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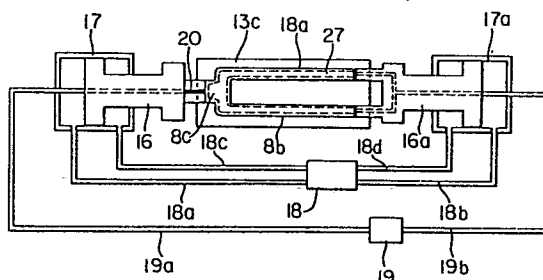
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⑤④ **Method for the manufacture of front fork of single unit type for bicycles from center butted ferrous tubular material.**

⑤⑦ A front fork blank of the single unit type is manufactured from a center butted tube, the wall thickness of its middle portion exceeding that of both end portions of the tube, as a starting material. The center butted tube is produced by a known machine including a mandrel and a die. The center butted tube is bent at two positions with the right angle to form a tubular fork. The tubular fork is set in a sectional die which has a concave recess corresponding to a protuberant socket, and subjected to the known oil hydraulic bulge-forming process in order to bulge-form the socket at the middle of the top of the tubular fork. The socket is opened to receive a stem (Fig. 13).



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10 Method for the Manufacture of Front Fork of Single Unit
Type for Bicycles from Center Butted Ferrous Tubular
Material

The present invention relates to a method for the manufacture of a front fork blank for use in bicycles, and more particularly to a method for manufacturing a front fork of the single unit type from a center butted ferrous tubular material as a starting material in which a crown member to which a pair of blades are joined by brazing and the like is no longer required. The method for manufacturing the front fork of the single unit type conforms to present requirements of the saving of material, energy and labor.

As is known in the bicycle industry, the front fork comprises a stem, a crown, and a pair of blades. The stem, crown, and blades are manufactured separately. Except for the stem, the front fork is assembled by joining two blades to the crown. The manufacture of the crown itself requires a somewhat complicated step.

In bicycle tubing, the term "butted tube" refers to a tube having a wall which is thicker at a certain part along its length than the remainder. There exist three different types of butted tubing: single, double, and differential (or triple) butted tubes. Single butted tubes are thicker

1 at one end only, double butted tubes are thicker at both
ends, and differential butted tubes have ends of varying
thickness. The butted tubes are butted because the stress
in a tubing frame is highest at the ends where the tubes
5 are joined. By butting, the tube can be made thinner and
lighter as steel is removed from the middle of the tube
where the stress is relatively low.

The term "center butted tube" used in the present invention
10 refers to a tube wall thickness of which exceeds only in
the middle that of its two end portions. In the bicycle
tubing, however, the center butted tube has never been
mentioned, because the center butted tube may be of no use
for bicycles.

15 As described above, it is generally considered that the
butted portion of the tube is thicker than the other portion
thereof, and is thus also stronger than the other portion.
Accordingly, the present invention is directed to the
20 application of the thick and strong portion of the center
butted tube to a crown portion of the single unit front
fork.

According to US-A-4 305 269 and JP-A-47375/81 both end
25 portions of a tubular ferrous blank are tapered, and its
middle portion is shaped ellipsoidal; the tubular blank so
shaped is bent at two positions of the middle portion at
right angles to form a two-blade fork; the tubular fork
formed is set in a sectional die of top and bottom molds,
30 and is subjected to the oil hydraulic bulge-forming step to
bulge-form a protuberant socket in the middle. The socket
can receive a stem to form a front fork blank of the single
unit type.

35 It should be noted that the center butted tube is not applied
as a starting material in the above U.S. and JP-prior art
documents.

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1 Accordingly, it is a prime object of the present invention
to provide a method for the manufacture of a front fork
blank of the single unit type for bicycles by applying a
center butted tubular ferrous material as a starting
5 material.

It is another object of the invention to provide a method
for the manufacture of a front fork blank of the single
unit type for bicycles by applying the center butted tubular
10 ferrous material as a starting material and applying also
the oil hydraulic bulge-forming process thereto with a
view to saving material, energy, and labor, and thus marked-
ly reducing the manufacturing cost.

