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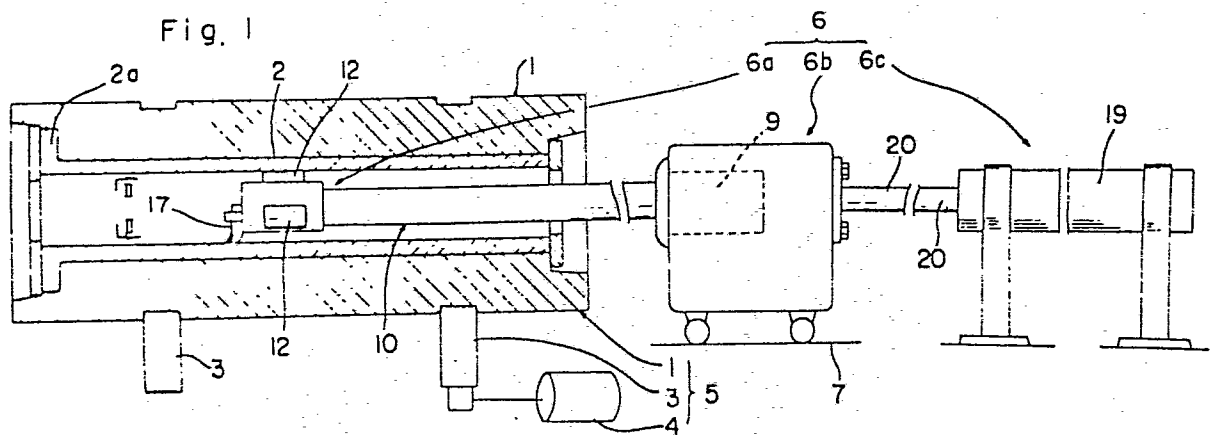
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(54) **METHOD AND DEVICE FOR MACHINING INNER SURFACE OF MOLDED CYLINDRICAL ARTICLE.**

(57) Method and device for pressurizing the inner surface of a molded cylindrical article by the step of pressurizing and forming the inner surface of the article while rotating a pressing unit (6a) of pressurizing means (6) relative to a molded article (2) during a period of time which begins immediately after completion of solidification of the article ready for pressurizing and forming, and which continues until the transition temperature of the article has been reached the temperature at which the tensile strength and elongation of the article undergo an abrupt change. This is performed in order to pressurize and cause the collapse of blowholes and air bubbles in the molded article, and to harden the inner surface thereof.

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TUBULAR CAST PIECE INNER SURFACE TITLE MODIFIED
WORKING METHOD AND APPARATUS THEREOF

Technical Field

- 5 (1) This invention relates to a tubular cast piece inner surface working method and apparatus thereof, for pressure-compacting the tubular cast piece inner surface in a predetermined temperature range.

Background Art

- 10 (2) Tubular cast pieces are manufactured generally by centrifugal casting method or by casting method employing core means. With such method, it is known that there appear shrinkage cavities or pores on the tubular inner surface as the tubular cast piece cools
15 down. Consequently, it is clear that such shrinkage cavities or pores lower the strength and gastightness of the tubular cast pieces.

- (3) In order to eliminate the drawbacks mentioned above, there has conventionally been proposed the
20 method, in manufacturing the tubular cast pieces by centrifugal casting method, of pouring melt into the metal mold for centrifugal casting and pressing the tubular inner surface employing rollers or the like



prior to completion of solidification of the melt, to thereby pressure-sealing the shrinkage cavities or pores.

(4) In case of using the tubular cast pieces as fluid pipe-line and the like, it has on the other hand been required to manufacture the products such that the strength and gastightness of the pipes themselves are excellent in the matter of course and that the products have the pipe inner surface excellent in abrasion resistance and corrosion resistance and at the same time low in fluid resistance as is realized by enhancing the hardness of the pipe inner face.

(5) However, with the conventional methods for pressure-demolishing and sealing the shrinkage cavities or pores it may all right have been possible to crush down the shrinkage cavities or pores but it has not been possible to harden the tubular inner surface, since thereby one gives pressure on the tubular inner surface in its soft state prior to completion of the melt solidification.

(6) On the other hand, practiced generally and widely with the intention of hardening the cast piece surface is a method of pressure-working the surface at normal temperature, namely of applying the so-called cold working. However, an apparatus is required to generate tremendous heavy pressure when to crush down



at the same time the shrinkage cavities or pores with such a method, and there is a drawback such as causing distortion in the tubular body by applying such heavy pressure, and so such a method has not actually been
5 practiced.

Disclosure of Invention

(7) In view of the limitation of the prior art as mentioned above, this invention has as its object to provide a tubular cast piece inner surface working
10 method and an apparatus thereof, satisfying the two requirements in contradiction to each other.

(8) For attaining the object, the tubular cast piece inner surface working method according to this invention is characterized by: positioning a pressing
15 head of pressing means in inner hollow space of a tubular cast piece formed by casting; and pressure-compacting the said tubular cast piece inner surface, within a temperature range starting from that immediately after completion of the said tubular cast piece solid-
20 ification to the transition temperature, by means of the said pressing head while bringing the said pressing head and the said tubular cast piece in relative rotation.

(9) The invention took notice of the mechanical properties of metals in general, especially that the
25 "elongation" as will facilitate the working gets suddenly



better above the transition temperature, and have confirmed through experiments that by pressure-compacting the metal surface while bringing the metal and the pressing element in relative rotation, even immediately after the metal solidification, hardness of the worked surface is enhanced. The transition temperature as is referred to in this invention means the temperature where the mechanical properties (tensile strength and elongation) show abrupt changes.

