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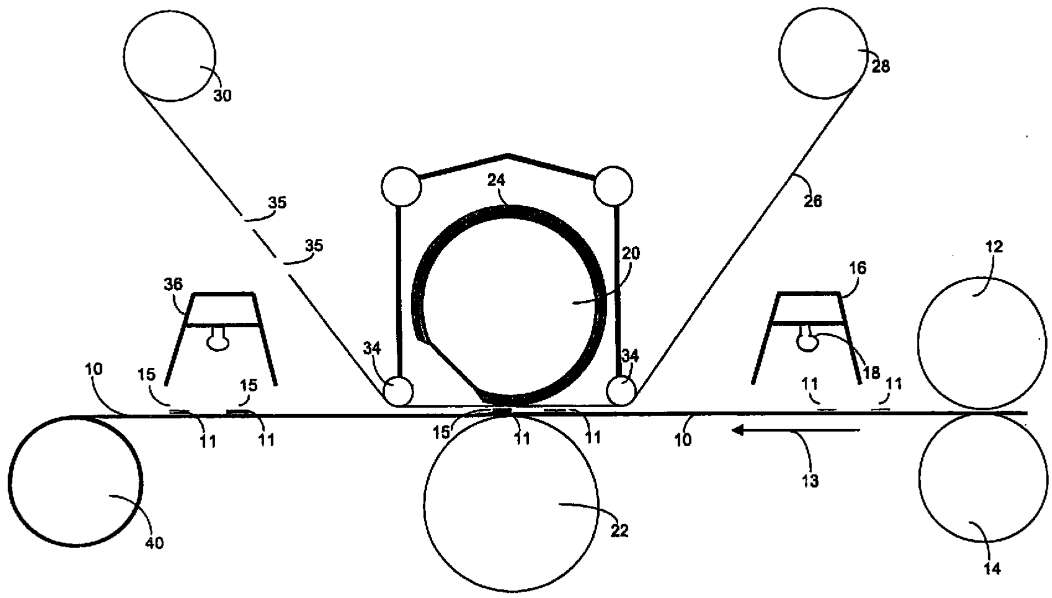
**(54) Title:** COLD FOIL STAMPING




**(57) Abstract:** Sheets (10) to which foil is to be applied are printed with an adhesive pattern corresponding to the area where foil is to be applied. This pritning takes place between rolls (12, 14). The adhesive (11) stays wet and non-tacky until activated by, for example, ultra-violet light. The adhesive (11) stays wet and non-tacky until activated by, for example, ultra-violet light. The adhesive coated substrate moves through a first UV station (16) where adhesive activation is started and then through a nip (20, 22) where a foil web (26) is pressed against the now tacky adhesive. Foil is transferred from the foil web (26) to the sheets (10). After leaving the nip, the substrate and the applied foil move through a second UV station (36) where adhesive cure is completed.

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*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

# Cold Foil Stamping

This invention relates to cold foil stamping, ie the application of a decorative foil to a substrate. The foil could be metallic, it could be holographic or it could be any other type of foil suitable for application to a substrate through the process to be described in this specification.

Both hot and cold foil stamping are known processes. In hot foil stamping, the foil is manufactured with a heat and pressure sensitive adhesive on one face, and a shaped and heated die presses the foil into contact with the substrate whereupon the adhesive is activated and the foil adheres to the substrate over an area corresponding to the shape of the die. In hot foiling, the transfer of foil to the substrate is limited by the time taken for the heat of the die to transfer through the carrier and foil layers activating in turn the release layer and the adhesive. The faster the process, the more die temperature is needed to allow the foil to transfer. Most foils have a window of operating temperature within which the foil will activate and transfer. At temperatures below this window, the release layer will not separate and the adhesive will not become tacky resulting in no transfer. Above the window the release layer may activate as may the adhesive but the transfer will be spoilt by over temperature damage to those and other layers in the foil. Transfer may be achieved but the finished result will show heat burn marks in the foil, creasing and gassing streaks.

Depending on which foil is to be applied, the speed of application is limited by complications that arise when using die temperatures above the normal operating window.

In cold foil stamping, the adhesive is applied first to the substrate over an area corresponding to the area where foil is to be applied. The adhesive can be a liquid or a viscous fluid or gel which can be applied by a printing process and can be of a type which remains wet (ie inert or not tacky) until activated. When foil application is to begin, the adhesive is activated (eg by exposure to UV light) and the foil is pressed against the substrate so that it adheres to the areas printed with adhesive but does not adhere elsewhere.

