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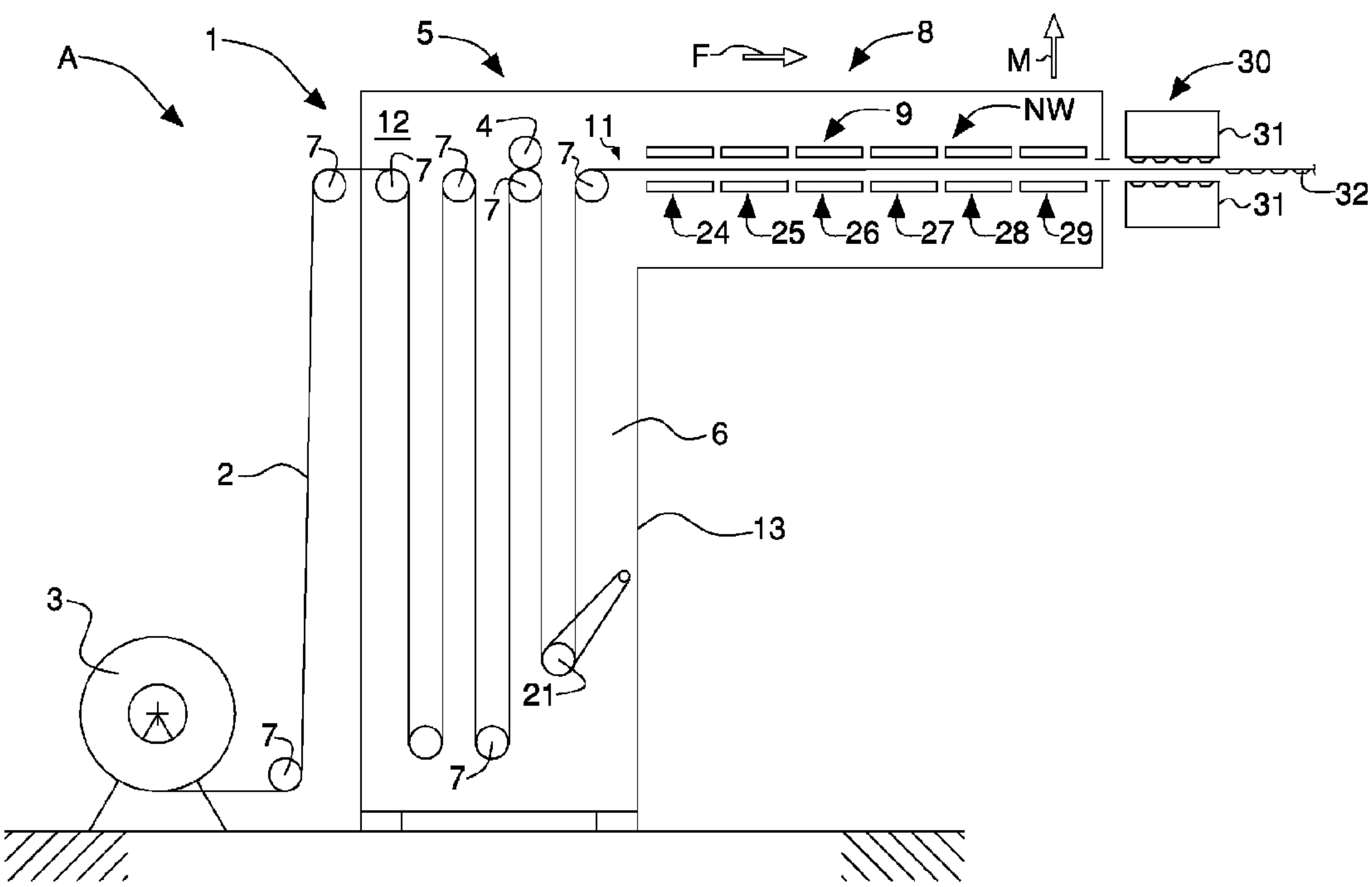

(57) **Abrégé/Abstract:**
A forming apparatus for forming objects (32) by forming a sheet of thermoformable material (2), comprises a thermal conditioning station (5) including a kiln (6) for heating the material (2) to an operating temperature, and a heating station (8) positioned downstream of the thermal conditioning station (5) and including heating means (9) to heat set portions of the material (2) to a temperature near a softening temperature of the material (2). In order to reduce reject material (2) at the restart of the apparatus (1) following a machine downtime, the kiln (6) and the heating means (9) are positioned near one another in such a manner that a part (11) of the material (2) interposed between the thermal conditioning station (5) and the heating station (8) is heated by the heat generated by kiln (6) and/or by the heating means (9). A heating station and a method for heating set portions (23) are also disclosed.

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(54) **Title**: FORMING APPARATUS, HEATING STATION AND METHOD FOR HEATING SET PORTIONS

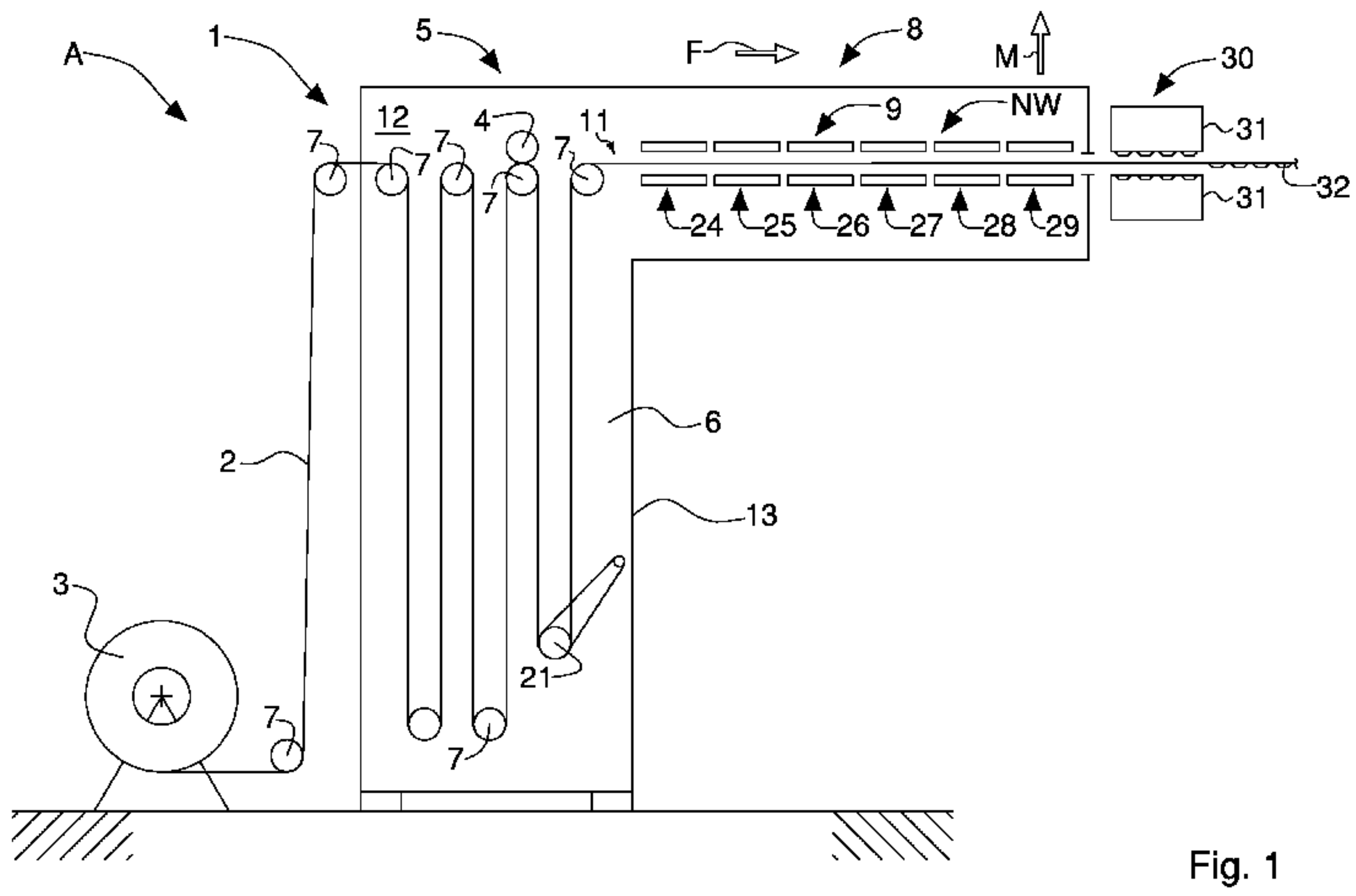

Fig. 1

(57) **Abstract**: A forming apparatus for forming objects (32) by forming a sheet of thermoformable material (2), comprises a thermal conditioning station (5) including a kiln (6) for heating the material (2) to an operating temperature, and a heating station (8) positioned downstream of the thermal conditioning station (5) and including heating means (9) to heat set portions of the material (2) to a temperature near a softening temperature of the material (2). In order to reduce reject material (2) at the restart of the apparatus (1) following a machine downtime, the kiln (6) and the heating means (9) are positioned near one another in such a manner that a part (11) of the material (2) interposed between the thermal conditioning station (5) and the heating station (8) is heated by the heat generated by kiln (6) and/or by the heating means (9). A heating station and a method for heating set portions (23) are also disclosed.

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FORMING APPARATUS

The invention relates to a forming apparatus for forming objects from a thermoformable sheet material, for example polypropylene.

The invention further relates to heating stations that are insertible into a forming apparatus arranged for forming objects by forming a thermoformable sheet material, for example polypropylene.

Also, the invention relates to a method for heating set portions of a thermoformable sheet material following a machine downtime of a forming apparatus.

Forming apparatuses for forming objects by forming a thermoformable sheet material are known that comprise a system for advancing in an indexed manner the thermoformable sheet material.

This material is unwound from a reel and is initially passed through a thermal conditioning station.

The thermal conditioning station comprises a kiln arranged for heating the material to an operating temperature that is sufficient for preheating the material throughout the thickness thereof, i.e. as far as the innermost part thereof, or, as commonly said in the technical field, as far as the "heart".

Subsequently, this preheated material is passed through a heating station positioned at a certain distance from, and downstream of the thermal conditioning station.

The heating station includes a plurality of heatable plates arranged in pairs along a horizontal advancing direction of the material through the heating station.

In particular, the plates of each pair are positioned on opposite sides of the thermoformable sheet material, such as to heat opposite faces thereof.

All the pairs of plates are simultaneously drivable between an operating position in which both plates of each pair contact the material to heat the material and a non-operating position in which the plates of each pair are at a certain distance from the material.

Also subsequently, the material that is thus softened is passed through a forming station in which it is deformed plastically to obtain the desired objects.

One drawback of the aforesaid apparatuses relates to the significant quantity of material to be rejected at the restart of the forming apparatus after a more or less protracted machine downtime.

This is due to the fact that at the restart the part of the material interposed between the thermal conditioning station and the heating station is no longer usable and is therefore to be rejected because during the stop it cools to a temperature at which it is no longer possible to reheat it homogeneously, i.e. to ensure the appropriate physical and mechanical properties thereof, in the heating station.