15 Further objects of the invention will be better understood
from the following detailed description with reference to
the accompanying drawings, in which:

Figure 1 is a schematic view of a ferrous tubular starting
material of this invention showing a longitudinal
20 welded seam represented as a dotted line,

Figure 2 is a sectional view wherein one of the machines
for making a center butted tube having an outer
thick wall in the middle is shown in a very
simplified manner,

25 Figure 3 is a sectional view showing the same center butted
tube having the same outer thick wall in the
middle as the tube of Fig. 2;

Figure 4 is a sectional view showing another center butted
tube having an inner thick wall in the middle,

30 Figure 5 is a sectional view showing an additional center
butted tube having an inner and outer thick wall
in the middle,

Figs. 6-8 are front views of front fork blanks bent and
formed from straight center butted tubes of
35 Figs. 3-5, respectively,

- 1 Figure 9 is a front view of a front fork blank of the
single unit type manufactured in accordance with
the method of the invention,
- Figure 10 is a perspective view of a conventional crown
5 member available on the market,
- Figure 11 is a schematic view showing three components of
a conventional front fork before assembly as
compared with that of the single unit type de-
picted in Fig. 9;
- 10 Figure 12 is a simplified schematic view showing how each
component of the oil hydraulic bulge forming press
machine according to this invention is formed;
- Figure 13 is a schematic plan view showing how a tubular
fork blank set in a bottom mold of a sectional
15 die is subjected to the oil hydraulic bulge
forming step, and how a working oil under press-
ure is delivered to the die,
- Figure 14 is a detailed plan view of the bottom mold of
the sectional die in which the tubular fork blank
20 is set, and a mandrel is inserted into the open-
ing of the die,
- Figure 15 is a schematic view of the mandrel with a concave
recess which corresponds to the bulge-formed
socket of the front fork blank, and
- 25 Figure 16 is a schematic view of the sectional die consist-
ing of top and bottom molds having an opening into
which the mandrel is to be inserted.

Referring to the drawings in more detail, Fig. 1 shows the
30 tubular ferrous stock 1 with the longitudinal welded seam 1a,
which is specified in JIS (Japanese Industrial Standard)
G 3445 "Carbon Steel Tubes for Machine Structural Purposes"
STKM 11A-13A. The steel described therein contains less
than 0.25 % C, less than 0.35 % Si, 0.30-0.90 % Mn, less
35 than 0.040 % P, less than 0.040 % S, the remainder being Fe;

1 and has the following physical properties: its tensile
strength is more than 38 kg/mm², and its elongation more
than 35 %. As for the welded seam, a spirally welded seam
is not suitable, because in charging the welded tubular
5 blank into the sectional die described hereinafter, care
should be taken that the welded seam 1a is located outside
the area where a single component is to be bulge-formed.

A seamless tube may be used as a tubular blank, offering
10 the advantage that no attention may be paid to the welded
seam so that the seamless tube may be automatically charged
into the die, though, on the other hand, the seamless tube
is more expensive than the welded tube.

15 Fig. 2 shows one of the known machines for making a butted
tube, the invention and development of which are quite
old. The "Bicycle Technical Information Bulletin" No. 13
of Japan reports that the "butted tube" (developed in
1890) was imported from British Reynolds Co. into Japan as
20 a steel tube having a thick end wall. Rauch et al.:
"Fahrradtechnik" published in West Germany 1980 by Biele-
felder Verlagsanstalt KG describes that the "butting process"
was invented in 1935 by Reynolds Co., and further developed
(p. 48).

25 As mentioned hereinbefore, the center butted tube whose
wall is particularly thick in the middle of the tube length
has never been applied for use in the bicycle tubing. If
the center butted tube is conceived as a tube as whose
30 wall is only thick in the middle, three different types
are proposed as follows:

- (1) The middle portion of the center butted tube
protrudes, which is called "center butted tube with an
out er thick wall" (see Fig. 3).

- 1 (2) The middle portion of the center butted tube is plain
and straight, but its inside middle portion protrudes:
"center butted tube with an inner thick wall" (Fig.4).
(3) The middle portion of the center butted tube, and its
5 inside middle portion protrudes: "center butted tube
with both inner and outer thick walls" (Fig. 5).

