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(54) Plastic film bonding machine with adhesive spreading devices.

(57) The invention relates to a plastic film bonding machine in which solventless adhesive is used.

The adhesive spreading devices comprise a pair of ground steel rollers which effect an initial rolling of the adhesive, a rubber-covered roller in contact with one of the said steel rollers and with a spreader roller, and pneumatic systems designed to keep the rubber roller pressed against the said rollers at a constant pressure whatever the roller rotation speed.

The machine also includes a stop element designed to limit the movements of the said rubber roller.

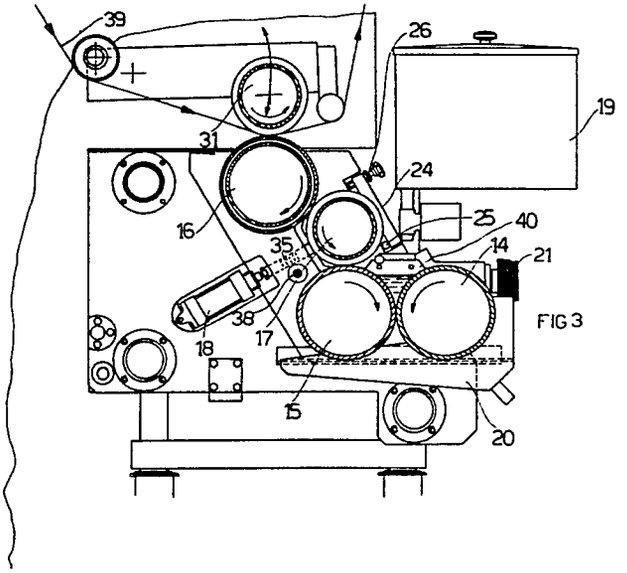

FIG 3

EP 0 324 892 A2

PLASTIC FILM BONDING MACHINE WITH IMPROVED ADHESIVE SPREADING DEVICES

This invention relates to a plastic film bonding machine using solventless adhesive.

The novelty of the machine lies in the adhesive spreading systems, which distribute the adhesive evenly and constantly at any machine operation speed.

Currently known plastic film bonding apparatus basically comprises film feed systems consisting of pay-out reels with suitable tensioning devices, systems designed to spread a layer of adhesive on one of the two sheets of film, bonded systems and film reeling systems.

This type of apparatus, an example of which is illustrated in Fig. 1, generally uses solvent-based adhesive.

In the apparatus illustrated a layer of plastic film is conveyed from pay-out reel 1, fitted with suitable tensioning devices 2, to station 3, where systems of a known type apply a layer of solvent with adhesive onto one side of the film.

The film next runs over roller unit 4 and is conveyed into furnace 5, where the solvent is evaporated.

From furnace 5 the first sheet of film is sent to bonding station 6, where it is bonded to a second sheet of film conveyed from pay-out reel 7, identical to reel 1.

The two bonded sheets of film are then reeled onto winding reel 8. Unfortunately, the solvents used for the adhesive are highly pollutant, with the result that their use is gradually declining, especially as pollution legislation is becoming increasingly strict.

In recent years, machines which bond plastic film with solventless adhesive have been introduced. However, while this system offers considerable advantages as it totally eliminates the pollution and danger involved in solvent use, it also presents numerous disadvantages, because the high viscosity of this type of adhesive makes it very difficult to spread the exact amount evenly on the film.

To give some idea of the difficulties which may be encountered, it is sufficient to note that the amount of adhesive used is approx. 0.8 - 1.5 grams per square metre of film, and that during spreading the film moves at high speed, often as fast as 5-6 metres per second.

The problem which the technical expert faces thus consists in designing systems which spread the exact amount of adhesive evenly and regularly while the film is moving.

Various systems have been devised for this purpose, but none of them wholly solves the problem.

For example, some known machines comprise a pair of counter-rotating rollers, one of which picks up the adhesive from a container; the adhesive sticks to the roller surface and is proportioned by adjusting the distance between the rollers.

However, this system is imprecise, especially when minimal amounts of adhesive have to be distributed on the surface of the film.

Other systems use a steel roller with a mechanically engraved surface containing a number of cells which fill with adhesive. A doctor blade placed in contact with the roller surface removes the excess adhesive, so that when the film comes into contact with the roller it only takes up the adhesive in the cells. Once again, this system is not wholly satisfactory, especially as the amount of adhesive applied depends on the size of the cells, so that the roller has to be replaced with one containing cells of different sizes whenever the amount of adhesive distributed on the surface unit is altered.