A further drawback of such forming apparatuses is the significant energy waste thereof.

In fact, the heat generated by the aforesaid plates in the non-operating position, i.e. in the position in which they are following a machine downtime, is dispersed in the surrounding environment.

One drawback of the aforesaid heating station relates to the significant quantity of material to be rejected at the restart of the forming apparatus after a more or less protracted machine downtime.

This is due to the fact that at the restart the part of the material contained in the heating station is no longer reusable and is thus to be rejected.

In fact, following the restart of the forming apparatus, only the portion of material positioned at a first pair of plates positioned further upstream of the advancing direction is reheated for a set time to ensure subsequent satisfactory forming, inasmuch as this portion, advancing the material in an indexed manner, is subsequently heated also by all the subsequent pairs of plates, positioned downstream of the first pair of plates along the advancing direction, up to a temperature that is such as to permit the softening and plastic deformation thereof.

Vice versa, the remaining portions of material positioned downstream of this portion along the advancing direction are gradually heated by a decreasing number of pairs of plates, this entailing inappropriate heating, inasmuch as the heating is for a shorter time than the set time, for subsequent forming.

In other words, these portions are not heated by the pairs of plates positioned upstream of the portions, along the advancing direction.

Further, in a machine downtime condition, the plates are positioned in the non-operating position, i.e. they are distant from one another. This, together with the force of gravity, causes deformation of the material, which is arranged over a curved surface, i.e. it "bellies".

This deformation compromises the physical and mechanical properties of this part of the material that cannot be subsequently formed efficiently and thus has to be rejected.

Also, the part of material contained in the heating station during the stop cools to a temperature at which it is not subsequently possible to heat this part evenly, i.e. to ensure suitable physical and mechanical properties in the heating station.

A further drawback of this heating station is the significant energy waste associated therewith.

In fact, the heat generated by the aforesaid plates in the non-operating position, i.e. in the position in which they are following a machine downtime, is dispersed from the heating station in the surrounding environment.

One object of the present invention is to improve forming apparatuses for forming objects from thermoformable sheet material.

A further object is to provide forming apparatuses that compared with known apparatuses enables rejects of material to be reduced after restarts following machine downtimes.
A still further object is to obtain forming apparatuses that enable energy consumption to be optimised.
Another object of the present invention is to improve the heating stations that are includable in forming apparatuses arranged for forming objects from thermoformable sheet material.
A further object is to provide heating stations that are includable in forming apparatuses arranged for forming objects from thermoformable sheet material that compared with known apparatuses enable rejects of material to be reduced after restarts following machine downtimes.
A still further object is to obtain heating stations that are includable in forming apparatuses arranged for forming objects from thermoformable sheet material that enable energy consumption to be optimised.
Another further object is to provide a method for heating set portions of a thermoformable sheet material that compared with known methods enables rejects of material to be reduced after restarts following machine downtimes.
Such objects and still others are all achieved by a forming apparatus and by a heating station made according to one or more of the following claims.
The invention can be better understood and implemented with reference to the attached drawings, which illustrate some embodiments thereof by way of non-limiting example, in which:
Figure 1 is a schematic frontal view of a forming apparatus according to the invention in a first embodiment;
Figure 2 is an enlarged detail of Figure 1;
Figure 3 is a plan view of the enlarged detail in Figure 2;
Figure 4 is a schematic frontal view of a forming apparatus according to the invention in a second embodiment;
Figure 5 is a schematic frontal view of a forming apparatus according to the invention in a third embodiment;

Figure 6 is an enlarged detail of Figure 5;
Figure 7 is a plan view of the enlarged detail in Figure 5;
Figure 8 is a schematic frontal view of a forming apparatus according to the invention in a fourth embodiment;
Figure 9 is a schematic frontal view of a forming apparatus according to the invention in a fifth embodiment;
Figure 10 is a schematic frontal view of a forming apparatus according to the invention in a sixth embodiment;
Figure 11 is a schematic frontal view of a forming apparatus according to the invention in a seventh embodiment;
Figure 12 is a schematic frontal view of a forming apparatus according to the invention in an eighth embodiment.

With reference to Figure 1 there is shown a first embodiment A of a forming apparatus 1 arranged for forming objects 32 from a thermoformable sheet material, for example polypropylene.

The material 2 is unwound from a reel 3 and moved, for example in an indexed manner, by advancing means along an advancing direction F through a plurality of operating stations.

In particular, this advancing means includes a driven roller 4, a plurality of rollers 7, or gears, and a guide pulley 21.

The aforesaid operating stations comprise a thermal conditioning station 5 through which the material 2 is advanced.

The thermal conditioning station 5 comprises a kiln 6 arranged for heating the material 2 to an operating temperature that is sufficient for preheating the material 2 throughout the entire thickness thereof, i.e. as far as the innermost part thereof, or, as it is commonly called in the technical field, as far as the "heart".

Inside the thermal conditioning station 5, the rollers 7, or gears, are positioned in such a manner as to make the material 2 travel along a sufficiently long path in the kiln 6 as to be heated to the desired operating temperature, whilst the guide pulley 21 is positioned in such a manner as to maintain the material 2 taut both during advancing of the latter in an indexed manner and during a machine downtime.

The aforesaid operating stations further comprise a heating station 8, positioned downstream of the thermal conditioning station 5, through which the material is advanced 2 that was previously heated by the kiln 6.

The heating station 8 is provided with heating means 9 that are positioned in succession along the substantially horizontal advancing direction F, of the material 2 through the heating station 8, to heat set portions 23 (Figures 2 and 3) of the material 2 to a temperature near a softening temperature of the material 2.

In particular, the kiln 6 and the heating means 9 are positioned near one another in such a manner that a part 11 of the material 2 interposed between the thermal conditioning station 5 and the heating station 8 is heated by the heat generated by the kiln 6 and/or by the heating means 9.

In the first embodiment A, the apparatus 1 comprises a single heating chamber 12, bounded by a thermally insulated case 13 housing both the kiln 6 and the heating means 9.

In this manner, when the apparatus 1 restarts after a more or less protracted machine downtime, the part 11 of the material 2 is still usable.

In fact, this part 11 is maintained by the aforesaid heat generated by the kiln 6 and/or by the heating means 9 at a temperature that is even and sufficient for ensuring, at the restart, suitable physical and mechanical properties for correct subsequent forming.

Further, the apparatus 1 enables significant energy to be saved, inasmuch as the heat dispersed by the heating means 9 is used to heat the heating chamber 12, inasmuch as, owing to the thermally insulated case 13, it is not dispersed in the environment as occurs in known apparatuses.

In a second embodiment B, shown in Figure 4, the apparatus 1 comprises, instead of the single heating chamber 12, a first heating chamber 14 for housing the kiln 6 and a second heating chamber 15, communicating with the first heating chamber 14, for housing the heating means 9.

In particular, the first heating chamber 14 is bounded by a thermally insulated first case 16, whereas the second heating chamber 15 is bounded by a second case 17, which is also thermally insulated and contiguous with, more precisely in contact with, the first case 16, a passage 33 for the material 2 being provided between the first case 16 and the second case 17.

A third embodiment C, shown in Figure 5, is a version of the first embodiment A.

The third embodiment C differs from the first embodiment A inasmuch as the advancing direction F of the material 2 through the heating station 8 is substantially vertical.

Consequently, in the third embodiment C, the heating means 9 is positioned substantially vertically.

In this manner, at the restart of the apparatus 1 after a more or less protracted machine downtime, a portion 20 of the material 2 is still usable that is contained, at the moment of the machine downtime, in the heating station 8.

In fact, this portion 20, during the machine downtime, remains arranged, owing to the force of gravity, along a substantially vertical and flat surface, this ensuring, at the restart, suitable physical and mechanical properties of this portion 20 for correct subsequent forming.

Further, in the third embodiment C, the guide pulley 21 is positioned in the heating station 8 upstream of the heating means 9 along the advancing direction F so as to maintain the material 2 taut both during advancing of the latter in an indexed manner and during a machine downtime.

In this manner, the guide pulley 21, together with the force of gravity, contributes to maintaining the portion 20 arranged along the aforesaid surface substantially vertical and flat, in particular during the machine downtimes.

A fourth embodiment D, shown in Figure 8, is a version of the second embodiment B.

This fourth embodiment D differs from the second embodiment B inasmuch as the advancing direction F of the material 2 through the heating station 8 is substantially vertical.
In this manner, also in the fourth embodiment D, the heating means 9 is positioned substantially vertically.
Also in the fourth embodiment D, the guide pulley 21 is positioned in the heating station 8 upstream of the heating means 9 along the advancing direction F, such as to keep the material 2 taut both during advancing of the latter in an indexed manner and during a machine downtime.
A fifth embodiment E, shown in Figure 9, is a version of the fourth embodiment D.
This fifth embodiment E differs from the fourth embodiment D inasmuch as the apparatus 1 does not comprise the second heating chamber 15, communicating with the first heating chamber 14, for housing the heating means 9.
In other words, in the fifth embodiment E only the thermally insulated first case 16 is provided, which bounds the first heating chamber 14 in which the kiln 6 is housed.
Also in the fifth embodiment E the heating means 9 is positioned substantially vertically.
In this manner, at the restart of the apparatus 1 after a more or less protracted machine downtime, a portion 20 of the material 2 is still usable, which is contained, at the moment of the machine downtime, in the heating station 8 (Figures 6 and 7).
In fact, this portion 20, during the machine downtime, is arranged, owing to the force of gravity, along a substantially vertical and flat surface, this ensuring, at the restart, suitable physical and mechanical properties of this portion 20 for correct subsequent forming.
Further, also in the fifth embodiment E, the heating station 8 comprises a guide pulley 21 for maintaining the material 2 taut both during advancing of the latter in an indexed manner, and during a machine downtime.

In this manner, the guide pulley 21, together with the force of gravity, contributes to maintaining the portion 20 arranged along the aforesaid substantially vertical and flat surface, in particular during the machine downtimes.

A sixth embodiment F, shown in Figure 10, is a version of the second embodiment B.

This sixth embodiment F differs from the second embodiment B inasmuch as the apparatus 1 does not comprise the second heating chamber 15, communicating with the first heating chamber 14, for housing the heating means 9.

In other words, in the sixth embodiment F there is provided only the thermally insulated first case 16, bounding the first heating chamber 14 in which the kiln 6 is housed.

Also in the sixth embodiment F, the heating station 8 comprises the guide pulley 21 for maintaining the material 2 taut both during advancing of the latter in an indexed manner, and during a machine downtime.

A seventh embodiment G is shown in Figure 11.

In the seventh embodiment G, the apparatus 1 is devoid of the kiln 6.

Also, in the seventh embodiment G, the material 2 is unwound from a reel 3 and moved, for example in an indexed manner, by advancing means along an advancing direction F through a plurality of operating stations.

In particular, this advancing means includes a driven roller 4, a plurality of rollers 7, or gears, and a guide pulley 21.

