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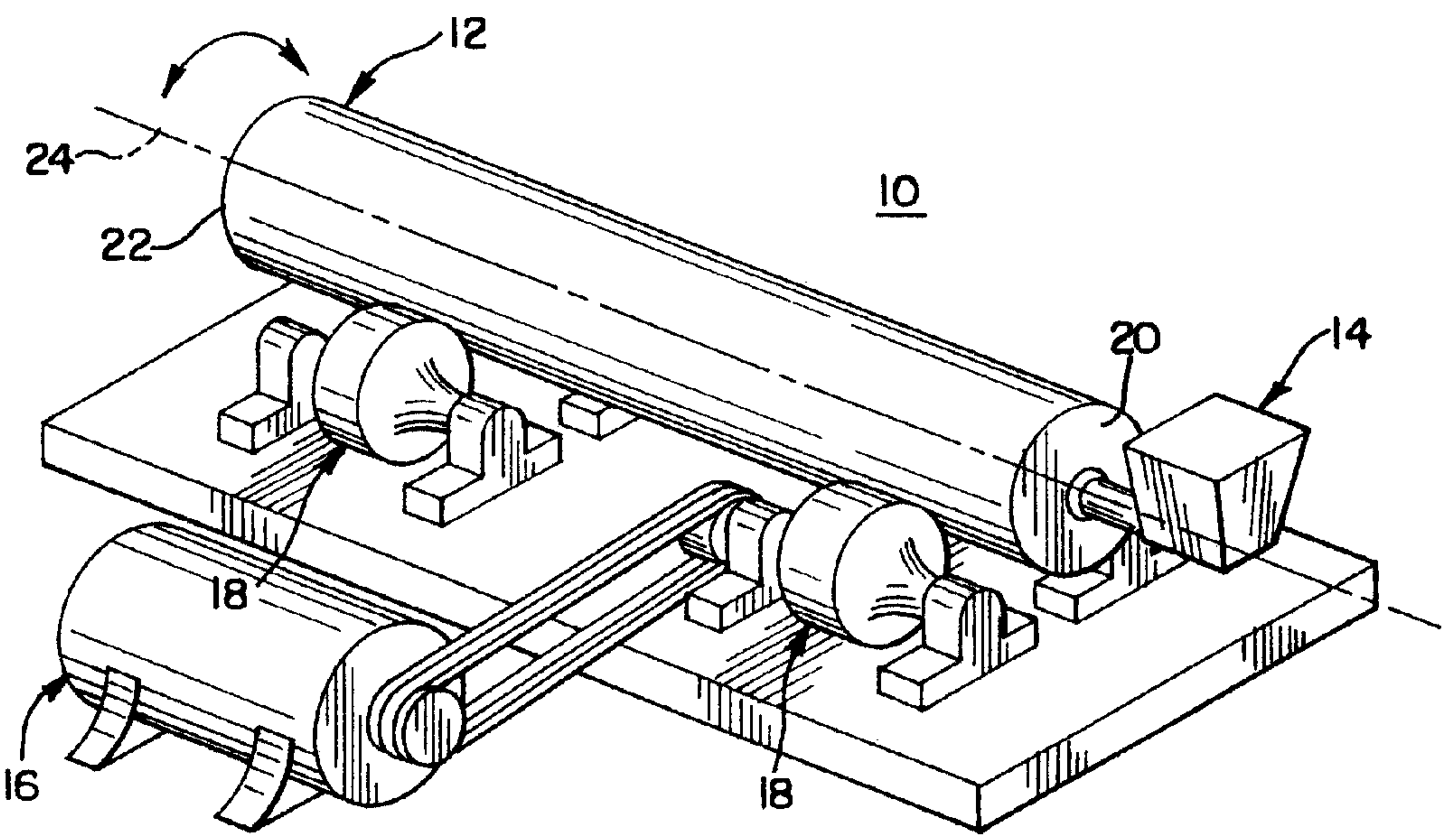
(54) **REVETEMENT INTERIEUR DE PROTECTION POUR L'AUGE DE COULEE D'UNE MACHINE A COULER**

(54) **PROTECTIVE LINING FOR A CASTING MACHINE POURING TROUGH**




(57) The present invention provides a preformed trough liner generally of a graphite or carbon and carbon filament combination for a casting operation, which may be a centrifugal casting operation, which liner may be a single formed component or may be a plurality of segments cooperating to provide a predetermined length and shape of a trough and channel, and the preformed liner may be secured by various means to maintain it within the trough housing.

# ABSTRACT OF THE DISCLOSURE

The present invention provides a preformed trough liner generally of a graphite or carbon and carbon filament combination for a casting operation, which may be a centrifugal casting operation, which liner may be a single formed component or may be a plurality of segments cooperating to provide a predetermined length and shape of a trough and channel, and the preformed liner may be secured by various means to maintain it within the trough housing.

# PROTECTIVE LINING FOR A CASTING MACHINE POURING TROUGH

## Background of the Invention

The present invention provides a pouring spout for a casting operation. More specifically, a liner for a pouring spout trough is provided to minimize erosion, abrasion and expansion of the pouring spout from the heat of the molten metal.

In general, the pouring spout for a centrifugal casting machine may be broadly characterized as an elongate and u-shaped trough. The trough provides a channel for transfer of a molten metal between a holding vessel, such as a ladle, tundish or holding furnace. In the case of low-melting metals, which may include aluminum, zinc and lead, and some of their alloys, the operating temperatures will generally be less than 1000°F. However, in the case of high-melting temperature metals, such as iron and steel, the temperatures can be expected to be 2500°F. and higher.

Handling and transfer of molten metals at elevated temperatures requires high-temperature tolerant materials, such as refractory materials, which may include calcium oxides, magnesium oxides, alumina and silica or combinations of these refractories. This is reflected in the refractory brick linings of reaction vessels for iron and steel manufacture, as well as the transfer ladles and the runners for transfer to the ladles. Although the refractory brick will accommodate the elevated temperatures of the molten metals, the transfer of molten metal, especially at higher temperatures, induces erosion and abrasion on the transfer surface, that is the refractory brick. Indicative of the erosive effect of a molten metal flowing on a surface is the requisite that the pouring spout in a steel ladle must be replaced after every use to avoid leaking around the nozzle and pouring spout. This condition exists even though the nozzle and pouring spout may include a refractory clay coating on a refractory brick base. Replacement of this pouring nozzle is expensive and time consuming. The nozzle must be replaced as the molten metal rushing past the constricted nozzle abrades and erodes this surface and inhibits the stopper rod end from nesting firmly in the nozzle to inhibit leaks. Similarly, the runner troughs in a blast furnace cast-house are lined with a graphite clay for wear and heat tolerance. However, the troughs are reworked, patched and rebuilt to an acceptable clay depth after each cast to avoid iron breakouts and wear of the underlying refractory brick.