Other systems use a steel roller, partly immersed in the adhesive container and in contact with a rubber roller which, when pressed against the former, distributes the adhesive in a sufficiently thin layer.

Once again, this system does not entirely deal with the problem, as it does not guarantee consistent results under all machine operating conditions.

As the roller rotation speed increases, the external rubber layer tends to buckle, which alters the thickness of the layer of adhesive remaining on the roller, and therefore the amount of adhesive distributed per film surface unit.

In some machines the adhesive is passed between several pairs of rollers with decreasing clearances. The rollers are mounted on supports fitted with micrometer regulation devices, and the distance between each roller and the next is measured by comparators. This system, like those described above, does not satisfactorily meet the requirements of the case, as it is extremely complicated and it is particularly difficult to maintain the precision of the micrometer regulations when the machine gathers speed.

There is consequently a strongly felt need in the industry for systems which spread solventless adhesive evenly onto film moving at high speed and guarantee consistent results, especially at different film feed speeds.

This invention consequently proposes a plastic film bonding machine in which the spreading device consists of a pair of counter-rotating steel rollers which take up the adhesive, a rubber roller which is kept pressed at a constant pressure against one of the said rollers, and a spreader roller which picks up the adhesive from the said

rubber roller and applies it to the film.

Each of the various rollers moves at a higher speed than the preceding one in accordance with fixed ratios, to ensure the necessary adhesive distribution.

This invention will now be described in detail by way of example and not of limitation, with special reference to the annexed figures in which:

- Figure 2 contains a diagram of an apparatus in accordance with the invention
- Figure 3 shows a cross-section of the adhesive spreading systems
- Figure 4 shows a front view of the devices illustrated in Fig. 3
- Figs. 5 and 6 show a detail of the devices illustrated in Figs. 3 and 4.

In the apparatus according to the invention, a sheet of plastic film conveyed from pay-out reel 9 passes through adhesive spreading devices (assembly 10) and is then sent to bonding station 11, where it is bonded to a sheet of film conveyed from a second pay-out reel 12.

The bonded film is then reeled onto winding reel 13.

The spreading unit consists of a pair of heated chrome-plated steel counter-rotating rollers 14 and 15, chrome-plated steel spreader roller 16 and intermediate roller 17, which is kept pressed against rollers 15 and 16 by a pair of pneumatic pistons or similar 18.

Roller 17 is mounted on a support which allows it to float slightly in relation to adjacent rollers 15 and 16. The relative mechanisms are illustrated in Figs. 5 and 6.

Each end of the shaft of roller 17 is inserted into seating 22 in support element 23, which in turn runs in seating 32 in the shoulder of the machine.

Seating 22 is slightly larger than the shaft of roller 17, to allow a degree of shaft play.

Each support 23 is connected to rod 34 of piston 18. Rod 34 contains a toothed part 35 which engages the corresponding teeth of a gear 36, also fitted to shoulders 41 of the machine using bearings 37, for example. Shaft 38 connects gears 36, forcing them to rotate together. This causes supports 23 of roller 17 to move together, with the result that the roller axis always remains basically parallel to its original position except for the slight play referred to above. As a result, roller 17 is kept pressed against adjacent rollers 15 and 16 with constant elastic force due to the pressure to which pistons 18 are subjected, but is allowed to float slightly to compensate automatically for any play or dimensional variations in rollers 15 and 16.

Rollers 14, 15 and 16 are interconnected by reducers of a known type, such as the pulley and worm screw type, so that they rotate at differing speeds in a constant ratio.

Roller 15 rotates at a higher speed than roller 14, and roller 17 moves at a higher speed than the preceding rollers.

Roller 15 has a fixed shaft, while roller 14 is mounted on a support which enables the distance between it and roller 15 to be regulated.

These regulation systems are of known type, and are therefore not described in detail.

The machine also includes gravimeter 21 which returns roller 14 to its exact previous position whenever it has to be moved, with no need for remeasurement.

The clearance between rollers 14 and 15 is a few hundredths of a millimetre.

A heated adhesive tank 19 is fitted above these rollers, and a collector tray 20 is fitted below them.

Rollers 14, 15 and 16 are activated by independent motor 27 (Fig. 4) and the motion from pulleys 28 is transmitted to the roller shafts via Schmidt joints 29.