This invention thus intends to attain at a single stroke both pressure-sealing of the shrinkage cavities or pores and surface-hardening treatment of the tubular cast piece inner surface, as have conventionally been considered different working processes.

Namely, by crushing down the shrinkage cavities or pores on a tubular cast piece inner surface with mild pressure at temperature within a range for facilitating the pressure-compacting, and simultaneously by pressure-compacting the inner surface while bringing the tubular cast piece and the pressing head in relative rotation, it has been made possible to attain at a single stroke also inner surface headening of the tubular cast piece subjected to the pressure-compacting, without substantially causing distortion on to the tubular cast piece.

It has thereby been made possible to heighten and equalize metal structure density near the tubular



cast piece inner surface, thus expecting enhancement
of the strength and gastightness of the overall tubular
cast piece, and simultaneously to harden the inner
surface, thus to obtain the tubular cast piece excellent
5 in abrasion resistance and corrosion resistance and at
the same time low in resistance in fluid transfer.

(12) It can therefore be rightly said that quite
remarkable industrial value accrues therefrom in manu-
facturing the various tubular cast pieces, for instance
10 as hydraulic cylinder parts, internal combustion engine
cylinder parts, various kinds of cast iron pipes, vacuum
vessel parts and various rolls, atomic power station
piping and the like or else high-strength aluminium alloy
castings, cast steel pipes and the like, with which
15 quality enhancement comes more and more in need hence-
forward.

(13) Another object of this invention is to provide
a tubular cast piece inner surface working apparatus for
practicing the method mentioned above.

20 (14) For attaining such an object, the tubular cast
piece inner surface working apparatus of this invention
is characterized in that it comprises: pressing means
having a pressing head constructed to be capable of
pressing the tubular cast piece inner surface during
25 the time from that immediately after completion of the
solidification to the transition temperature; and driving



means for bringing the said tubular cast piece and pressing head stage in relative rotation.

(16) Namely, since one works, during the time from immediately after completion of the tubular cast piece solidification to the transition temperature and while giving pressure on the tubular cast piece inner surface with the pressing head, the inner surface by bringing the pressing head and the tubular cast piece in relative rotation with driving means, it has been made possible to crush down the shrinkage cavities or pores as may have been caused in the tubular cast piece thus for heightening metal structure density of the tubular cast piece in its wall thickness direction and at the same time to harden the inner surface.

15 (17) It has hereby made possible to provide a tubular cast piece excellent in strength of the overall tubular cast piece and abrasion resistance as well as corrosion resistance of the inner surface thereof.

Moreover, since one crushes down the shrinkage cavities or pores on the tubular cast piece inner surface and heightens metal structure density in its wall thickness direction, it has been made possible to eliminate gas-communicating holes to the outside as might be formed by successive continuation of the inner surface pores or shrinkage cavities, which results in advantage of this cast piece, when used as a member with which gastightness



is required as is the case of vacuum vessel parts and the like, of giving full play of its quite excellent gastightness.

5 Further objects and advantages of this invention will become clear from the explanation now to follow.

Brief Description of Drawings

Drawings show, by way of example, the best embodiment of the tubular cast piece inner surface working method and apparatus thereof according to this invention, wherein:

15 Fig. 1 is a vertical section of an essential portion of a centrifugal casting machine with rough overall side elevation of a tubular cast piece inner surface working apparatus,

Fig. 2 is an enlarged end view of pressing means as viewed according to arrows II-II in Fig. 1,

20 Fig. 3 is an enlarged side elevation, partly in section, of an essential portion of pressing means,

25 Fig. 4 is a photographic picture of an aluminium alloy tubular cast piece section showing the status worked by the method of this invention and the unworked status,

Fig. 5 is a vertical sectional view showing a tubular cast piece to apply the method of this invention on, having its section in round shape,

5 Fig. 6 is an end view of the tubular cast piece shown in Fig. 5, and

Fig. 7 is a vertical sectional view showing a tubular cast piece to apply the method of this invention on, having its section of uneven diameter.

10

Best Mode for Carrying Out the Invention

This invention is now explained in more detail hereunder with reference to the accompanying drawings.

(20) Fig. 1 shows a vertical section of an essential
15 portion of a centrifugal casting machine with rough overall side elevation of a tubular cast piece inner surface working apparatus. In this embodiment, one casts and forms the tubular cast piece by centrifugal casting method and apparatus thereof, but one may as
20 well form same by any other casting method. Shown at (21) is a metal mold for centrifugal casting, and at (2) is a tubular cast piece as is cast in the said metal mold (1). The tubular cast piece (2) is equipped at an end portion, as is illustrated, with a flange (2a).
25 At (3) are driving rollers which support the said metal

mold (1) and also drive same into rotation. These driving rollers (3) are connected to an electric motor (4) via suitable means, both of these members together with the said metal mold (1) constituting driving means (5). However, one may as well adopt substitute driving construction for driving rollers (3), in case that one obtains the tubular cast piece by any other casting method than centrifugal casting method.

(22) At (6) is pressing means, and it is constructed with: a pressing head (6a) to be inserted and positioned in inner hollow space of the said tubular cast piece (2); a pressing effort generating unit (6b) to generate the pressing effort of the pressing head (6a); and a travel-causing apparatus (6c) to move the pressing effort generating unit (6b) and the pressing head (6a) along the axial direction of the said tubular cast piece (2).

