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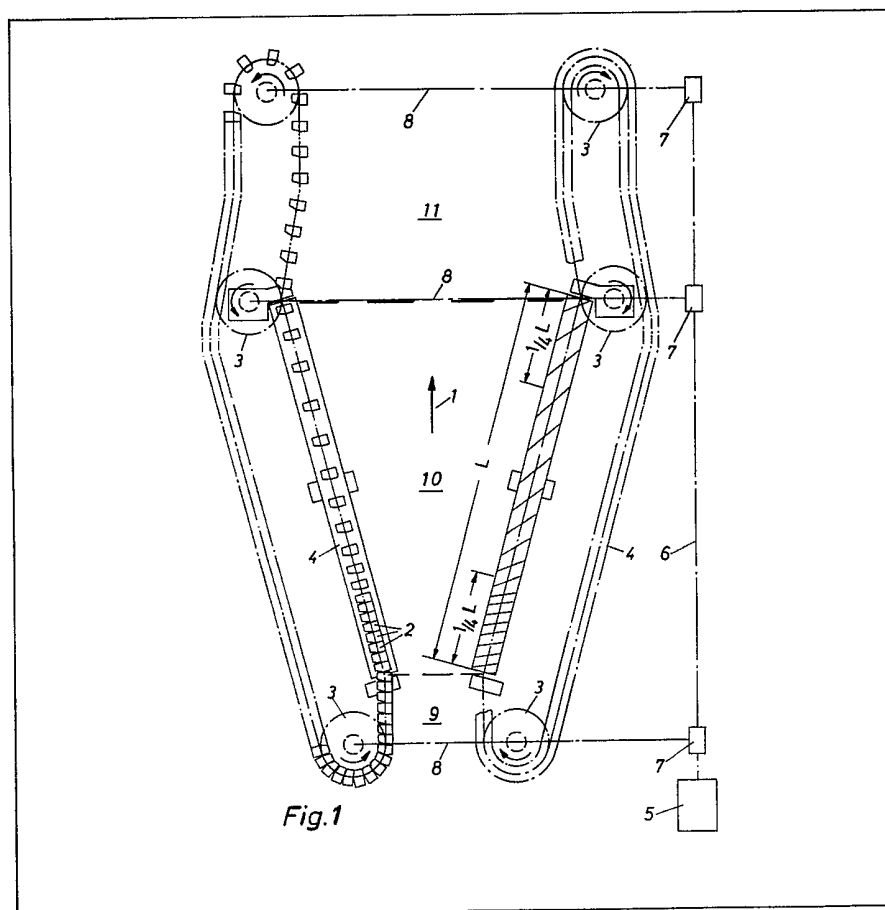
(54) A device for simultaneous biaxial stretching of strips of thermoplastic plastics