This system overcomes the problems due to the difference in size between the drive assemblies and the rollers, eliminating the need to use shafts with universal joints, which would considerably increase the size of the apparatus.

Spreader roller 16 is connected to the main motor of the machine via pulley 30.

A rubber idle presser roller 31 fitted above roller 16 keeps film 39 pressed against the spreader roller to transfer the adhesive. The width of rubber roller 17 is less than that of the film bonded; alternatively, the central part of the rubber roller has a greater diameter, but is still less wide than the film.

A pair of separator elements 40 consisting, for example, of walls made of teflon or similar material, is inserted between rollers 14 and 15. The shape of the separators is complementary to that of the rollers, and they can be slid along a pair of support guides.

The separators serve to delineate the width of the layer of glue picked up by the rollers.

This system is designed to ensure that the glue is not squeezed from the sides of the film and depsited on the roller surface as a result of the pressure exerted by roller 31 during bonding, as this would slow the roller speed and compromise the operation of the entire apparatus.

Spreader roller 16 and rubber presser roller 31 are wider than the film bonded.

As the surface of plastic film has a very low friction coefficient, roller 31 tends to skid slightly in relation to the upper film. If this is not prevented, the upper film would be fed through the machine at a slightly lower speed than the film below, producing a difference in tension between the two layers and causing the bonded film to roll up.

If, however, rollers 16 and 31 are wider than the film, they will advance at perfectly synchronized speeds due to the rubber/steel contact between the ends of the two rollers, thus ensuring that both layers of film are fed through the machine simultaneously. The machine operates as follows:

The apparatus is first set up by suitably regulating the clearance between steel rollers 14 and 15 and activating piston 18 to bring rubber roller 17 against rollers 15 and 16.

Screw 26, which constitutes an adjustable travel stop for support arm 24 of roller 17, is then regulated to distance the said roller slightly from the preceding ones.

Under these circumstances, screw 26 constitutes a stop which limits the movements of roller 17, preventing it from coming too close to rollers 15 and 16, and thus ensuring that it is not "sucked in" during movement due to buckling of the rubber layer.

Roller 17 is therefore kept pressed against rollers 15 and 16 with constant elastic force produced by the pressure applied to pneumatic cylinder 18, but is unable to come too close to them even when the rubber layer tends to buckle as the rotation speed increases, which would cause the drawbacks described above.

At this point the film is inserted between presser roller 31 and spreader roller 16, the heating of the steel rollers and the adhesive contained in tank 19 is switched on, and the machine can be started up.

The film conveyed from pay-out reel 9 passes between rollers 16 and 31 and is then sent to bonding station 11.

Devices of known type pick up a quantity of adhesive from tank 19 and drop it into the space between rollers 14 and 15 and separators 40.

A thin layer of this adhesive, depending on the clearance between the said rollers, adheres to roller 15 and is distributed over its surface, partly because this roller rotates faster than the preceding one.

The layer of adhesive is picked up by roller 17, which deposits it on spreader roller 16.

As mentioned, each of these rollers rotates faster than the preceding one, with the result that the layer of adhesive is distributed more and more thinly.

On the basis of a few tests, an expert in the field can easily determine the ideal clearance between rollers 14 and 15 and the ratio between the speeds of rollers 14, 15 and 17 and spreader roller 16, depending on the type of adhesive and the type of film used.

For example, if polypropylene film is fed through the machine at a speed of 4.2 metres per second and an adhesive such as ADCOTE (Comochem trademark) is used, the clearance between rollers 14 and 15 is eight-hundredths of a millimetre, the ratios between the speeds of rollers 14, 15 and 16 are 1:80:100 with roller 14 rotating at a surface speed of approx. 10 cm per sec., and the spreader roller moves at the speed of 4.5 m/sec.

The machine also contains devices of known type which synchronise the speed of secondary motor 27 with that of the main motor of the machine so as to maintain a constant ratio between the speed of roller 16 and the speeds of the remaining rollers.

An expert could easily devise numerous modifications and variations, which should be deemed to be comprised in this invention.

Claims

1. Plastic film bonding machine characterised by the fact that it contains adhesive spreading systems comprising:
- a pair of proportioning rollers designed to take up the adhesive in the form of a thin layer of constant thickness
- a spreader roller designed to apply the adhesive to one side of the film as it is fed through the machine
- an intermediate roller designated to take up the adhesive from the said proportioning rollers and spread it on the said spreader roller
each of the said rollers rotating at a higher speed than the preceding one, and the spreader roller having a surface speed equal to the film feeding speed.