Cold foil stamping has one particular advantage over hot foil stamping; it can achieve better adhesion of the foil to the substrate at high throughput rate. As no heat is applied to the substrate, there are less limitations on the nature of the substrate to which foil can be applied.

Cold foiling uses the tack effect of part cured adhesive combined with chemical compatibility of the foil and adhesive to effect the transfer.

When the correct combination of foil and adhesive are used, the speed of transfer has little effect on quality of the finished product.

According to the invention, there is provided a method of applying foil from a foil web to a substrate, the method comprising the steps of printing the substrate with a curable adhesive in the areas to which foil is to be applied, subjecting the substrate to a first adhesive activation stage in which the adhesive is partially activated, passing the substrate and a foil web through a nip where the foil is pressed against the partially activated adhesive, separating the foil web from the substrate after leaving the nip and subjecting the substrate to a second adhesive activation stage to fully cure the adhesive.

The level of UV exposure in the first stage is preferably less than that in the second stage.

The adhesive can be either a cationic application system or a free radical application system.

The substrate can be in the form of discrete sheets or a continuous web.

The adhesive is preferably printed on the substrate using a lithographic printing process, although a flexographic printing process can alternatively be used, particularly if the press is web-fed rather than sheet-fed.

The substrate can be embossed in the nip, at the same time as foil is applied to the substrate. The embossing may be wholly within the plane of the substrate (micro-embossing) or may distort the embossed part of the substrate out of the initial plane of the substrate. The embossing can take place on the area of the substrate being foiled, or on an area of the substrate immediately adjoining an area to which foil is being applied.

The invention also provides apparatus for applying foil from a foil web to a substrate, the apparatus comprising a printing station for printing the substrate with a curable adhesive in the areas to which foil is to be applied, a first adhesive activation station in which the adhesive on the substrate is initially partially activated, a second adhesive activation station in which the adhesive on the substrate is activated again to complete adhesive cure, and a nip between the first and second adhesive activation stations in which foil can be pressed against the partially activated adhesive, means for transporting the substrate from the printing station, past the first adhesive activation station, through the nip and past the second adhesive activation station and foil transport means for feeding foil to and from the nip.

The adhesive is preferably activated by exposure to ultra-violet light, and the activation stations preferably include a source of ultra-violet light.

The apparatus can be based on a conventional two colour printing press or two impression units of a multicolour press, with the adhesive being printed in one stage and the foil being applied in the nip of the second stage. The press can be either web fed or sheet fed.

By splitting the adhesive activation process into two, many advantages are obtained.

The invention will now be further described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 shows a schematic diagram of a first foiling apparatus according to the invention;

Figure 2 shows a schematic diagram of a second foiling apparatus according to the invention;

Figure 3 shows a schematic diagram of a third foiling apparatus according to the invention;

Figure 4 shows a schematic diagram of a fourth foiling apparatus according to the invention; and

Figure 5 illustrates a process in which flat foiling and embossing are combined as separate processes in the same operation.

Figures 1 to 4 each show a press which is in principle very similar to a conventional sheet fed two colour printing press.

Figure 1 shows an apparatus which is web-fed. The web 10 is unwound from a reel (not shown) and is passed through a first set of cylinders 12,14 where adhesive is printed on the web, in a pattern corresponding to the areas where foil is to be applied. The adhesive used is a conventional cold-foiling adhesive which remains wet and non-tacky until activated by exposure to ultra-violet light. In the drawing, the adhesive is indicated schematically at 11. From the printing station 12,14 the sheets travel in the direction of the arrow 13 to a first UV activation stage at 16, where the sheets 10 pass under a UV lamp 18.

The printing process used to apply the adhesive in the printing station 12,14 can be any known process. However the use of the lithographic offset process allows good control of the thickness of the adhesive coating which plays a key part in controlling the quality of the finished product. Flexographic printing is also possible but the quality is generally not so fine as with lithography.

Next, the sheets are passed through a nip between two cylinders 20 and 22. The cylinder 20 is a steel impression cylinder coated with a compressible layer 24 which covers part or all of the useable circumference of the cylinder and the cylinder 22 is a plain steel cylinder either with or without a suitable material coating.

A foil web 26 is also passed through the nip 20,22. The foil web consists of a carrier layer and a foil layer. In the foiling process, parts 15 of the foil layer are transferred from the foil web to the web 10 in the areas where the substrate design calls for foil to be applied. The carrier layer is, and remains, continuous. The web 26 passes from a foil unwind reel 28 to a foil rewind reel 30. It passes around guide rollers 34 and through the nip 20,22. In Figure 1, the areas of the foil web from which foil has been transferred are shown at 35. Of course the foil web will still be continuous because the foil carrier layer (which is not shown separately in the figures) will still be present.