A similar application may be found in the casting industry, that is the casting of molten metal into sand molds, graphite molds, centrifugal molds, die casting or ingot molds. In some cases, molten metal may be directly poured from a ladle into a mold. However, in many cases, a runner may extend between a pouring spout or tundish to a mold, which runner transfers the molten metal from a tundish or spout to the mold. This may be the technique chosen to allow a smoother or more even metal flow rate between the molten metal source and the mold to provide a more controlled pouring cycle. An example of this requisite for a smoother metal flow is the metal transfer between the pouring spout and the casting mold during centrifugal casting as in the Delavaud process or the horizontal axis centrifugal process.

In a broad description, a horizontal mold in a centrifugal casting process is placed on rollers for rotation about its central axis. A pouring spout is positioned at one end of the mold, which may be a cylinder, to receive molten metal and, a runner or trough extends from the spout into the mold generally along the central axis. Molten metal is transferred to the pouring spout by a ladle or other means and flows into the runner or trough for delivery to the mold along the central axis. As a practice in at least one casting shop, the trough is provided with a clay liner generally conforming to the trough shape. However, this clay liner wears during the pouring-transfer of the molten metal to the mold, and must be rebuilt or reconditioned after each cast or casting cycle.

## SUMMARY OF THE INVENTION

The present invention provides a trough liner for a trough shell of a casting process. This trough is utilized to communicate molten metal between a transfer or holding device, such as a hot-metal ladle or pouring spout, to a mold. The trough liner is a long-wearing and heat-tolerant material with a carbon or graphite and graphite fiber structure to tolerate the transfer of molten metal along its surface with a minimal amount of abrasion and erosion. This trough liner may be utilized for a plurality of casts or heats within a casting cycle before it must be refurbished or replaced. The trough liner is preformed to conform to the shape and length of the trough. Thus, the preformed liner may be nested in the trough and secured in position by an accompanying hold-down clip. This arrangement provides for rapid preparation of a trough, minimizes maintenance as the trough material is longer wearing than present lining materials, and it increases the production rate by avoiding unnecessary trough maintenance.

## BRIEF DESCRIPTION OF THE DRAWING

In the figures of the Drawing, like reference numerals identify like components, and in the Drawing:

Figure 1 is a representation of a horizontal-centrifugal casting apparatus;

Figure 2 is a representation of a horizontal-centrifugal casting apparatus in longitudinal cross-section with the pouring spout and trough;

Figure 3 is an end view of the attaching flange for the pouring spout of an extant pouring trough;

Figure 4 is a cross-sectional view of the trough along its longitudinal axis;

Figure 5 illustrates a cross-sectional view of the trough and liner arrangement with a pool of molten metal coursing through the trough;

Figure 5A is an exemplary bar clamp and bolt;

Figure 5B is an exemplary strap and clip securing arrangement;

Figure 6 is a plan view of a trough and a preformed liner; and,

Figure 6A is an illustration of the trough of Figure 6 as a segmented arrangement.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Figure 1 illustrates a horizontal, centrifugal casting apparatus 10 with mold 12, pouring spout 14, drive motor 16 and rollers 18. Mold 12 is shown as an elongate cylinder with first end 20, second end 22 and longitudinal axis 24. In this illustration, rollers or roller bearings 18 are secured in trunions 26 for rotation therein, and mold 12 is rotatable about longitudinal axis 24 during the casting process. Pouring spout 14 is shown in Figures 1 and 2 as a holding pot or tundish-like apparatus for retention of molten metal, although it may only act as a spout or it may be a ladle with a pouring spout. This particular structure is merely exemplary and not a limitation.

The longitudinal cross-sectional illustration of Figure 2 shows a horizontal, centrifugal casting apparatus 10 with pouring trough 26 extending into mold cavity 28. Trough first end 30 with connecting flange 36 is coupled to pouring spout 14, which flange 36 is noted in Figure 3. Trough second end 32 extends into mold cavity 28 in proximity to mold second end 22. In Figure 2, hot-metal ladle 34 is in a tilted, pouring position above spout 14, which is indicative of molten metal transfer into spout 14 during a casting operation. The molten metal is transferred or flows from spout 14, down trough 26 into cavity 28. As the metal is flowing, mold 12 is simultaneously being rotated for even distribution of the metal within cavity 28 to form a cast article with relatively uniform dimensional and mechanical characteristics.

Pouring trough 26 has a u-shaped channel 40 as shown in Figures 3, 4 and 5. In practice, centrifugal casting practice is frequently utilized for high-temperature metals such as cast iron, steel and alloy materials, and troughs 26 are frequently formed from similar materials, such as cast iron. As a consequence, pouring troughs 26 are exposed to flowing molten metals at elevated temperatures. Flowing molten materials frequently abrade and erode the surfaces of trough 26. In centrifugal casting, a smooth trough surface 38 is desired to promote the smooth flow of metal into cavity 28 to produce a smooth or uniform cast product. The desirable smooth flow characteristic of channel 40 would also enhance control of the molten metal feed rate.

Enhancement of smooth metal flow through channel 40 is promoted by the application of a protective coating, such as coating 42 in Figure 5. Historically this trough liner 42 was a pressed or molded clay, which was hand-applied to and conformed to the shape of channel 40 prior to the introduction of the molten metal. Thereafter, a slurry or suspension material, frequently referred to as 'blackening', was brushed or otherwise applied to the clay liner material. This slurry is generally reapplied to the clay liner after every other heat of molten metal to preserve the liner surface integrity, but the slurry coating may be applied more often or as needed. Neither the blackening or clay liner are known to have a prolonged wear life.

There is a significant heat transfer through the clay to underlying trough 26. The heat transferred to trough 26 can lead to expansion or growth of trough 26 and consequently to distortion of channel 40, which is defined by underlying trough or housing 26. In addition, the inconsistent or erratic heat transfer and distortion can cause spalling of isolated areas of the clay material from trough surface 38. Further, the clay liners 42 are susceptible to rapid erosion and abrasion from the flowing molten metal. The usual manner of accommodating rapid deterioration of clay lining 42 is to redress or patch the liner surface as often as necessary, which can avoid the necessity of rebuilding the trough channel lining after every casting cycle or the casting of every heat of molten metal. It is known that a heat of metal may be defined differently in various metal pouring shops and thus this is only a characterization of the cycle and the precise definition of the frequency of repair will be dependent upon the individual shop practice.

As noted above, liners 42 have generally been provided by hand-molding and conforming a paste-like clay to the shape of trough 26. However, it has been found that utilizing a preformed liner 44, as shown in the plan view of Figure 6, provides a plurality of benefits unavailable with the clay compaction methods presently utilized in the industry. More specifically, preformed liner 44 may be provided from a pressed graphite material or a combination of graphite and graphite fiber pressed into preformed liner 44. In this configuration, liner 44 may be nested in channel 40 against surface 38 with little or no preparation of underlying trough surface 38. Nozzle end 48 of liner 44 is arced or curved to inhibit back flow of molten metal from mold 12, which would interfere with a smooth flow rate of molten metal. Graphite liner 44 can be formed or machined to accommodate arced nozzle end 48.

