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CONVENTION

60 0159

APPLICATION FOR A STANDARD PATENT

I/We Imperial Chemical Industries PLC

of Imperial Chemical House,
Millbank,
London SW1P 3JF,
UNITED KINGDOM.

hereby apply for the grant of a standard patent for an invention entitled:

JOINING METAL TUBES

which is described in the accompanying complete specification.

Details of basic application

Number of basic application: 8722151

Convention country in which basic application was filed: UNITED KINGDOM

Date of basic application : 21 September 1987

Address for Service:

PHILLIPS ORMONDE & FITZPATRICK
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367 Collins Street
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Dated: 9 August 1988

PHILLIPS ORMONDE & FITZPATRICK
Attorneys for:
Imperial Chemical Industries PLC

By:

Our Ref : 103018
POF Code: 1453/1453

APPLICATION ACCEPTED AND AMENDMENTS ALLOWED 23.5.90.

6012q/1

N.34472/AU

COMMONWEALTH OF AUSTRALIA

Patents Act

DECLARATION FOR A PATENT APPLICATION

In support of the Convention application made by

IMPERIAL CHEMICAL INDUSTRIES PLC

(hereinafter called "applicants") for a patent for an invention entitled:

JOINING METAL TUBES

I, Alan Bryan Beck,
Officer duly appointed, of Imperial Chemical House, Millbank, London, SW1P 3JF England

do solemnly and sincerely declare as follows:

1. I am authorised to made this declaration on behalf of the applicant.

2. ROY HARDWICK

Is the actual inventor of the invention and the fact upon which the applicants are entitled to make the application is as follows:

Applicants are the assignees of the said invention from the actual inventor

3. The basic application for patent or similar protection on which the application is based is identified by country, filing date, and basic applicant is as follows:

Filed in United Kingdom on 21/9/87 appln 8722151
by IMPERIAL CHEMICAL INDUSTRIES PLC

4. The basic application referred to in paragraph 3 hereof was the first application made in a Convention country in respect of the invention the subject of the application.

Declared at Welwyn Garden City,
Herts, England,
Dated 4th August 1988.

IMPERIAL CHEMICAL INDUSTRIES PLC

Alan B. Beck

Attorney

To: The Commissioner of Patents

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(19) AUSTRALIAN PATENT OFFICE (10) Acceptance No. 600159

(54) Title
JOINING METAL TUBES

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(56) Prior Art Documents
US 4528910
US 4148257
US 3877373

(57) Claim

1. A method of expanding a metal tube into engagement with a surrounding coaxial tubular metal member comprising:- locating at least a portion of said tube coaxially within a bore of the metal member to define a first space between the external wall of the said portion of said tube and the metal member, said first space being sealed against the ingress of liquid; locating an explosive charge coaxially in the bore of the said tube and axially coincident with at least a portion of said first space, any space between the explosive charge and the inner wall of the metal tube being filled with shock transmitting material; inserting the said metal member and said tube portion coaxially within a bore of a thick walled metal die member to define a second space between the said metal member and metal die member, said second space extending axially at least

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over the length of said first space; said metal die member being immersed in a liquid so that the said second space is filled with said liquid; and exploding the explosive charge.

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COMPLETE SPECIFICATION
(ORIGINAL)

Class Int. Class

Application Number:
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Complete Specification Lodged:
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Related Art:

This document contains the amendments made under Section 49.

and is correct for printing.

APPLICANT'S REFERENCE: N.34472/AU

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Complete Specification for the invention entitled:

JOINING METAL TUBES

Our Ref : 103018
POF Code: 1453/1453

The following statement is a full description of this invention, including the best method of performing it known to applicant(s):

JOINING METAL TUBES

This invention relates to a method of expanding a metal tube into engagement with a surrounding coaxial tubular metal member by means of an explosive charge. The method may be operated so that the expanded portion of tube becomes either mechanically engaged with, or explosively bonded to, the surrounding metal member, and is particularly advantageous for joining large tubular metal elements. One especially useful commercial application of the invention is in attaching steel coupling members to the ends of aluminium pipe lengths for assembly into composite oil-well drill pipes.

Oil-well drill pipes are normally made up of steel pipe segments at each end of which is a steel coupling. These couplings are screwed together to lengthen the drill pipe as drilling depth increases thereby making up a composite length of the drill pipe.

There are advantages in using aluminium pipe which will more easily bend. This allows greater freedom and increased capability in directional drilling. It is desirable, however, to use steel to provide strong coupling components on each end of the drill pipe.