For the sake of clarity, the cylinders 20 and 22 are shown out of contact. In fact they will press against one another and against the foil and the web 10.

In the nip, the foil layer of the foil web 26 is pressed against the surface of the sheet which carries the (now tacky) adhesive and foil adheres to the sheet wherever adhesive is present. The foil transferred to the sheet is indicated schematically at 15. For example, the area to be foiled could be a crest in the middle of each sheet, or in several places on the sheet. The shape of the crest will have been printed in adhesive by the cylinders 12,14 and a crest shaped area of foil will then be transferred from the foil web to the sheet.

At this stage, the tackiness of the adhesive should be just sufficient to ensure complete transfer of the foil to the sheet in the adhesive printed area.

The foil web leaves the nip and is wound up on the rewind reel 30.

The web 10 then passes beneath a second UV station 36 with a lamp 38. This lamp supplies sufficient energy to ensure that the adhesive is fully cured, before the web is wound up on a rewind reel 40.

Figure 2 shows an apparatus essentially the same as that in Figure 1, except that in this case the apparatus is sheet fed, with the sheets being shown at 110. The apparatus will be set up in a known manner to handle sheet fed stock. The finished sheets are collected on a stack 140.

Figures 3 and 4 show sheet-fed apparatus with facilities for flat foiling with or without micro-embossing (Figure 3) and foil embossing (Figure 4) as well as the ability to allow foil stepping through foil accumulators 32 (for example as described in British Patent 2 254 586). Although shown as separate processes, blind embossing, foil embossing flat foiling with or without micro-embossing can be processed in any combination all in the same pass. Parts of the apparatus which are the same as those shown in Figures 1 and 2 carry the same reference numerals.

In Figure 3, the upper impression cylinder 224 is steel and carries one or more dies 200 and 201. The opposing cylinder 222 may be plain or coated with a compressible material. The die 200 has to register with the adhesive printed areas 11 and because the die has a relief pattern on its surface, it embosses that pattern into the surface of the foil, at the same time as that foil 15 is picked up by and adhered to the tacky adhesive 11. The embossing (so-called micro-embossing) lies wholly within the plane of the sheet 110, ie the non-foiled side of the sheet is not substantially distorted by the existence of the embossing on the opposite face of the sheet. The special compressible coating on the impression cylinder 222 helps to ensure that this condition is achieved.

For optimum foil usage, the foil web should be able to travel at different speeds and in different directions to the sheets or web to which foil is to be applied. It is desirable to apply as much as possible of the foil from the foil web to the sheets. If, for example, each sheet is to have two crests applied to it spaced apart in the direction of travel by 10 times the size of the crest, then if the foil was travelling at the same speed as the sheets, the area of foil between the crests would never be applied to a sheet and would be wound up on the rewind reel with the carrier layer.

Foil transport mechanisms are therefore known which allow the foil to be wound backwards or forwards between each stamping, so that an unused part of the foil web will register with that part of the next sheet which has been printed with adhesive and which is to have foil applied to it. It is possible for the foil to be registered with the substrate. This is necessary for example with a registered image hologram foil, where the correct hologram image has to be precisely placed in a desired position relative to printed images on a substrate.

Figures 3 and 4 show apparatus equipped with foil web control devices. Foil accumulators as described in our British patent 2 254 586 are shown at 32. Other foil control devices (of a type known per se) are shown at 33.

To enable optimum use of foil, the foil web 26 has to be capable of moving in both directions, ie sometimes the foil unwind reel 28 may act as an unwind reel and sometimes as a rewind reel, and sometimes the foil rewind reel 30 may act as a rewind reel and sometimes as an unwind reel. The accumulators 32 ensure that tension is kept in the foil web 26 at all times, whilst the movement of the foil web is being controlled. Within the nip 222,224 the situation will arise where, between impressions, the sheets 110 are moving in one direction through the nip and the foil web 26 is moving in the opposite direction. However when a die 200 is in position to make an impression, the foil web and the sheets will be moving in the same direction, at the same speed.

Figure 4 shows an embodiment similar to that of Figure 3. However in this case the cylinders 322 and 324 are set up for foil embossing of the sheets 110. Both cylinders are steel. The cylinder 324 carries embossing dies 300 and the cylinder 322 carries the corresponding counter-die 301 so that the sheets 10 can be foiled and embossed at the same time and in the same area. This embossing displaces the plane of the substrate, so that the existence of the embossing is evident on both sides of the sheet 110.