From Fig. 2, it can be seen that the center butted tube 2
having the outer thick wall 2a can in principle manufactured
10 by a known mechanism consisting of a die 14 which surrounds
the tube 2 and a mandrel 15 closely inserted into the in-
side of the tube 2. The outside diameter of the mandrel 15
is almost equal to the inside diameter of the tube 2 so
that the mandrel 15 can be inserted into the inside of the
15 tube to be processed so as to support the external force
of the die 14 imposed on the wall of the tube. The tube 2
into which the mandrel 15 has been inserted is then sub-
jected to the cold drawing or extruding process by the
die 14 in order to reduce the wall thickness of the tube 2
20 except for the middle portion, namely the butted portion
2a, to about 60 % of the original wall thickness, whereby
the center butted tube 2 with the outer thick wall 2a is
formed.

25 It is understood that Fig. 2 shows the fundamental principle
of the known metal processing mechanism for manufacturing
a butted tube. In addition, there are many other machines
which may be used in the manufacture of any of the center
butted tubes listed under (1)-(3) above:

30 Initially, the length of a tubular starting material is
about 60-65 cm. It is elongated to about 90 cm when being
subjected to a series of cold rolling, drawing, swaging,
and tapering steps, etc. The length of the middle portion
of the tubular blank is selected to be about 10-15 cm,
35 and the length of each blade portion is equal to about
half the balance, namely, about 34 - 40 cm, respectively.

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1 The outside diameter of the tubular material is in the
range of 23.8-25.4 mm and the wall thickness is 2-2.3 mm.
This size and dimension is merely illustrative, and it is
understood that the present invention should not be
5 limited thereby.

The wall thickness of the butted portion of the center
butted tube listed in (1) and (2) is in the range of
2-2.3 mm which is the original thickness of the tubular
10 starting material, and while the thickness of the two end
portions which are reduced by 40 % is in the range of
1.2 - 1.38 mm, which is 60 % of the original thickness.
The wall thickness of the butted portion of the center
butted tube of (3) is almost the same as that of (1) and
15 (2). The details are omitted.

Next, both reduced or thin portions of the center butted
tube are subjected to the tapering process by a known
swaging machine and the like to form tapered blades. In
20 addition, the section of the butted portion may be shaped
elliptically or ovally, as desired.

The center butted tubes depicted in Figs. 3-4 are then
subjected to the bending process producing about right
25 angles in the same direction and in the same plane at two
positions so as to form tubular fork blanks as shown in
Figs. 6-8. It should be noted that the butted portion of
the tube includes both bent shoulders at two positions as
illustrated in Figs. 6-8 in order to give the shoulders
30 sufficient strength to support both blades. It is also
to be noted that the longitudinal welded seam of the
tubular material should face downwardly, in other words,
the seam of the butted portion faces downwardly so that
the seams of both blade portions between the two blades
35 face each other.

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1 The bending operation wherein the straight center butted
tube is bent at two places, producing nearly the right
angle to form a tubular fork shape with two prongs or
blades, is performed by a known method and machine. The
5 bending operation may be carried out either in two steps,
bending one blade first and then the other or in a single
step bending two blades simultaneously.

Fig. 9 is a simplified view showing a front fork blank 8
10 with two blades 8a and 8b of the single unit type. A
socket 8c is to be formed by the oil hydraulic bulge-
forming process which is described in detail hereinbelow.
It is to be noted that the front fork blank 8 of the single
unit type as shown in Fig. 9 should be compared with a
15 disassembled front fork of the prior art illustrated in
Fig. 11. The conventional front fork is manufactured by
joining two blades to a crown member shown in Fig. 10 by
brazing and the like. As can be seen the front fork of the
single unit of the present invention requires neither a
20 crown nor a brazing step. Thus it is clear that the
manufacturing cost of this invention can be considerably
reduced as compared with that of the prior art.

As regards the manufacture of a crown member depicted in 10,
25 such a crown member is at present generally manufactured
in two methods: (a) a molten metal is cast into a crown-
shaped mold; and (b) a metal plate is subjected to the
metal drawing process in a press machine, and the thus
formed product is welded together to obtain a finished
30 crown. Accordingly, the manufacturing cost of the crown
should not be negligible.