Clip 46 in Figure 5 may be used to secure liner 44 in channel 40. As an illustrative example of clip 46, rectangular bar 49 in Figure 5A has through-bore 51 to receive a shoulder bolt 53. Bolt 53 is matable in threaded passage 55 of trough wall 57, as shown in Figure 5. After insertion of liner 44, clip 46 may be secured to trough 26 by bolt 53, rotated into position over liner 44 and securely anchored in position to maintain liner 44 in trough channel 40. Alternatively, straps 59 and clips 61, which are illustrated in Figure 5B, may be used to secure liner 44 in channel 40 by wrapping strap 59 around trough 26 and anchoring the ends of strap 59 with clip 61. Similar strap and clip arrangements are known in the industry and are frequently utilized for banding heavy metal packages and steel coils.

Graphite liner 44 is known to be less susceptible to wear, erosion and abrasion as evidenced by the use of graphite in molds for the bottom pressure casting of steel railroad wheels and, as the base or floor for vertical furnaces and electric arc furnaces for the manufacture of iron and steel. In fact, it is expected that use of a preformed graphite liner 44 would permit operation of an eight-hour shift in a plant operation without need to rebuild or redress trough liner 44, which is in contrast to the present operating characteristic requiring redressing after every other heat or approximately every forty minutes of metal teeming. This would eliminate the necessity of maintaining a readily available supply of patching material to redress a worn clay liner 42 after each cast cycle.

In addition to the above noted liner improvement characteristics improved and preformed liners 44 would remove an individual from the potentially dangerous exposure to residual molten metal in the liner and the elevated temperatures from trough 26 and clay liner 42 as well as the surrounding environment. This latter condition would result from the reduced frequency of requisite liner maintenance from erosion, abrasion or spalling, which is the cracking or flaking of particles out of a surface. Further, spalling may occur during the flow of molten material over the liner surface, which would potentially transfer tramp material, clay, to the molten metal and the cast product. This latter condition would possibly generate an inclusion in the cast metal structure, or such a spall could create a pore in liner 42 to underlying wall surface 38 of trough 26. Direct exposure of wall surface 38 to molten metals, such as cast iron above 2400°F. can heat wall surface 38 and cause expansion of trough 26.

In operation, centrifugal mold assembly 10 is operable to produce a cast article. In a specific exemplary application, centrifugal mold 12 rotates in its carriage assembly on bearing rollers 18 to receive molten iron for the production of cast iron pipe (not shown). This casting practice is known in the art and industry for the production of pipe and other articles. The centrifugal casting method is often utilized to produce cast-iron pipe as the molten metal will uniformly distribute itself along the length of mold 12. Further, this casting technique permits the casting of pipe ends in mold 12.

As noted above, trough 26 is susceptible to wear and erosion from the transfer of molten cast-iron on trough surface 38. Maintenance of trough 38 and a smooth trough surface have been an ongoing industry practice for safety and productivity. Therefore, it has been the historical practice to provide a clay or clay like material on surface 38 to inhibit erosion and to minimize heat transfer to surface 38, which heat transfer can lead to wall growth or thermal expansion of surface 38. As earlier indicated, the centrifugal casting technique requires a constant and preferably smooth flow rate of molten metal, which flow rate is more easily controlled when the rate is constant. The constant flow rate is promoted by a smooth surface on trough 38 or lining 45. Thus the above-described redressing and recoating of trough liner surface 45 with the blackening slurry has been required, which requires constant evaluation, vigilance and attention by maintenance operators.

Although trough 44 in Figure 6 is illustrated as a continuous solid length form, it is considered that trough liner 44 could be provided by a plurality of segments, as shown in Figure 6A. The exact number of segments would be dependent upon the operator, but it is considered that such multiple segments would ease replacement of liner 44; provide for replacement of a small segment in the event of early failure of such segment; would ease storage and handling of the various segments; and, would provide for minimal inventory carrying costs by maintaining a plurality of smaller, similar-sized straight segments which are interchangeable. Further, it is expected that such smaller segments would be less expensive and easier to produce by a supplier.

Preformed liner 44 may be produced from a graphite or a graphite- graphite fiber material. Alternatively, liner 44 may be manufactured from a reinforced carbon-carbon material available from various suppliers, such as the MER Corporation of Tucson, Arizona. This material is expected to provide increased wear against hot metal erosion. Liner materials generally are known to inhibit heat transfer to the underlying surface 38 for the inhibition of thermal expansion, but the machined or formed graphite liner reduces associated spalling of a coating, such as paste-like, clay-liner material 42. The known wear, wear rate or erosion of uncoated troughs 38 or troughs with clay liners 42, is considered to be an inhibition to smooth manufacturing processes. Graphite molds are utilized for steel castings with nominal repair and replacement, and a similar use of graphite liners for trough liners can be expected to reduce the wear rate of trough liners 44, which would minimize the exposure of operators to troughs 26 at elevated temperatures. Reduction of the frequency of repair and replacement of mold linings, such as clay liner 42, provides reduced maintenance costs and improved operating efficiencies by reducing the frequency of replacement of liners for trough 26 in a casting machine.

Those skilled in the art will recognize that certain variations can be made in the illustrative embodiment. While only specific embodiments of the invention have been described and shown, it is apparent that various alterations and modifications can be made therein. It is, therefore, the intention in the appended claims to cover all such modifications and alterations as may fall within the true scope of the invention.

We Claim:

1. A trough for communication of a molten metal from a means for holding molten metal to a casting mold for receipt of said molten metal, said trough comprising:

a housing with a first end and a second end,

said housing defining a channel between said first end and said second end,

said casting mold having an internal volume, and an opening to receive said trough for communication of said molten metal to said internal volume,

means for lining said channel, said means for lining preformed and insertable in said channel to protect said housing against any of erosion, abrasion, oxidation, and expansion during communication of said metal from said means for holding said molten metal.

2. A trough for communication of a molten metal to a casting mold for receipt of said molten metal as claimed in Claim 1, said channel having a generally u-shaped cross-section, and

said means for lining preformed to mate with said channel to maintain said channel cross-sectional shape and to insulate said housing from said molten metal.

3. A trough for communication of a molten metal to a casting mold for receipt of said molten metal as claimed in Claim 2 wherein said preformed lining is formed graphite.

4. A trough for communication of a molten metal to a casting mold for receipt of said molten metal as claimed in Claim 2 wherein said preformed lining is a formed carbon and carbon filament composition.

5. A trough for communication of a molten metal between a casting mold for receipt of said molten metal as claimed in Claim 2, said lining means further comprising

a clip and means for securing, said clip secured to said trough by said securing means to maintain said means for lining in said channel.

6. A trough for communication of a molten metal between a casting mold for receipt of said molten metal as claimed in Claim 2, wherein said lining means is a single component insertable in said housing to provide said trough and channel.

7. A trough for communication of a molten metal between a casting mold for receipt of said molten metal as claimed in Claim 2, wherein said lining means has a plurality of preformed segments, said segments aligned in said housing to define said trough and channel between said first end and said second end.

