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(54) **Folding machine for folding sheet material in a concertina fashion.**

(57) A folding machine for folding sheet material such as paper in concertina fashion, the sheet material being fed along a path (CE) towards a folding station, where there is a specularly symmetrically arranged roller and endless band arrangement (RM^2, RF^2; RM^3, RF^3; NA^1, NA^2; RO and RF^4, RF^5) arranged to draw the sheet material firstly in one direction between one of the rollers (RF^5) and an adjacent working run of one of the endless bands (NA^2) until a detecting means (CF^1) is reached, which causes reversal of some components to cause the sheet material to be fed in the opposite direction towards and in between the working run of the other endless band (NA^1) and its adjacent roller (RF^4) until another detecting means (CF^2) is reached. This latter again causes reversal to produce the first fold and the sequence is repeated to fold and layer the sheet material. A roller (RO) is provided to assist during start-up of an operating cycle and is shiftable away from its initial position to a position where it assists in drawing the sheet material in alternate directions as folding proceeds.

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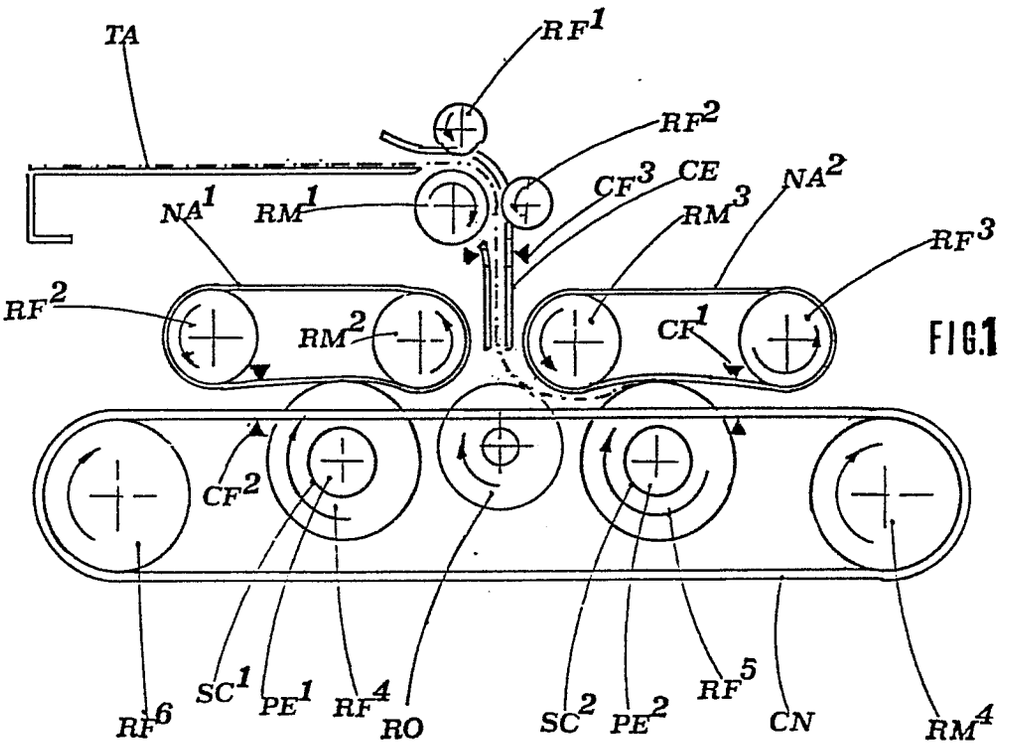
TA
RF1
RF2
CF3
CE
NA2
NA1
RM1
RM3
RF3
RF2
RM2
CF1
CF2
SC1
PE1
RF4
RO
SC2
PE2
RF5
CN
RF6
RM4

FIG.1

TITLE MODIFIED
see front page

IMPROVEMENTS IN OR RELATING TO FOLDING MACHINES FOR FOLDING SHEET MATERIAL IN CONCERTINA FASHION

This invention relates to a folding machine for folding sheet material in concertina fashion.

