

ROLLER OF VARIABLE OUTER DIAMETER TYPE, AND
CARRYING APPARATUS AND METHOD USING THE SAME

1 Background of the Invention:

Field of the Invention:

This invention relates to a roller of variable
outer diameter type and a transferring apparatus and
5 method using the same. More particularly, it relates
to the transferring apparatus and method for shifting
articles transported by using the rollers of variable
outer diameter type, the transferring apparatus
including a conveyer apparatus having such rollers of
10 variable outer diameter type mounted on a shaft driven
by a motor to transport an article, and other conveyer
means , for example a belt conveyer, a chain conveyer
or a roller conveyer (including one having rollers
having a smaller outer diameter), arranged in the
15 vicinity of a conveyer apparatus using such rollers of
variable outer diameter type.

Description of the Related Art:

A roller of variable outer diameter type used
to vary the size of an outer diameter of a roller by
20 using a fluid such as a compressed air has been
proposed, for example, in Japanese Patent Application
Unexamined Publication Nos. 3-20420 and 3-259843 in
which an elastic cylindrical pressure chamber (including
a combination of a plurality of pressure chambers)

1 secured to a rotary shaft(s) is supplied with a
compressed air to cause the cylindrical elastic body to
be expanded for varying its diameter. Also, in shifting
articles from one to another, an actuator such as a
5 cylinder using an air or hydraulic pressure may be
interposed.

However, all of the above-mentioned devices
have an elastic cylindrical body expanded by pressure of
a fluid supplied therinto so as to change the outer
10 diameter size of the elastic cylindrical body.

Typically, since the pressure of compressed air supplied
under a centralized control in a factory is in a range
of from about 4.5 Kgf/cm² to about 8.5 Kgf/cm² and hence
widely varies in the pressure range to be unstable.

15 In the case of the above conventional roller,
when the ratio of the outer diameter size of an elastic
cylindrical body in the expansion thereof to that in the
normal state thereof is large (i.e. the coefficient
of expansion being large), even if it is formed of a
20 flexible elastic body such as a rubber, a repetition of
expansion accompanying with an elastic strain of more
than 50% in excess of 200,000 times tends to cause its
fatigue fracture due to the tension thereof at an
extremely high probability. It is extremely difficult
25 to obtain elastic material in low cost in order to meet
this problem.

When a high pressure fluid, for example, a high
pressure compressed air of about 5.5 kgf/cm² or more,

- 1 is used for transported articles being a heavy load,
the tension in the circumferential direction of the
cylindrical elastic body at the time of expansion in the
above conventional devices is extremely enlarged.
- 5 Rubber or other elastic materials restricts the
structure and the fatigue-resistance number so that
their use is made extremely difficult.

It is also noted in the conventional
cylindrical elastic body that the outer diameter size
10 thereof changes in accordance with changing of the inner
pressure thereof. Accordingly, in order to make the
outer diameter size thereof constant at the time of the
expansion, it is necessary to control the supplied fluid
pressure with a high accuracy. As a result, the
15 structure becomes complicated, and further an expensive,
high-performance pressure sensor and pressure control
unit are required. Further, inasmuch as transported
articles may have varied bottom configurations and may
be metallic members with acute projections, there is an
20 undesirable high possibility that when such portions
with acute projections make direct contact with the
cylindrical elastic body made of rubber member, a
fracture of the latter is caused in a short period of
time.

25 Moreover, a carrying apparatus in which an
actuator is interposed is complicated in structure and
high in cost, and requires a prolonged time period in a
shifting operation.

1 Summary of the Invention:

This invention resolves the foregoing problems, and the object of the invention is to provide a roller of variable outer diameter type which is
5 simple in construction and less expensive in assembling, and a transferring apparatus and transferring method utilizing that roller.

In order to resolve the foregoing problems, a roller of variable outer diameter type according to the
10 invention comprises a holding member having a plurality of through holes radially arranged along a side surface thereof and provided with a hollow portion communicating with these through holes; a sealing member having diaphragms arranged so as to correspond to the
15 respective through holes; and sliders respectively fitted slidably in the through holes and forming an outer peripheral surface of the roller, the sliders being urged and displaced via the diaphragm by means of a fluid supplied in the sealing member in such a
20 direction that the outer diameter size of the roller is enlarged.

More specifically, the roller of the variable outer diameter type has a pipe formed with a plurality of through holes along a cylindrical surface thereof, a
25 sealing member fittedly mounted inside the pipe and having pot-like-shaped diaphragms therein so as to correspond to each of the through holes, sliders slidably fitted in each of the through holes and

1 forming an outer peripheral surface of the roller,
the sealing member and the pipe being hermetically
clamped by means of a rotary shaft provided with an
opening for fluid supply and for urging the diagrams
5 and side plates disposed at both sides of the end
surfaces of the said pipe, and the sliders being urged
and displaced via the diaphragms by fluid, e.g., a
compressed air, supplied from a rotary-type joint
connected to the rotary shaft in such a direction that
10 the outer diameter size of the roller is enlarged.

Stated otherwise, a plurality of elastic
diaphragms disposed along the inner wall surface of the
closed pipe are urged by the fluid supplied through the
opening of the rotary shaft.

