58
2,811,941	11/1957	Conrad	72—58
2,892,254	6/1959	Garvin	72—58
2,972,971	2/1961	Hillgren	72—58

RICHARD J. HERBST, Primary Examiner