8. A trough for communication of a molten metal between a casting mold for receipt of said molten metal as claimed in Claim 5, wherein said lining means has a plurality of preformed segments, said segments aligned in said housing to define said trough and channel between said first end and said second end, each said segment maintained in said housing by said means for securing.

9. A trough for communication of a molten metal between a casting mold for receipt of said molten metal as claimed in Claim 5, wherein said lining means is a single component insertable in said housing to provide said trough and channel within said housing, said single component maintained in said housing by said means for securing.

10. A trough for communication of a molten metal between a casting mold for receipt of said molten metal as claimed in Claim 5, wherein said means for securing has a bar with an aperture,

a threaded bolt,

said housing defining a threaded passage,

said bolt extending through said aperture to mate with threaded passage to secure bar to said housing, said bar extending at least over said lining means to maintain said lining means in said housing.

11. A trough for communication of a molten metal between a casting mold for receipt of said molten metal as claimed in Claim 8, wherein said means for securing has a plurality of bars, each said bar having an aperture,

a plurality of threaded bolts,

at least one of said bars associated provided for each said lining segment,

said housing defining at least one threaded passage for each said lining segment,

a bolt provided for each said bar and aperture, each said bolt extending through said aperture to mate with a threaded passage to secure said associated bar to said housing, each said bar extending at least over said associated lining means to maintain said lining means in said housing.

12. A trough for communication of a molten metal between a casting mold for receipt of said molten metal as claimed in Claim 5, wherein said means for securing is a strap and clip,

said strap having a first end and a second end,

said strap extending around said housing to provide said first end and second end in proximity to each other,

said clip generally placed over said proximate ends and crimped to secure said ends with said strap surrounding said housing to maintain said lining means in said housing to provide said trough and channel.