Italian Patent Specification Numbers 906,210 and 911,967 disclose such folding machines.

The present machine is intended to enable sheet material such as paper to be folded in concertina fashion whilst being responsive to different kinds and thicknesses of paper sheets by utilising the capabilities of electric microprocessors.

According to the present invention, there is provided a folding machine for folding sheet material in concertina fashion, the machine comprising means to feed the material along a path towards a folding station, characterised in that a roller arrangement at said folding station includes first and second pairs of rollers having respective endless bands running around them, a third pair of rollers, a working run of each endless band being adjacent and substantially tangential to a respective one of said third pair of rollers, and a further roller, which is driven and is shiftable between a first position, where it can direct the sheet material at the start of a working cycle to between one of said endless bands and the adjacent one of said third pair of rollers, and a second position in which it remains during the remainder of the folding cycle to carry and move the stack of material being folded, and there being detecting means to detect the leading edges of the sheet material as folding progresses to cause reversal of drive of said roller arrangement to produce the folds.

For a better understanding of the invention and to show how the same may be carried into effect, reference will now be made, by way of example, to the accompanying drawings, in which:-

Figures 1, 2 and 3 are schematic vertical elevational views respectively showing three different operative positions of a folding machine, viz. at an initial stage of an operating cycle, after a first reversal condition and after a second reversal condition to produce sheet material which has been folded in concertina fashion,

Figure 4 shows different folding stages of a sheet to provide complete concertina folding of the sheet, and

Figure 5 is a diagrammatic perspective view of part of the folding machine, this Figure showing feeding rollers and the feed path in phantom.

The general construction of the machine will first be described.

A horizontal table TA is provided for feeding longitudinal sheets FO (Figure 4) of material such as paper to be concertina folded to an inlet location and a feed means is provided in the form of a unidirectionally driving inlet roller RM^1 co-operating with associated idler rollers (or balls) RF^1 and RF^2, these rollers serving to feed the sheets to an entry path or track CE.

NA^1 and NA^2 are sets of strongly tensioned endless bands extending around driving rollers RM^2 and RM^3 and around idler rollers RF^2 and RF^3 respectively, these bands being arranged at the folding station according to a specular symmetry about the plane of the intended direction of feed of the sheet material along the inlet path CE.

Respective working runs of the bands NA^1 and NA^2 are arranged tangentially with respect to idler rollers RF^4 and RF^5, these rollers RF^4 and RF^5 having respective tapered portions PE^1 and PE^2 and toroidal guide grooves SC^1 and SC^2 to accommodate endless belts CN wound around a pair of lower rollers RM^4 and RF^6. The roller RM^4 is driven and its direction of rotation can be reversed and the roller RF^6 is an idler roller. Accordingly, the rollers RM^2 and RM^3 drive respectively the rollers RF^4 and RF^5 via the bands NA^1 and NA^2.

Another roller RO is arranged to be driven in a direction which depends on the direction of rotation of the driving rollers RM^2, RM^3 and RM^4 and is shiftable in said plane from an upper position (Figure 1) at the beginning of the operating cycle in order to direct the sheet material towards the band NA^2 and a lower position, which is achieved after the beginning of the cycle, whilst continuing to rotate in the same direction as the roller RM^4, in order not to hinder the formation of folds in the sheet material (Figures 2 and 3).

Detecting means in the form of photoelectric cells CF^1 and CF^2 control the directions of rotation of the driving rollers RM^2, RM^3 and RM^4. In addition, a photoelectric cell CF^3 is located adjacent to the entry path CE.

In operation, starting from the Figure 1 position, the driving roller RM^1 feeds the sheet FO towards the entry path CE until the sheet drops to the folding station to meet the rotating roller RO (which is in its upper position) so that the sheet is directed between the lower, working run of the band NA^2 and the roller RF^5 and consequently the sheet is positively carried towards the photoelectric cell CF^1. As soon as the leading edge of the sheet breaks the light beam directed towards the

photoelectric cell, a servocontrol causes the direction of rotation of the driving rollers RM^3 and RM^4 to be reversed, whilst the driving roller RM^1 continues to rotate always in the same initial direction. As can be seen from Figure 2, this has the effect of drawing the sheet material such as paper to form a loop to provide a first fold therein.