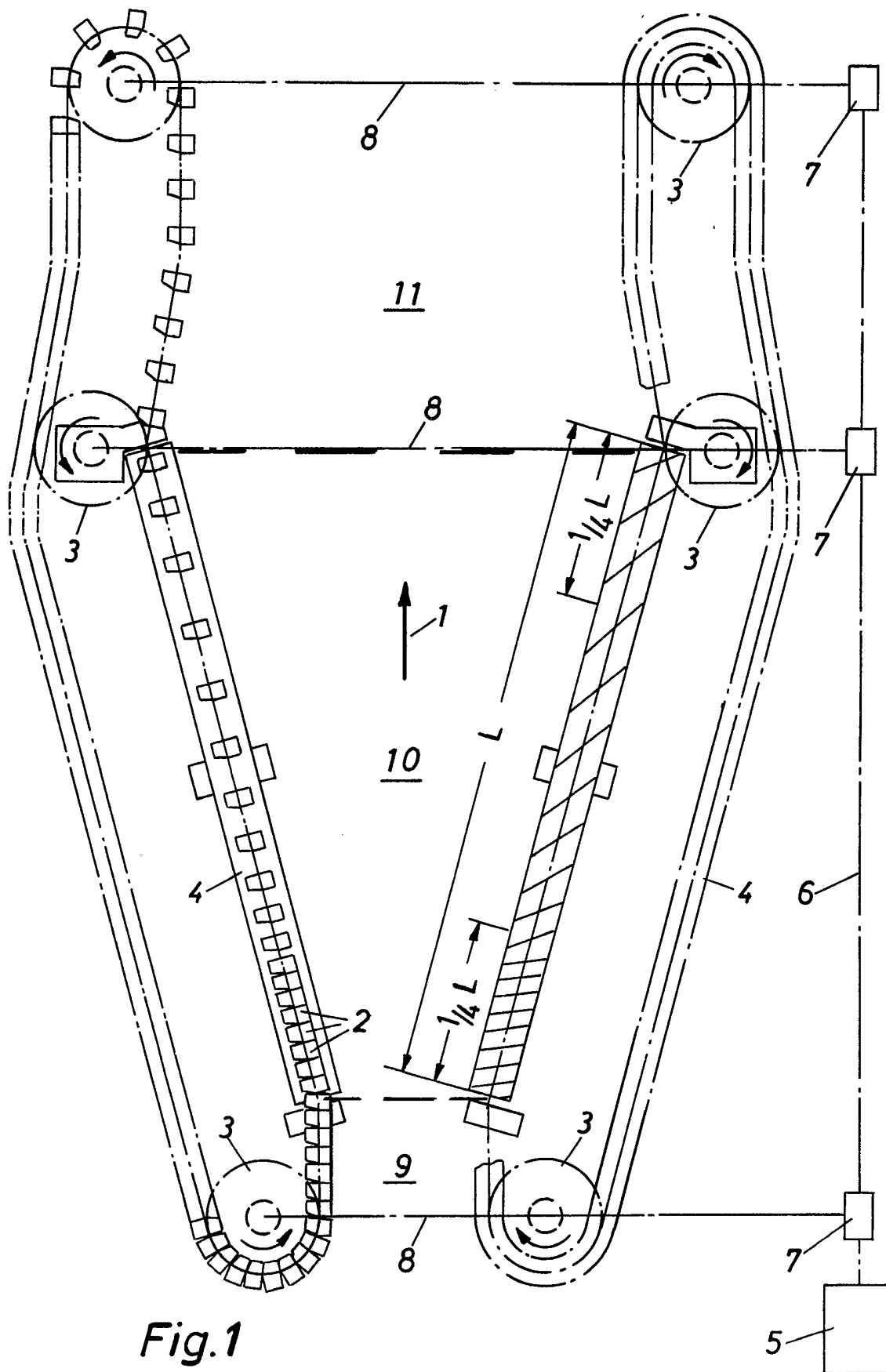
(57) A device for simultaneous biaxial stretching of strips of thermoplastic plastics, comprises clamps 2 arranged for gripping both longitudinal edges of the strip in an inlet zone 9, a stretching zone 10, and a fixing zone 11;