This embossing can be carried out in the specific areas where foil 15 has been applied to printed adhesive areas 11. The embossing can also be carried out (see Figure 5) in very close proximity to the area being foiled. When using hot foil stamping technology it is not possible to blind emboss a sheet in very close proximity to the area being foiled. If one were to attempt hot foil stamping and embossing in this way the foil layer would contact the embossing area and foil would be transferred to the embossed area of the paper. When the areas to be foiled and embossed are in the shape of a border then this process becomes impossible to achieve in one pass of the machine. Embossing is generally done at temperatures around 40°C and therefore can't be done next to a hot foil stamping die at 120°C.

Many products such as greetings cards and wine labels are therefore produced in two separate processes first foiled and then embossed.

When the cold foiling process is used embossing and foiling can be done in one pass as there is no heat to cause foil to transfer to the embossed area. As a result, using cold foil stamping, it is possible to produce the effect shown in Figure 5, where a substrate 410 is foiled in one area 400 and embossed in a directly adjacent area or areas 402. Both the foiling and the embossing can be done with a single (combined foil and embossing) die 404 In this figure, the foil is shown at 406.

Separating the adhesive activation into two stages as shown has three distinct advantages; firstly it reduces the amount of UV radiation which is needed, and therefore reduces costs. Secondly it makes it much more likely that the adhesive will be fully cured at the end of the process. This applies to both cationic and free radical systems (see below). Thirdly, it allows a full range of foil indexing (ie stepwise movement of the foil through the nip) which avoids unnecessary foil wastage.

Adhesives used for cold foil stamping can be divided into two classes, known as 'free radical' and 'cationic'. These names which are well known to the skilled man refer to the manner in which they cure. Both can be cured by exposure to UV light.

Free radical adhesives require continuous exposure to UV light until the cure is complete; if the UV light is taken away before cure is complete, the adhesive will never fully cure. A problem therefore is to ensure that curing is complete, and the conventional solution is to expose the adhesive to an excess of UV light. Conventional cold foil stamping processes using free radical adhesives position the UV lamp(s) downstream of the nip and in an area where the foil web and the substrate are in contact, so that the adhesive is exposed to UV light before the foil and the substrate are separated.

Cationic adhesives cure to completion once activation has been started. The problem with these adhesives is to control the time before complete cure, and to ensure that the adhesive is tacky at the time when the foil and the substrate are brought into contact. This requires careful control of process speed. Conventional cold foil stamping processes using cationic adhesives position the UV lamp(s) upstream of the nip, to make the adhesive tacky before the foil and the substrate meet in the nip. The speed of the process and the power of the UV light are ideally set so that the adhesive achieves its maximum tackiness in the nip, and on leaving the nip, adhesive cure continues without further energy input. This process greatly reduces the risk of the adhesive remaining tacky once the foiled sheets are stacked, and thus reduces the risk of the sheets sticking to one another in the stack.

The apparatus shown here can be used with either free radical or cationic adhesives.

In the case of free radical adhesives, the first stage UV exposure is direct to the adhesive. The second stage is to the substrate with foil adhered to the adhesive, ie not normally through the foil web. Sufficient tackiness is produced in the first stage to allow a relatively long time period between first and second stages which allows economical use of foil.

The energy level of the first UV station, and the time for which the adhesive is exposed here to UV radiation will be selected just to make the adhesive tacky, but not to complete the cure of the adhesive.

In the case of cationic adhesives, the process of the invention allows the initial UV exposure to initiate a relatively slow cure, leading to a wide time window during which the adhesive remains tacky, followed by a rapid post cure.

Claims

1. A method of applying foil from a foil web to a substrate, the method comprising the steps of printing the substrate with a curable adhesive in the areas to which foil is to be applied, subjecting the substrate to a first adhesive activation stage in which the adhesive is partially activated, passing the substrate and a foil web through a nip where the foil is pressed against the partially activated adhesive, separating the foil web from the substrate after leaving the nip and subjecting the substrate to a second adhesive activation stage to fully cure the adhesive.

2. A method as claimed in Claim 1, wherein at least one of the adhesive activation stages uses ultra-violet light as activator.

3. A method as claimed in Claim 2, wherein the level of UV exposure in the first stage is less than that in the second stage.

4. A method as claimed in any preceding claim, wherein the adhesive is a cationic adhesive curing system.

5. A method as claimed in any one of Claims 1 to 3, wherein the adhesive is a free radical adhesive curing system.

6. A method as claimed in any preceding claim, wherein the substrate is in the form of discrete sheets.

7. A method as claimed in any one of Claims 1 to 5, wherein the substrate is a continuous web.

8. A method as claimed in any preceding claim, wherein the substrate is embossed in the nip, at the same time as foil is applied to the substrate.