15 As a consequence, the respective sliders
passing through the holes formed along the cylindrical
side surface of the pipe and inserted in the plot-like
diaphragm are urged out of the pipe. And, an arc
portion forming an outer peripheral surface of the
20 roller and located at a head portion of each slider is
displaced at a predetermined dimension so that the
roller diameter is enlarged to form a desired outer
periphery surface of the roller (outer diameter side).

This, the projecting portion (differential
25 portions in level) of each slider is abutted against
each side plate to restrict the operating range thereof.

After finishing the transfer of articles
between the transporting conveyers, the compressed air

1 inside the pipe is discharged and the sliders are
returned by the tension of a rubber ring disposed in a
groove of the outer peripheral surface of the roller to
the original position while urging the diaphragm. As a
5 result, the above arc portion of each slider forms an
outer peripheral surface (outer diameter size) of an
original small roller.

A conveyer apparatus according to the present
invention is provided with the above-mentioned rollers
10 of variable outer diameter type at both end portions of
a shaft and with a plurality of rotary shaft means
driven by a motor.

Further, an apparatus for transferring
articles is provided with the rollers of variable outer
15 diameter type at both end portions of a shaft, a
plurality of rotary shaft means driven by a motor, and
conveyer means disposed in the vicinity of the rotary
shaft means.

By virtue of the foregoing construction, the
20 present invention makes the construction of a roller and
a conveyer apparatus using the roller extremely simple.

Moreover, an excessive tension is not applied
on a diaphragm included in the roller of variable outer
diameter type. When the diaphragm is deformed from
25 the pot-like-shape into a planar shape, there are
generated only a slight compression and a slight pending
strain.

Accordingly, even if a repetitive operation

1 exceeding 2,000,000 times or a compressed air of a
pressure exceeding 5 Kgf/cm² is applied to the roller
according to the present invention, it does not cause a
fatigue fracture.

5 In addition, since the operating range of the
sliders is restricted by the side plates, the maximum
outer diameter size of the roller that the sliders form
is always made constant, regardless of the magnitude of
the fluid pressure applied to the diaphragms.

10 Furthermore, as the bottom-surfaces of
transported articles are in contact with a head portion
of the slider so that diaphragms made of an elastic
material or the like are not in direct contact
therewith, there is no possibility that it is separated
15 or broken due to a hard projection or the like of the
bottom surface in the transported article.

Brief Description of the Drawings:

Fig. 1 is a longitudinal-sectional view of a
roller of variable outer diameter type according to one
20 embodiment of the present invention;

Fig. 2 is a cross-sectional view taken along
the line II-II of Fig. 1;

Fig. 3 is a longitudinal-sectional view
illustrating the state where a compressed air is
25 supplied to the roller of variable outer diameter type;

Fig. 4 is a cross-sectional view taken along
the line IV-IV of Fig. 3;

1 Fig. 5 is a longitudinal-sectional view of a
sealing member included in the roller of variable outer
diameter of Fig. 1;

Fig. 6 is a plan view of the sealing member
5 of Fig. 5;

Fig. 7 is an elevational view of a slider
included in the roller of variable outer diameter type
of Fig. 1;

Fig. 8 is a plan view of the slider of Fig. 7;

10 Fig. 9 is a plan view of a transferring
apparatus using rollers of variable outer diameter type
in accordance with one embodiment of the present
invention;

Fig. 10 is an elevational view of the
15 transferring apparatus of Fig. 9;

Fig. 11 is a plan view of another transferring
apparatus using rollers of variable outer diameter type
in accordance with the embodiment of the present
invention;

20 Fig. 12 is a cross-sectional view of another
application of the rollers of variable outer diameter
type according to the embodiment of the present
invention;

Fig. 13 is a cross-sectional view taken along
25 the line XIII-XIII of Fig. 12;

Fig. 14 is an elevational view of a slider
included in the roller of variable outer diameter type
of Fig. 12;

1 Fig. 15 is a plan view of the slider included
in the roller of variable outer diameter type of Fig.
12;

5 Fig. 16 is a cross-sectional view of still
another application of the rollers of variable outer
diameter type in accordance with the embodiment of the
present invention;

10 Fig. 17 is a cross-sectional view of yet
another application of the rollers of variable outer
diameter type in accordance with the embodiment of the
present invention; and

15 Fig. 18 is a cross-sectional view of further
application of the rollers of variable outer diameter
type in accordance with the embodiment of the present
invention.

Detailed Description of the Preferred Embodiments:

[Example 1]

20 A roller of variable outer diameter type in
one embodiment of the present invention will first be
described with reference to Fig. 1 through Fig. 8. In
Figs. 1 and 2, a pipe 1 is made of a metallic material
or a hard material such as epoxy resin or FRP
(fiber-reinforced plastic) resin. Also, the pipe 1
has a plurality of through holes 12 radially formed
25 along a cylindrical surface thereof, e.g. four (4)
through holes located at every 90 degrees thereon.

The pipe 1 is also worked by continuous

1 machining of a metallic pipe with a NC (numerically controlled) lathe, or injection molding of an above-mentioned resin material.

Further, the pipe 1 is held via the edge portions 9C of a sealing member 9 between side plates 2 and 3 from both sides thereof.

The side plates 2 and 3 each are in the form of a disk having an end portion thereof bent so as to provide generally a U-shaped cross section.

10 The side plates 2 and 3 are formed typically by press-machining metallic plates but may each be made alternatively by injection-molding a resin material such as FRP (e.g. glass fiber-reinforced plastic).