The photoelectric cell CF^3 mounted in the entry path CE is instrumental in initiating the rotation of the rollers RM^2, RM^3, RM^4 and RO.

The same cycle is then repeated but in the opposite direction as soon as the next leading (folded) edge of the sheet reaches the photoelectric cell CF^2. The folding cycles are repeated till the exhaustion of the length of sheet material being fed in, so that it becomes folded in concertina fashion (Figure 4). Provision may be made for microprocessors co-operating with the photoelectric cells CF^1,CF^2 in order to survey and regulate the folding of the sheets.

Comparing Figures 1 and 2, after the first fold has been made, the roller RO is shifted into its lower position and remains in that position as a result of a control impulse given by the photoelectric cell CF^1. The roller RO is driven in synchromism with the roller RM^4 and this achieves a rolling support for the sheet to be folded.

It will be appreciated that the present folding machine does not have stationary channels between which the pack of folded sheet material can slide during the folding operation as with a known machine; on the contrary, the "channels" are movable and consist of the belts CN and bands NA^1, NA^2 which accompany the material during the reciprocating movement whereby movement of the material is

not hindered thereby inhibiting consequent jamming of the machine.

Furthermore, the utilisation of one or more bands NA^1, NA^2 in lieu of a rigid roller in order to carry out the deflection of the fold against the rollers RF^4, RF^5 permits a better performance to be obtained than that obtained with known folding machines, since the surfaces of the bands between the rollers can yield and permit the passage of folded paper packets presenting a significant thickness. The choice of a second folding roller as provided in known folding machines for small sheets would force the second roller to lose its initial parallelism if a sheet is folded which presents a width less than that of the second roller. Consequently the pressure upon the paper would not be uniform and the operation would not be correct. In a preferred embodiment of the present machine, it is possible to fold sheets having a number of different lengths and widths up to 10 metres.

It will be further appreciated that the provision of the roller RO performs the important job of orientating correctly the leading border of the paper, so as to orientate the latter according to the required inlet or feed direction, without sensing the initial pre-bending that the paper may present in the opposite direction.

The arrangement of two folding sets as shown in Figure 1 permits a pyramid effect to be eliminated, this effect being present in the known roller type folding machine. This effect is usually present when relatively long sheets have to be folded since, if the number of folded portions is increased, the latter results always in that each succeeding sheet folded is a little shorter than the preceeding folded layers, so that the paper concertina folded packet so produced will present a pyramid shape.

CLAIMS

1. A folding machine for folding sheet material in concertina fashion, the machine comprising means to feed the material along a path (CE) towards a folding station, characterised in that a roller arrangement at said folding station includes first and second pairs of rollers (RM^2, RF^2 and RM^3, RF^3) having respective endless bands (NA^1, NA^2) running around them, a third pair of rollers (RF^4, RF^5), a working run of each endless band being adjacent and substantially tangential to a respective one of said third pair of rollers, and a further roller (RO), which is driven and is shiftable between a first position, where it can direct the sheet material at the start of a working cycle to between one of said endless bands and the adjacent one of said third pair of rollers, and a second position in which it remains during the remainder of the folding cycle to carry and move the stack of material being folded, and there being detecting means (CF^1, CF^2) to detect the leading edges of the sheet material as folding progresses to cause reversal of drive of said roller arrangement to produce the folds.

2. A folding machine as claimed in claim 1, wherein said roller arrangement is symmetrically arranged at said folding station about the plane of the intended direction of feed of material along said path at said folding station and wherein said further roller has its axis of rotation lying in said plane and is shiftable in said plane between said first and second positions.

3. A folding machine as claimed in claim 1 or 2, wherein said feed means comprises a feed roller (RM^1) which co-operates with idler means (RF^1, RF^2).