As steel and aluminium are incompatible for fusion welding the two components cannot be joined by this method. Screwing the components together is also impracticable since screw threads reduce the aluminium wall section to

intolerable levels unless the wall thickness of the aluminium is increased by local upsetting of the tube end during manufacture and this is expensive. Shrink fitting is an alternative procedure which has had only very limited success due to a high incidence of joint failure.

This invention provides a novel method of attaching the steel coupling members by means of explosive expansion of the aluminium tube into a suitably profiled bore of the steel coupling.

The use of explosives to expand a tubular metal component into the bore of a second metal component to form either a mechanical or explosively bonded joint is well known. The bore configuration of the outer component or the outside diameter of the inner component must be specifically contoured for fabricating an explosively bonded joint and/or the detonation rate of the explosive must be tightly controlled. The explosive force must be considerable to achieve an explosive bond and this requires complex procedures and components if the outer component is relatively thin and needs support to prevent its expansion. Formation of a mechanical joint by explosive requires much less explosive and thinner outer components can be utilized, but again, expensive outer supporting components and associated expensive handling is necessary when the outer component is not sufficiently thick to resist expansion by the explosion. Moreover the supporting inner surface of the supporting component must be shaped to conform to the exterior surface of the outer component and for complex surfaces this would increase the cost of the supporting component.

In the expansion process the explosive charge is placed coaxially within the bore of the portion of the tubular metal inner component to be expanded, and is usually contained within a component fabricated from a shock transmitting material such as polyethylene, located as a closely fitting insert within the tubular metal component.

Water is also often used as a means of transmitting shock waves being a most efficient transmitting medium giving a minimum attenuation of the shock wave. It is commonly used for explosive forming of components, but is has the disadvantage as a shock transmitting material for tube expansion that it can not be used to locate the explosive charge positively in the tubular component.

The method of explosive expansion of metal tubes hitherto used is impractical for the production of large explosively joined components in large numbers as is required in the production of oil-well drill pipes.

The bore size of a typical drill pipe is relatively large and thus requires a corresponding large shock transmitting insert to accommodate the explosive contained within. Polyethylene transmitting inserts are too expensive because of the volume of polyethylene required and the extended moulding cycle time necessary to maintain dimensional stability of the thick walled insert and prevent cavitation within the wall during manufacture. Moreover, the thick wall of the polythene insert would cause significant attenuation of the shock wave which, in turn, would require an increase in the explosive charge which would need to be accommodated by increasing the bore dimensions of insert thereby reducing the wall thickness. Thus a polyethylene insert of conventional design is not considered commercially acceptable.

The outside diameter and wall thickness of a typical drill pipe steel coupling are such that the coupling would require external support to prevent its radial expansion by the explosive forces needed to join it to a drill pipe. Closely fitting split dies of the kind previously used as external support for the outer component in explosively coupling tubular metal components are not suitable as they are expensive to produce, time consuming to assemble, and become distorted in use.

It is an object of this invention to provide an improved method of explosively expanding a metal tube into engagement with a surrounding coaxial tubular metal member, which can avoid the use of polyethylene inserts and closely fitting external split dies.

In accordance with the invention a method of expanding a metal tube into engagement with a surrounding coaxial tubular metal member comprises:-

A method of expanding a metal tube into engagement with a surrounding coaxial tubular metal member comprising:- locating at least a portion of said tube coaxially within a bore of the metal member to define a first space between the external wall of the said portion of said tube and the metal member, said first space being sealed against the ingress of liquid; locating an explosive charge coaxially in the bore of the said tube and axially coincident with at least a portion of said first space, any space between the explosive charge and the inner wall of the metal tube being filled with shock transmitting material; inserting the said metal member and said tube portion coaxially within a bore of a thick walled metal die member to define a second space between the said metal member and metal die member, said second space extending axially at least over the length of said first space; said metal die member being immersed in a liquid so that the said second space is filled with said liquid; and exploding the explosive charge. The liquid conveniently is water.

When the explosive charge explodes the resulting shock wave is transmitted through the shock transmitting material in the tube bore to radially expand the tube into engagement with the surrounding tubular metal member. The said first space conveniently contains only air which provides insignificant resistance to the expansion of the tube. The liquid in the said second space being incompressible prevents expansion of the tubular metal member thereby maintaining the outside profile of the metal member. The shock wave across the liquid filled second space is not sufficient to distort or otherwise damage the heavy, thick-walled metal die member and the metal tube with the metal member attached may be readily and quickly extracted from the die member, which may be reused indefinitely. The die member can be fabricated from inexpensive materials and it requires no maintenance.