2. Apparatus in accordance with claim 1, characterised by the fact that it contains presser systems designed to keep the said intermediate roller pressed against the proportioning and spreader rollers at a constant pressure, and includes travel stop systems designed to limit the movements of the said intermediate roller so as to prevent it from coming too close to the remaining rollers.

3. Apparatus in accordance with claim 2, in which the said presser systems consist of a pair of pneumatic pistons whose rods are connected to the shaft of the said intermediate roller.

4. Apparatus in accordance with claim 2, characterised by the fact that the said intermediate roller 17 is mounted on supports designed to allow it to float slightly in relation to adjacent rollers 15 and 16.

5. Apparatus in accordance with the above claims, characterised by the fact that the porportioning rollers and the spreader roller are heated and made of chrome-plated steel, and the intermediate roller is covered with rubber.

6. Apparatus in accordance with one of the previous claims, characterised by the fact that it uses Schmidt joints to transmit motion to the proportioning and spreader rollers.

7. Apparatus in accordance with claims 1 and 2, characterised by the fact that the width of the said intermediate roller is less than that of the film bonded.

8. Apparatus in accordance with claim 1, characterised by the fact that the spreader roller is wider than the film bonded, and a rubber idle presser roller, also wider than the film bonded, is fitted in contact with the said spreader roller.