4. A folding machine as claimed in claim 3, wherein said idler means comprises idler rollers or balls.

5. A folding machine as claimed in any one of the preceding claims, wherein a feed table (TA) is provided to hold and facilitate feeding of the sheet material to be folded.

6. A folding machine as claimed in any one of the preceding claims, wherein said feed path leading to said folding station extends downwardly.

7. A folding machine as claimed in any one of the preceding claims, wherein said third pair of rollers are idler rollers and one of each of said first and second pairs of rollers are driven rollers.

8. A folding machine as claimed in claim 7 and further comprising a fourth pair of rollers (RM^4, RF^6), one of which is driven, around which rollers endless belts (CN) extend to assist in conveying the sheet material being fed from said path to the respective endless bands as folding proceeds, said endless belts also extending around grooves in said third pair of rollers so as to prevent any mis-leading of the sheet to be folded.

9. A folding machine as claimed in any one of the preceding claims, wherein said detecting means comprises a photoelectric cell adjacent each working run of said endless bands.

10. A folding machine as claimed in claim 9, wherein said photoelectric cells are coupled with microprocessors controlling actuation of the machine and further

comprising means (CF^3) in said feed path to detect the arrival of sheet material to initiate an operating cycle.

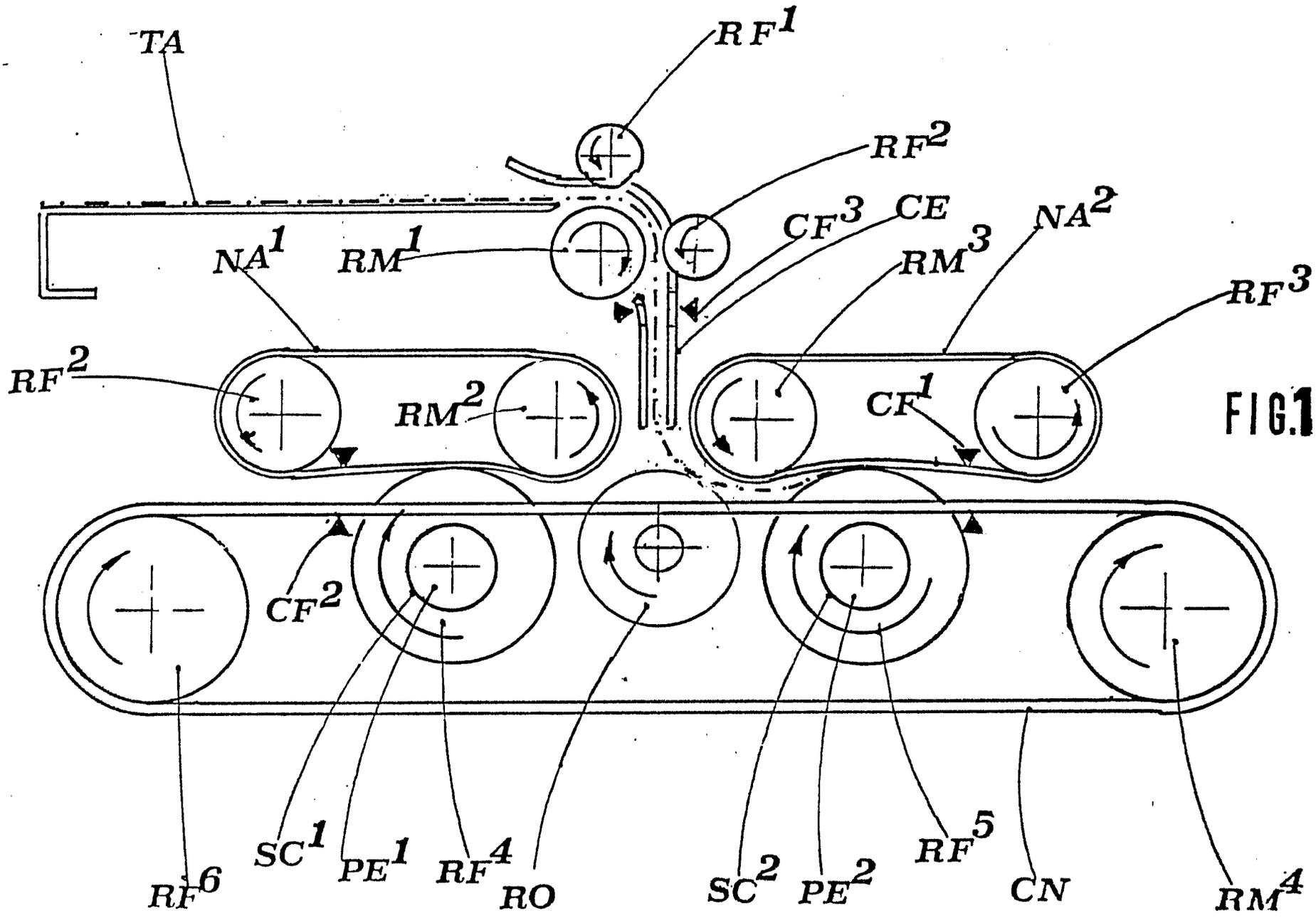

FIG.1

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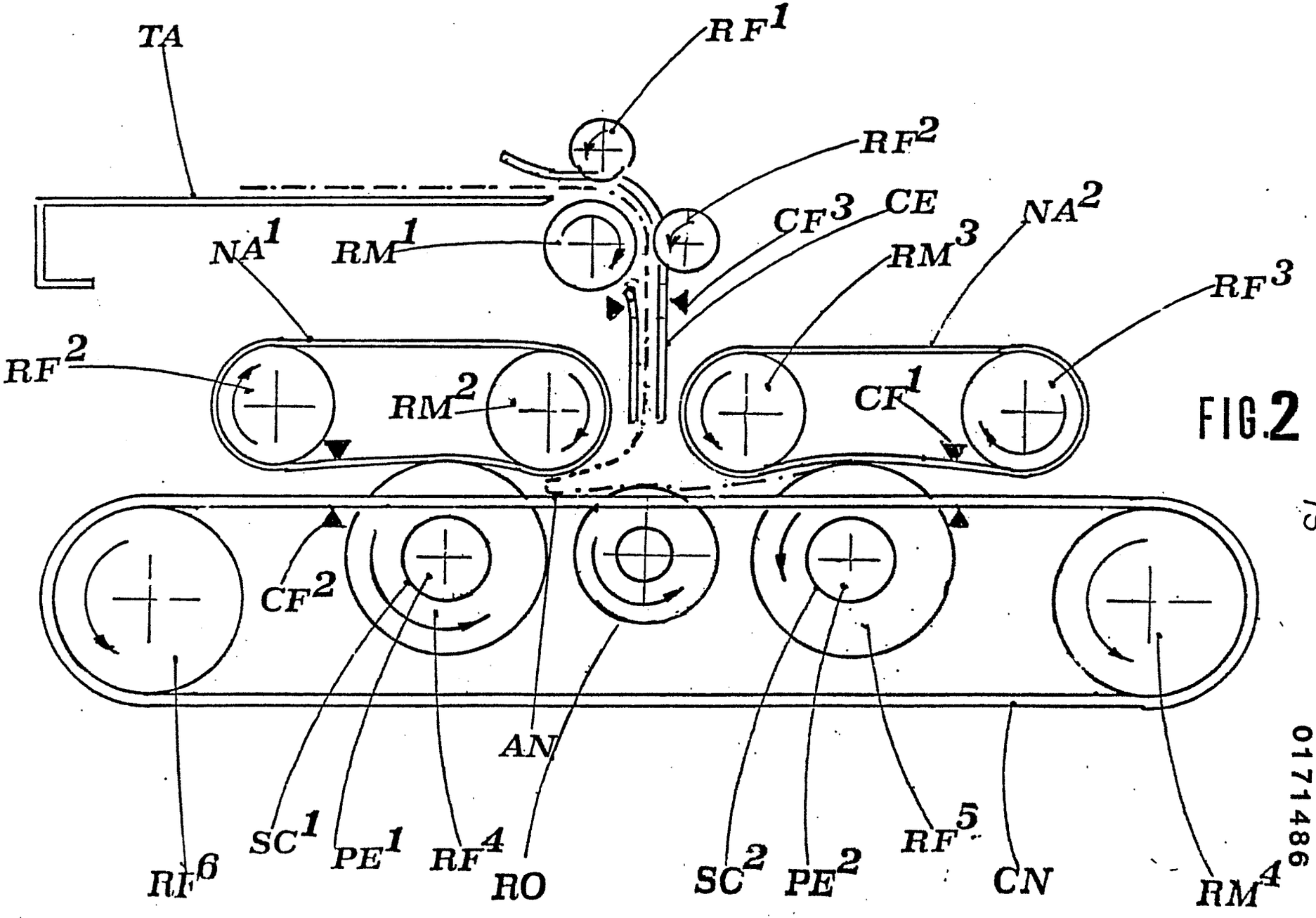