The guide pulley 21 is positioned in such a manner as to maintain the material 2 taut both during advancing of the latter in an indexed manner, and during a machine downtime.

The heating station 8 is provided with heating means 9 which is positioned in succession along the substantially horizontal advancing direction F of the material 2 through the heating station 8, to heat set portions 23 (Figures 2 and 3) of the material 2 to a temperature near a softening temperature of the material 2.

The heating station 8 further comprises a thermally insulated

case 13 that houses the heating means 9.
In particular, the case 13 has a substantially parallelpipedon shape and comprises an inlet 33 and an outlet 66 for the material 2.
In this manner, at the restart of the apparatus 1 after a more or less protracted machine downtime, a portion 20 of the material 2 is still usable that is contained, at the moment of the machine downtime, in the heating station 8.
In fact, this portion 20 is maintained by the heat generated by the heating means 9 at a temperature that is even and sufficient to ensure, at the restart, suitable physical and mechanical properties for correct subsequent forming.
Further, the heating station 8, provided with the thermally insulated case 13, permits a significant energy saving, inasmuch as the heat dispersed by the heating means 9 is used to maintain the aforesaid portion 20 heated and is not dispersed in the environment as occurs in known heating stations.
An eighth embodiment H is shown in Figure 12.
In the eighth embodiment H, the apparatus 1 is devoid of the kiln 6.
Also, in the eighth embodiment H, the advancing direction F of the material 2 through the heating station 8 is substantially vertical.
Consequently, the heating means 9 is positioned substantially vertically.
In this manner, at the restart of the apparatus 1 after a more or less protracted machine downtime, a portion 20 of the material 2 is still usable that is contained, at the moment of the machine downtime, in the heating station 8 (Figures 6 and 7).
In fact, this portion 20, during the machine downtime, is arranged, owing to the force of gravity, along a substantially vertical and flat surface, this ensuring, at the restart, suitable physical and mechanical properties of this portion 20 for correct subsequent forming.

In this embodiment the guide pulley 21 is positioned in the heating station 8 upstream of the heating means 9 along the advancing direction F so as to maintain the material 2 taut both during advancing of the latter in an indexed manner, and during a machine downtime.

In this manner, the guide pulley 21, together with the force of gravity, contributes to maintaining the portion 20 arranged along the aforesaid substantially vertical and flat surface, in particular during the machine downtimes.

The aforesaid heating means 9 comprises a plurality of pairs of plates 24, 25, 26, 27, 28 and 29 (Figure 2, 3, 6 and 7).

In particular, the heating means 9 includes a first pair of plates 24, a second pair of plates 25, a third pair of plates 26, a fourth pair of plates 27, a fifth pair of plates 28 and a sixth pair of plates 29 arranged in succession along the advancing direction F.

These pairs of plates 24, 25, 26, 27, 28 and 29 are positioned such that the first pair of plates 24 is positioned further upstream of the advancing direction F with respect to the remaining pairs of plates 25, 26, 27, 28 and 29.

Each pair of plates 24, 25, 26, 27, 28 and 29 comprises two heatable plates 22 that face one another and are positioned on opposite sides of the material 2, such as to heat opposite faces thereof.

In use, the plates 22 of each pair of plates 24, 25, 26, 27, 28 and 29 are movable along a movement direction M that is substantially perpendicular to the advancing direction F, this movement direction M being substantially vertical in the first embodiment A, in the second embodiment B, in the sixth embodiment F and in the seventh embodiment G, and being substantially horizontal in the third embodiment C, in the fourth embodiment D, in the fifth embodiment and in the eighth embodiment H.

In particular, the plates 22 of each pair of plates 24, 25, 26, 27, 28 and 29 are movable along the movement direction M, moving towards and away from one another between an operating position, which is not shown, in which they contact and heat the material 2 substantially to the softening temperature, and a non-operating position NW, shown in Figures 1 to 12, in which they are at a certain distance from the material 2.

Also, in use, each pair of plates 24, 25, 26, 27, 28 and 29 is movable along a further movement direction N that is substantially horizontal and perpendicular to the advancing direction F and to the movement direction M (Figures 3 and 7).

In particular, each pair of plates 24, 25, 26, 27, 28 and 29 is movable along the further movement direction N between a first position, which is not shown, in which the plates 22 of each pair of plates 24, 25, 26, 27, 28 and 29 face, and are at a certain distance along the movement direction M from the respective portions 23 of the material 2, and a second position NX, shown in Figures 3 and 7, in which they are mutually facing and positioned laterally with respect to the material 2.

More precisely, the pairs of plates 24, 25, 26, 27, 28 and 29 are positioned in the second position NX during the machine downtimes, in such a manner as not to overheat, during the machine downtimes, the respective portions 23 of the material 2 contained, at the moment of the machine downtime, in the heating station 8.

The heating station 8 further comprises controlling means, which is not shown, for driving each pair of plates 24, 25, 26, 27, 28 and 29 between the operating position and the non-operating position NW.

In a normal operating step, the controlling means simultaneously drives the pairs of plates 24, 25, 26, 27, 28, 29, maintaining each in the respective operating position for a time set by the following formula:

$t_{running} = t_{heating}/n$, where:

- $t_{running}$ = time for which the pairs of plates 24, 25, 26, 27, 28 and 29 are maintained at running speed in the respective operating positions;
- $t_{heating}$ = total heating time required for softening the set portions 23 of the portion 20 that are positioned at each pair of plates 24, 25, 26, 27, 28, 29 and are intended for being subsequently deformed plastically;
- n = number of pairs of plates 24, 25, 26, 27, 28, 29 (in this case n = 6).

Vice versa, in an apparatus 1 restart step following a machine downtime, the controlling means drives the pairs of plates 24, 25, 26, 27, 28, 29 independently of one another, maintaining the pairs of plates 24, 25, 26, 27, 28, 29 in the respective operating positions respectively for a time set by the following formula:

$t_{restart(i)} = t_{running} * p_{(i)}$, where:

- $t_{restart(i)}$ (with i = 1, … m) = maintenance time at the restart of the i-th pair of plates 24, 25, 26, 27, 28, 29 in the respective operating position;
- $t_{running}$ = time of maintenance at running speed of the pairs of plates 24, 25, 26, 27, 28, 29 in the respective operating positions;
- $p_{(i)}$ (i = 1, … m) = position of the i-th pair of plates 24, 25, 26, 27, 28, 29 in relation to the advancing direction F in the heating station 8, where i = 1 indicates the position of the first pair of plates 24 further upstream with respect to the advancing direction F, and i = 6 indicates the position of the sixth pair of plates 29 positioned further downstream with respect to the advancing direction F.

In other words, at the restart, the pairs of plates 24, 25, 26, 27, 28 and 29 will be maintained in the respective operating positions respectively for a time:

- $t_{restart(1)} = t_{running} * 1$ for the first pair of plates 24;
- $t_{restart(2)} = t_{running} * 2$ for the second pair of plates 25;
- $t_{restart(3)} = t_{running} * 3$ for the third pair of plates 26;

- $t_{restart(4)} = t_{running} * 4$ for the fourth pair of plates 27;
- $t_{restart(5)} = t_{running} * 5$ for the fifth pair of plates 28;
- $t_{restart(6)} = t_{running} * 6$ for the sixth pair of plates 29.

In particular, during this restart step, the sixth pair of plates 29 will be driven first and subsequently the pairs of plates 24, 25, 26, 27, 28 positioned further upstream than the sixth pair of plates 29 with a delay set by the following formula:

$t_{driving(j)}$ (with j = 1, … m-1) $= t_m + t_{running} * (p_{(m)} - p_{(m-j)})$, where:

- $t_{driving(j)}$ (with j = 1, … m-1) = time in which to restart the j-th pair of plates 24, 25, 26, 27, 28, positioned upstream of the pair of plates 29 positioned further downstream with respect to the advancing direction F, in the respective operating position;
- t_m = time in which the pair of plates 24, 25, 26, 27, 28, 29 is driven that is positioned further downstream with respect to the advancing direction F;
- $t_{running}$ = time of maintenance at running speed of the pairs of plates 24, 25, 26, 27, 28, 29 in the respective operating positions;
- $p_{(m)}$ = position of the m-th pair of plates 29 in the heating station 8 positioned further downstream with respect to the advancing direction F, for example $p_{(m)}$ = 6 for the sixth pair of plates 29;
- $p_{(m-j)}$ (with j = 1, … m-1) = position of the (m-j)-th pair of plates 24, 25, 26, 27, 28 in the heating station 8, for example $p_{(m-j)}$ = 1 for the fifth pair of plates 28.

For example, for $t_{heating}$ = 12 seconds, $t_{running}=t_{heating}/n=12$ seconds/6=2seconds, at the restart the pairs of plates 24, 25, 26, 27, 28, 29 will be respectively driven at the times:

- t_m = for the sixth pair of plates 29;
- $t_{restart(5)} = t_m + 2$ seconds $* (6-5) = t_m + 2$ seconds for the fifth pair of plates 28;

- $t_{restart(4)}$ = t_m + 2 seconds * (6-4) = t_m + 4 seconds for the fourth pair of plates 27;
- $t_{restart(3)}$ = t_m + 2 seconds * (6-3) = t_m + 6 seconds for the third pair of plates 26;
- $t_{restart(2)}$ = t_m + 2 seconds * (6-2) = t_m + 8 seconds for the second pair of plates 25;
- $t_{restart(1)}$ = t_m + 2 seconds * (6-1) = t_m + 10 seconds for the first pair of plates 24.

At the end of the restart, the controlling means again simultaneously drives the pairs of plates 24, 25, 26, 27, 28, 29 by maintaining each in the respective operating position for the $t_{running}$ time.

In this manner, by advancing the material in an indexed manner, all the set portions 23 are heated to a temperature that is such as to enable the set portions 23 to be softened and deformed plastically.

For example, for $t_{heating}$ = 12 seconds, $t_{running}=t_{heating}/n=12$ seconds/6=2 seconds, and at the restart, there will be:

- $t_{restart(1)}$ = 2 * 1 = 2 seconds for the first pair of plates 24;
- $t_{restart(2)}$ = 2 * 2 = 4 seconds for the second pair of plates 25;
- $t_{restart(3)}$ = 2 * 3 = 6 seconds for the third pair of plates 26;
- $t_{restart(4)}$ = 2 * 4 = 8 seconds for the fourth pair of plates 27;
- $t_{restart(5)}$ = 2 * 5 = 10 seconds for the fifth pair of plates 28;
- $t_{restart(6)}$ = 2 * 6 = 12 seconds for the sixth pair of plates 29.

In this manner, at the restart of the apparatus 1 after a more or less protracted machine downtime, the portion 20 of the material 2 contained, at the moment of the machine downtime, in the heating station 8 is still reusable, inasmuch as each set portion 23 is heated, before leaving the heating station 8, to a temperature that is such as to enable the set portion 23 to be softened and subsequently deformed plastically.