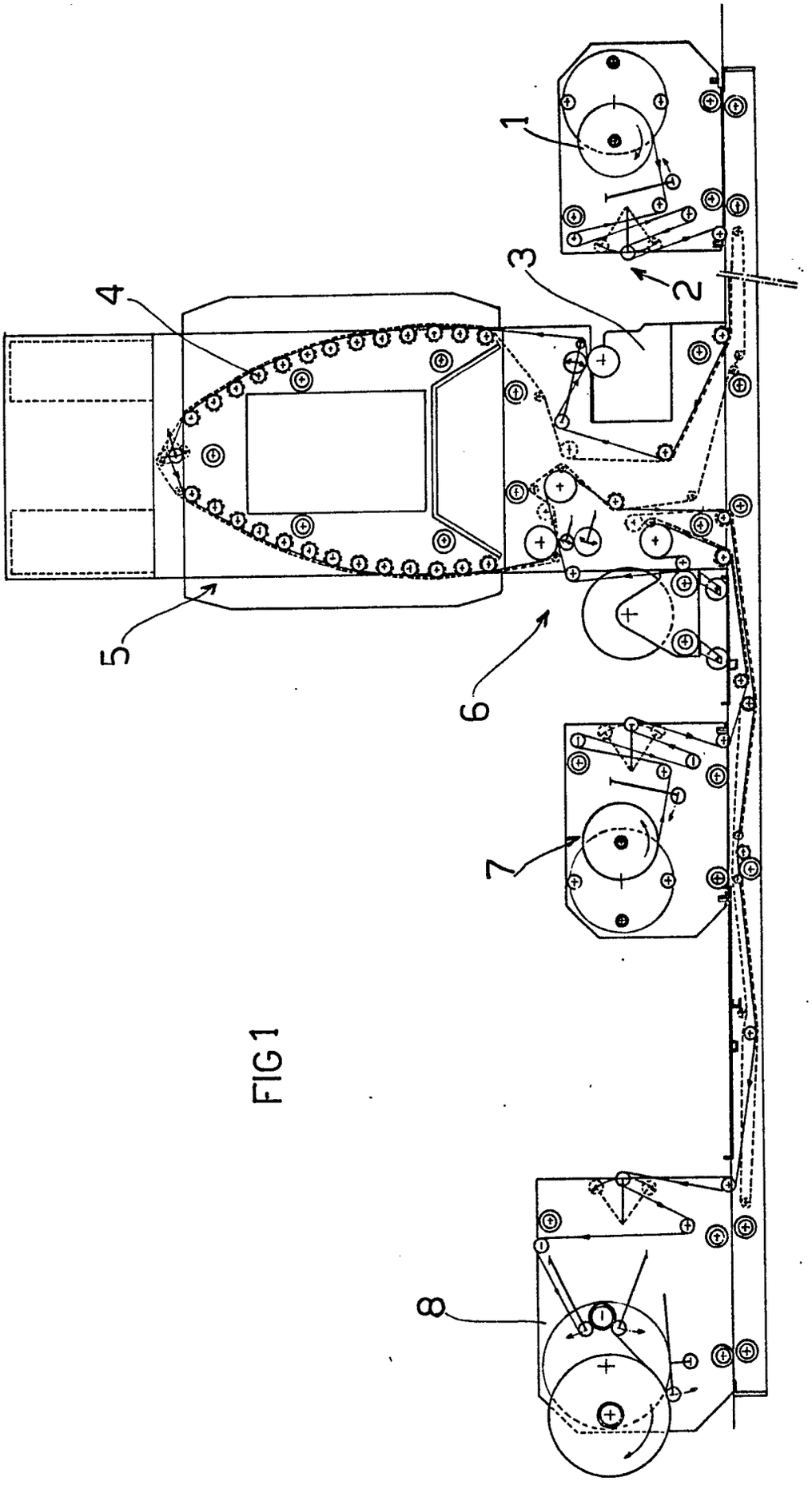

FIG1

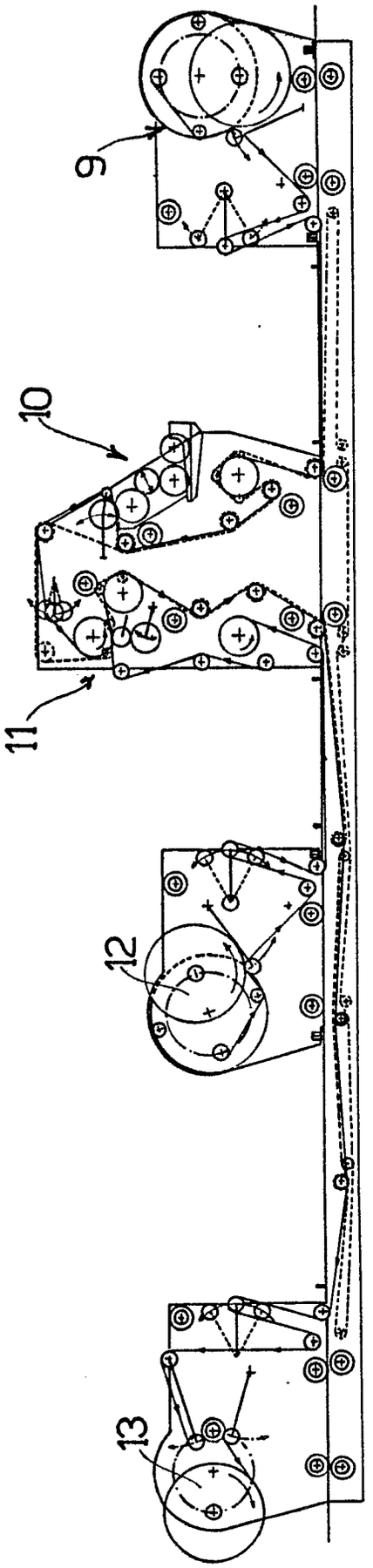