FIG.1

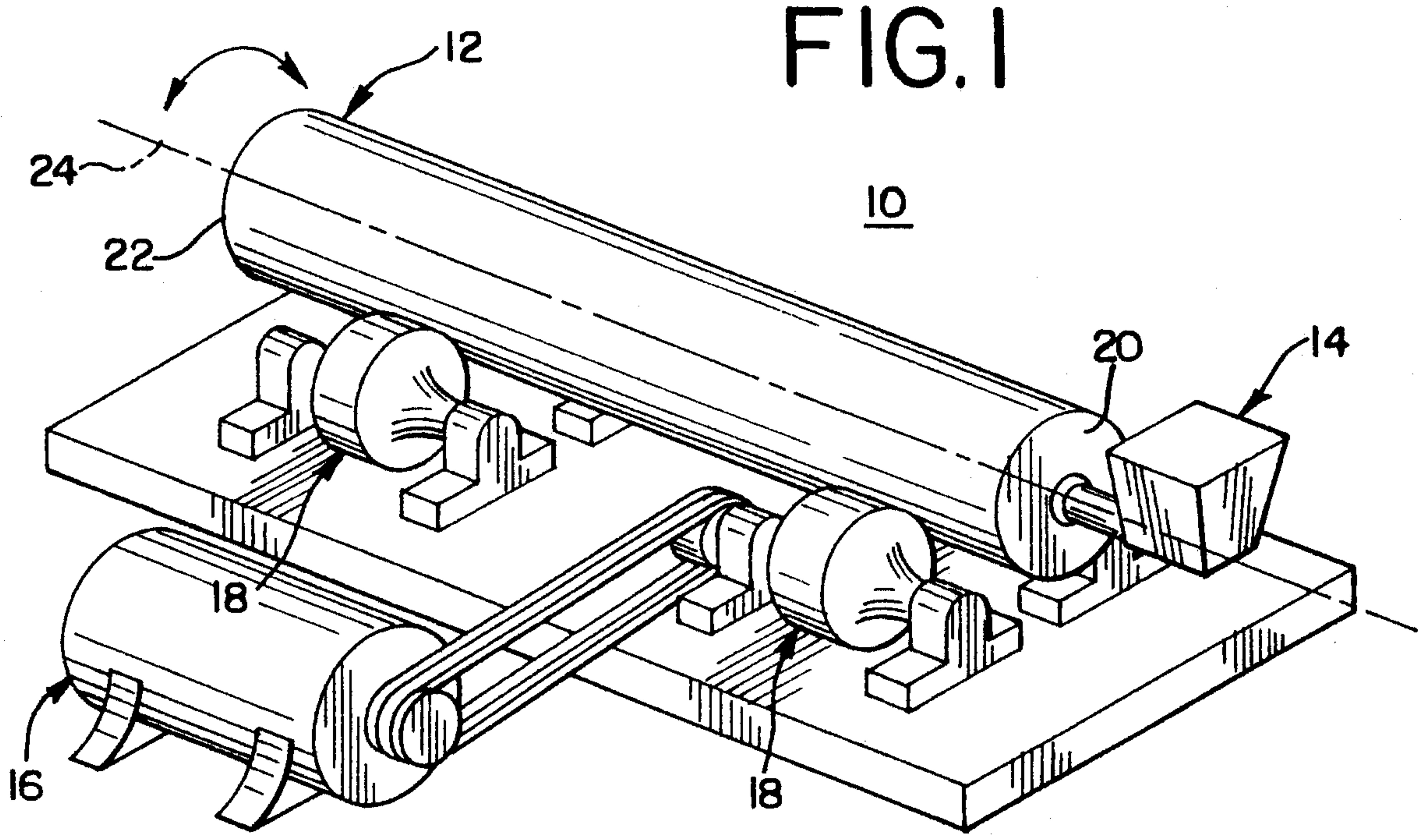



FIG.2

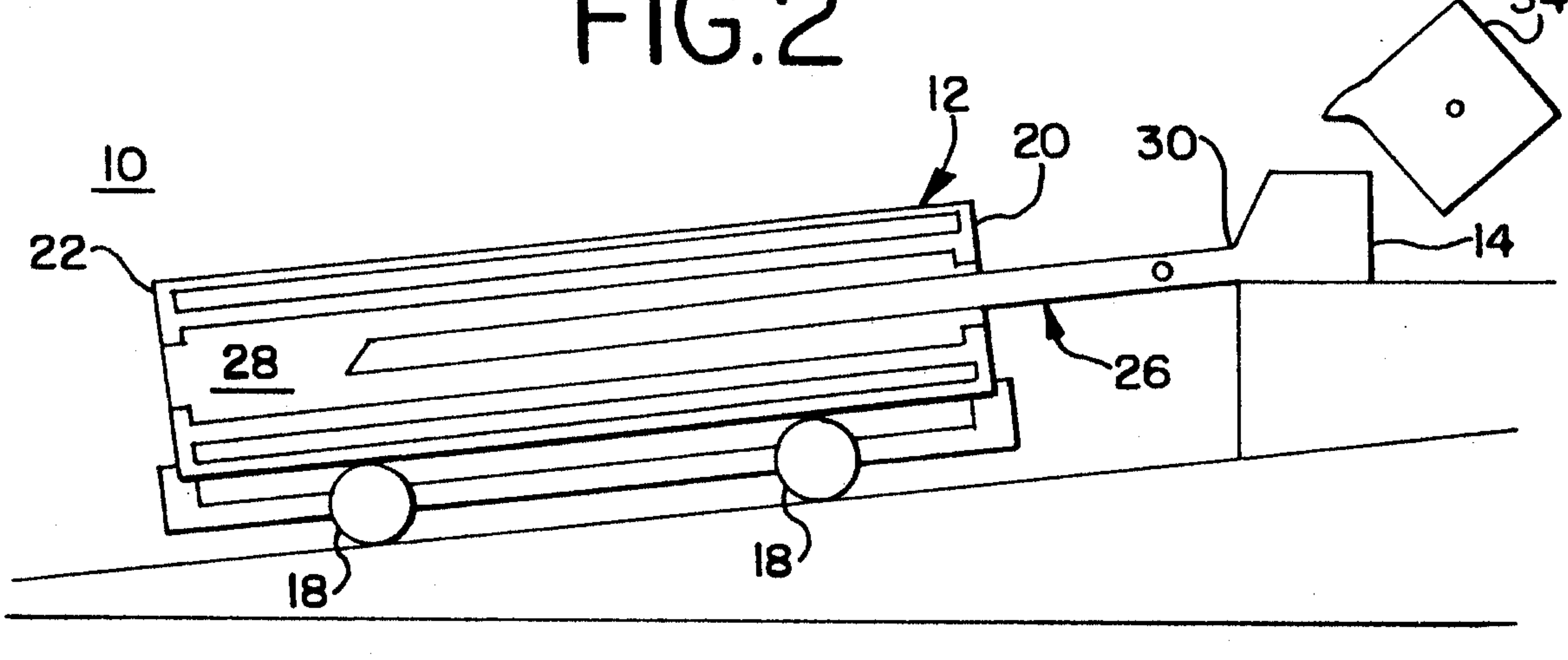


FIG.3