In order to do so, the controlling means maintains the respective pairs of plates 24, 25, 26, 27, 28 and 29 in the respective operating positions in such a manner that the pairs of plates 25, 26, 27, 28 and 29 positioned gradually downstream of the first pair of plates 24 with respect to the advancing direction F remain in the respective operating position for intervals of time that increase as the distance increases that separates the pairs of plates 25, 26, 27, 28 and 29 from the first pair of plates 24.

In one embodiment of the invention, which is not shown, the pairs of plates are greater or lesser in number than six.

Still subsequently, the material 2 that has been thus softened by the pair of plates 24, 25, 26, 27, 28 and 29 is passed through a forming station 30 in which the material 2 is deformed plastically to obtain the desired objects 32 by forming means 31.

Also, downstream of the forming station 30 a shearing station can be provided that is not shown, where suitable cutting means separates the objects 32 formed from the sheet of material 2 from which they have been obtained.

CLAIMS

1. Forming apparatus for forming objects by forming a sheet of thermoformable material, said apparatus comprising a thermal conditioning station including a kiln for heating said material to an operating temperature and a heating station positioned downstream of said thermal conditioning station and including heating means, which is positioned along an advancing direction (F) of said material in said heating station to heat set portions) of said material to a temperature near a softening temperature of said material, wherein said kiln and said heating means are positioned near one another in such a manner that a part of said material interposed between said thermal conditioning station and said heating station is heated by the heat generated by said kiln and/or by said heating means, wherein said heating means comprises a pair and at least one further pair of heatable plates that face one another and are positioned on opposite sides of said material, said plates being movable along a movement direction (M), substantially perpendicular to said advancing direction (F), towards and away from one another between an operating position in which they contact and heat said material and a non-operating position (NW) in which they are at a certain distance from said material and further comprising control means for driving independently of one another said pair of plates and said at least one further pair of plates between said operating position and said non-operating position.

2. Apparatus according to claim 1, and comprising a heating chamber for housing both said kiln and said heating means.

3. Apparatus according to claim 2, wherein said heating chamber is bounded by a thermally insulated case.

4. Apparatus according to claim 1, and comprising a first heating chamber for housing said kiln and a second heating chamber, communicating with said first heating chamber, for housing said heating means.

5. Apparatus according to claim 4, wherein said first heating chamber and said second heating chamber are bounded respectively by a first case and by a second case that are thermally insulated.

6. Apparatus according to claim 1, and comprising advancing means for advancing said material along said advancing direction (F).

7. Apparatus according to claim 6, wherein said advancing means is configured in such a manner as to advance said material in an indexed manner.

8. Apparatus according to claim 1, wherein said advancing direction (F) is substantially vertical.

9. Apparatus according to claim 1, wherein said heating station includes tensioning means acting on said material to maintain said material taut in said heating station.

10. Apparatus according to claim 1, wherein said advancing direction (F) is substantially horizontal.

11. Apparatus according to claim 1, wherein said heating means is movable along a further movement direction (N) substantially perpendicular to said advancing direction (F) and to said movement direction (M) between a first position in which said heating means faces said material and a second position (NX) in which said heating means is positioned laterally with respect to said material.

12. Method for heating set portions of a sheet of thermoformable material following a machine downtime of a forming apparatus arranged for forming objects by forming said material, said method comprising driving a plurality of heating means of a heating station included in said forming apparatus between respective operating positions in which each of said heating means contacts and heats one of said portions and respective non-operating positions (NW) in which each of said heating means is at a certain distance from said material, wherein said driving comprises driving independently of one another each of said heating means in such a manner that when said apparatus starts following said machine downtime each of said heating means is maintained in the respective operating position respectively for a time:

$t_{restart(i)} = t_{running} * p_{(i)}$, where:

- $t_{restart(i)}$ (i = 1, … m) = time of maintenance at restart of the i-th heating means in the respective operating position;
- $t_{running} = t_{heating}/n$, where: $t_{running}$ = time for which said heating means in the respective operating positions is maintained at running speed, $t_{heating}$ = total heating time required for softening said portions and n = number of said heating means; and
- $p_{(i)}$ (with i = 1, … m) = position of the i-th heating means) with respect to an advancing direction (F) of said material in said heating station, where i = 1 indicates the position of the heating means positioned further upstream with respect to the advancing direction F, and i = m indicates the position of the heating means positioned further downstream with respect to said advancing direction (F).

13. Method according to claim 12, and comprising, following said machine downtime, driving with a delay the heating means positioned upstream of the heating means positioned further downstream with respect to the

advancing direction (F), said delay being equal to $t_{driving(j)}$ (with j = 1, … m-1) = $t_m + t_{running} * (p_{(m)} - p_{(m-j)})$, where:

- $t_{driving(j)}$ (with j = 1, … m-1) = time in which to restart the j-th heating means positioned upstream of the heating means positioned further downstream with respect to said advancing direction (F) in the respective operating position;
- t_m = time in which the heating means is driven positioned further downstream with respect to the advancing direction F;
- $t_{running}$ = time for which the pairs of plates in the respective operating positions are maintained at running speed;
- $p_{(m)}$ = position of the m-th heating means in said heating station positioned further downstream with respect to said advancing direction (F);
- $p_{(m-j)}$ (with j = 1, … m-1) = position of the (m-j)-th heating means in said heating station.

14. Method according to claim 12 or 13, wherein after said driving independently there is provided driving simultaneously said heating means, each being maintained in the respective operating position for said $t_{running}$.