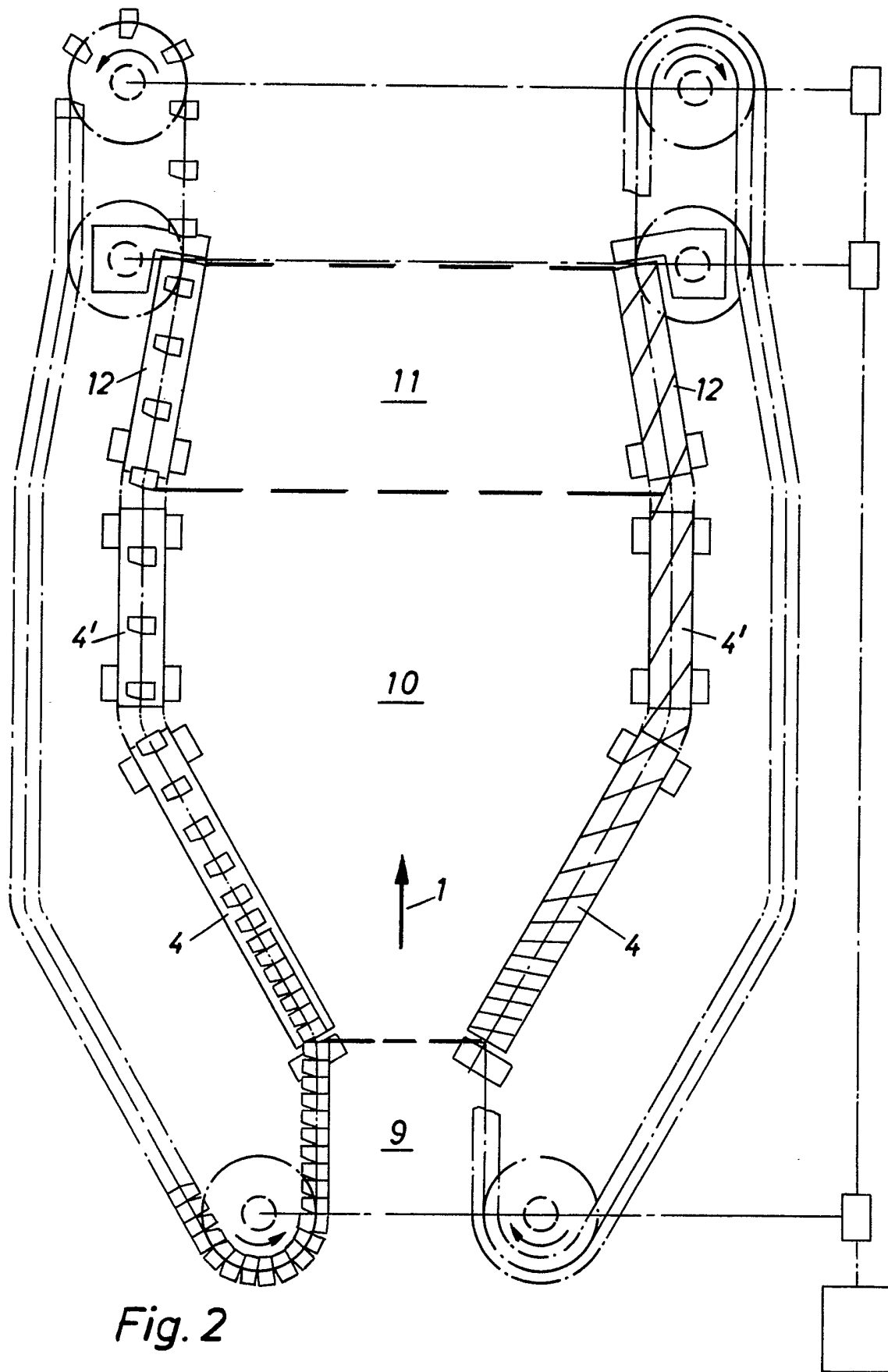
the clamps 2 being movable along guideways by screw-threaded spindles 4 situated in parallel with the guide-