FIG.2

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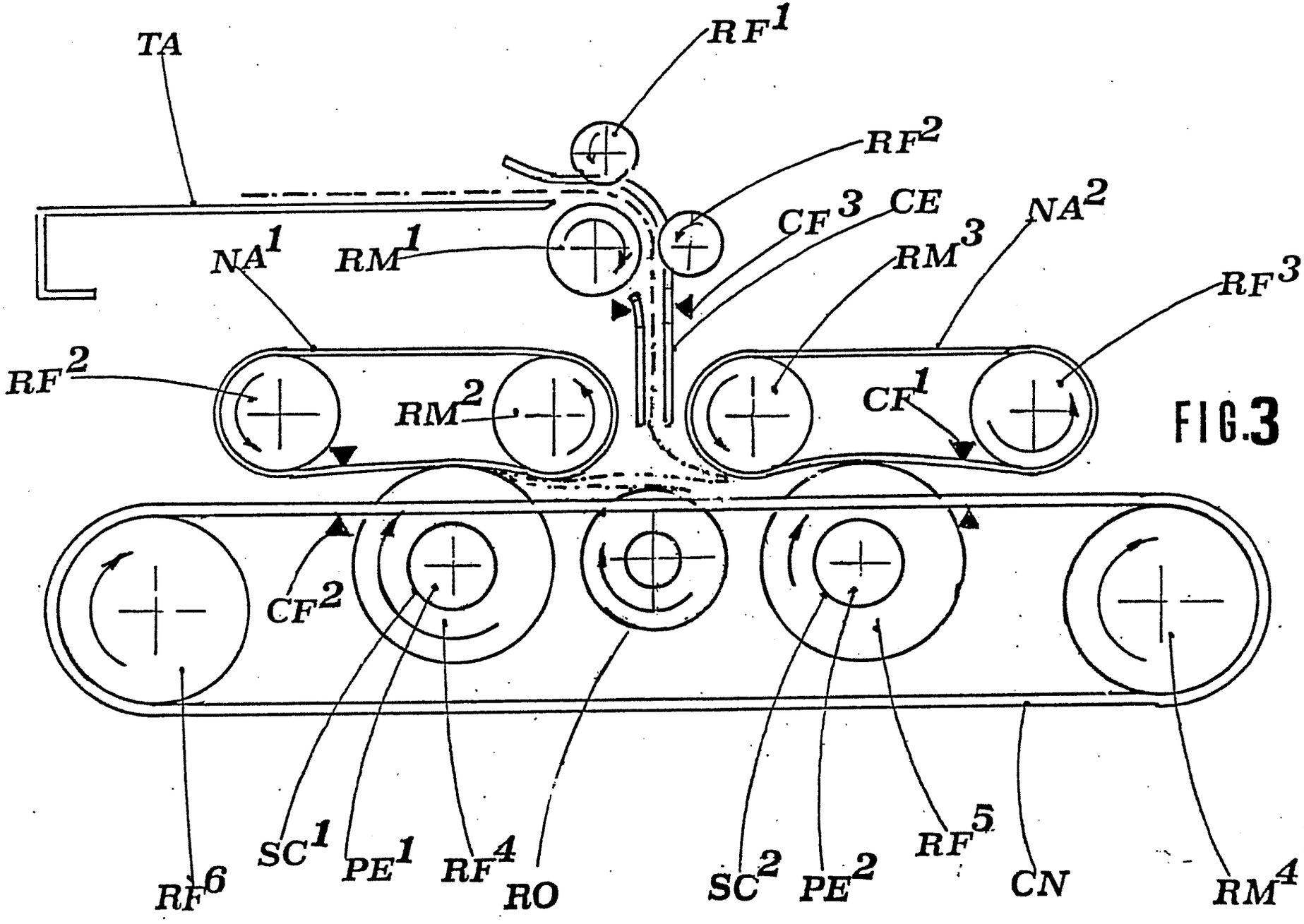