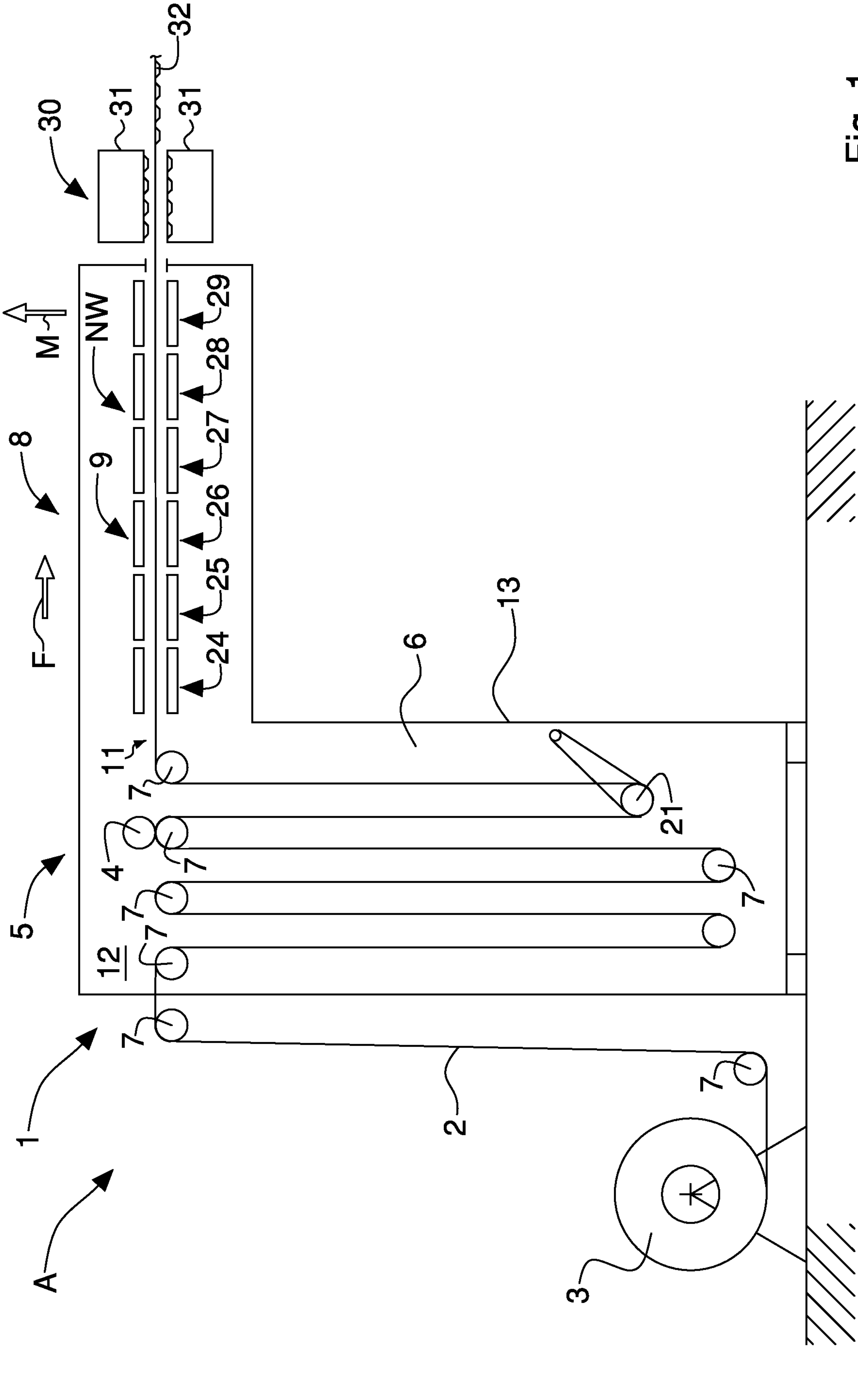

Fig. 1

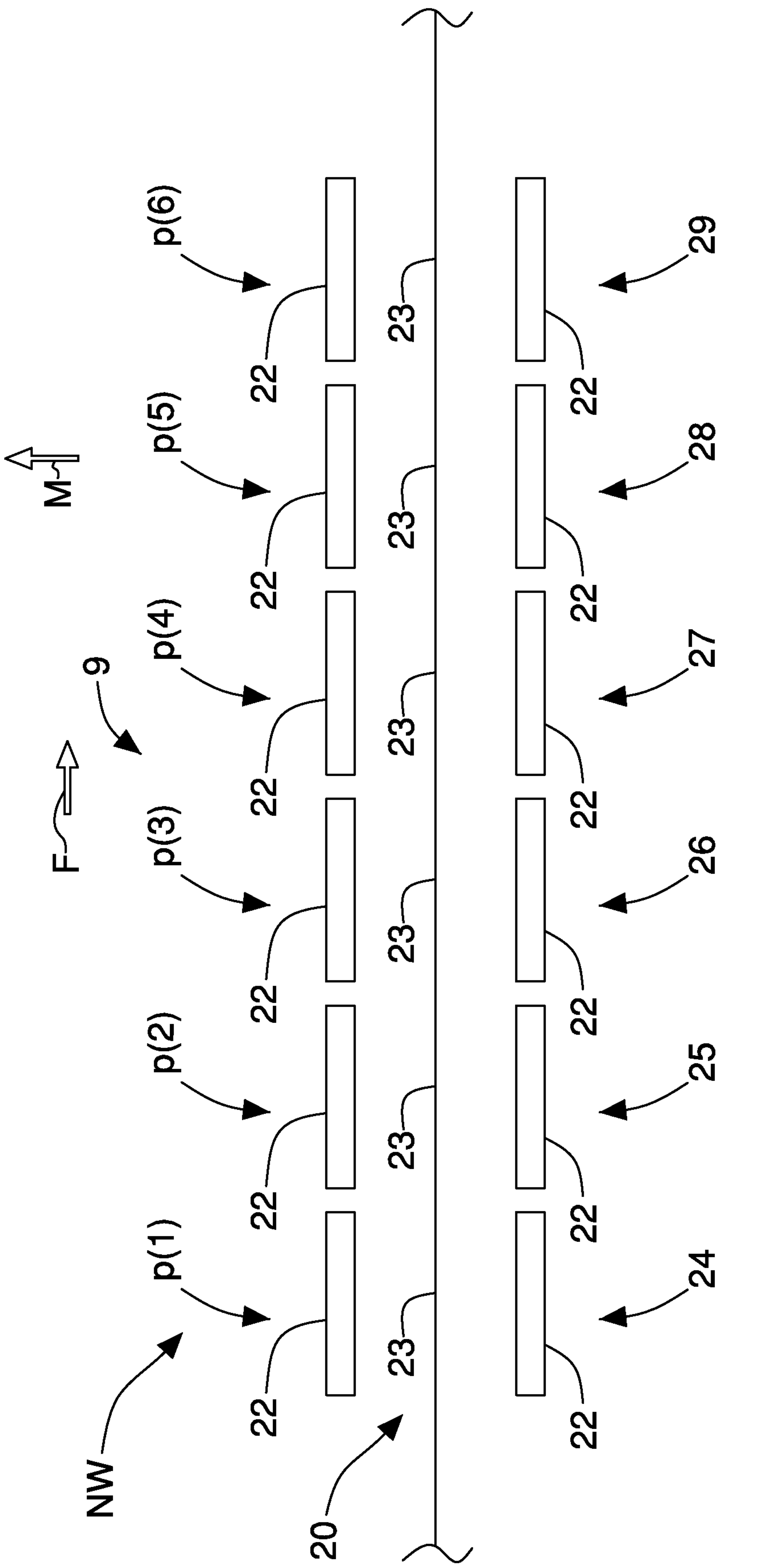

Fig. 2

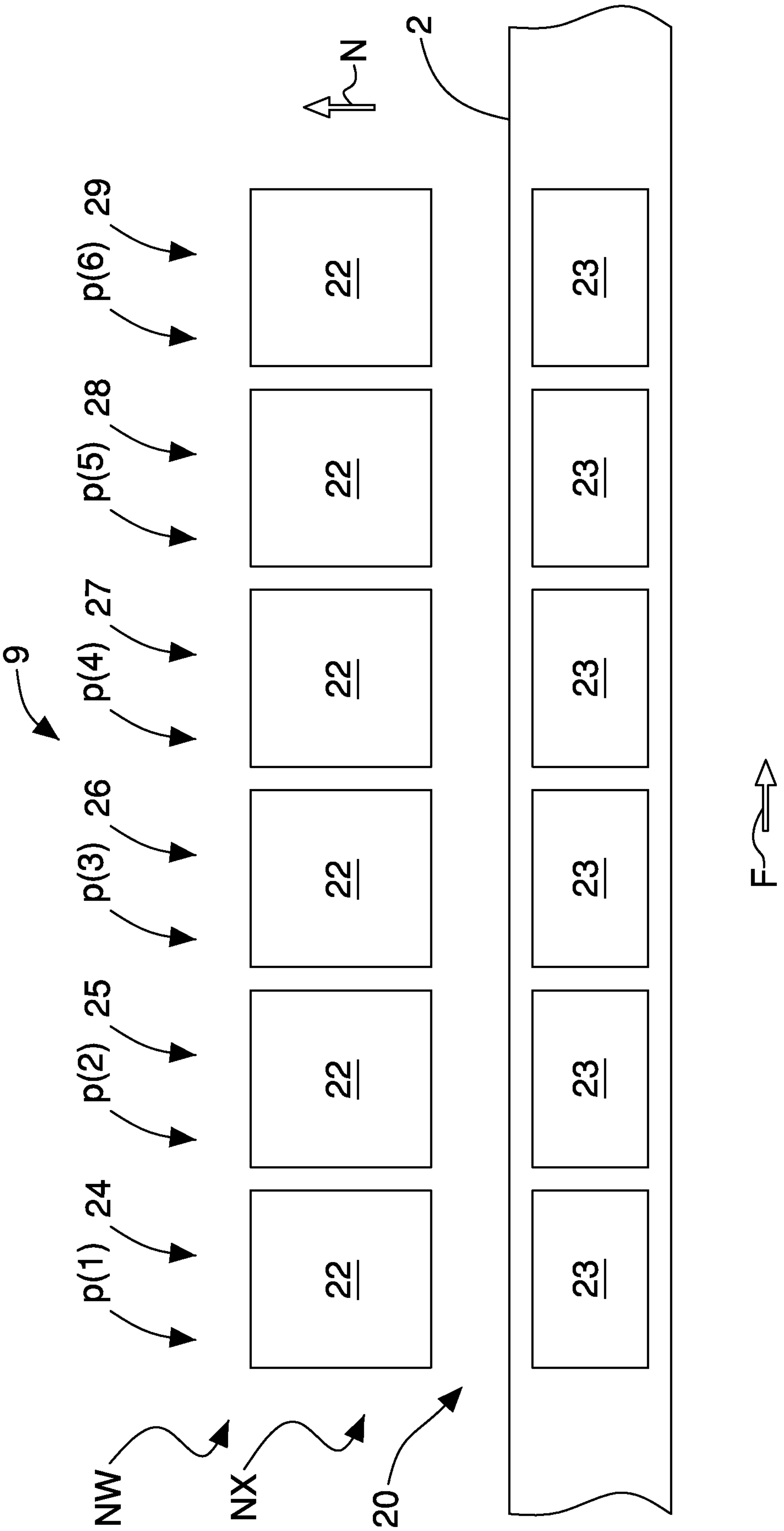

Fig. 3

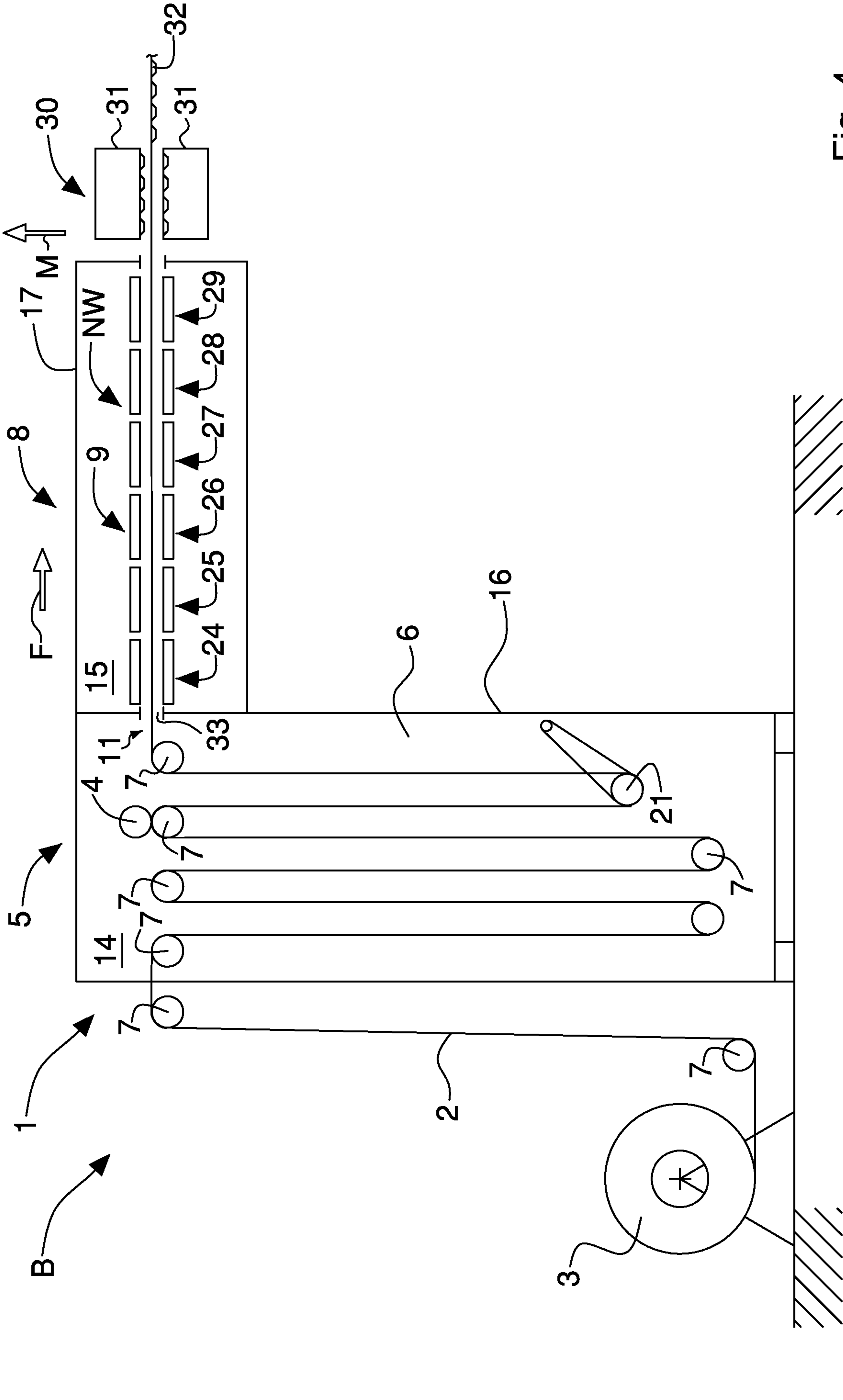
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Fig. 4