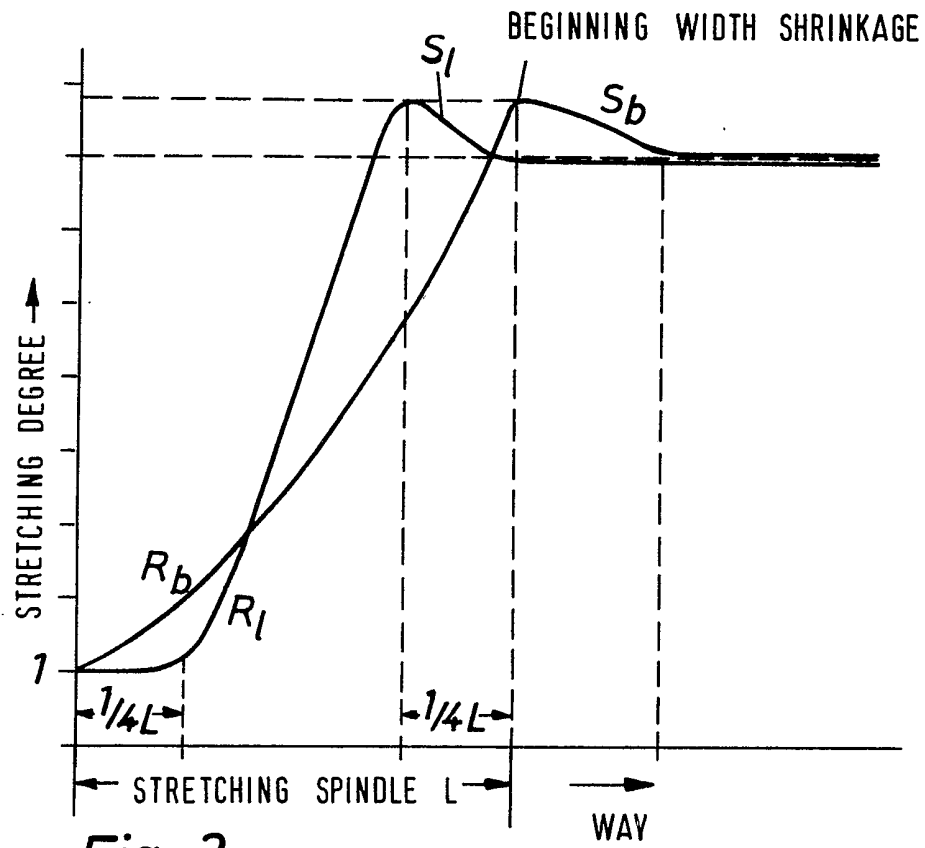
ways;