FIG.3

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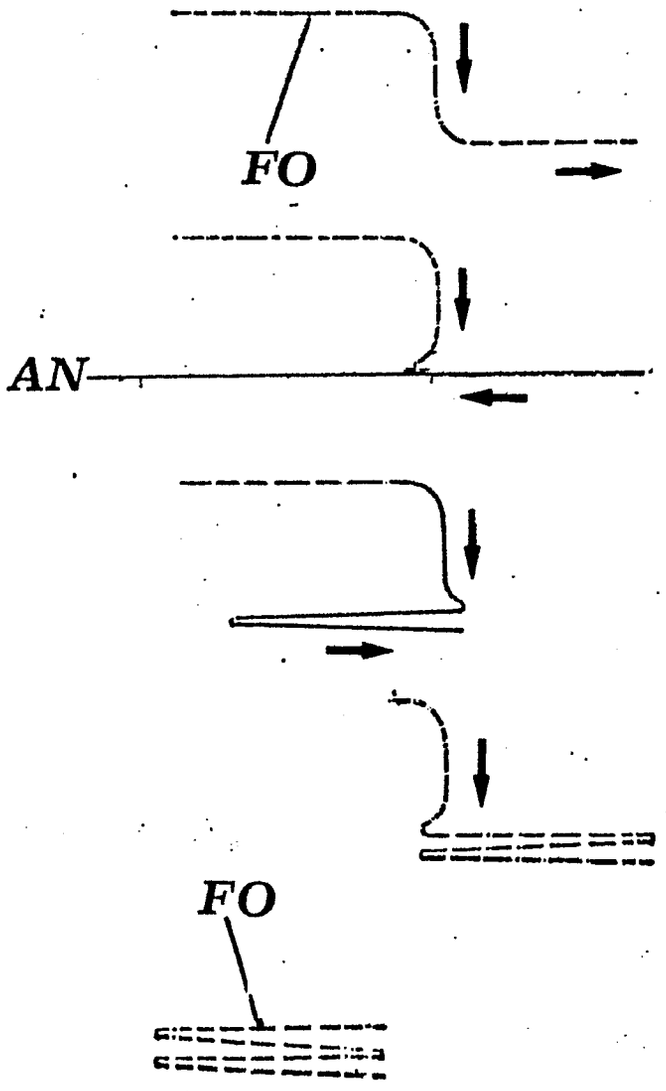