A roller shaft 4 and the side plates 2 and 3 arranged coaxially with the pipe 1 are hermetically sealed and fastened each other with disk-shaped rubber gaskets 5, disk-shaped gasket stops 6 and bolts 8.

The state of mounting rectangular rotation stop plates 13 is illustrated by the arrow C in Fig. 1.
20 The rotation stop plates 13 are fittedly inserted at two pairs of positions or totaled four positions in H-cut groove portions of the roller shaft 4 (portions generally oval-shaped in cross-section of the roller shaft 4 as not shown), respectively, perpendicularly to
25 the sheet of drawing of Fig. 1 and are secured, together with the disk-shaped rubber gasket stops 6, to the side plates 2 and 3 by means of the bolts 8.

Depending on the fastening strength of the

1 bolts 8, the disk-shaped rubber gaskets 5 protrude in
the direction of urging the roller shaft 4 from the
outer periphery thereof so as to perform a sealing
function. Accordingly, the surface-finish machining
5 for the roller shaft 4 is made unnecessary and a
sufficient sealing can be maintained with a rough
surface thereof as it is when a steel material is just
drawn.

The side plates 2 and 3 and the pipe 1 are
10 completely sealed and fastened hermetically with the
edge portions 9C of the sealing member 9, bolts 7 and
nuts 14.

The afore-mentioned sealing member 9, as shown
in Fig. 5, is provided by integrally forming an elastic
15 material such as, for example, silicon rubber, buthyl
rubber or a soft plastic material. The method of
forming it may be selected optionally in any integral
forming including casting and injection-molding.

The sealing member 9 is fittedly mounted
20 inside the pipe 1.

The sealing member 9, whose configuration
is shown in Figs. 5 and 6, includes a cylindrical body
portion 9D, through holes 9B, diaphragms 9A, edge
portions 9C and annular grooves 9E.

25 The through holes 9B, four in number, are
provided at four positions corresponding to the four
through holes 12 provided in the aforementioned pipe 1,
respectively, and cause supporting shaft portions 10A

1 of the sliders 10 as mentioned later to be slidably fitted therein.

The diaphragms 9A are also provided at four positions corresponding, respectively, to the four 5 through holes formed in the cylindrical side surface of the afore-mentioned pipe 1. And they each are formed with a convexity (pot-like shape) projecting internally of the cylindrical body portion 9D.

The annular recess 9E and the flange-like 10 edge portions 9C located at the end portions of the pipe 1 enable the side plates 2 and 3 and the pipe 1 to be hermetically sealed by fastening the bolts 7 and the nuts 14.

Incidentally, it is needless to say that the 15 pot-like shaped diaphragms 9A of the sealing member 9 may be bellows-like or be formed to have a polyhedron or any optional shape.

As is apparent from Fig. 1, the through holes 12 of the pipe 1 in which the sliders 10 are fitted are 20 hermetically sealed by the diaphragms 9A of the sealing member 9.

As shown in Figs. 7 and 8, the sliders 10 each include a shaft portion 10A, an outer peripheral surface portion 10B of the roller, a projecting portion 10C and 25 a recessed portion or groove 10D.

Also, each slider 10 may be molded by resin material such as an FRP into a desired configuration. Where a heat-resistance is required, it may be a

1 metallic material so as to be formed by die-casting or a casting method.

Further, the arc-shaped outer peripheral surface portions 10B of the roller provided to form the
5 outer peripheral surface of the roller at one end side of the shaft 10A are arranged point-symmetrically by putting the recess 10D between them.

By arranging the arc portions point-symmetrically and shifting them at a predetermined
10 distance, when four sliders 10 are disposed at four positions thereof as arranged radially by every 90 degrees, a mutual interference of the arc portions is effectively prevented and they form a continuous roller peripheral surface when the roller is enlarged in its
15 diameter.

Further, the recesses 10D of the sliders 10 have a rubber ring 11 attached thereto. This rubber ring 11 has a function to urge a plurality of sliders 10 (four ones as shown in Fig. 1) simultaneously towards
20 the axial center of the roller shaft 4 and to restore it to the original position.

As to means for restoring the sliders 10 to their original positions, the rubber ring 11 may be replaced optionally by any other equivalent means such
25 as means for applying a negative pressure to the afore-mentioned diaphragms 9A or means for bridging a tension coil spring in an annular form.

The high-pressure compressed air is supplied

1 into the cylindrical body portion 9D of the sealing member 9 through a rotary-type air joint 17, a blind hole 15 and a communication hole 16 formed in the roller shaft 4.

5 By the supply of the high-pressure air, as shown by the arrow B in Figs. 3 and 4, the diaphragms 9A of the sealing member 9 is pressed and deformed from the pot-like form into a planar form, thereby urging the sliders 10 outwardly of the pipe 1.

10 The stroke ends of the sliders 10 provided by the air pressure become an operating limit of the sliders 10 as the projecting portions 10C of the sliders 10 are brought into contact with those U-shaped edge portions 2A and 3A of the side plates 2 and 3 which are
15 bent in a brim form.

The sliders 10 pushed outwardly of the pipe 1, as shown in Figs. 3 and 4, forms a predetermined outer peripheral surface (outer diameter size) which is made one size larger. At the same time, naturally, the
20 rubber ring 11 fitted in the recesses 10D of the sliders 10 is enlarged.