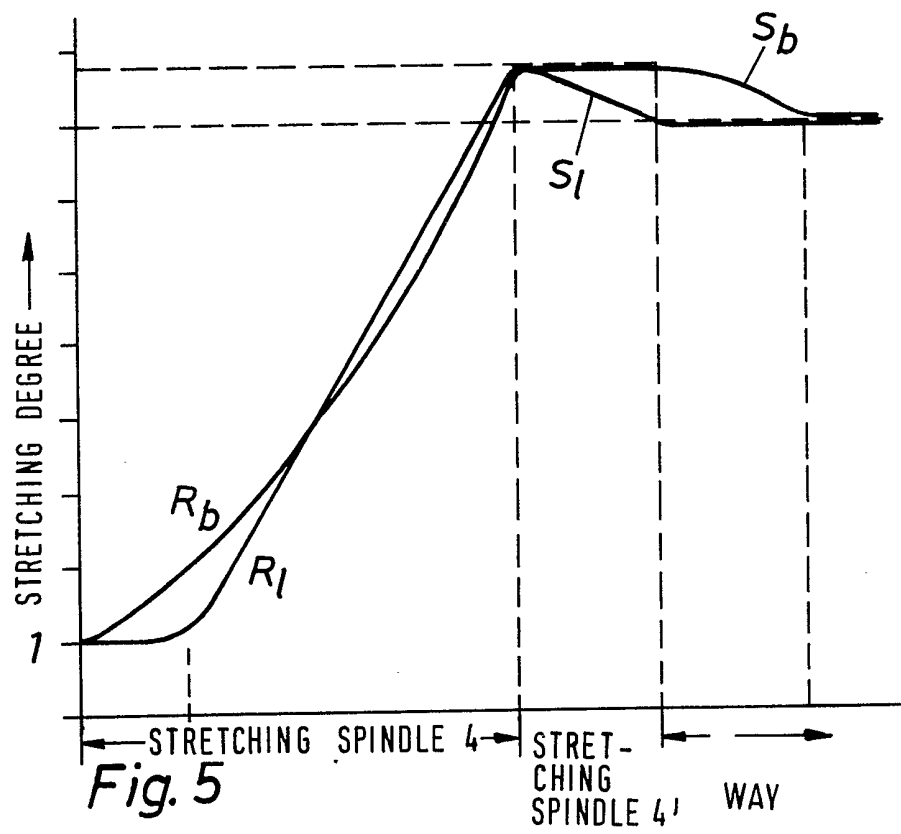
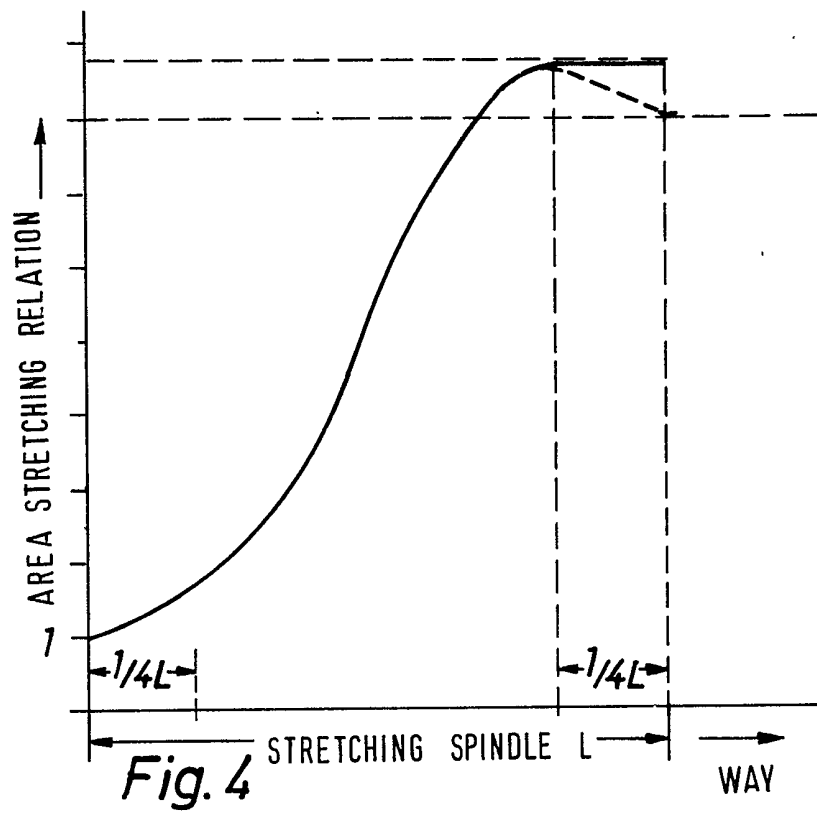
the spindle screw-thread pitch in the first quarter of the length of the stretching zone 10 remaining constant or increasing from an initial pitch to maximally double the initial pitch and the maximum screw pitch occurring in the last quarter of the length of the stretching zone 10. Such an arrangement allows the degree of longitudinal stretch and transverse stretch at any particular point in the stretching procedure to be controlled.