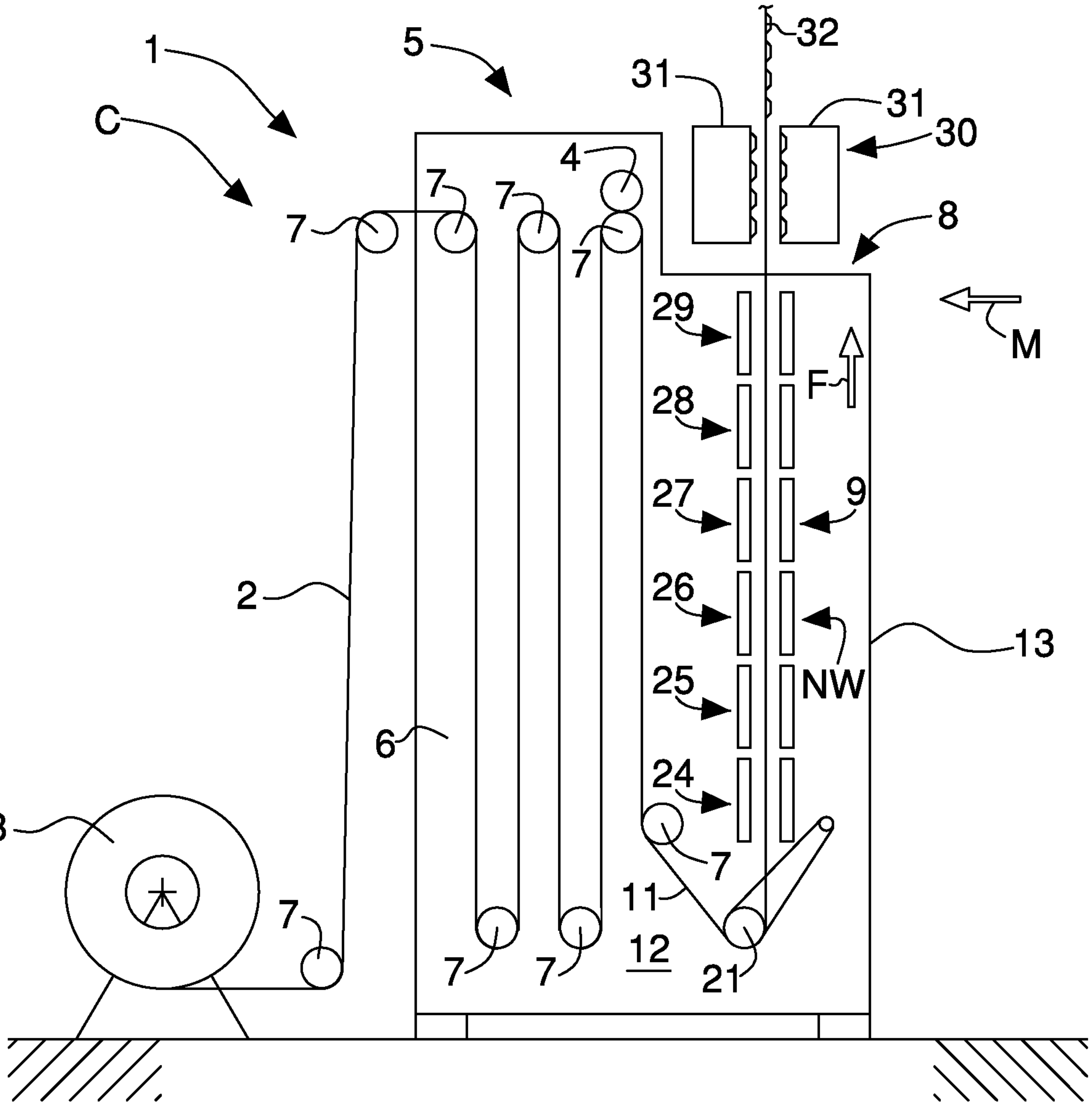
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Fig. 5