Typically, as a conventional cylindrical elastic body made of a rubber material has a pressure resistance of 2 kgf/cm^2 , it is small in its ability to
25 lift an article for transportation (weight allowance).

In the present invention, in order to secure a transporting ability which is no less than that of a conventional air cylinder, a high-pressure compressed

1 air of more than 5 kgf/cm² is applied to the diaphragms
9A.

In this case, the afore-mentioned diagrams 9A
made of a soft rubber material or the like are deformed
5 into planar forms to come onto an acute edge portion and
to be pushed into small gaps. As a consequence, when
they are repeatedly pushed intensively into minute gaps
of a hard member made of a metal or the like, the soft
surfaces of the diaphragms 9A will be separated little
10 by little and eventually their intensity of pressure
resistance is so dropped as to cause a fracture.

In order to avoid a rupture or a cracking of
the diaphragms 9A repeatedly operated under an high-
pressured fluid, according to the present invention the
15 end edge configuration of the supporting shaft 10A is
made spherical to provide R-corners 10E as shown in Fig.
7.

Under air-pressure operating conditions, there
is provided an arrangement in which as shown by the
20 arrow A in Fig. 4, the portions of deformation of the
diaphragms 9A are accepted by the surface of the
cylindrical body portion 9D of the sealing member 9 and
the R-corners 10E of the supporting shaft 10A to
minimize the bending strain and exfoliation of the
25 diaphragms 9A.

By the foregoing arrangements, the diaphragms
9A in accordance with the present invention are made
to possess a life of utilization as withstands a

1 repetitive operation of more than 2,000,000 times under
the operating air pressure of no less than 5 kgf/cm².

As will be described later, after an article
is transferred from a first position to a second
5 position by transporting means using rollers of variable
outer diameter type as above described, the compressed
air which has urged the diaphragms 9A is discharged
through the hole 15 in the roller shaft 4 for compressed
air supply.

10 As the air pressure inside the sealing member
9 is reduced, the tension of the rubber ring 11 causes
the supporting shaft 10A to urge internally of the pipe
1 so as to restore the initial state as shown in Figs.
1 and 2. As a result, the outer peripheral surface
15 (outer diameter size) of the roller outer peripheral
surface portions 10B is reduced to less than the outer
diameter size of the side plates 2 and 3.

Next, a conveyer apparatus and a transferring
apparatus constructed by using rollers of variable
20 diameter type 100 as mentioned above will be described
hereinafter. Such an apparatus is effective as means
for transporting, diverging and joining any articles
such as television receivers and semiconductor boards.
The conveyer apparatus has the construction provided
25 with a plurality of rotary shaft means having rollers of
variable outer diameter type 100 mounted on their
shafts. The rotary shafts are driven by motors via a
belt, chain or gear transmissions.

1 The transferring apparatus includes a conveyer
apparatus provided with a plurality of rotary shaft
means having rollers of variable outer diameter type 100
mounted on their shaft portions and another conveyer
5 apparatus additionally provided in the vicinity of the
afore-said conveyer apparatus.

For example, any combination is made possible
of a conveyer using rollers of variable outer diameter
type with a belt conveyer, of a conveyer using rollers
10 of variable outer diameter type with a chain conveyer or
of a conveyer using rollers of variable outer diameter
type with a roller conveyer including rollers having
small outer diameter.

The transferring apparatus receives a prede-
15 termined compressed air supplied via the respective
roller shafts. As a consequence, the outer diameter
size of each roller is enlarged as mentioned above, and
the roller shaft 4 supported by ball bearings or the
like is rotated by a drive motor and transmission means
20 such as a chain so that an article is pushed up (lifted)
from the transporting surface of the chain conveyer etc.
and transported or diverged in any directions as desired.

After an article is transported or diverged
therein, the rollers of variable diameter type 100 are
25 actuated to discharge the compressed air in the sealing
member 9 to restore their outer diameter size to the
initial state and wait for the following transported
articles.

1 In this way, the roller of variable outer
diameter type 100 according to the present invention, by
virtue of the fact that it is provided with a sealing
member 9 having diaphragms made of an elastic material
5 and a plurality of sliders forming a roller peripheral
surface, enables articles to be transported or diverged
in an extremely simple construction.

One embodiment of the transferring apparatus
using rollers of variable outer diameter type 100 will
10 be described below in further detail with reference to
Figs. 9 and 10.

The transferring apparatus 200 is constructed
by a transport conveyer using chains, belts or rollers
driven by a motor, as means for entraining and
15 transporting articles, and another conveyer apparatus
having a plurality of rotary shaft means with rollers
of variable outer diameter type 100 mounted on two
positions of their shafts at the two end portions
thereof for transporting or diverging the articles.

20 In the case of the apparatus shown in Fig. 9,
a pair of transporting belts 37 are arranged at both
of sides so as to hold therebetween a plurality of
rotary shaft means (three as shown for the purpose of
convenience) having rollers of variable outer diameter
25 type 100 mounted on their shaft portions.

Also, the direction of advance of the
above-mentioned belts 37 and the direction of rotation
of the rollers of variable outer diameter type 100 are

1 intersected normal to each other.

The drive transmission of rotationally driving the rollers of variable outer diameters type 100 may be performed by way of a belt, pulleys or sprockets, a
5 chain or the like.

The pulleys 39 and 40 are held by bearings (not shown) mounted on a frame 36 and the conveyer belts 37 are driven by the pulleys 39 and 40.