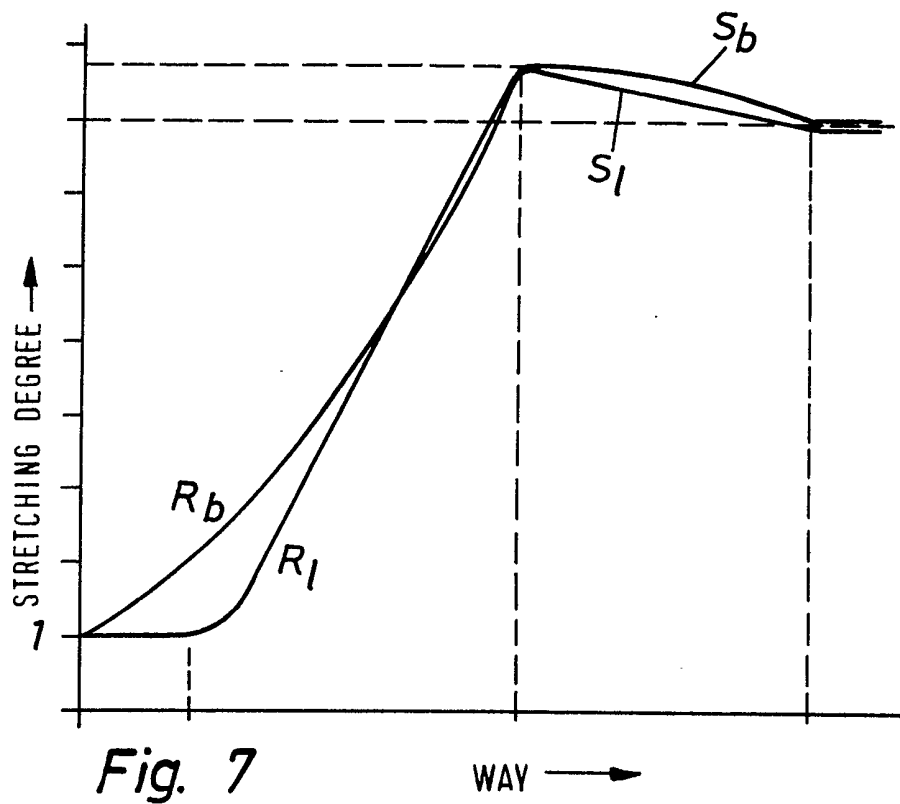
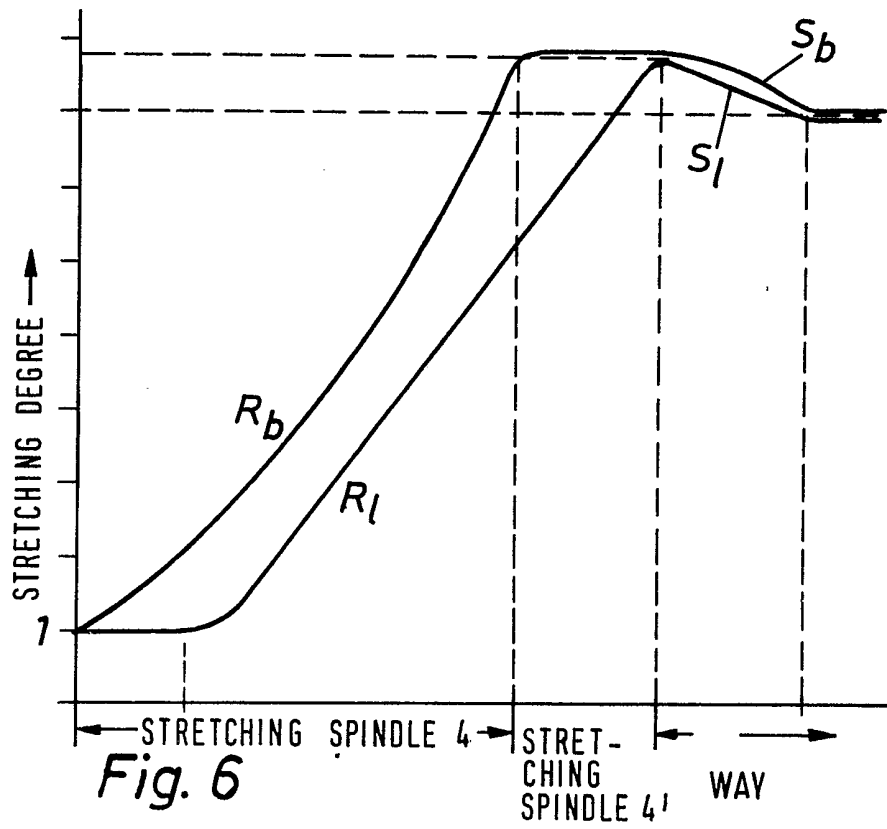


**Fig. 1**



*Fig. 3*





## SPECIFICATION

**A device for simultaneous biaxial stretching of strips of thermoplastic plastics**

The invention relates to a device for the simultaneous biaxial stretching of strips of thermoplastic plastics, having clamps, so-called "Spannkluppen", arranged for gripping both sides of the longitudinal edges of the strip in an inlet zone, a stretching zone, and a fixing zone.