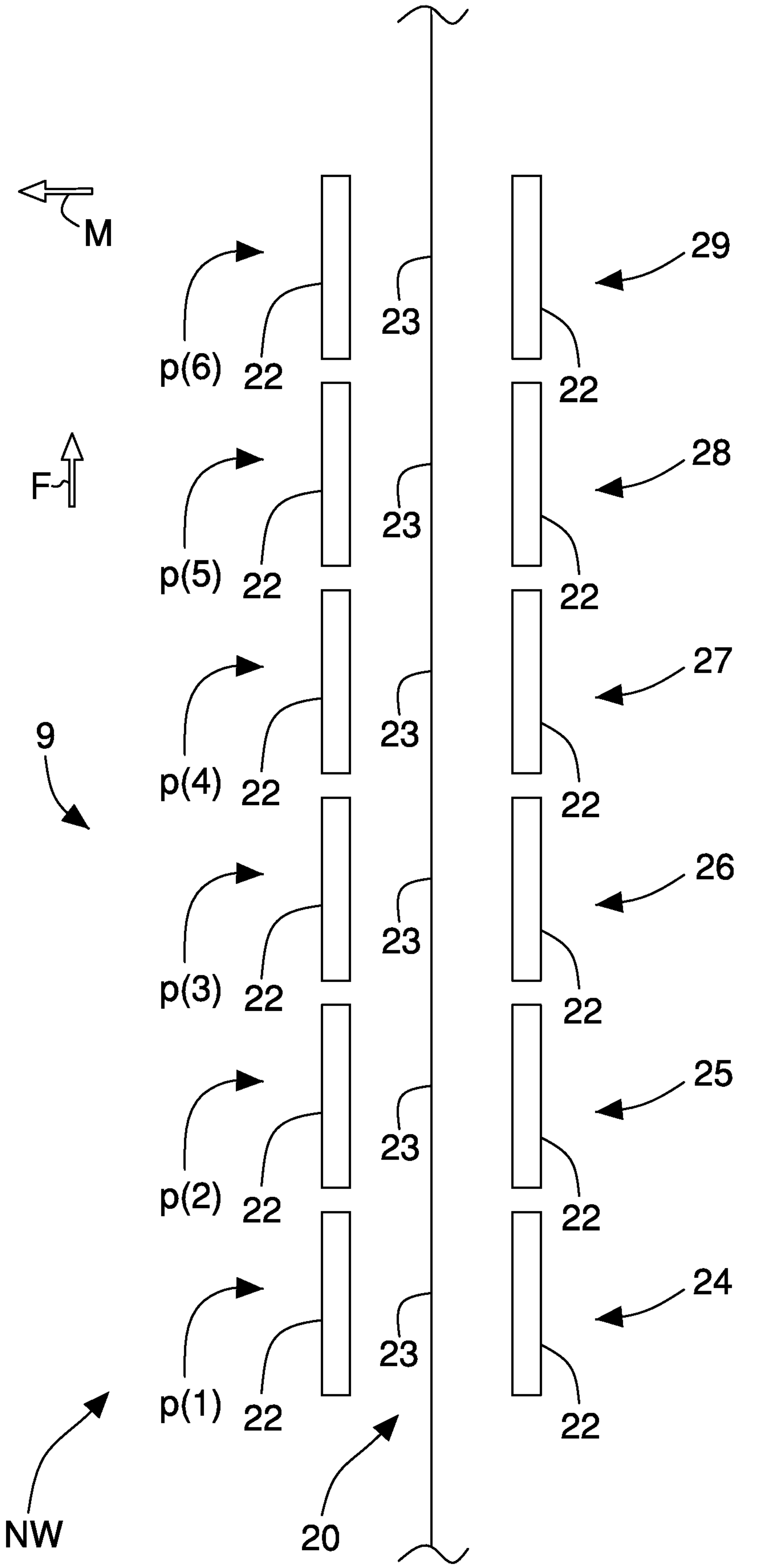

Fig. 6

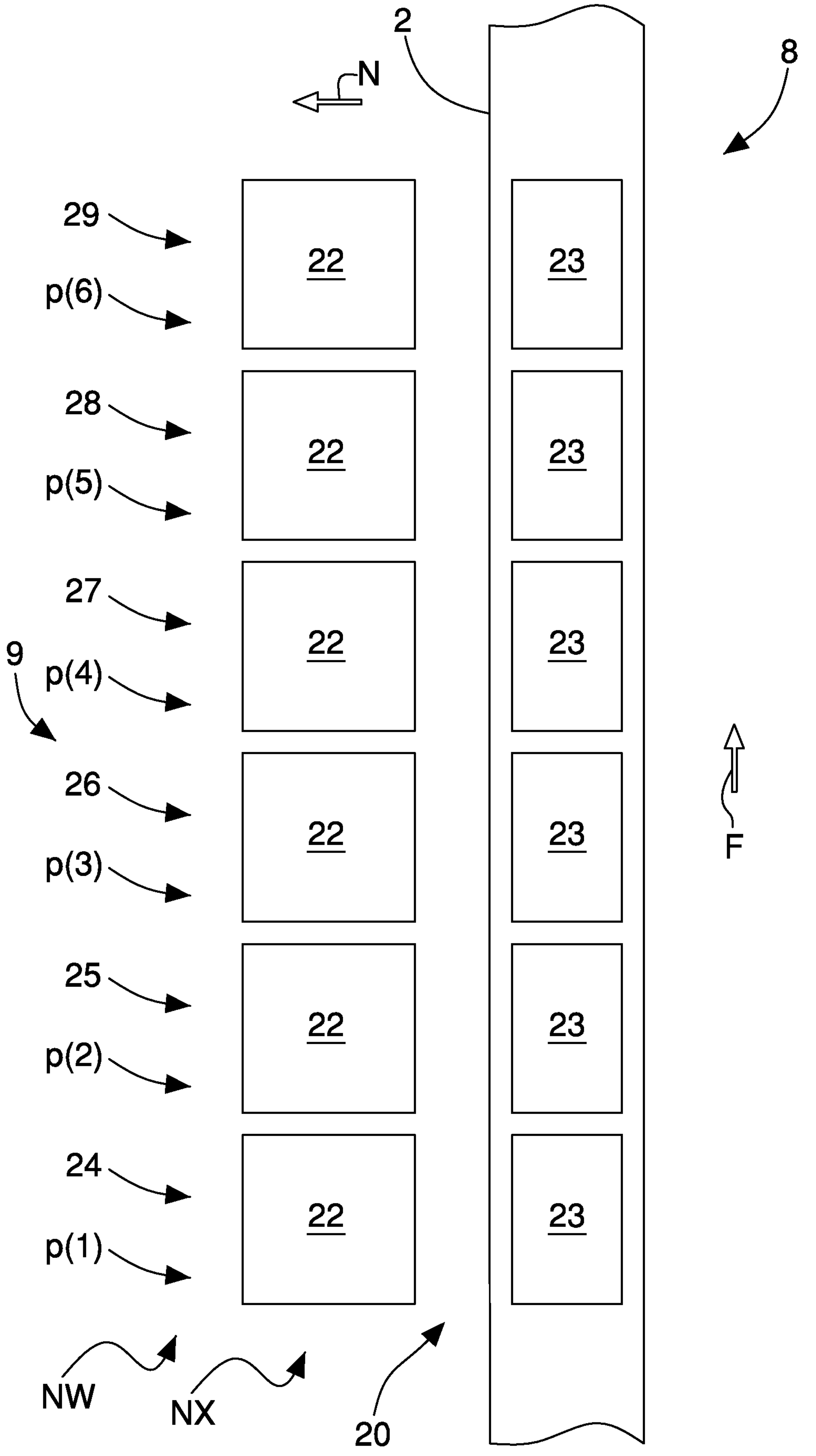

Fig. 7

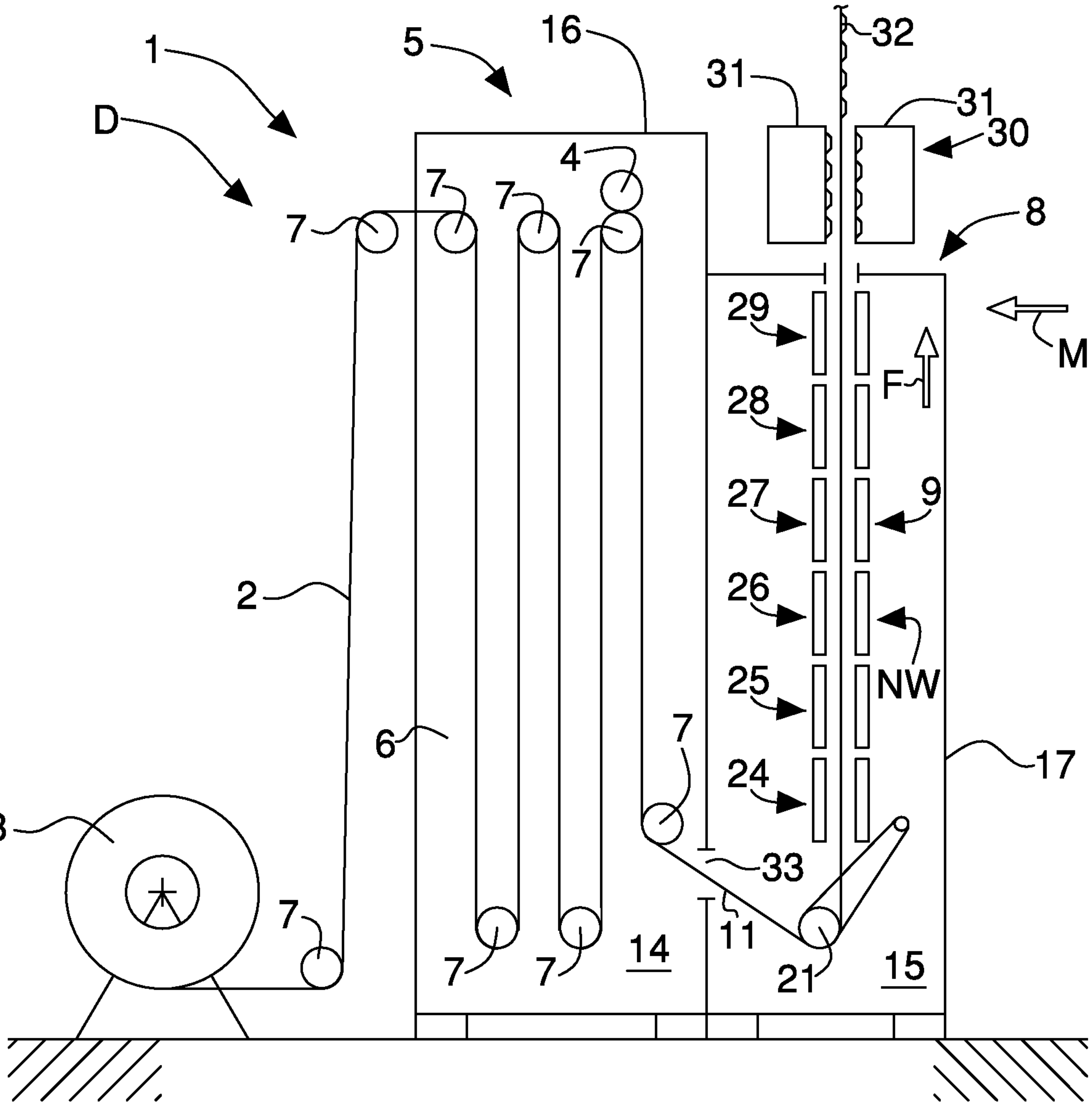
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Fig. 8