The pulleys 39 and sprockets 41 are secured
10 to the rotary shaft 20. The driving force of a drive motor 38 is transmitted to the sprockets 41 by sprockets 19 and chains 18.

Two rollers of variable outer diameter type 100 are mounted at each two positions in both end
15 portions of each of rotary shafts 28, 22 and 29, respectively and are journaled by bearings 23.

In the initial state, i.e. in a state in which the compressed air is discharged and the roller peripheral surface 10B is contracted, the article
20 transporting surface of the rollers of variable outer diameter type 100 is lower in height than the upper surface of the conveyer belt 37. (It is shown by the height H2 in Fig. 10.)

In an operating state, i.e. in a state in
25 which the compressed air is supplied and the roller peripheral surface 10B is expanded, it is higher in level than the upper surface of the conveyer belt 37. (It is shown by the height H1 in Fig. 10.)

1 In the case of a transferring apparatus 200
shown in Fig. 10, the rotary shafts 22, 28 and 29 are
arranged parallel to one another.

 The rotary shaft 22 receives the driving fore
5 of a motor 27 transmitted by way of a connection of
sprockets 24 and 26 and a chain 27.

 The rotary shafts 28 and 29 receive the
driving force of the rotary shaft 22 transmitted by way
of sprockets 30 and 32 and a chain 31.

10 Next, the operation for transferring articles
will be explained.

 An explanation will be made in the case where
an article is received from the direction of arrow Y and
transferred (diverged) in the direction of arrow X.

15 First, a compressed air is supplied into the
rotary shafts 22, 28 and 29 to cause the rollers of
variable outer diameter type 100 to be rotated at the
height of H1 while drawing an article from the direction
of arrow Y.

20 Next, after the drawing of the article is
completed (or after the article reaches a first
position), the rollers of variable outer diameter type
100 will be stopped, and the compressed air is
discharged to bring the article to the height of H2
25 (the outer diameter is reduced), then the article is
loaded upon the upper surfaces of the transporting belts
37 to transfer it in the direction of arrow Y (in the
direction of a second position) therefrom.

1 On the other hand, in case an article is
transferred from the direction of arrow X to the
direction of arrow Y, the rollers of variable outer
diameter type 100 stand to wait first at the height of
5 H2.

When the article is reached by the conveyer
belts 37 onto the rollers of variable diameter type 100
(the first position), the outer diameter size of the
rollers of variable diameter type will be changed to
10 the height of H21 to lift the article from the upper
surfaces of the conveyer belts. Thereafter, the rollers
of variable outer diameter type 100 are rotationally
driven to shift the article in the direction of arrow Y
(in the direction of the second position).

15 In such a manner, the transferring apparatus
200 is capable of transferring an article in a direction
perpendicular to the direction of advance of the belt
conveyer and this shift can be reversed.

Compared with the construction as in the
20 conventional apparatus in which the entirety of a
conveyer apparatus such as a belt conveyer, roller
conveyer or chain conveyer is elevated using an
air-cylinder or the like so as to change the direction
of the transportation of an article, the transferring
25 apparatus 200 according to the embodiment of the present
invention is extremely simple in structure and can be
assembled in low cost.

Furthermore, due to simplicity in

1 construction, the reliability of an equipment including
such an apparatus has been largely enhanced.

Here, naturally, it is needless to say that a
single unit of the afore-mentioned conveyer apparatus
5 using the rollers of variable outer diameter type may be
itself be used as a conveyer apparatus for transporting
articles as in the prior art.

Next, a transferring apparatus 300 according
to another embodiment of the present invention in which
10 the number of rollers of variable outer diameter type
100 and the arrangement of rotary shafts are varied is
shown in Fig. 11.

In this transferring apparatus, an article
can be received from the direction of arrow Y to
15 transfer it in the direction of arrow X, or vice versa.

The transferring apparatus 300 basically
includes three transport means, viz. transport belts
37A, a conveyer apparatus having a plurality of rotary
shaft means provided with rollers of variable outer
20 diameter type mounted thereon, and a roller conveyer 42
which is separately prepared.

More specifically, it is provided with first
conveyer means having three, four and six rollers of
variable outer diameters type 100 arranged in three
25 rows, respectively, from the left-hand side. Next, it
is provided with second conveyer means including two
belt conveyers 37A arranged at both sides in the
vicinity of the first conveyer means, and further with

1 the roller conveyer 42 as third conveyer means which intersects at a predetermined angle with the second conveyer means.

In order for an article to be transferred
5 onto the roller conveyer arranged in the direction of arrow A at a predetermined angle or conversely from the roller conveyer, each of the rollers of variable diameter type 100 has the angle of arrangement as gradually varied in such a manner as to be twisted in
10 an arc-like fashion.

Incidentally, the rollers of variable outer diameter type 100 are power-transmitted by pulleys 34 and 35 and a cross-belt (not shown) tensioned between these pulleys from drive shafts 22A, 28A and 29A.
15 Also, one roller of variable outer diameter type 100 is mounted to each rotary shaft at a time and journaled in a predetermined manner thereto by bearing means from both sides thereof.

At this point, it will be needless to say
20 that the cross-belt may be a round belt, a timing belt or any other optional power transmitting means.