In a convenient manner of carrying out the method, the metal member and the metal tube portion may be inserted into the bore of the die member so that the liquid may fill the space between the explosive charge and the inner wall of the metal tube. The liquid is conveniently water. When the explosive charge is immersed in liquid in this manner and fired the noise from the explosion is substantially reduced.

The space between the said metal tube and surrounding metal member (first space) may be advantageously sealed by providing at each end a sealing member comprising at least two resilient "O" ring sealing elements to contact the metal tube and metal member respectively. A preferred sealing member is one formed integrally with a tubular containiner for holding and locating the explosive charge.

The invention is further illustrated by a preferred method of joining coupling members to lengths of metal tube which is hereinafter described with reference to the accompanying drawings wherein

Fig.1 shows diagrammatically in longitudinal, medial cross-section an assembly of a length of metal tube, a coupling member and an explosive charge.

Fig.2 shows diagrammatically in longtitudinal medial cross-section the assembly of Fig.1 inserted into a surrounding die member and immersed in water.

Referring to Fig.1, in a method of joining a coupling member to a length of aluminium drill pipe a metal collar 1 formed with recesses 3 containing "O" rings 5 and 6 and having a magnet 7 in a further recess in its rear face is slipped over an aluminium tube 9. An internally threaded tubular steel coupling member 11 is located upon the aluminium tube 9 so that the end of the aluminium tube abuts the face of stop 13 formed as a portion of reduced diameter at an end of the coupling member 11. The collar 1 is brought forward to magnetically contact the rear face of the coupling member 11 and is secured by two grub screws 15 tightened against the aluminium tube 9 thereby holding the coupling 11 and aluminium tube 9 securely in abutment at the stop 13 and effecting a seal between the "O" ring 5 and the rear face of the coupling member 11 and between the "O" ring 6 and aluminium tube 9.

A polyethylene component 17 comprising a tubular sealing member 48, a coaxial tubular pocket 49 and an annulus 50 connecting the member 48 and pocket 49, is inserted into the open end of the coupling 11 until a flange 19 of the sealing member 48 abuts the face of the coupling member 11. The

sealing member 48 is formed with two recesses 21 which contain two compressible o-rings 23 and 24 of resilient material such as foam rubber or synthetic plastics. On abutment of the flange 19 and coupling member 11, the inner O-ring 24 is sited against the bore of the aluminium tube 9 and the outer O-ring 23 is sited against the bore of the coupling member 11 thus effecting a watertight seal on both sides of the stop 13. Thus the space 26 between the aluminium tube 9 and coupling member 11 is sealed against the ingress of water. An explosive charge 28, is located in the pocket 49 and is thereby firmly positioned coaxially within bore 30 the tube 9 and axially coincident with the coupling member 11.

A detonator 32 is located within the explosive charge 28.

Referring now to Fig.2, the detonator wires 34 are passed through the rear of a steel ring die assembly 36 which is immersed in water 40 in tank 38. The assembly of coupling member 11, aluminium tube 9, collar 1, polyethylene component 17 and explosive charge 28 is lowered beneath water 40, the end of the coupling member 11 being inserted axially within bore 42 of the steel ring die assembly 36,to leave a space 44 between the outer surface of the coupling 11 and bore of the steel ring die assembly 36 which space is filled by the water.

Water also enters the bore of tube 9 via apertures 46 in the annulus 50 of component 17.

On initiation of the explosive charge 28 the shock wave is transmitted by the water 40 in the bore of the tube 9, which is thereby expanded radially into the space 26 to engage the internal thread of coupling 11 and effect a joint between the tube 9 and coupling 11. The water 40 cannot be

displaced from the space 44 during the brief time span of the explosion and it behaves as an incompressible fluid effectively preventing expansion of the coupling 11.

The bore 42 of the die 36 is made sufficiently large to provide a layer of water thick enough to prevent damage to the die assembly 36. Generally, for the sizes of coupling members and tubes used for oil drill pipes a water layer thickness of 5 to 15 mm. is adequate.

CLAIMS The claims defining the invention are as follows:

1. A method of expanding a metal tube into engagement with a surrounding coaxial tubular metal member comprising:- locating at least a portion of said tube coaxially within a bore of the metal member to define a first space between the external wall of the said portion of said tube and the metal member, said first space being sealed against the ingress of liquid; locating an explosive charge coaxially in the bore of the said tube and axially coincident with at least a portion of said first space, any space between the explosive charge and the inner wall of the metal tube being filled with shock transmitting material; inserting the said metal member and said tube portion coaxially within a bore of a thick walled metal die member to define a second space between the said metal member and metal die member, said second space extending axially at least over the length of said first space; said metal die member being immersed in a liquid so that the said second space is filled with said liquid; and exploding the explosive charge.