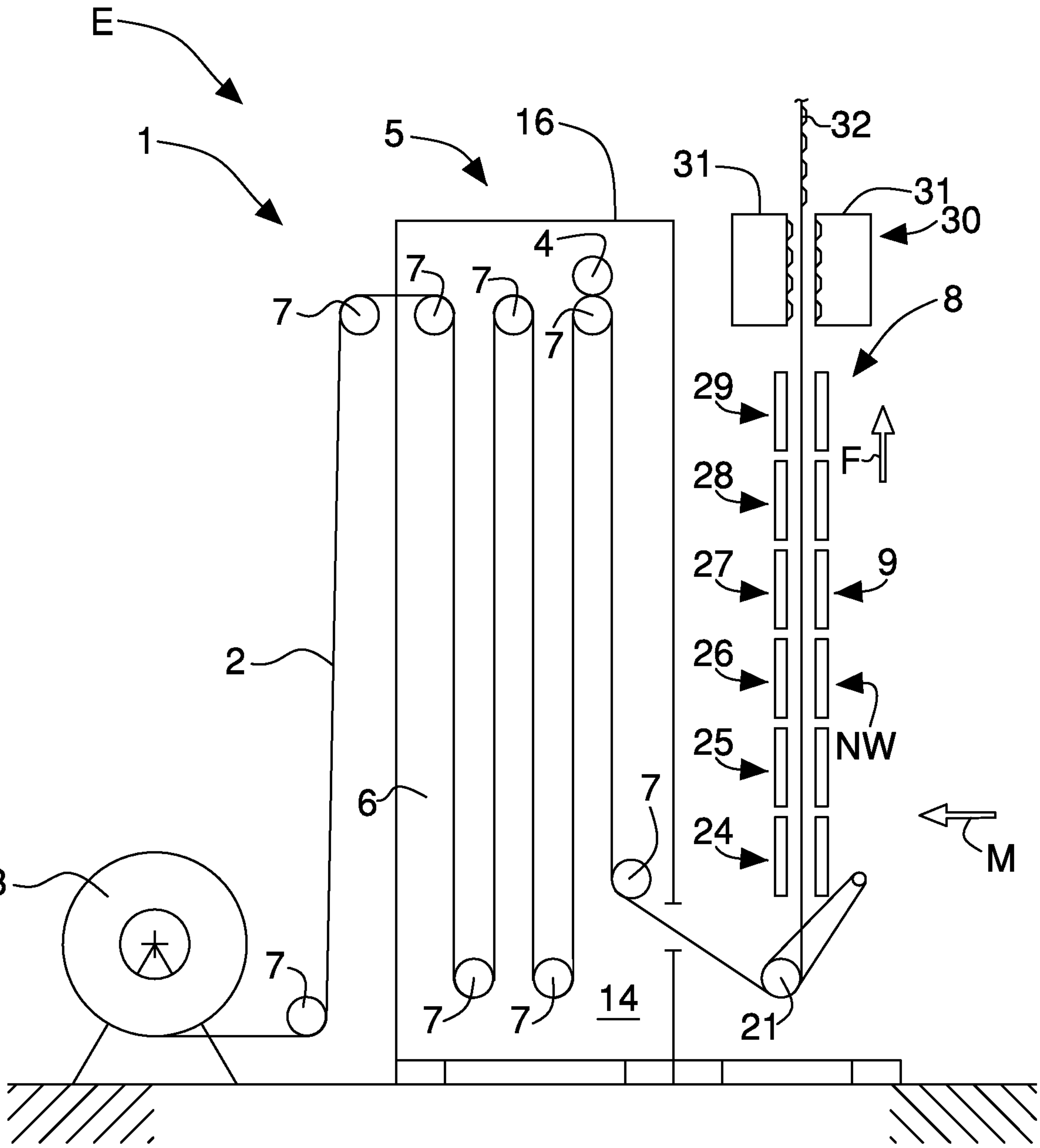


Fig. 9

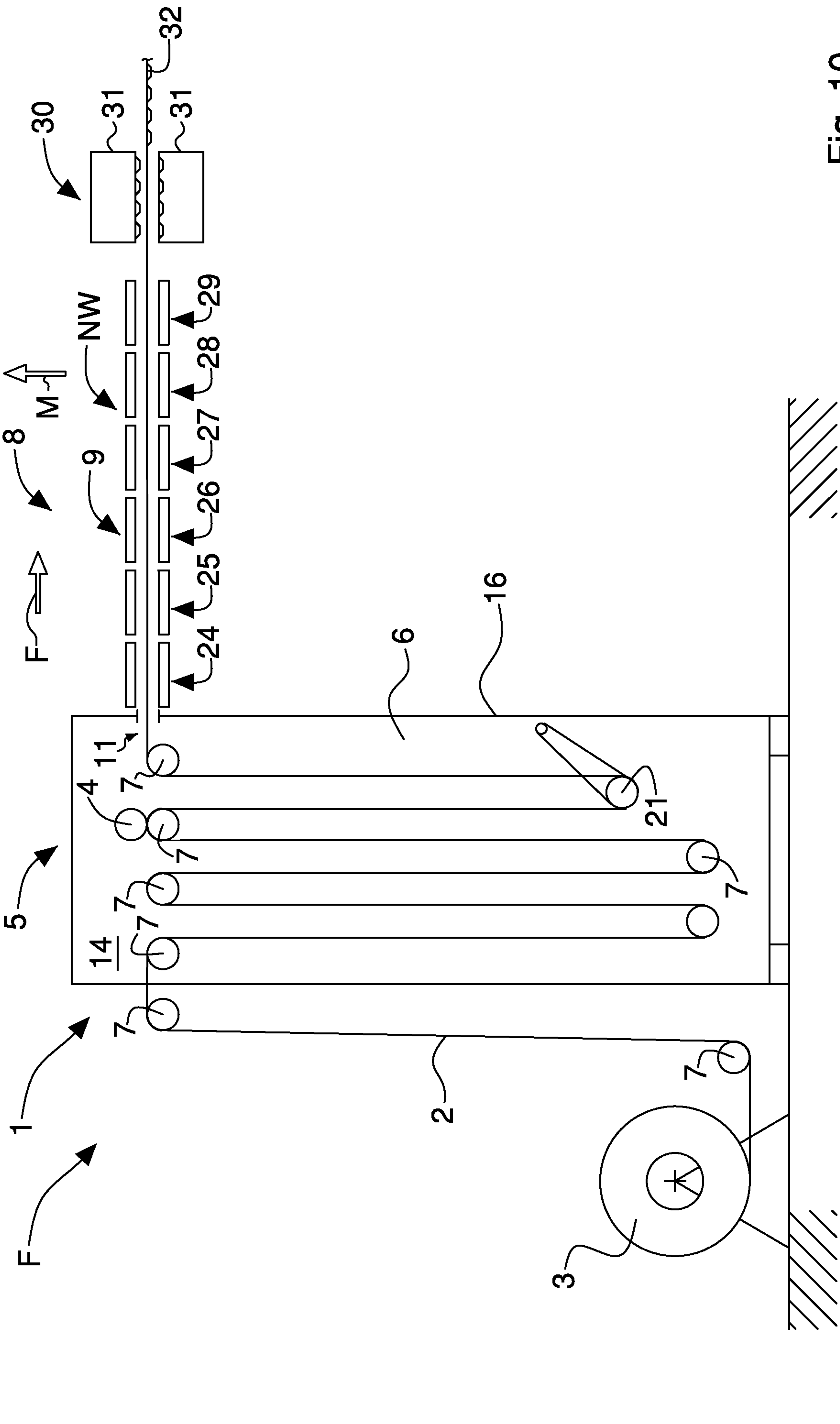


Fig. 10

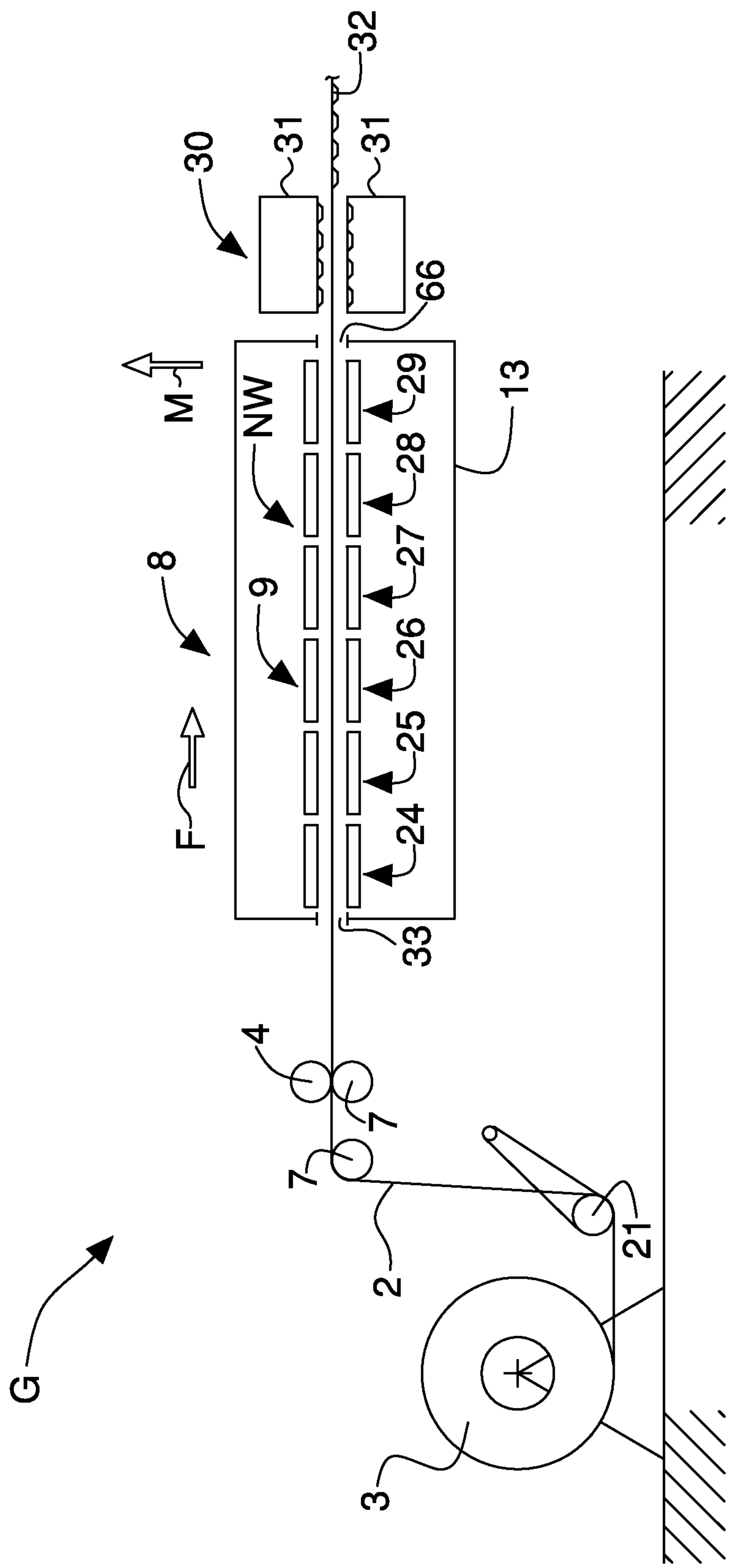


Fig. 11

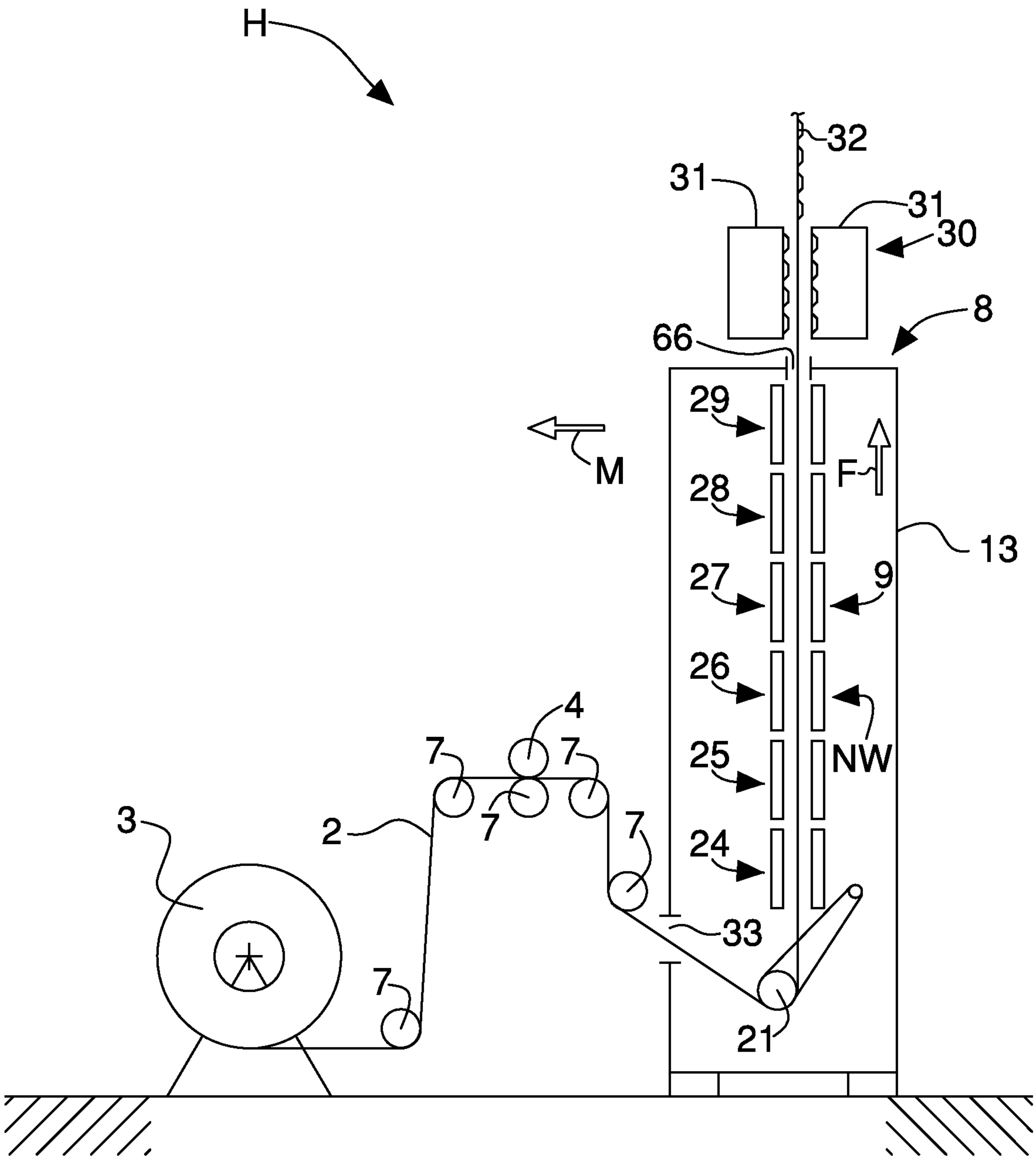
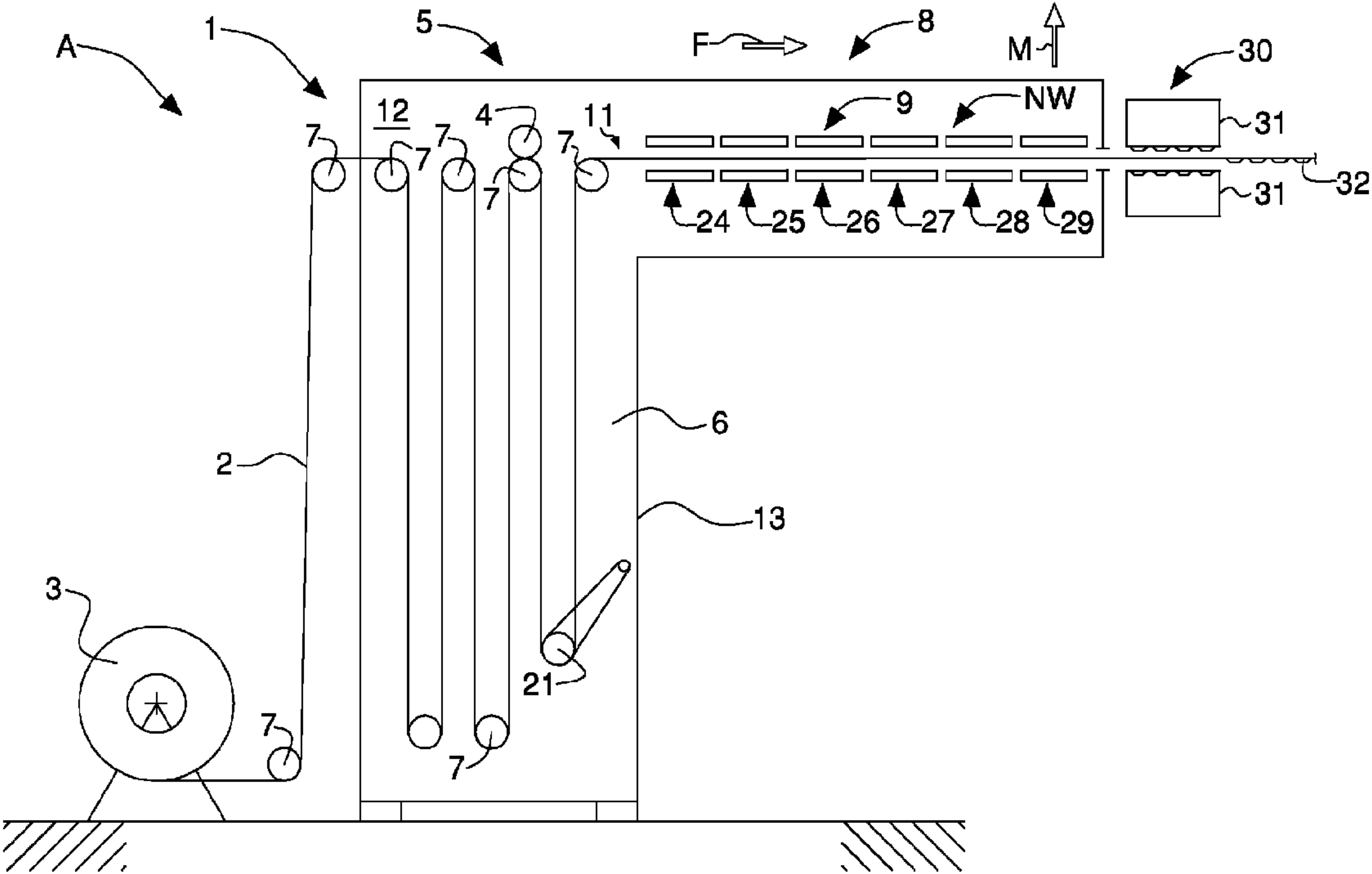


Fig. 12



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