As mentioned in the foregoing, the transferring apparatus 200, 300 using rollers of variable outer diameters type in accordance with the
25 present invention is capable of instantaneously lifting an article to be transported by supplying compressed air, so that the direction of transportation can be varied and diverged or joined such articles at as high

1 speed.

[Example 2]

Other roller of variable outer diameter type
400 according to another embodiment of the present
5 invention will be described with reference to Figs. 12
to 15.

Compared with the rollers of variable outer
diameter type described in Example 1, rollers of
variable outer diameter type 400 to be described in
10 Example 2 is so constructed as to omit a sealing member
9 using the diaphragm function.

More specifically, the roller 400 includes a
holding member provided with a plurality of through
holes radially arranged along a side surface thereof
15 and a fluid-feeding opening communicating with these
through holes and sliders respectively fitted slidably
in the through holes and forming a roller peripheral
surface, wherein the sliders are urged and displaced by
a fluid supplied into the fluid-feeding opening in such
20 a direction that the roller outer diameter size is
enlarged.

Also, the clearance (interstice size) between
each slider and a through hole in which it is slidably
fitted is dimensioned to be several tens μm , and by
25 finishing the fitting state in the order of H7f6 the
roller of variable outer diameter type is made compact
in structure and small in outer size.

Fig. 12 is a cross-sectional view of rollers

1 of variable outer diameter type 400, showing the state
of mounting it on a hollow shaft 121.

Fig. 13 is a cross-sectional view taken along
the line XIII-XIII in Fig. 12, illustrating the state
5 in which air is supplied in the hollow shaft 121 to
enlarge the roller outer diameter. Here, however, "O"
rings are omitted as shown.

Fig. 14 is an elevational view of a slider
124, and Fig. 15 is a plan view of the slider 124.

10 First, the hollow shaft 121 is prepared for
providing a hollow portion 132 at its axial center for
supply of a fluid such as air. This hollow shaft 121
is sealed at its one end with a plug 129 and has its
other end having a rotary-type air coupling (rotary
15 joint) 130 attached thereto so as to deliver air of a
predetermined pressure thereto. Moreover, the hollow
shaft 121 is journaled by a pair of bearing at both
sides thereof to be spaced with a predetermined
distance.

20 The rotary driving of the hollow shaft 121 is
carried out by a drive motor, a pulley and belt means; a
drive motor, sprockets and a chain; a drive motor and
gear transmission means or the like (any of them not
shown).

25 Further, the hollow shaft 121 is provided at
two sites in the vicinity of the bearings 131 with four
through holes (eight in total) radially arranged by
every 90 degrees along a side surface thereof which

1 communicate with the hollow portion 132.

The hollow shaft 121 has a disk body 123
securely mounted thereon as members for retaining
sliders 124 as will later be described. Fig. 12 shows
5 the state in which they are mounted at two sites.

Each disk body 123 has four perforated
openings or through holes 128 radially arranged
corresponding to the through holes 122 with each hole
communicating with each other.

10 Furthermore, in each through hole 128 of the
disk body 123, there is slidably fitted a slider 124.
In the embodiment of Fig. 12, one disk body 123 is
provided with four sliders 124 fitted in the through
hole 128.

15 Each slider 124 includes a supporting shaft
124A and outer peripheral surface portions 124B of the
rollers as well as in the Embodiment 1. Its detailed
configuration is shown in Fig. 14.

The shaft 124A is fitted in the corresponding
20 through hole 128 with a predetermined clearance
(interstice size) in the state of a fit of H7f6. It is
provided at one or two sites (one site in Fig. 12) with
"O" rings 125 in its outer peripheral portion to prevent
air leakage and to ensure a dust proof. As a matter of
25 course, the shaft 124A is surface-finished by a lathe or
grinder to the extent that it has a mirror state or a
nearly mirror state. When the slider is resin-molded,
however, its surface finish is made unnecessary by

- 1 improving the surface roughness of a mold used.

The roller outer peripheral surface portions 124B which hold a recess 124C between them are arc-shaped and arranged point-symmetrically so as to
5 form a roller outer peripheral surface of a predetermined angle (roller outer diameter).

By arranging the arc-like portions 124B so that they are deviated with a predetermined distance point-symmetrically, where the sliders 124 are arranged
10 radially at four sites every 90 degrees, the arc portions 124B is prevented from mutually interferring with each other, thereby continuing to form a continuous roller outer peripheral surface when the roller diameter is enlarged.

15 The surface configuration of the roller peripheral surface may be set as desired. It may be smooth as shown in Figs. 13 and 14 or alternatively may be corrugated, as shown in Fig. 7 and 8, so that it has U- or V-shaped shallow grooves 10F which are formed
20 with a predetermined distance substantially over an entire surface thereof. Of course, it may be knurled by grooves 10F crossing with one another.

Further, the roller outer peripheral surface portion may be optional also in its cross-section. It
25 may be a U-shaped recess 124C formed as a substantial]-shape as shown in Fig. 12 or otherwise may be set to be V-, U- or spherical-shaped depending upon a particular need.

1 The annular recess or groove 124C is provided with a ring-shaped tension coil spring 126 corresponding to the rubber ring 11 in Example 1 so as to be fitted thereinto.

5 The function of the ring-shaped tension coil spring 126 is, as described in Example 1, to restore the sliders 124 to the initial state, i.e. to the state in which the outer diameter size of the roller is a small original size.