(23) The said travel-causing apparatus (6c) is constructed with an oil hydraulic cylinder (19) fixed in a stationary position and a well-known oil hydraulic pump system (not illustrated) to supply oil pressure thereto, and a piston rod (20) of the said oil hydraulic cylinder (19) is connected to the said pressing effort generating unit (6b) proper. The pressing effort generating unit (6b) is constructed with a holder (10) to sustain the said pressing head (6a), an oil hydraulic cylinder (9), a piston rod (11) thereof (see Fig. 3)



and an oil hydraulic pump system (not illustrated) to drive the oil hydraulic cylinder (9). Here, the pressing effort generating unit (6b) is constructed to be movable in running travel on rail means (7), and it is thereby made possible to smoothly move the said pressing head (6a) along the axial direction of the said tubular cast piece (2) by actuation of the said travel-causing apparatus (6c).

(24) The said holder (10) is provided to extend out from the said pressing effort generating unit (6b) machine frame, for sustaining the said pressing head (6a). The said piston rod (11) is provided to pass through the inside of the said holder (10) for free advancing towards the said pressing head (6a) and retiring, and on the tip end thereof there is formed a taper portion (11a). At (12) are three pressing rollers, and they are disposed at equal intervals in the circumferential direction of the said pressing head (6a), with each of them having the rotary axis in parallel with the axis of the said piston rod (11). However, the pressure-compacting object may anyhow be attained if there is at least one pressing roller.

(25) In Fig. 3, spacing interval between the two pressing rollers is shortened for easier drawing construction and for clearer view.

(26) At (18) is a guide member, with one end thereof

fixed on to the tip end of the said pressing head (6a)
by means of a nut and with the other end thereof
inserted into a hole bored in the said taper portion
(11a), and it functions as a guide when the taper
5 portion (11a) is operated to advance or retire.

(27) The said pressing rollers (12) are mounted to
be idly rotatable on supporting shafts (14) fixed on
the respective supporter members (13). Each of the
supporter members (13) is held to be slidable in the
10 radial direction of the said piston rod (11) or the
said tubular cast piece (2) relative to the said pressing
head (6a) proper, and has a cam surface (13a) formed on

(28) the side of the axis thereof. It is so made that by
the movement of the said piston rod (11) the taper
15 portion (11a) thereof comes to abut against the said
cam surfaces (13a), thus to urge and push the said
supporter members (13) and to cause the pressing rollers
(12) provided thereon to urge and push against the inner
surface of the said tubular cast piece (2). Thus, cam
20 means (15) is constructed with the taper portion (11a)
of the piston rod (11) and the cam surface (13a) of the
said supporter member (13). The said pressing roller
(12) is constructed in a shape having a plain surface
(12a) of narrow width in the central portion thereof and,
25 on both sides thereof, slant surfaces (12b). By the use
of the said flat surface (12a) of narrow width, there

are advantages accruing hereto in that one can heighten the urging pressure force against the inner surface of the said tubular cast piece (2) and further that one can work out the inner surface smooth. However, as the shape of the pressing rollers, one may otherwise as well suitably use beer-barrel shape of smooth gradual bulging, those having various shapes of bulging, or else cylindrical body and the like, and one may further adopt such construction as to forcibly drive the pressing rollers into rotation. At (16) are compression springs which are interposed between the said pressing head (6a) proper and the said supporter members (13) and function to compress the said supporter members (13) when the same are moved as urged and pressed by the action of said cam means (15) and to cause the said supporter members (13) to restore to the original positions, namely to the non-compaction-acting position, when the cam action has been released. Fig. 3 shows such state that the cam action by said cam means (15) has been released, thus with the compression springs (16) extended and with the supporter members (13) in the non-compaction-acting position.

At (17), as shown in Figs. 1 and 2, is a cutting tool for scraping off the inner surface of the said tubular cast piece (2) and is mounted at the tip end of the said pressing head (6a).

Fig. 3 is drawn in such state that this cutting tool (17) has been removed.

(32) Now, the method of this invention is explained hereunder using the metal mold (1) for centrifugal casting as well as driving means (6) as mentioned above.

(33) First, one pours aluminium alloy melt for casting into the metal mold (1) and forms the tubular cast piece (2) by centrifugal casting method. Subsequently, one inserts the pressing head (6a) of pressing means (6) in inner hollow space of the tubular cast piece (2) and positions same therein.

(34) Immediately after completion of the said tubular cast piece (2) solidification, the oil hydraulic cylinder (9) of the pressing effort generating unit (6b) is actuated, thus the piston rod (11) thereof is drawn and the taper portion (11a) at the tip end thereof causes the supporter members (13) of the pressing rollers (12) to move towards the inner surface of the said tubular cast piece (2).

(35) Each of the pressing rollers (12) functions thereby for pressure-compacting the tubular cast piece (2) inner surface.

(36) All this while, the said metal mold (1) is continuously rotated and the said pressing rollers (12) are made to effect the pressure compacting while idly rotating.



(37) Here, by the said pressing effort generating unit (6b) being moved on rail means (7) by the travel-causing apparatus (19)^{6c}, one causes the said pressing head (6a) to move along the axial direction of the tubular cast piece (2) and thus effects the pressure compacting all over the tubular inner surface.