FIG 2

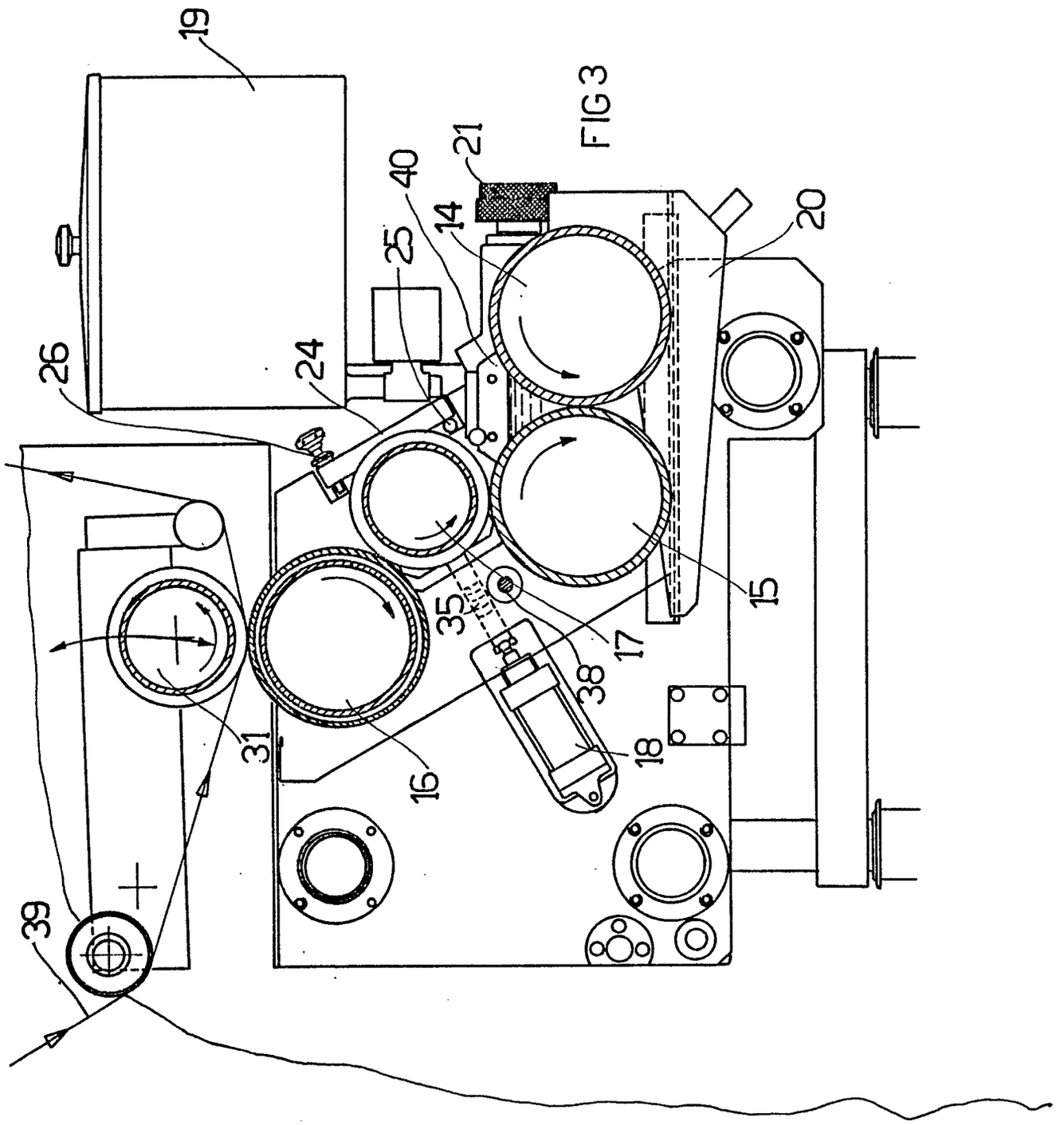

FIG 3