FIG.4

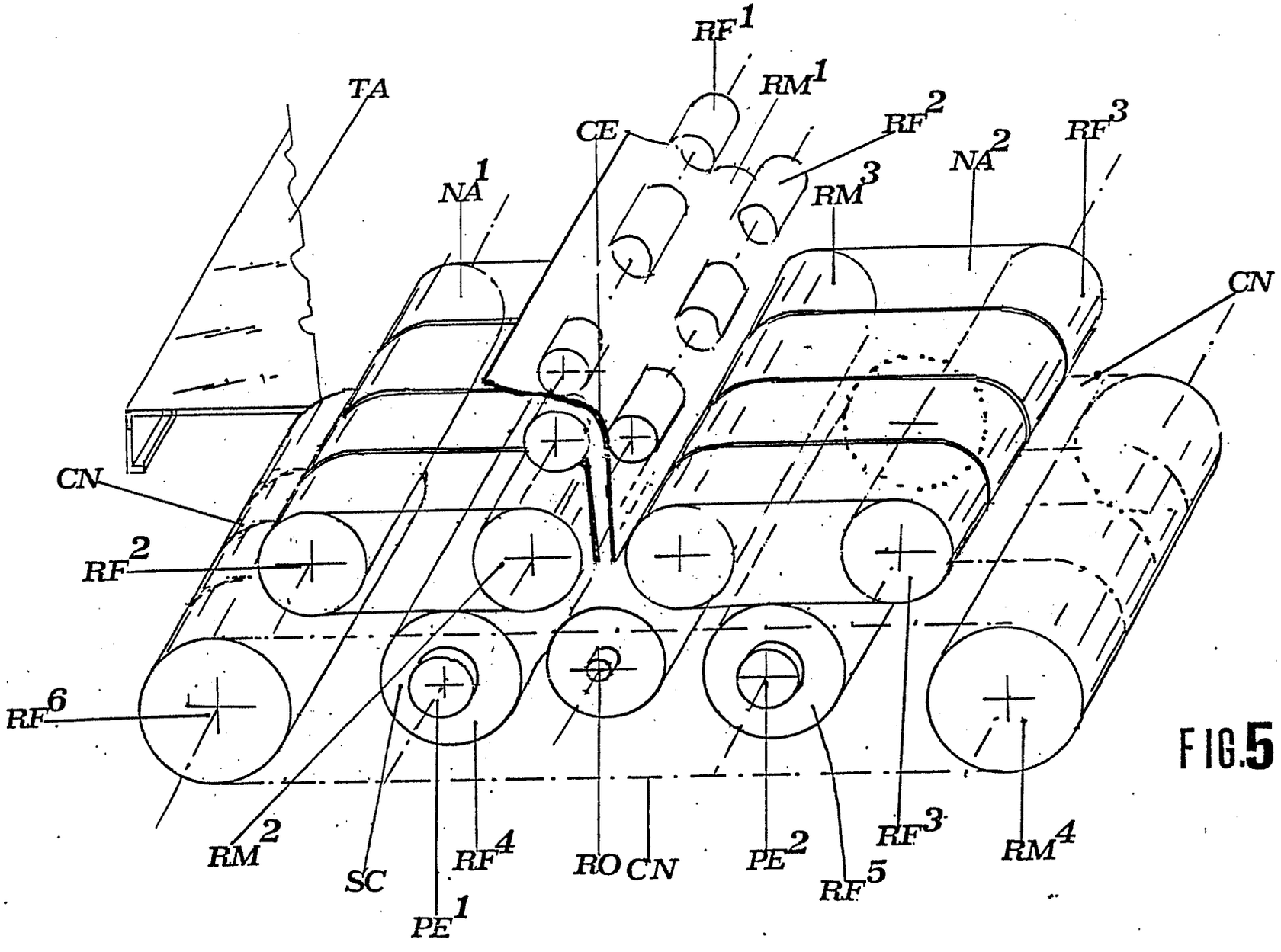

FIG.5

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EUROPEAN SEARCH REPORT

0171486
Application number

EP 84830337.6

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl 4)
Y	EP - A1 - 0 037 650 (HARPER & TUNSTALL LTD) * Fig. 4,5; pages 8-12 * --	1-10	B 65 H 45/20
Y	DE - A - 2 227 582 (METEOR-SIEGEN GMBH) * Fig. 1,2; page 5, line 13 - page 10, line 29 * ----	1-10	

TECHNICAL FIELDS SEARCHED (Int. Cl 4)

B 65 H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	16-07-1985	SÜNDERMANN

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

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