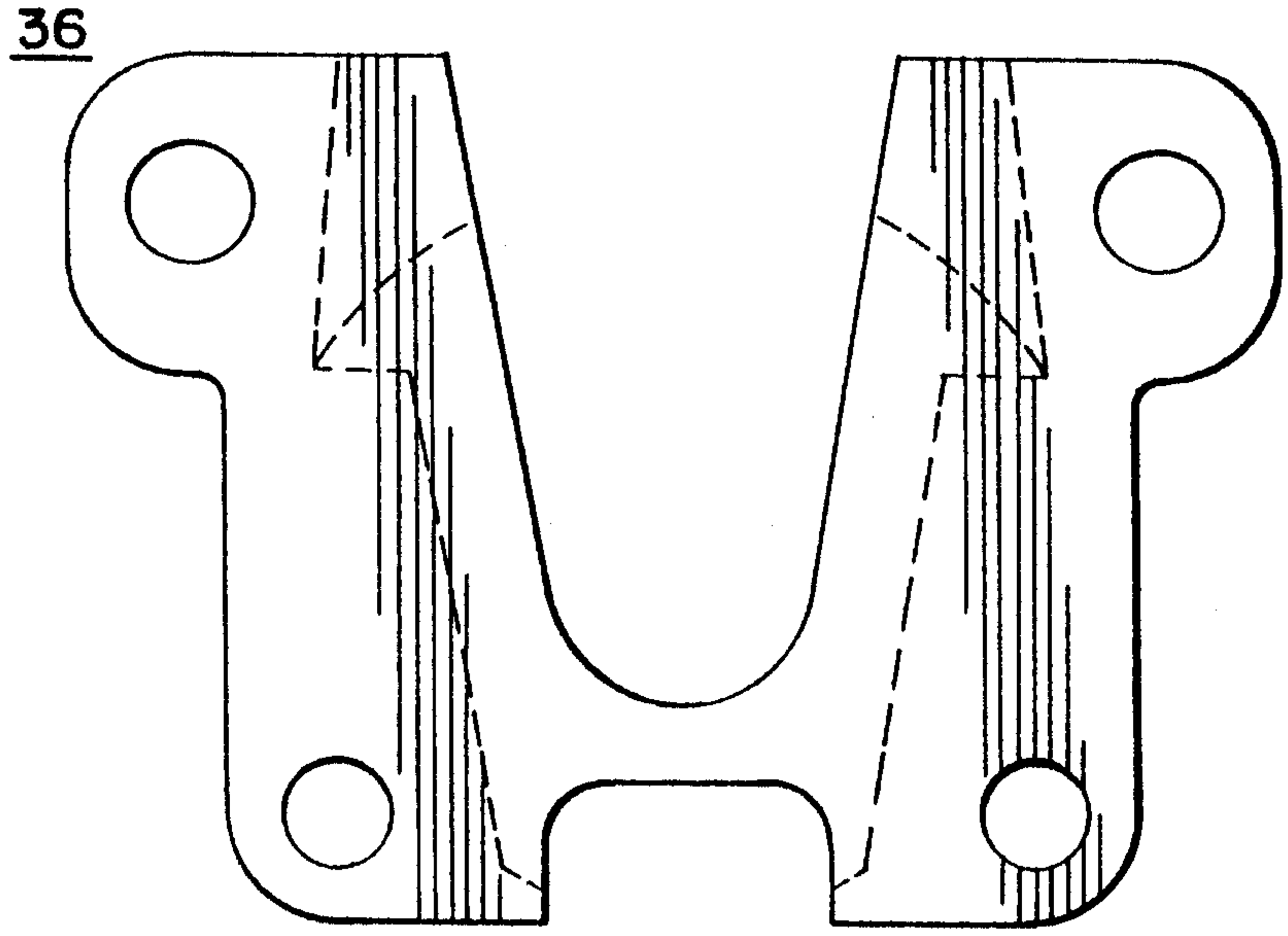



FIG.4

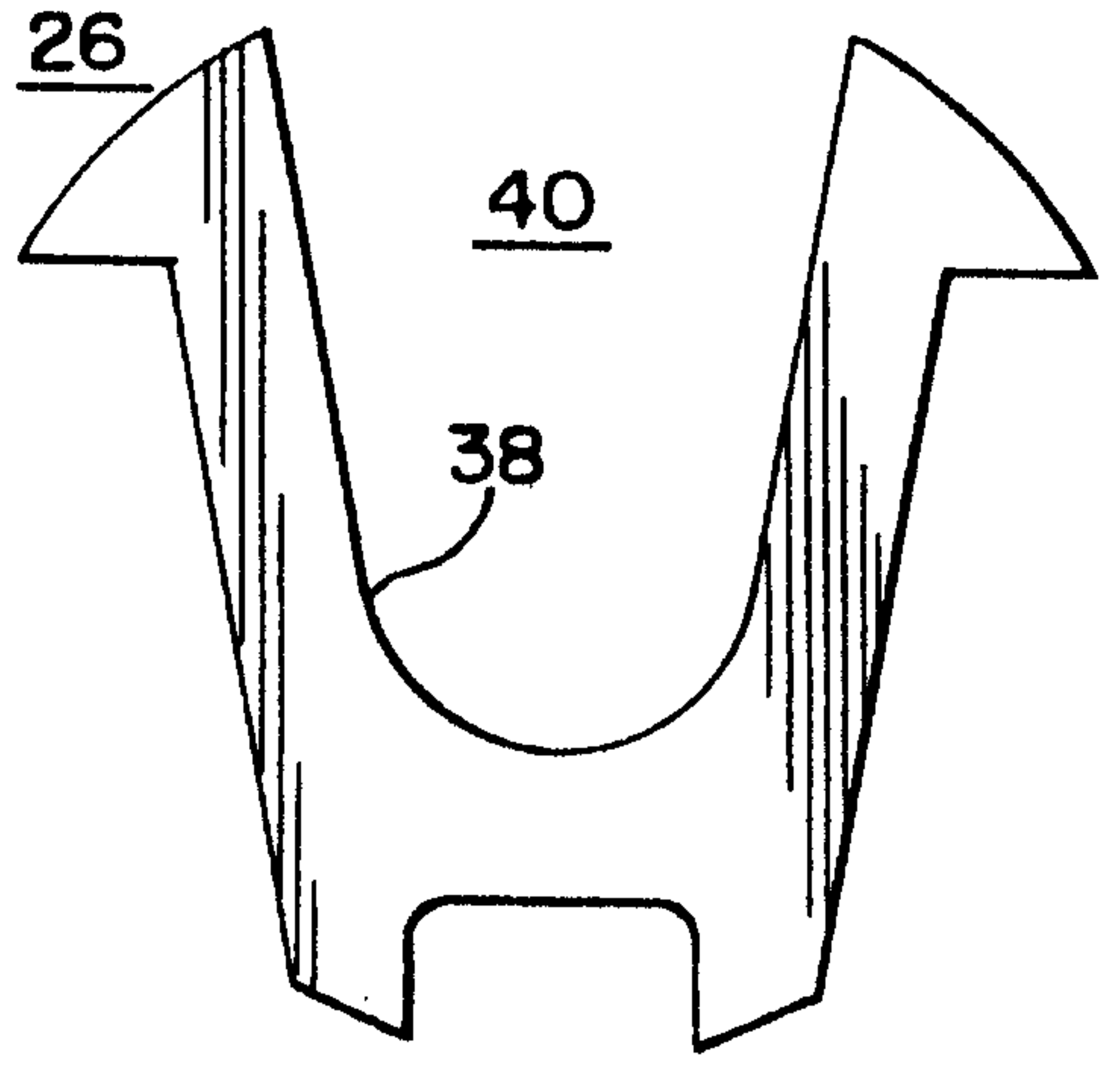


FIG.5

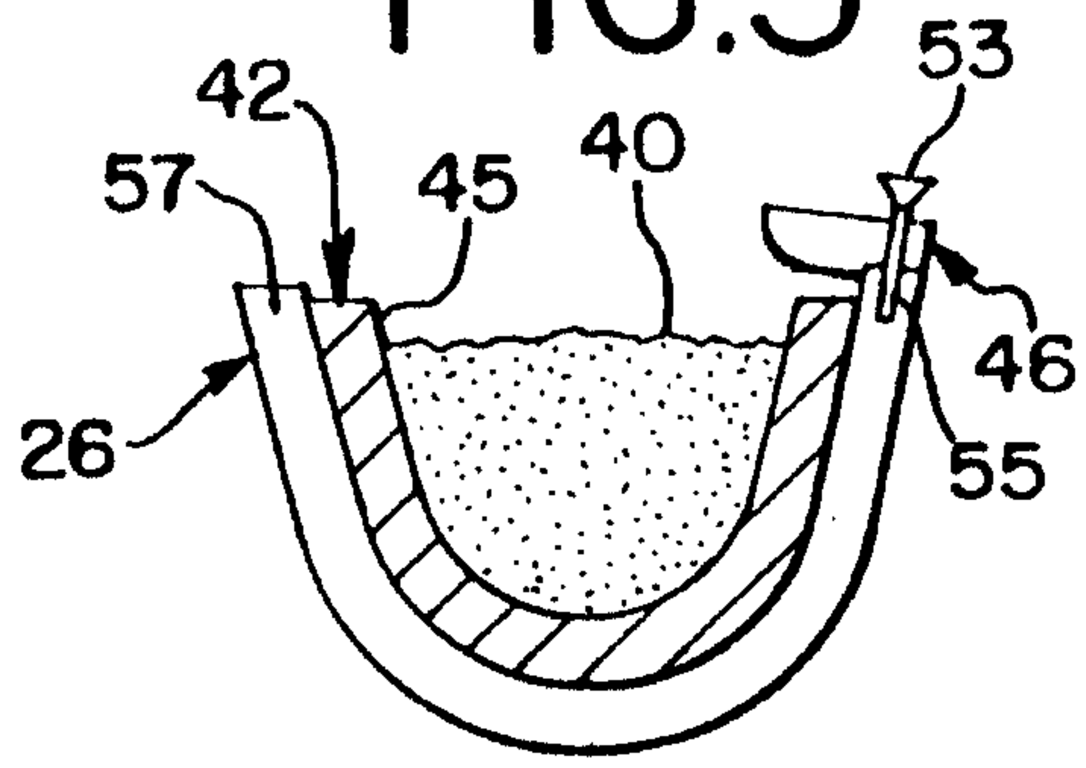