Next, the tubular fork blank of the single unit type shown
in Figs. 6-8 is set into a sectional die 13 (Fig. 16)
35 consisting of a top half 13b and a bottom half 13c, and is
subjected to the oil hydraulic bulge-forming process to form

- 1 a socket 8c (Fig. 9). The oil hydraulic bulge-forming process to expand a component of a desired shape from the tubular stock by inserting it into the sectional die 13 (Fig. 16), and introducing a working oil under high
- 5 pressure into the tubular blank in the die to expand the above component is disclosed in Japan Patent Nos. 417,728; 417,730; 418,055 (1963), and also in "Industrie Anzeiger", 1966, pp. 770 and 1001.
- 10 Fig. 12 shows a schematic view of a bulge-forming press machine 21 comprising an arch frame 22, a vertically reciprocating ram 23 suspended from the top, and a pair of horizontally reciprocating opposed rams 24,25 at either side. The top half 13b of the die 13 is secured to the
- 15 vertical ram 23 with its recess facing downwardly, and the bottom half 13c is bolted onto the bed 26 with its recess facing upwardly so that the tubular fork blank is set within the die 13 when the top half 13b is exactly put on the bottom half 13c.
- 20
- It is to be noted that Fig. 13 of the drawings of this invention is a modified plan view illustrated in Fig. 3 of US-A-4 051 704 entitled, "Method for the Manufacture of Ornamental Head Lug of Single Unit Type for Bicycles" in-
- 25 vented by S. Kumura. In this US-A-4 051 704, a straight tubular blank is set in the sectional die and subjected to the oil hydraulic bulge-forming process to expand two protuberant components with the hydraulic oil delivered from both end openings of the tubular blank. However, in this
- 30 invention, when a tubular fork blank is subjected to the oil hydraulic bulge-forming process, the left side of the plan view of Fig. 13 is no longer required, because the hydraulic oil should be delivered from the right side only as both end openings of the tubular fork are directed to
- 35 the same right side. Therefore the oil and pressure lines depicted at the left side of the view of Fig. 13 are closed to be inoperative. The tubular fork blank 8 has two

- 1 tubular blades 8a,8b, with the result that there is a
hollow void from one end opening of the one blade 8a to
the other end of the other blade 8b as seen from the top.
First, the hydraulic oil which is not pressurized is
5 introduced into one end opening of the blade in the
direction of the arrow as shown in Fig. 14 with the other
end opening being closed to fill the whole tubular fork 8
in the die 13 with the oil. When both end openings are
tightly closed, the oil is put under pressure by applying
10 the high pressure pump 18 instead of the oil supply pump
19 to attain a desired pressure value of 950-1200 kg/cm².
Recent research has proved that the highest value of the
oil pressure reaches up to 1500 kg/cm².
- 15 In Fig. 13, piston 16, 16a are housed in cylinders 17,17a,
respectively, but the piston 16 is inoperative and a passage
20 is closed as described hereinbefore. The oil and pressure
are delivered from a central bore shown as a dotted line
and provided within the piston 16a. It is to be noted that
the central bore of the piston 16a is divided into two
parts, namely, tow end openings of two blades.

In Fig. 16, the sectional die 13 is provided with an open-
ing 13a at its end, and a mandrel 12 shown in Fig. 15 is
25 so designed that it can be inserted into the opening 13a.
The mandrel 12 has a flange 12b at its one end while a
concave recess 19a is formed at other end.

In carrying out the bulge-forming process of this invention,
30 both processes as shown in Figs. 13-14 are performed in a
similar way. The process of Fig. 13 is somewhat different
from that of Fig. 14 in that the mandrel of Fig. 15 is
not used in the former process while the mandrel must be
applied in the latter.

35

The sectional die 13 is provided with a recess correspond-
ing to a desired shape, and in the present invention the

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1 recess is formed as a socket 8c at the middle of the top
or shoulder of the tubular fork blank 8. As soon as the
working oil 27 with a pressure of 950-1500 kg/cm² is forced
into the tubular fork blank 8 in the die 13, the middle
5 top 8c is bulge-formed into the socket-like recess 8c of
the die 13 (shown as dotted line in Fig. 14). At the very
beginning, the production of a bicycle part or similar
product from a tubular material by the bulge-forming process
was considered almost infeasible, but mass production of
10 various bicycle parts by the bulge-forming process has
been in full swing for the past twenty years.