2. A method as claimed in Claim 1 wherein the said shock transmitting material is a liquid.

3. A method as claimed in Claim 2 wherein the said shock transmitting material and said liquid filling the said second space is water.

4. A method as claimed in Claim 3 wherein the water fills the space between the explosive charge and the inner wall of the said metal tube when the said metal member and the said metal tube portion are inserted into the bore of said die member.

5. A method as claimed in any one of claims 1 to 4 inclusive wherein said first space is sealed by providing at each end a sealing member comprising at least two resilient "O" ring sealing elements to contact the metal tube and metal member respectively.

6. A method as claimed in claim 5 wherein the sealing member is formed integrally with a tubular container for holding and locating the explosive charge.

7. A method as claimed in any one of claims 1 to 6 inclusive wherein the said metal tube is an aluminium tube and the said tubular metal member is a steel member.

8. A method as claimed in any one of claims 1 to 6 inclusive wherein the said second space is from 5 to 15 mm thick.

9. A method of expanding a metal tube into engagement with a surrounding coaxial metal member substantially as described herein and shown in the accompanying drawings.

10. A method, as claimed in claim 1 substantially as hereinbefore described with reference to any one of the examples.

DATED: 17 May, 1990
PHILLIPS ORMONDE & FITZPATRICK
Attorneys for:
IMPERIAL CHEMICAL INDUSTRIES PLC

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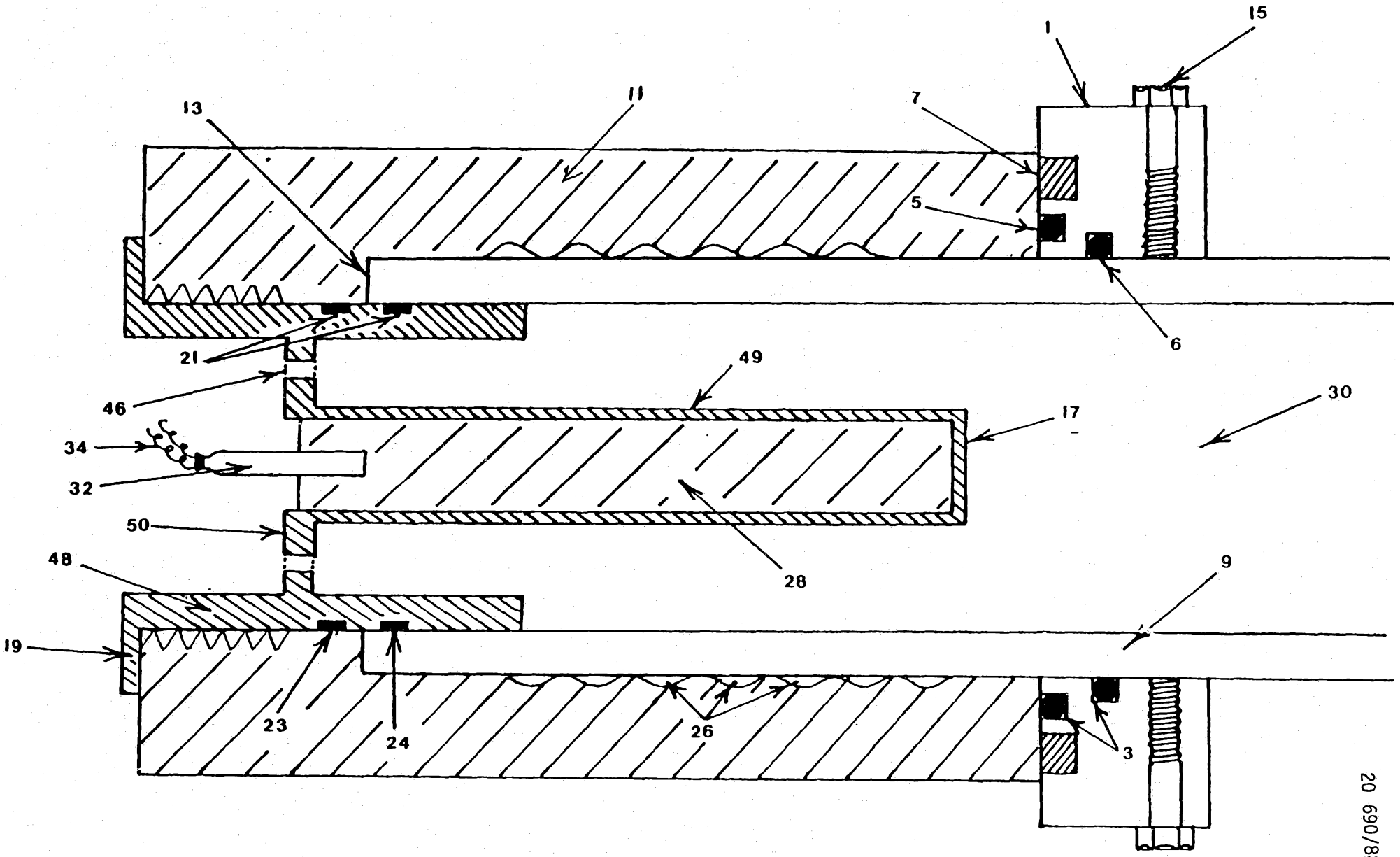