(38) By the way, explanation of the stage of the tubular cast piece (2) inner surface scraping off by the cutting tool (19) has been omitted, but if one effects the scraping-off stage prior to the said pressure-compacting stage, one can then unify the inner diameter of the tubular cast piece (2), thus enabling to make subsequent urging pressure force by the pressing rollers (12) all over the tubular cast piece (2) inner surface approximately uniform and making it possible to obtain the tubular cast piece of more excellent quality.

(39) On the other hand, if one effects the scraping-off stage after the said pressure-compacting stage, one can then produce the inner diameter of the tubular cast piece (2) at the value as is desired.

(40) Furthermore, by first effecting the scraping-off stage and subsequently performing the inner surface pressure-compacting stage and thereafter performing once again the scraping-off stage, one can obtain both of the advantages of the said two methods.

(41) It still further is possible to obtain the

tubular cast pieces of the qualities as are suited for the various uses, by supplementing a stage of applying certain special surface hardening treatment or the like after the final scraping-off stage is over.

- 5 (42) Now, this invention mentioned above is explained hereunder with reference to Field Example 1:

<Field Example 1>

- One took Al - 4.5%Mg alloy, cast same by metal mold centrifugal casting to a wall thickness of 35 mm, kept the tubular cast piece at 300°C after completion of the solidification, retaining same as integral with the casting mold, and put the inner surface thereof to a pressure by the pressing rollers at the urging pressure force of 200 kg/cm², and caused same to make two reciprocations over the full length on the inner surface, thus to cause reduction of 0.5 mm in the cast wall thickness.
- 10
15

- (43) A photographic picture taken of the section of the thusly obtained tubular cast piece, after applying dyeing color penetration flaw detection thereon, is Fig. 4. Central portion of the tubular cast piece of Fig. 4 is the portion the pressure-compacting mentioned above has been applied on, while both lateral sides thereof are left in the state just as formed by the conventional centrifugal casting method.
- 20

- 25 (44) As is clear from Fig. 4, it can be recognized that the portion on which the inner surface working has

been applied in accordance with the method of this invention appears to be white, namely that it has been changed to have dense structure, while both lateral sides thereof appear to be black (-actually, they are
5 dyed in red color -) on account of shrinkage cavities or pores as generated.

(45) Shown in Table 1 are differences between mechanical properties of the inner diameter periphery portion of this cast piece and mechanical properties
10 by the conventional method:

Table 1

	Tensile strength (kg/mm ²)	Elongation (%)
Conventional method	20.0	5.2
15 Method of this invention	28.5	20.6

(46) Note that these result are with respect to each test piece cut out in size of 14 mm outer diameter with its center located at 10 mm from the inner diameter periphery of the tubular cast piece.

20 (47) Next, Field Example 2 for demonstrating the surface hardening ensuing on pressure-compacting the tubular cast piece inner surface as is the object of this invention, is now described hereunder:

<Field Example 2>

25 (48) Shown in Table 2 are temperatures during the pressure-compacting when one cast the tubular cast pieces

using aluminium alloy substantially the same as in the said Field Example 1 with the pressure-compacting with urging pressure force of the pressing rollers set at 400 kg/cm², with showing of the relation with the hardness, at room temperature, of the inner surface and the unworked outer surface of the tubular cast piece as pressure-compacted at such temperature, as well as of the relation with the elongation and the tensile strength of the said aluminium alloy at such temperature of effecting the pressure-compacting:

Table 2

Pressure-compacting temp. (°C)	Brinell hardness		Mechanical properties at each temperature	
	Inner surface	Outer surface	Elongation (%)	Tensile strength (kg/mm ²)
500	76	74	40	1.0
450	78	74	41	1.2
400	80	75	44	2.0
350	81	75	45	3.5
300	84	74	45	6.0
250	85	75	45	9.1
200	87	74	40	14.8
150	88	74	25	22.5
100	88	74	8	28.1

(49) As is clear from Table 2 above, it is seen that the inner surface hardness of the tubular cast piece on which one effected the inner surface pressure working at 500°C is greater than the unworked tubular cast piece outer surface hardness. It is further seen that the inner surface hardness gets increased as the pressure-compacting work temperature lowers, to approximately reach the limit at about 150°C - 100°C.

(50) On the contrary, it is seen that the elongation, as a mechanical property, of the said aluminium alloy shows remarkable increase as the temperature goes up higher, with a clear border line of about 100°C, namely the transition temperature.

(51) From this, it is understood that by practicing the method of this invention in the range from the temperature immediately after completion of the casting object metal solidification to the transition temperature of that metal it is then possible to crush down with mild pressure force the shrinkage cavities or pores at the state of mild steel property of that metal, thus enabling to obtain the metal structure dense in the wall thickness direction of the tubular cast piece and uniform approximately, and at the same time to enhance the worked surface hardness.

(52) Since it is further noted from the said Table 2 that the tensile strength shows remarkable lowering as

the temperature goes up higher with a clear border line of about 200°C, it is seen that when one practices the pressure-compacting work further preferably in the range from 450°C to about 200°C it is then possible to perform
5 the inner surface compacting work to provide comparatively high value of hardness with milder pressure force.

(53) By the way, showing in regard to the transition temperatures of other metals is, by way of example, 500°C with respect to steel and cast iron, 600°C with
10 respect to 18-8 stainless steel and 450°C with respect to a copper alloy (70% copper, 30% zinc). As described above in detail, it is made possible according to this invention to work the tubular cast piece inner surface and to enhance the quality thereof, and it is further
15 noted that by enlarging partially the pressure force at the earlier stage of the pressure-compacting work, namely at high temperature state, it is possible even to work out the pressure compacting for causing the stepped profile in the tubular inner surface, as shown
20 in Fig. 5.