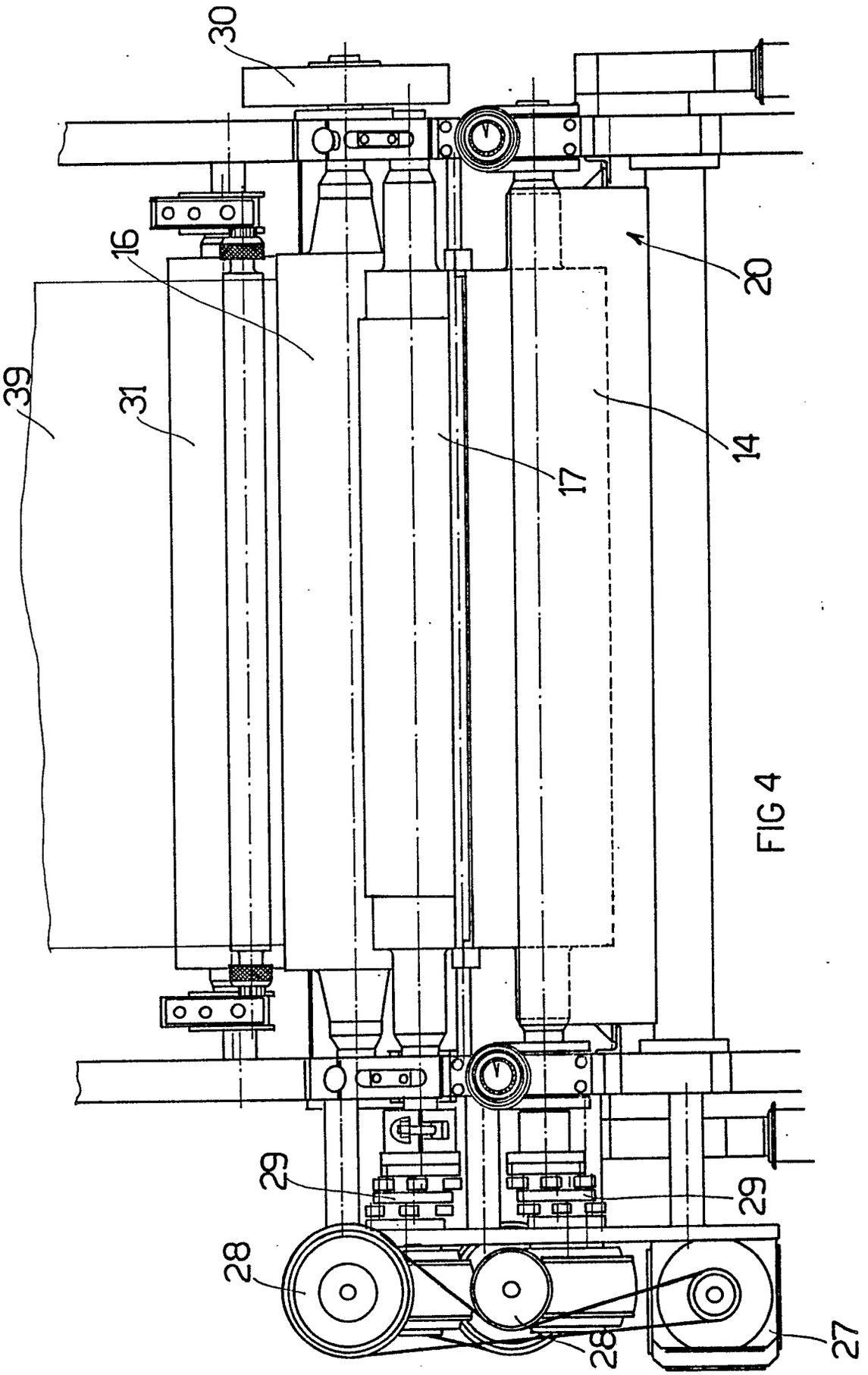

FIG 4

FIG 5

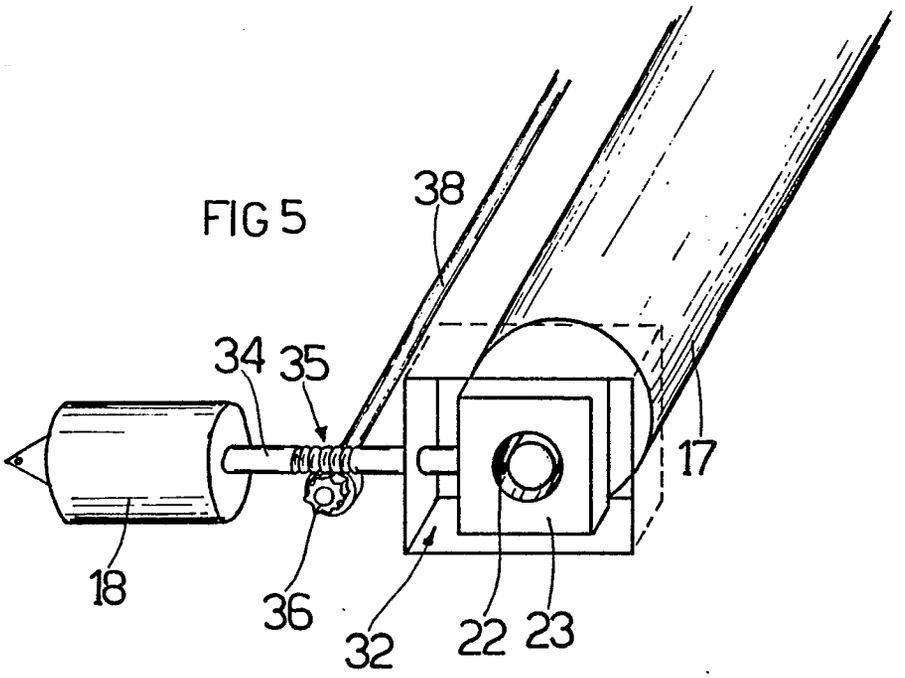

FIG 6