9. A method as claimed in Claim 8, wherein the embossing is wholly within the plane of the substrate.

10. A method as claimed in Claim 8, wherein the embossing distorts the embossed part of the substrate out of the initial plane of the substrate.

11. A method as claimed in any one of Claims 8 to 10, wherein the embossing takes place on an area of the substrate immediately adjoining an area to which foil is being applied.

12. Apparatus for applying foil from a foil web to a substrate, the apparatus comprising a printing station for printing the substrate with a curable adhesive in the areas to which foil is to be applied, a first adhesive activation station in which the adhesive on the substrate is initially partially activated, a second adhesive activation station in which the adhesive on the substrate is activated again to complete adhesive cure, and a nip between the first and second adhesive activation stations in which foil can be pressed against the partially activated adhesive, means for transporting the substrate from the printing station, past the first adhesive activation station, through the nip and past the second

adhesive activation station and foil transport means for feeding foil to and from the nip.

13. Apparatus as claimed in Claim 12, wherein the adhesive activation stations include a source of ultra-violet light.

14. Apparatus as claimed in Claim 12 or Claim 13, wherein the substrate transporting means comprises a sheet fed printing press.

15. Apparatus as claimed in Claim 12 or Claim 13, wherein the substrate transporting means comprises a web fed printing press.

16. Apparatus as claimed in any one of Claims 12 to 15, wherein the printing station is a lithographic printing station.

17. Apparatus as claimed in any one of Claims 12 to 16, wherein the nip is formed between two cylinders, at least one of which carries an embossing die to emboss the substrate.

18. Apparatus as claimed in Claim 17, wherein the embossing die is arranged to emboss an area of the substrate to which foil is to be applied.

19. Apparatus as claimed in Claim 17, wherein the embossing die is arranged to emboss an area of the substrate immediately adjacent to an area to which foil is to be applied.

20. Apparatus for applying foil from a foil web to a substrate substantially as herein described with reference to the accompanying drawing.

21. A method of applying foil from a foil web to a substrate substantially as herein described with reference to the accompanying drawing.

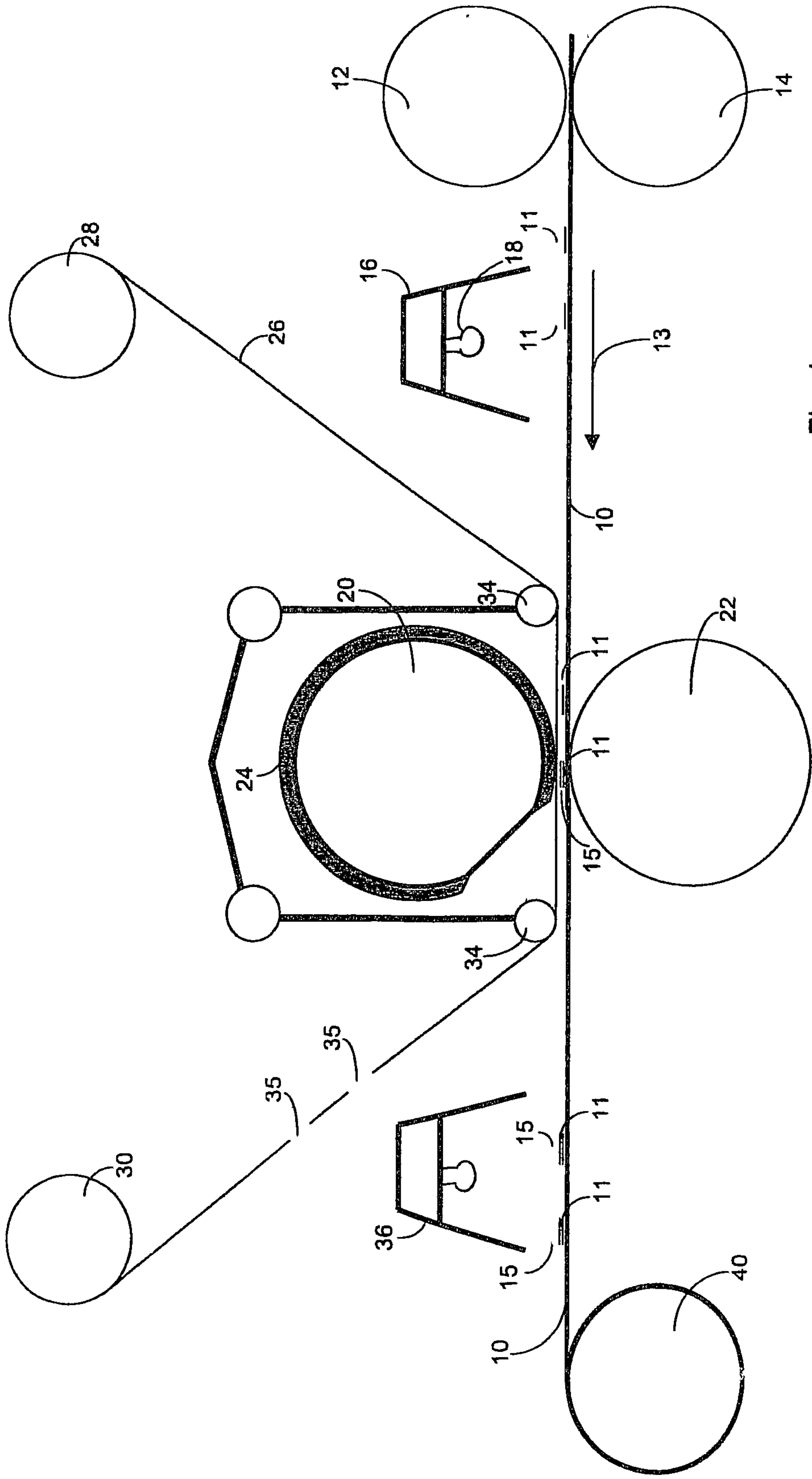
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Fig. 1