(54) It should further be noted that the method of this invention may as well be applied on tubular cast pieces having tapered section as shown in Fig. 7 and on tubular cast pieces of polygonal outer shape as shown
25 in Fig. 6.

(55) By the way, though it has been made to construct

pressing means (6) in this invention using oil hydraulic pressure, but such may as well be any construction only if the construction can press the tubular cast piece (2) inner surface.

5 (56) Furthermore, with respect to the method of bringing the tubular cast piece (2) and the pressing head (6a) of pressing means (6) in relative rotation, it is as well possible, even in the same case of using the metal mold for centrifugal casting machine, as
10 mentioned above, to cause the side of the pressing head (6a) to rotate or to cause same and the metal mold (1) supporting the tubular cast piece (2) to rotate in directions opposite to each other.

(57) Still further, it is also possible to make both
15 of the said two in one and the same direction but with different circumferential speeds of both of them at the abutment portions.

(58) Such methods for the relative rotation may be all the same also in case that one casts the tubular
20 cast piece by using other casting method and performs the pressure-compacting while sustaining the cast piece by any other chuck means or the like, and on the other hand it is also possible to use any suitable construction as driving means (5) to cause pressing means (6) and
25 the tubular cast piece in the relative rotation.

Industrial Applicability

- (59) As is clear from the above description, the tubular cast piece inner surface working method and apparatus thereof according to this invention may be
- 5 utilized for the various uses since strength and gas-tightness of the tubular cast piece as well as abrasion resistance and corrosion resistance of the inner surface thereof can thereby be enhanced, thus to the tremendous advantage in the industrial application thereof.

CLAIMS

1. Tubular cast piece inner surface working method characterized by: positioning a pressing head (6a) of pressing means (6) in inner hollow space of a tubular cast piece (2) formed by casting; and pressure-compacting
5 the said tubular cast piece (2) inner surface, within a temperature range starting from that immediately after completion of the said tubular case (2) solidification to the transition temperature, by means of the said pressing head (6a) while bringing the said pressing
10 head (6a) and the said tubular cast piece (2) in relative rotation.

2. In a method recited in claim 1, the tubular cast piece inner surface working method characterized in that the said tubular cast piece (2) casting is done by centrifugal casting method.

3. In a method recited in claim 2, the tubular cast

piece inner surface working method characterized in that the said tubular cast piece (2) has been cast of an aluminium alloy.

4. In a method recited in claim 3, the tubular cast piece inner surface working method characterized in that the temperature range of the said tubular cast piece (2) inner surface pressure-compacting is the range from 450°C to 150°C.

5. In a method recited in claim 2 or 4, the tubular cast piece inner surface working method characterized in that the said tubular cast piece (2) rotates with respect to the said pressing head (6a).

6. In a method recited in claim 2 or 4, the tubular cast piece inner surface working method charac-

terized in that the said pressing head (6a) rotates with respect to the said tubular cast piece (2).

7. In a method recited in claim 2 or 4, the tubular cast piece inner surface working method characterized in that the said tubular cast piece (2) and the said pressing head (6a) are rotated in one and the same direction and that the relative circumferential speeds of both of them are different.

8. In a method recited in claim 2 or 4, the tubular cast piece inner surface working method characterized in that the said tubular cast piece (2) and the said pressing head (6a) are rotated in directions opposite to each other.

9. In a method recited in claim 1 or 4, the tubular cast piece inner surface working method charac-

terized by performing, prior to the said tubular cast
piece (2) inner surface pressure-compacting by the
5 said pressing head (6a), cutting work of the inner
surface.

10. In a method recited in claim 1 or 5, the
tubular cast piece inner surface working method charac-
terized by moving the said pressing head (6a) along the
axial direction of the said tubular cast piece (2)
5 during the tubular cast piece (2) inner surface pressure-
compacting by the said pressing-head (6a).

11. In a method recited in claim 10, the tubular
cast piece inner surface working method characterized
by varying, during the said pressing head (6a) moving
in the axial direction of the said tubular cast piece
5 (2), the pressing effort as the same generates, thereby
forming up stepped profile on the said tubular cast
piece (2) inner surface.

12. A tubular cast piece inner surface working apparatus characterized in that it comprises: pressing means (6) having a pressing head (6a) constructed to be capable of pressing the tubular cast piece (2) inner surface as is kept within a temperature range starting from that immediately after completion of the solidification to the transition temperature; and driving means (5) for bringing the said tubular cast piece (2) and the said pressing head (6a) in relative rotation.

13. In an apparatus recited in claim 12, the tubular cast piece inner surface working apparatus characterized in that said pressing means (6) comprises a pressing head (6a) to be positioned in inner hollow space of the said tubular cast piece (2) and a pressing effort generating unit (6b) to be positioned outside thereof, wherein the former (6a) includes: at least a pressing roller (12) to come in abutment against the said tubular cast piece (2) inner surface, and cam means (15) for pressure-biasing the pressing roller(s) (12) against the said tubular cast piece (2) inner surface; and the latter (6b) includes an oil hydraulic cylinder (9) to cause said cam means (15) to act.

14. In an apparatus recited in claim 13, the tubular cast piece inner surface working apparatus characterized in that there are disposed three of the said pressing rollers (12) at equal intervals circumferentially about the said pressing head (6a) and that they are made free to idly rotate.

15. In an apparatus recited in claim 14, the tubular cast piece inner surface working apparatus characterized in that said driving means (5) is constructed to rotate only the said tubular cast piece (2).