The height of the bulge-formed socket 8c may be 5-10 mm,
as desired.

15

Next, the bulge-forming process in accordance with the
teaching of Fig. 14 will be described hereinbelow.

As soon as the pressure of the hydraulic oil filled in the
20 tubular fork blank set in the die 13 has reached the value
of 950-1500 kg/cm², the mandrel 12 with the recessed female
die 12a is caused to impinge on the middle top of the
tubular blank 8 in order to bulge-form the socket 8c. As
can be seen, the concave recess 12a of the mandrel 12
25 corresponds to the contour of the socket 8c to be bulge-
formed, in other words, the socket 8c acts as a male die
while the recess 12a acts as a female die. It is under-
stood that the die 13 of Fig. 13 is provided with the
recess 8c which corresponds to the contour of the socket
30 8c.

It is to be noted that the socket 8c should not be opened
simultaneously at the beginning of the high pressure oil
bulge-forming step, but should be opened by severing its
35 closed top after the bulge-forming step. The tubular front
fork blank thus manufactured by the bulge-forming process
from the center butted tube is an unfinished front fork

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1 product, from which a finished front fork article consist-
ing of stem (not shown), socket on the crown integral with
two blades, and fork ends (not shown) is obtained by the
known various working step.

5

Finally, the capacity of the rams now in operation is
described: vertical ram 23 is 120-360 t.; horizontal ram
24 or 25 is 60-180 t.; and the oil hydraulic pressure is
950-1500 kg/cm². The ferrous tubular blank can be bulge-

10 formed with the die being subjected to the combined load
mentioned above.

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1 Claims:

1. A method for the manufacture of a front fork blank of the single unit type for use in bicycles from a center butted ferrous tubular material having a middle butted portion and both thin end portions produced by subjecting a straight ferrous tubular material to a known metal drawing process in a machine provided with a mandrel inserted into said straight tubular material and a drawing die, comprises a series of steps of bending said two thin end portions of said center butted tubular material in the same direction and in the same plane relative to said middle butted portion constituting the top to form a tubular fork having two parallel blades; providing an opening at one end of a sectional die consisting of a top half and a bottom half and a mandrel with a concave recess designed to mate with a protuberant socket to be bulge-formed on said middle butted portion of said center butted tubular fork, said mandrel being capable of being inserted into said opening of said die; inserting said center butted tubular fork into said die designed to bulge-form said protuberant socket on said middle portion of said tubular fork; subjecting said tubular fork in said die to the combined load of a vertical compressive load, axial compressive loads, and a high pressure oil supplied into the interior of said tubular fork from both end openings of said tubular blades; and applying the known oil hydraulic bulge-forming process to bulge-form said protuberant socket on the middle of said tubular fork material.
2. Method as claimed in Claim 1 wherein said sectional die has no opening at one end, the interior of said sectional die is provided with a concave recess designed to mate with said protuberant socket to be bulge-formed on said middle butted portion of said tubular fork material, wherein no mandrel is provided.

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- 1 3. Method as claimed in Claims 1 or 2 wherein said butted
middle portion of said center butted tube is formed
with a wall outwardly protruding relative to said
straight thin wall of said center butted tube.
- 5 4. Method as claimed in Claims 1 or 2 wherein said butted
middle portion of said center butted tube is formed with
a wall inwardly protruding relative to said straight
thin wall of said center butted tube.
- 10 5. Method as claimed in Claims 1 or 2 wherein said butted
middle portion of said center butted tube is formed with
walls both outwardly and inwardly protruding relative
to the middle longitudinal line of said center butted
15 tube.
- 20 6. Method as claimed in any of Claims 1 to 5 wherein said ferrous
tubular fork blank for use in the bicycle has about
90 cm in length, the wall thickness of said center butted
portion is in the range of 2-2.3 mm, the length of said
center butted portion is in the range of 10-15 cm, the
outer diameter of said center butted portion is in the
range of 23.8-25.4 mm, the wall thickness of both thin
end portions is in the range of 1.2-1.38 mm, and the
25 original length of said straight ferrous tubular material
is in the range of 60-65 cm; and its chemical composition
is less than 0.12 % C, 0.35 % Si, 0.25-0.60 % Mn,
0.040 % P, and 0.040 % S maximum, respectively, the
remainder being Fe; and its physical properties being
30 as follows: tensile strength 32-42 kg/cm², elongation
30-40 %.