10 The disk body 123 has side plates 127 respectively arranged at its both side surfaces. The side plates 127 serve to regulate (limit) the stroke ends of the sliders 124 while preventing rotation of their supporting shaft.

15 More specifically, in case that air of a predetermined pressure is supplied into the through holes 128, the side plates 127 regulate the maximum outer diameter of the roller outer peripheral surface formed by the sliders 124 and prevent the sliders 124
20 from falling off the through holes 128.

 The roller of variable outer diameter type 400 with the foregoing construction is caused to enlarge its roller diameter by the air supplied through the afore-mentioned rotary-type air coupling (rotary joint)
25 130. Conversely, the air is discharged to reduce the roller outer diameter size to its initial small size. In this case, the speed of response of the sliders 124 for the air ranges from several tens msec to several

1 hundreds msec and hence is extremely fast.

Of course, needless to say, a speed controller designed to control the speeds of air inflow and outflow may jointly be utilized.

5 Incidentally, in Fig. 12, the position of the sliders shown by two-dot chain lines represents the state in which they are actuated by the air to enlarge the roller outer diameter.

While in the foregoing embodiment described
10 in connection with Fig. 12, two rollers of variable outer diameter type 400 are arranged for the hollow shaft 121, it is needless to say that the number and the sites of mounting of the rollers of variable outer diameter type 400 is optionally set and may be varied
15 as desired.

Further, the configuration and the combined structure of the disk bodies 123, the side plates 127 and the hollow shaft may optionally be varied.

For example, as in rollers of variable outer
20 diameter type 500 shown in Fig. 16, the disk bodies and side plates may be integrated to form members that constitute holding members 173 and the stroke ends of the sliders 124 may be regulated by stoppers 177.

Further, as in rollers of variable outer
25 diameter type 600 shown in Fig. 17, the disk bodies and the hollow shaft in Fig. 12 may be integrated to hold sliders, and as in rollers of variable outer diameter type 700 shown in Fig. 18, the disk bodies, the hollow

1 shaft and the side plates may be integrated to each
other. Any of such modifications may possibly be
adopted as desired.

Also, in Fig. 16, in lieu of stoppers 177 for
5 regulating the movements of the sliders 124, pins may be
projected from the holding members to restrict those
movements laterally of the shafts and the roller outer
peripheral surface portions. (not shown)

More specifically, a roller of variable outer
10 diameter type may be constructed that includes a holding
member provided with a plurality of through holes
radially arranged along a surface thereof and a
fluid-feeding opening communicating with these through
holes; and sliders respectively fitted slidably in the
15 through holes and forming a roller outer peripheral
surface, wherein the sliders are urged or displaced
by a fluid supplied in the fluid-feeding opening in
such a direction that the roller outer diameter size is
enlarged.

20 Furthermore, the disk bodies, the side plates,
the hollow shaft and the holding member formed by
integrating these components may optionally be altered
in their structural components and their machining
means, and may be made of polystyrene resin material
25 (PS), epoxy resin material or FRP which may be
resin-molded.

The description of a conveyer apparatus or
transferring apparatus constructed using the rollers of

1 variable outer diameter type 400, 500, 600 or 700
described in Example 2 is omitted for the reason that
they may be replaced for rollers of variable outer
diameter type 100 described in Example 1 to build up a
5 similar construction.

As described in the foregoing, according to a
roller of variable outer diameter type of the present
invention, the roller outer peripheral size (outer
diameter size) can be instantaneously altered with
10 stability in a simple structure without necessitating a
precision-machined part, even with such a high pressure
fluid as may vary from 5 Kgf/cm² to 8 kgf/cm² in
pressure magnitude. Also, the life of repetition and
the reliability are markedly.

15 Further, in the construction of not using a
diaphragm, the outer configuration size can be reduced
and the construction can further be simplified.

Furthermore, in a conveyer apparatus or
transferring apparatus for articles using the rollers
20 of variable outer diameter type according to the present
invention, the cost of manufacture is largely reduced,
and the apparatus are extremely made compact and
light-weighted, also enabling a diverging or joining
operation for articles to be carried out at an increased
25 speed in a transporting equipment and permitting an
expanded use of a roller and apparatus. Thus, a plenty
of advantageous effects are attainable in accordance
with the present invention.



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What is Claimed is:

1. A roller of variable outer diameter type,
comprising:

a holding member having a plurality of through
holes radially arranged in a side surface thereof and a
hollow portion communicating with said through holes;

a sealing member mounted in said hollow
portions and provided with diaphragms corresponding to
each of said through holes;

sliders fitted slidably in each of said
through holes and providing a roller peripheral surface;
and

said sealing member causing said sliders to
urge and displace via said diaphragms by fluid supplied
into the hollow portions thereof in such a direction
that an outer diameter size of the roller is enlarged. ✓

2. A roller of variable outer diameter type,
comprising:

a pipe having a plurality of through holes
formed in a cylindrical surface thereof;

a sealing member fittedly mounted inside said
pipe and provided with diaphragms arranged in accordance
with each of said through holes;

sliders fitted slidably in each of said
through holes and providing a roller peripheral surface;
and

side plate arranged at an end surface side of
said pipe to fasten said sealing member and said pipe

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hermetically therewith;

said sliders being urged and displaced by a fluid with said diaphragms in such a direction that an outer diameter size of the roller is enlarged.