16. In an apparatus recited in claim 14, the tubular cast piece inner surface working apparatus characterized in that said driving means (5) is constructed to rotate only the pressing head (6a) of said pressing means (6).

17. In an apparatus recited in claim 14, the tubular cast piece inner surface working apparatus characterized in that said driving means (5) is constructed to rotate the said tubular cast piece (2) and pressing head (6a) of pressing means (6) in directions opposite to each other.

18. In an apparatus recited in claim 14, the tubular cast piece inner surface working apparatus characterized in that said driving means (5) is constructed to rotate the said tubular cast piece (2) and pressing head (6a) of pressing means (6) in one and the same direction but with different circumferential speeds of both of them at the abutment portions.

19. In an apparatus recited in claim 15, the tubular cast piece inner surface working apparatus characterized in that said driving means (5) is constructed with a metal mold (1) for the centrifugal casting and with at least a driving roller (3) and an electric motor (4) connected thereto.

20. In an apparatus recited in claim 19, the tubular cast piece inner surface working apparatus characterized in that with respect to the said pressing roller (12) there are formed: a plain surface (12a) in the central portion thereof; and, on both sides of the surface, slant surfaces (12b).

21. In an apparatus recited in claim 19, the tubular cast piece inner surface working apparatus characterized in that the said pressing roller (12) is formed in a beer-barrel shape with central portion thereof forming smooth, bulging surface.

22. In an apparatus recited in claim 20, the tubular cast piece inner surface working apparatus characterized in that said cam means (15) is constructed with: a cam surface (13a) formed on supporter member(s) (13) supporting the said pressing rollers (12); and a taper portion (11a) formed on tip portion of a piston rod (11) of the said oil hydraulic cylinder (9).

23. In an apparatus recited in claim 22, the tubular cast piece inner surface working apparatus characterized in that in the said pressing head (6a) there are further provided at least a compression
5 spring (16) between the supporter member (13) of the said pressing rollers (12) and the pressing head (6a) proper.

24. In an apparatus recited in claim 13 or 23, the tubular cast piece inner surface working apparatus characterized in that said pressing means (6) is further equipped with a travel-causing apparatus (6c).

25. In an apparatus recited in claim 24, the tubular cast piece inner surface working apparatus characterized in that the said travel-causing apparatus (6c) includes an oil hydraulic cylinder (19) and a
5 piston rod (20) and that one end of the piston rod (20) is connected to the said pressing effort generating unit (6b).

26. In an apparatus recited in claim 13, the tubular cast piece inner surface working apparatus characterized in that the said pressing roller(s) (12) is/are constructed to be forcibly driven into rotation.