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FIG. 1

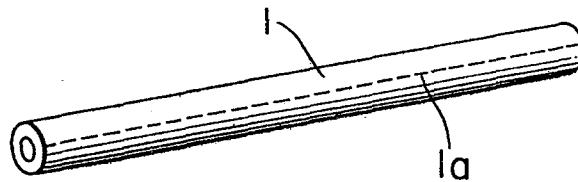


FIG. 2

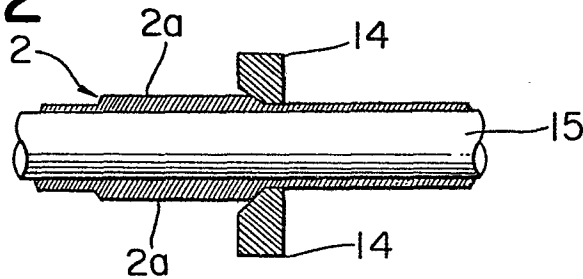


FIG. 3

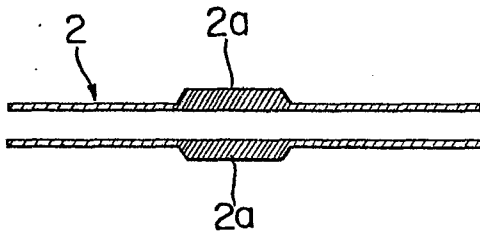


FIG. 4



FIG. 5

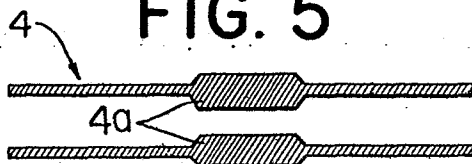
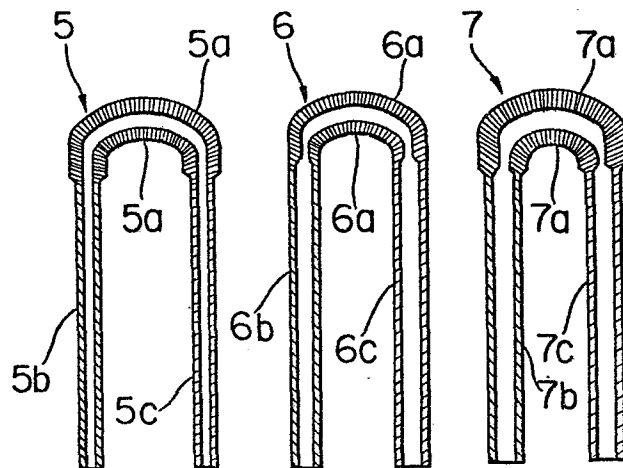