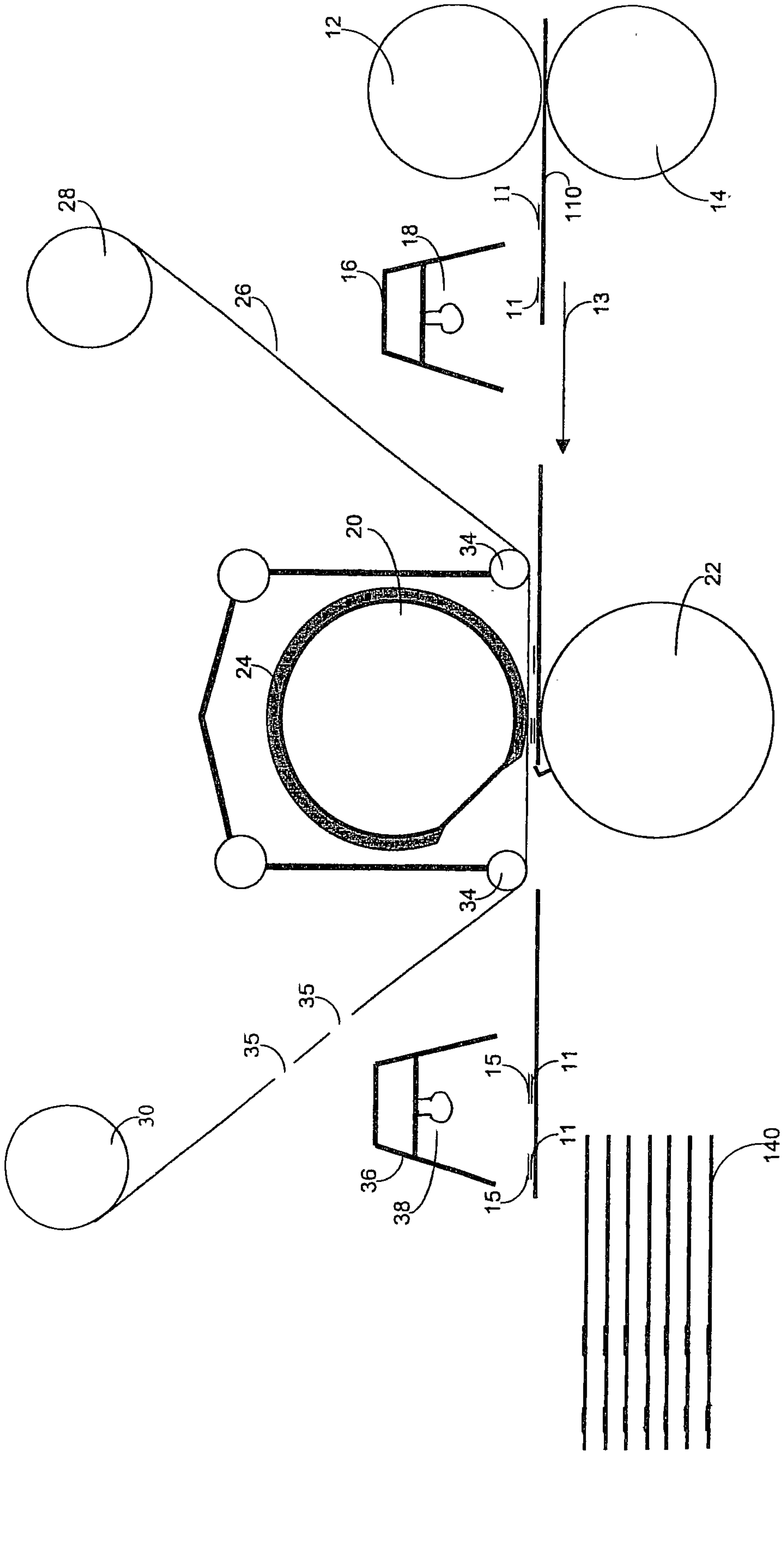
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Fig. 2