FIG.5A

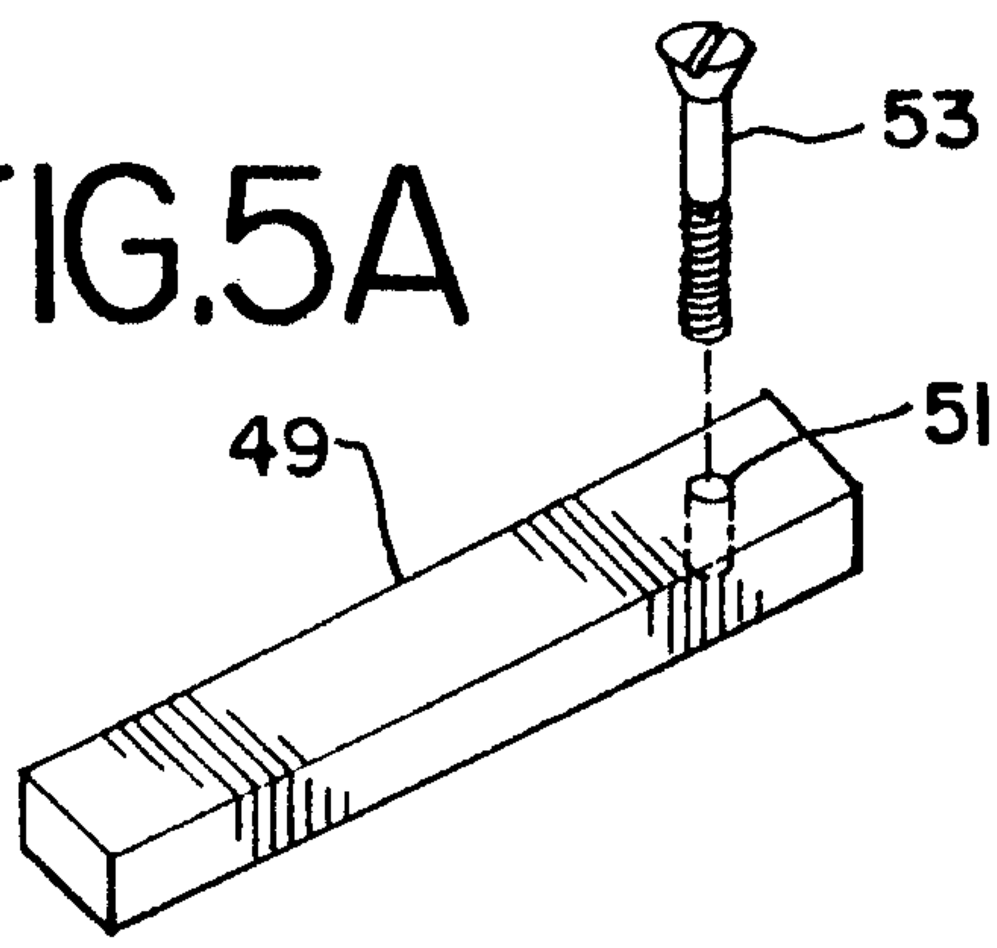
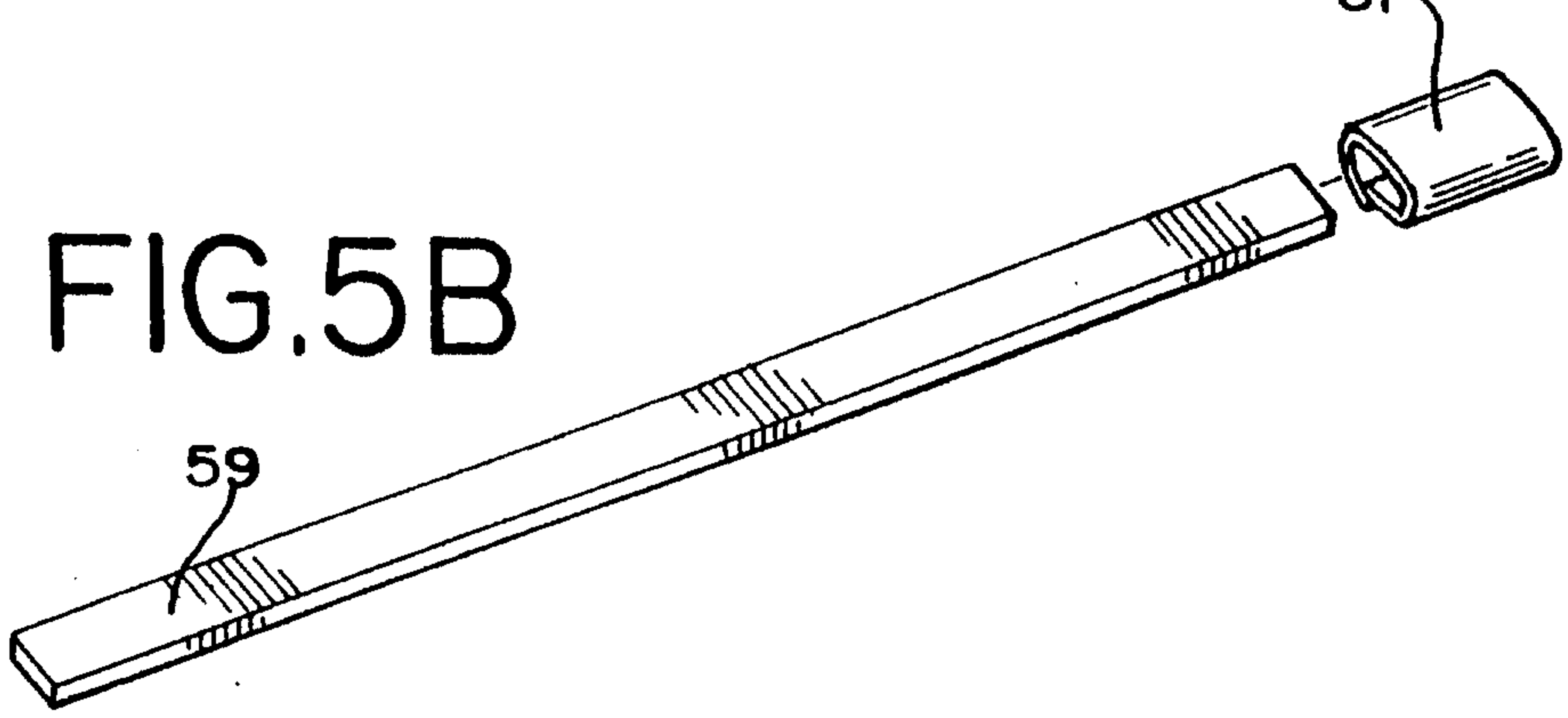