3. A roller of variable outer diameter type as set forth in claim 1, wherein said sliders each have an arc portion forming the roller peripheral surface of a predetermined angle and a supporting shaft fitted in each of said through holes.

4. A roller of variable outer diameter type as set forth in claim 1, said roller provides rotary shaft means installed in a plurality of axial portions of a conveyer apparatus.

5. An apparatus for transferring articles with a roller of variable outer diameter type as set forth in claim 1, comprising:

a plurality of rotary shaft means having said rollers of variable outer diameter type installed in axial portions thereof; and

conveyer means arranged in the vicinity of said rotary shaft means.

6. An apparatus for transferring articles as set forth in claim 5, wherein said conveyer means is one or more than means of a belt conveyer, a chain conveyer and a roller conveyer.

7. An apparatus for transferring articles, comprising:

rotary shaft means having a roller of variable

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outer diameter type as set forth in claim 1 and
installed in an axial portion thereof; and

a pair of transporting conveyers arranged at
both ends of said rotary shaft means so as to put it
therebetween.

8. An apparatus for transferring articles as
set forth in claim 7, wherein the direction of rotation
of said roller of variable outer diameter type
intersects the direction of advance of said transporting
conveyor.

9. An apparatus for transferring articles,
comprising:

a plurality of rotary shaft means having
rollers of variable outer diameter type as set forth in
claim 1 mounted on a shaft portion thereof;

a pair of transporting conveyor arranged at
both ends of said rotary shaft means so as to hold it
therebetween; and

a third conveyor means provided so as to
intersect with said conveyor belts at a predetermined
angle thereto.

10. An apparatus for transferring articles as set
forth in claim 9, wherein said third conveyor means is
a roller conveyor.

11. An apparatus for transferring articles as
set forth in claim 9, wherein each of said rollers of
variable outer diameter type is arranged with an
installing angle changed in at least one or more

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of the rollers.

12. A method of transferring articles, comprising the steps of:

transporting the article to first position by means of a transporting conveyer provided with a plurality of rotary shaft means having rollers of variable outer diameter type as set forth in claim 1 mounted on shaft portions thereof;

supplying a fluid to said rollers of variable outer diameter type at said first position; and

raising said article from said transporting conveyer and transporting it to a second position.

13. A method of transferring articles, comprising the steps of:

transporting the article to a first position by means of a plurality of rotary shaft means having rollers of variable diameter type as set forth in claim 1 mounted on shaft portions thereof;

discharging a fluid from said rollers of variable outer diameters type at said first position; and

lowering said article and transporting said article to a second position by means of another transporting conveyer separately prepared.

14. A roller of variable outer diameter type, comprising:

a holding member having a plurality of through holes radially arranged along a side surface thereof

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and provided with a fluid supply opening communicating with said through holes; and

sliders respectively fitted slidably in said through holes and forming a roller peripheral surface;

said sliders being urged and displaced by a fluid supplied to said fluid supply opening in such a direction that an outer diameter size of the roller is enlarged.

15. A roller of variable outer diameter type as set forth in claim 14, wherein the rollers of variable outer diameter type are mounted on a plurality of rotary shaft means provided in a conveyer apparatus.

16. An apparatus for transferring articles, including the roller of variable outer diameter type as set forth in claim 14, said apparatus comprising:

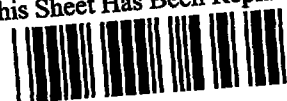
a plurality of rotary shaft means having said rollers of variable outer diameter type mounted thereon; and

conveyer means arranged in the vicinity of said rotary shaft means.

17. An apparatus for transferring articles as set forth in claim 16, wherein said conveyer means arranged in the vicinity of said rotary shaft means comprises at least one of a belt conveyer, a chain conveyer and a roller conveyer.

18. A roller of variable outer diameter type, comprising:

a holding member having a plurality of through





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holes arranged radially along a side surface thereof and provided with a fluid supply opening communicating with said through holes;

sliders respectively fitted slidably in said through holes and forming a peripheral surface of the roller;

said sliders being urged and displaced by a fluid supplied in said fluid supply opening in such a direction that an outer diameter size of the roller is enlarged; and

a member for restricting an operating range of said sliders.

19. A roller of variable outer diameter type, comprising:

a disk body having a plurality of through holes radially arranged along a side surface thereof and provided with a fluid supply opening communicating with said through holes;

sliders respectively fitted slidably in said through holes and forming an outer peripheral surface of the roller;

said sliders being urged and displaced by a fluid supplied in said fluid supply opening in such a direction that an outer diameter size of the roller is enlarged; and

a side plate arranged at a side surface of said disk body.

20 A roller of variable outer diameter type,

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comprising:

a hollow shaft provided with a plurality of through holes radially arranged along a cylindrical surface thereof:

sliders respectively fitted slidably in said through holes and forming an outer peripheral surface of the roller;

said sliders being urged and displaced by a fluid supplied in said hollow shaft in such a direction that an outer diameter size of the roller is enlarged; and

a member for restricting an operating range of said sliders.

21. A roller of variable outer diameter type, comprising:

a hollow shaft having a plurality of through holes radially arranged along a cylindrical surface thereof;

sliders respectively fitted slidably in said through holes and forming an outer peripheral surface of the roller;

said sliders being urged and displaced by a fluid supplied in said hollow shaft in such a direction that an outer diameter size of the roller is enlarged; and

a side plate mounted to said hollow shaft.

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