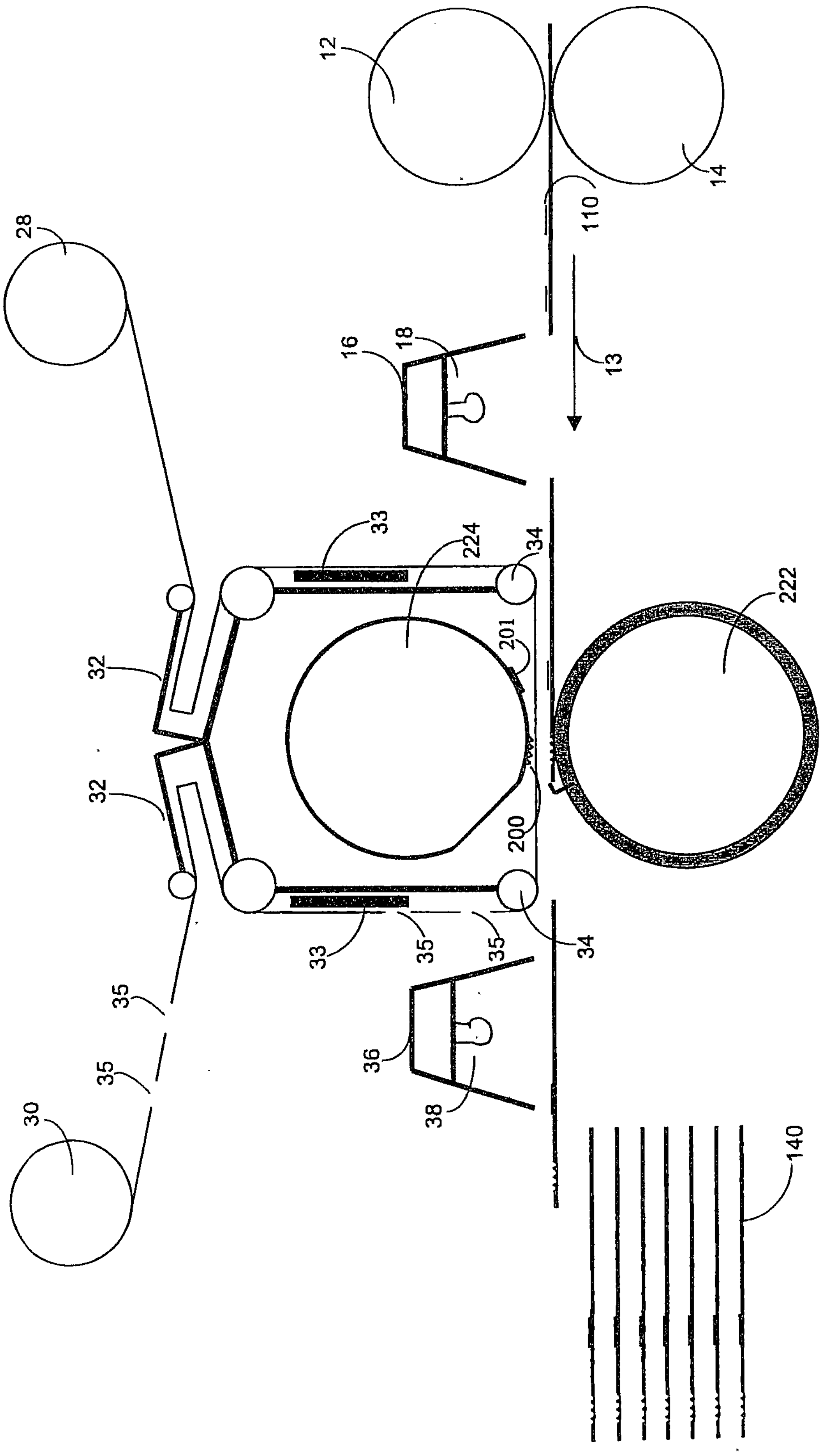
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Fig. 3