FIG.5B



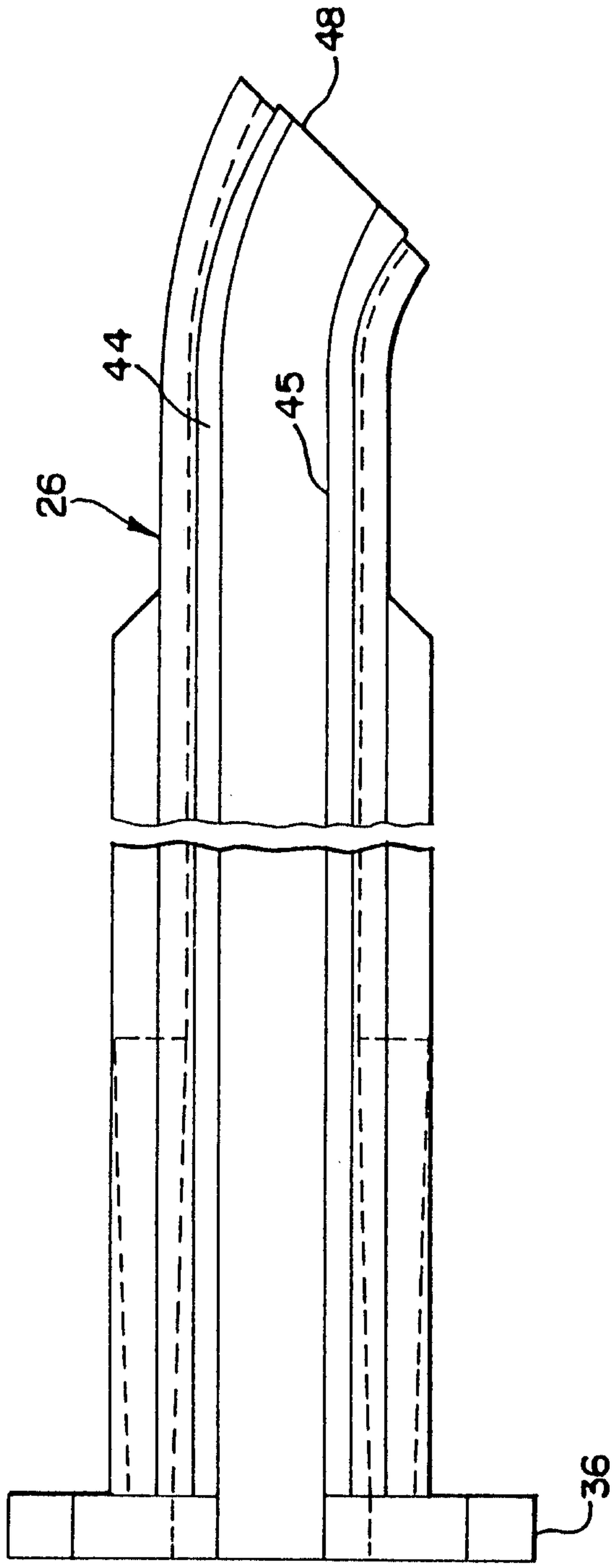



FIG.6

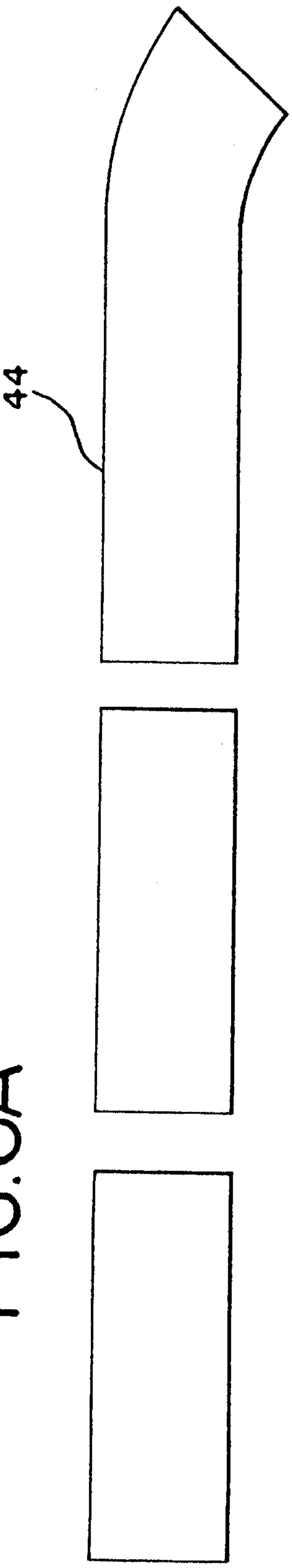
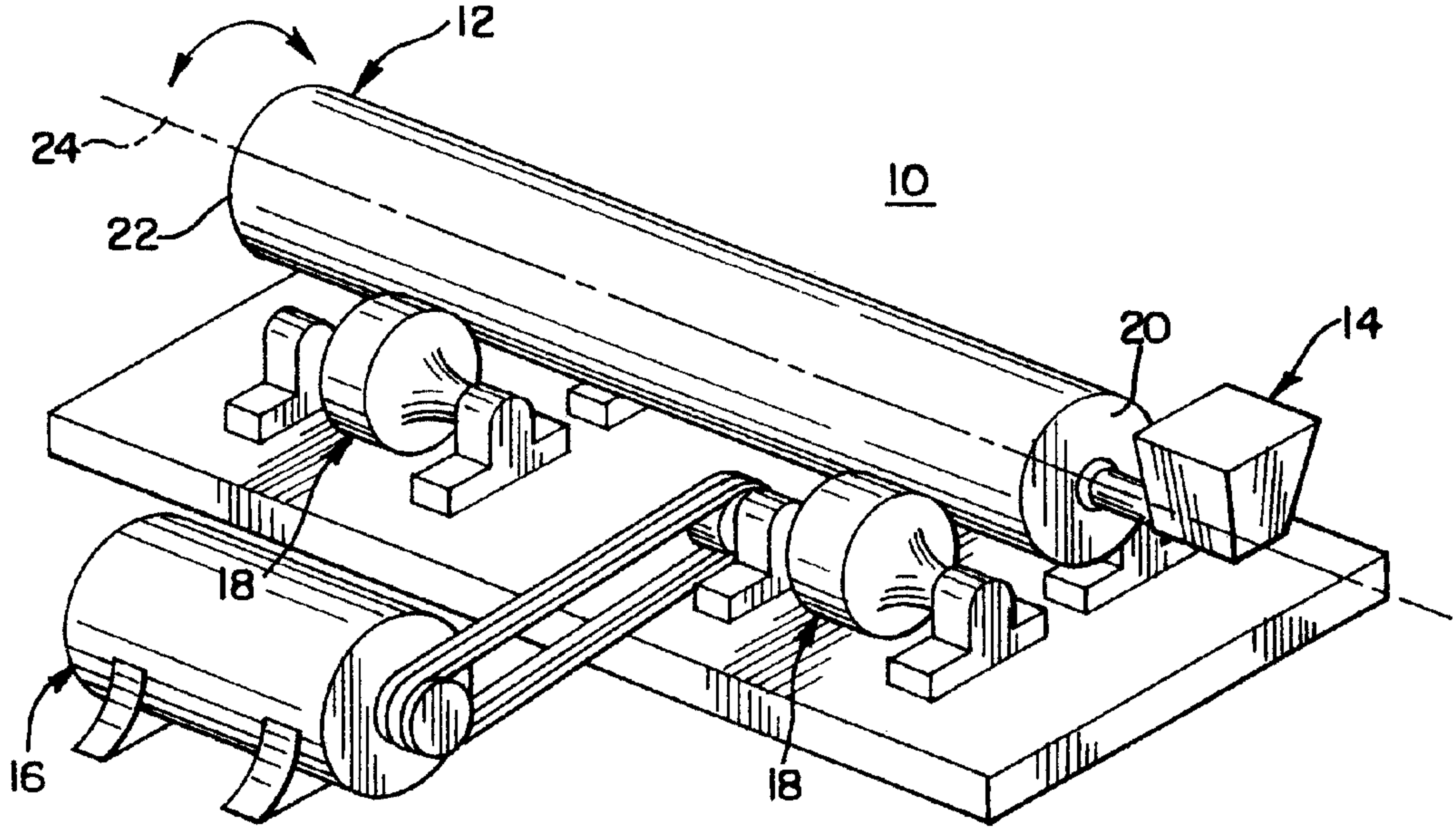



FIG.6A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