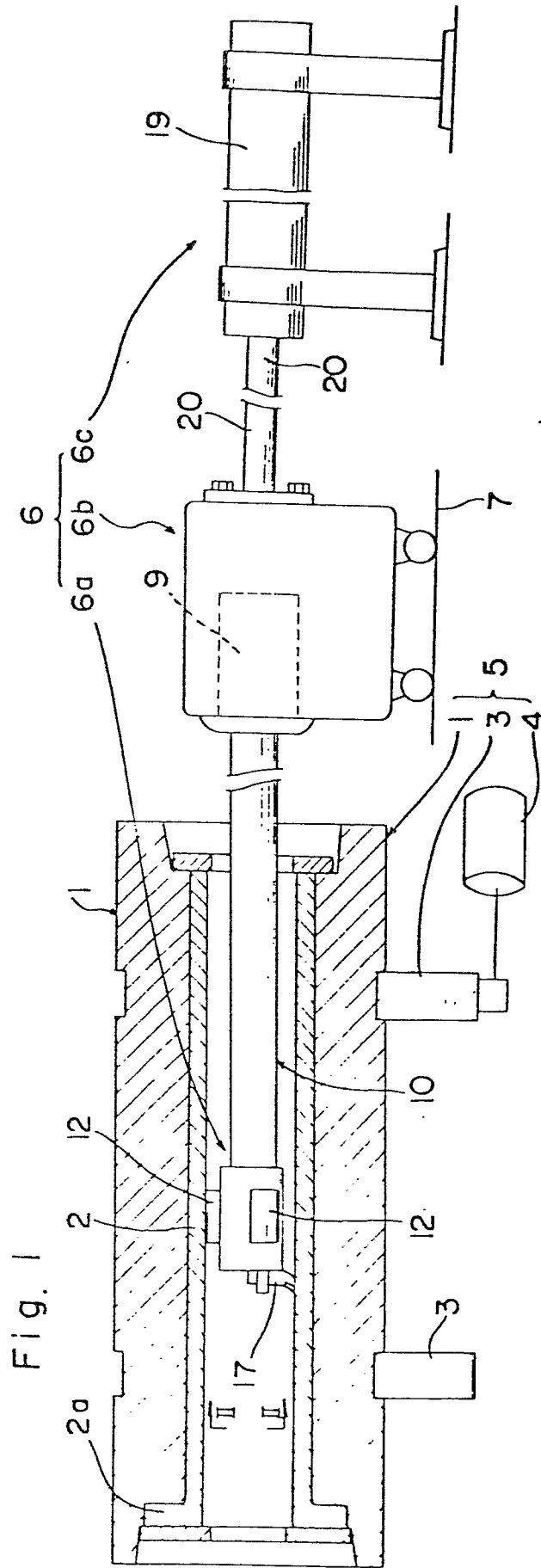


Fig. 2

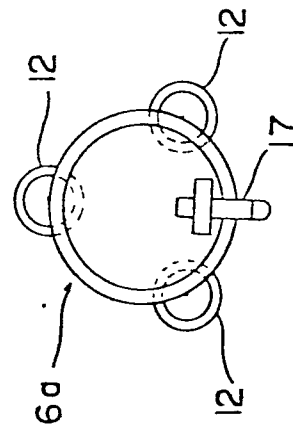


Fig. 7

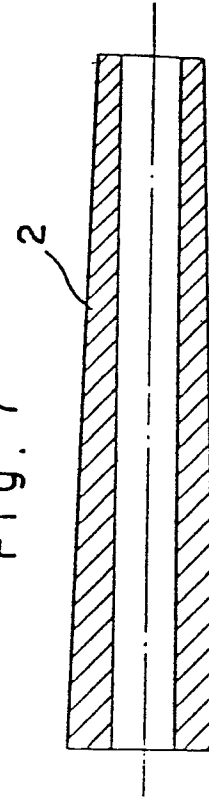


Fig. 3

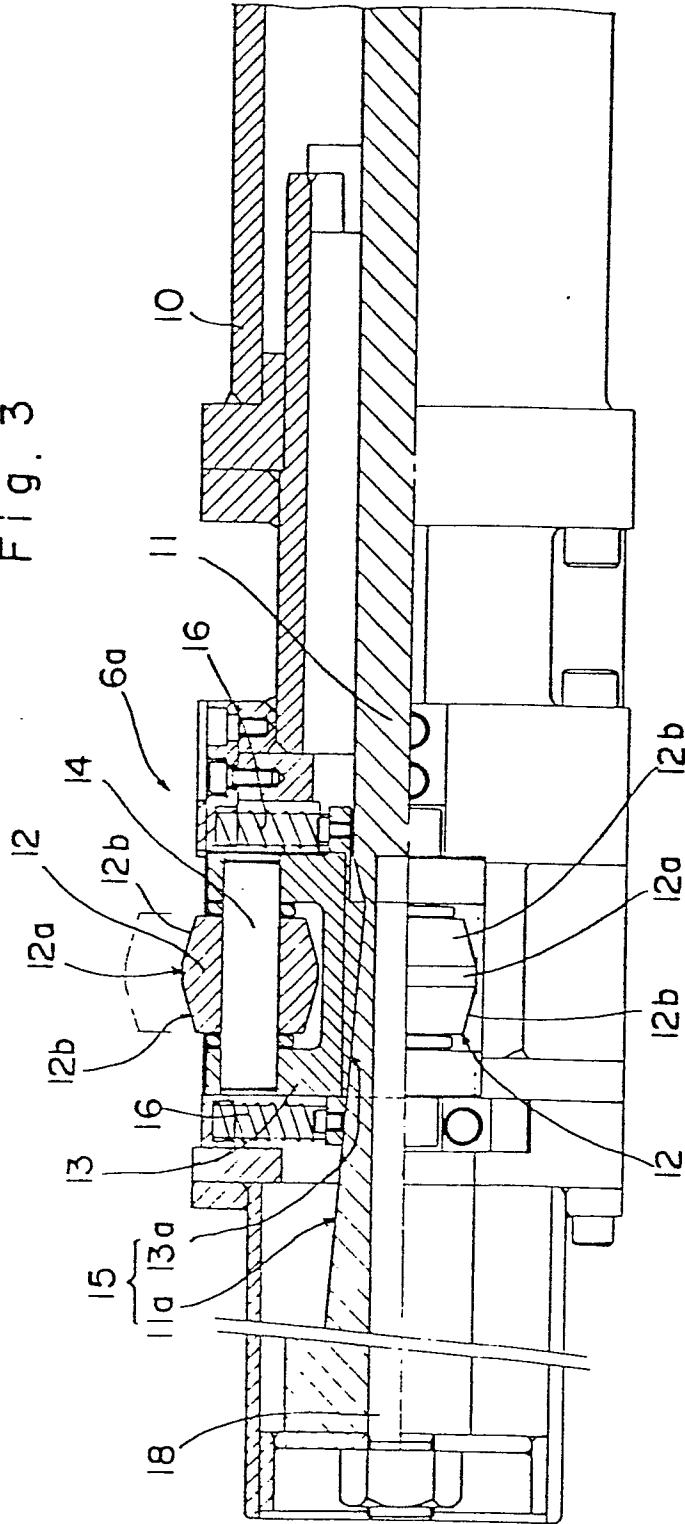


Fig. 6

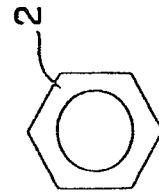
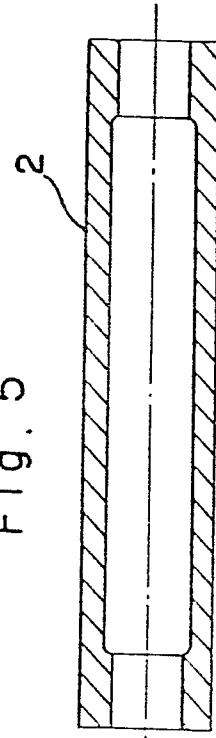
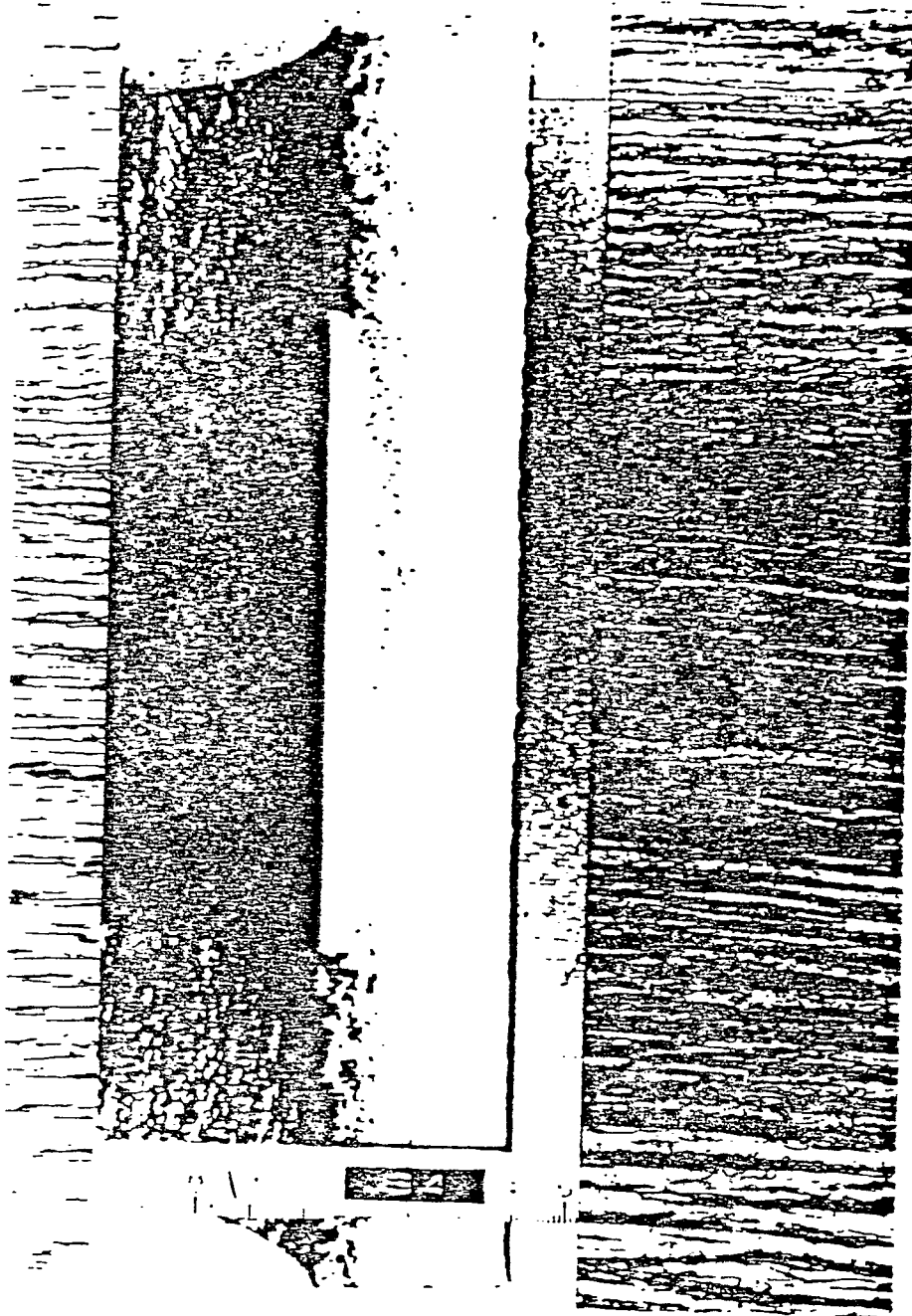


Fig. 5



3/3

Fig. 4



INTERNATIONAL SEARCH REPORT

0028653

International Application No PCT/JP79/00319

I. CLASSIFICATION OF SUBJECT MATTER (If several classification symbols apply, indicate all) *		
According to International Patent Classification (IPC) or to both National Classification and IPC		
B22D 29/00, B22D 13/10		
II. FIELDS SEARCHED		
Minimum Documentation Searched *		
Classification System	Classification Symbols	
IPC	B22D 29/00, B22D 13/00	
Documentation Searched other than Minimum Documentation to the extent that such Documents are Included in the Fields Searched *		
Jitsuyo Shinan Koho 1926 - 1979		
Kokai Jitsuyo Shinan Koho 1971 - 1979		
III. DOCUMENTS CONSIDERED TO BE RELEVANT ¹⁴		
Category *	Citation of Document, ¹⁶ with Indication, where appropriate, of the relevant passages ¹⁷	Relevant to Claim No. ¹⁸
X	JP, Y ₁ , 37-4824	(1-8, 10-12,) 24
X	JP, B ₁ , 48-7990 Column 2, lines 33 to 34	(9)
X	US, A, 3259975	(9)
A	JP, A, 50-50261	(1-4)
* Special categories of cited documents: ¹⁵ "A" document defining the general state of the art "E" earlier document but published on or after the international filing date "L" document cited for special reason other than those referred to in the other categories "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but on or after the priority date claimed "T" later document published on or after the international filing date or priority date and not in conflict with the application, but cited to understand the principle or theory underlying the invention "X" document of particular relevance		
IV. CERTIFICATION		
Date of the Actual Completion of the International Search *	Date of Mailing of this International Search Report *	
March 3, 1980 (03.03.80)	March 10, 1980 (10.03.80)	
International Searching Authority ¹	Signature of Authorized Officer ²⁰	
Japanese Patent Office		