FIG.1

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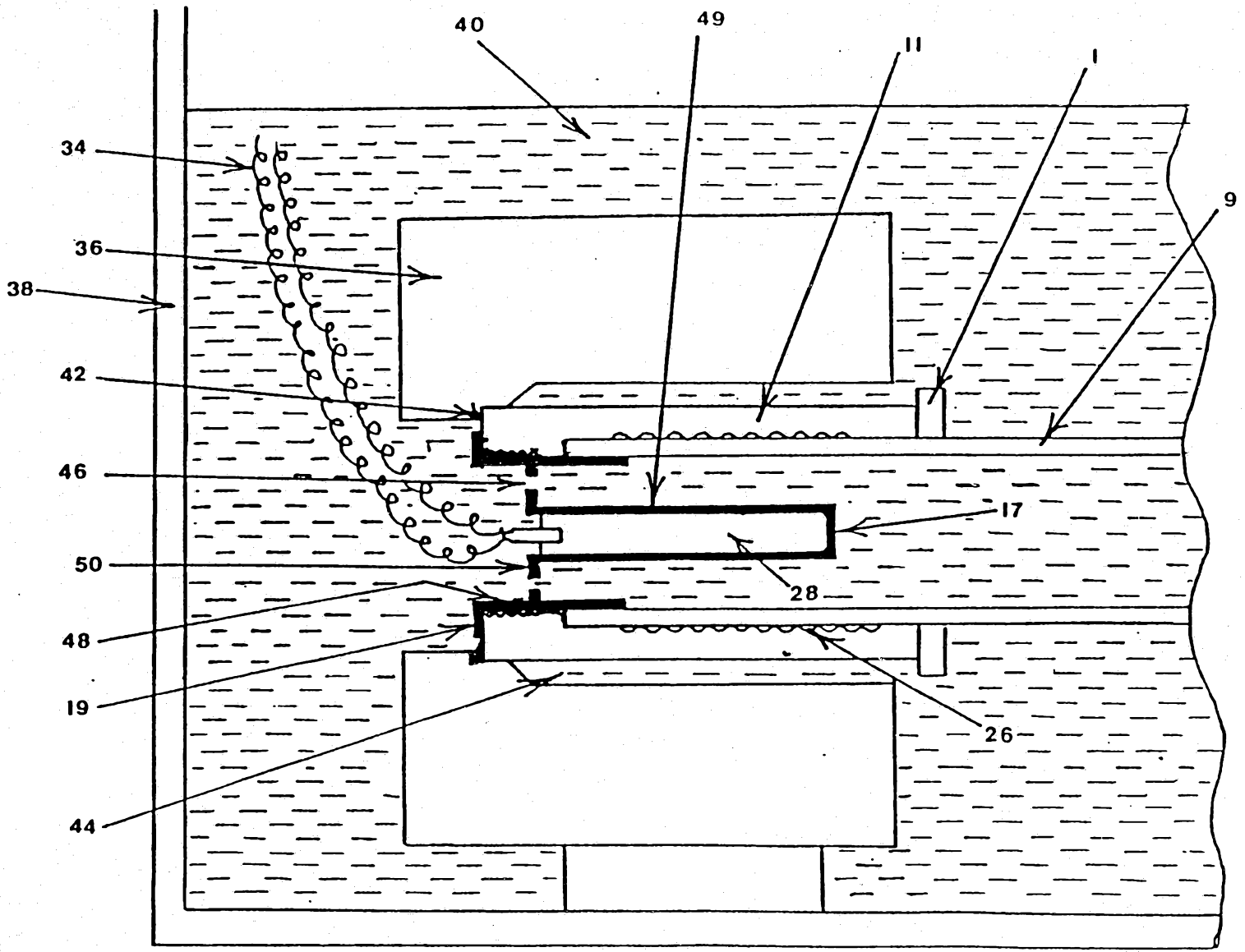

FIG. 2