FIG. 6 FIG. 7 FIG. 8



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FIG. 9

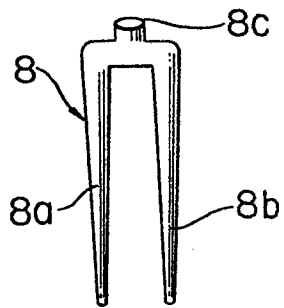


FIG. 10

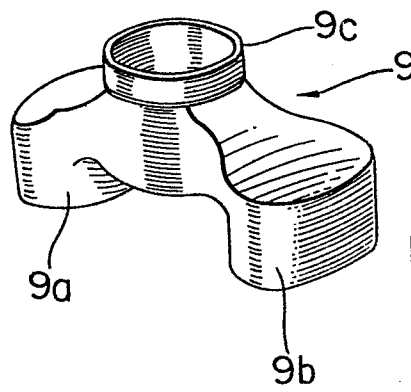


FIG. 11

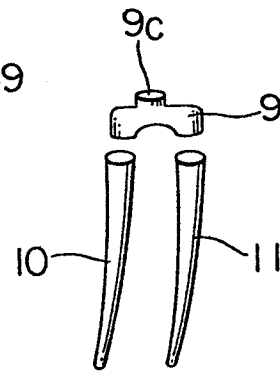
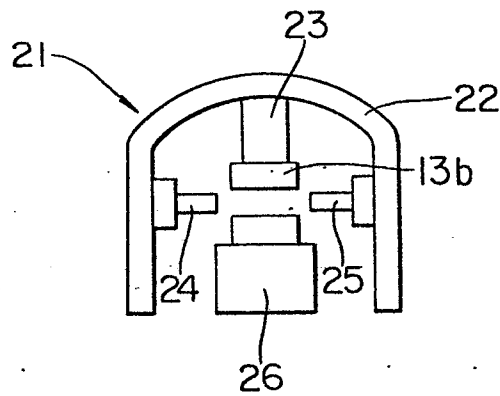
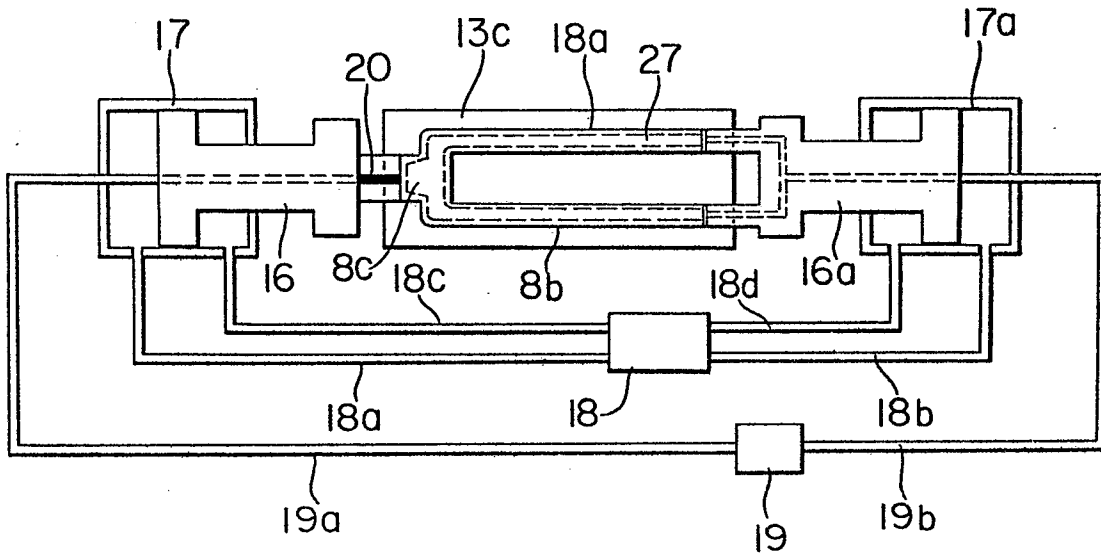
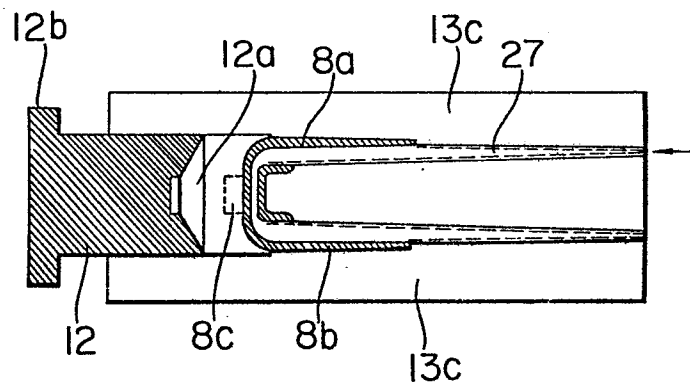
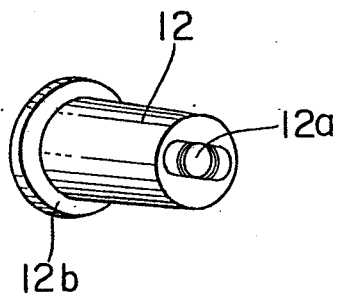


FIG. 12



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FIG. 13**FIG. 14****FIG. 15****FIG. 16**