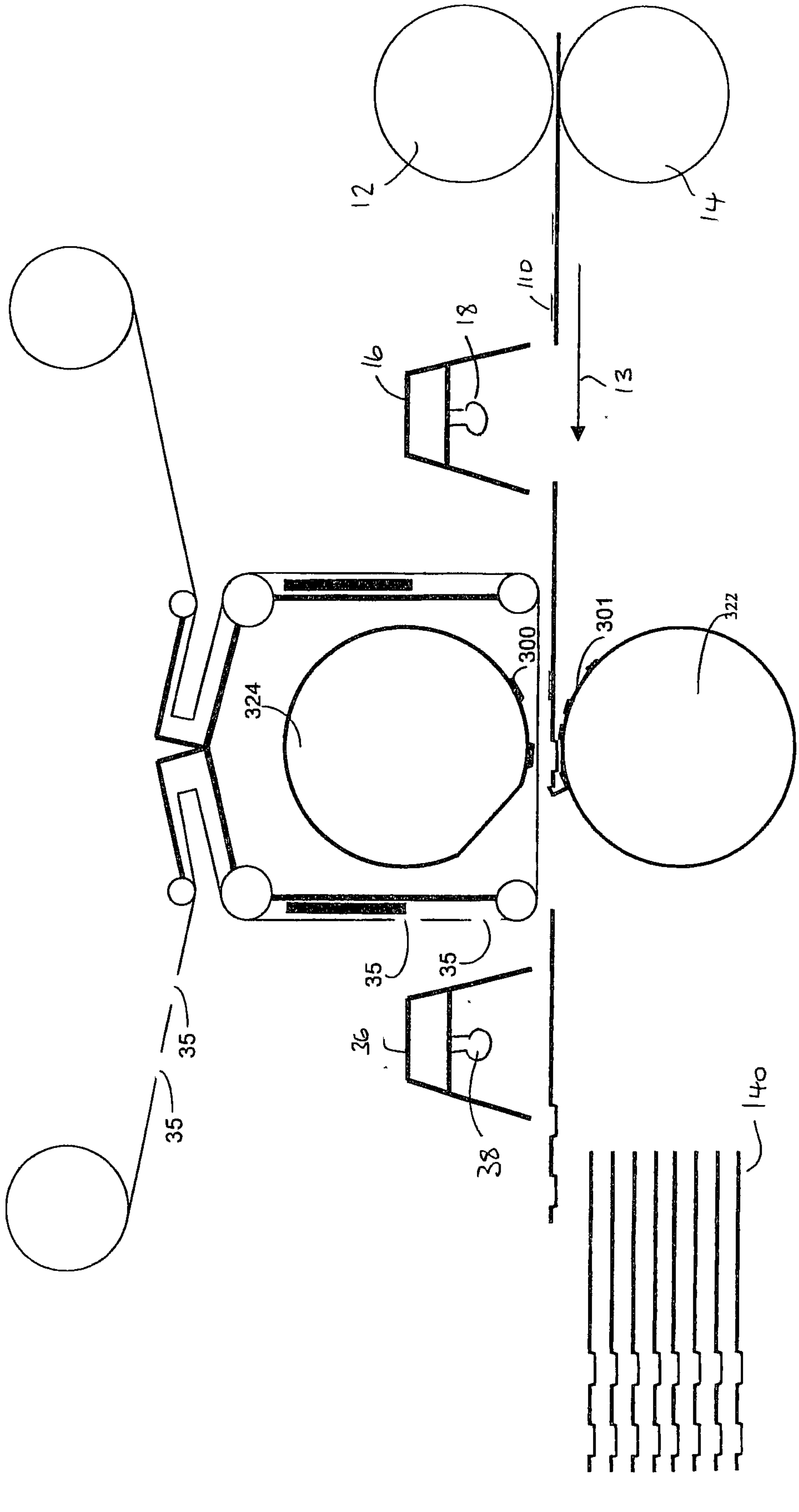


Fig. 4

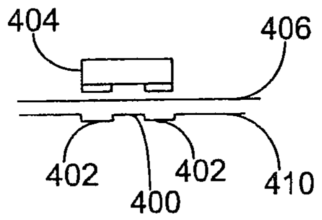


Fig. 5

# INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 01/04740

**A. CLASSIFICATION OF SUBJECT MATTER**
IPC 7 B41F19/06 B44C1/17 B41M3/00

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B41F B44C B41M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, PAJ, WPI Data

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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| 15 February 2002 | 26/02/2002 |

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