The term "simultaneous biaxial stretching" includes biaxial stretching wherein some of the stretching is carried out uniaxially.

The quality of the product of such a device depends, inter alia, on the mutual coordination of the longitudinal stretching and the transverse stretching as well as on control of the fixing step.

An object of some embodiments of the invention is the provision of a device wherein an optimum mutual coordination of longitudinal stretching, transverse stretching as well as fixing and/or shrink treatment, respectively, may be achieved.

The present invention provides a device for simultaneous biaxial stretching of strips of thermoplastic plastics, which comprises clamps arranged for gripping both longitudinal edges of the strip in an inlet zone, a stretching zone, and a fixing zone; the clamps being movable along guideways by screw-threaded spindles situated in parallel with the guideways; the spindle screw-thread pitch in the first quarter of the length of the stretching zone remaining constant or increasing from an initial pitch to maximally double the initial pitch, and the maximum screw pitch occurring in the last quarter of the length of the stretching zone.

According to the invention the pitch increase in the first quarter of the length of the stretching spindle may have a value of zero so that in this quarter of the stretching spindle of the stretching zone, only transverse stretching is carried out. In any case, transverse stretching predominates in the initial range of the stretching spindle. This is extremely advantageous for the orientation of the foil. The invention also allows a concerted control of the shrinkage.

According to one embodiment of the invention it is provided that the screw pitch again decreases in the last quarter of the length of the stretching spindle subsequent to the maximum value. This means that longitudinal shrinkage starts in the last quarter of the stretching zone so that particularly good fixing in the longitudinal direction is guaranteed.

In accordance with a preferred embodiment of the invention, the decrease of the pitch in the last quarter of the length of the stretching spindle is selected in such a manner that the instantaneous area stretching ratio within this range remains constant or decreases. By this provision, it is possible to control precisely fixing in the longitudinal direction as well as in the transverse direction.

Within the fixing zone arranged thereafter, additional shrinkage may occur.

In order to better control the stretching relations in the fixing zone, the thread pitch in the fixing spindles need not be constant. Thereby it is possible to

achieve, within the fixing zone, exact control of the shrinkage of width as well as of the shrinkage of length. It is particularly provided that the pitch of the fixing spindles is carried out, by sectors, increasing, decreasing or constant. By this embodiment of the invention one can achieve optimum adjustment of the characteristic values in the longitudinal direction and in the transverse direction as well as of the mutual interrelation of these characteristic values.

Embodiments of the invention will now be described with reference to the attached drawings, wherein:-

Figure 1 shows a schematic total view of a device according to the invention, having stretching spindles within the stretching zone,

Figure 2 shows a schematic view of a modified device with stretching spindles within the stretching zone and fixing spindles within the fixing zone.

Figures 3 to 7 show various diagrams for the elucidation of the stretching operation in regard to the different embodiments of the invention.

The device shown in Figure 1 is mounted on a basic frame, not shown. Symmetrically to the direction of transportation 1 of the strip there are provided clamping holder guideways for the clamps 2. The clamping holder guideways comprise guide rails, not shown, guide wheels 3, stretching spindles 4, and other conveying means such as conveying belts and chain drives. In the drawing these conveying means as well as the clamps are illustrated merely schematically and also only partially so that the clarity of the drawing is not affected.

The drive of the device is carried out by means of a driving motor which drives a main shaft 6. Via branching gears 7 additional driving shafts 8 are driven which drive via gears and/or bevel gear drives, respectively, the deflection wheels 3, the spindles 4, and further conveying equipment. Details of this drive are not shown.

An unstretched strip is introduced in an inlet zone 9 and, at both longitudinal edges, is engaged by clamps 2 and gripped. In a subsequent stretching zone 10, in which the stretching spindles 4 extend divergently to one another, the simultaneous stretching of the strip is carried out. Finally, there is provided a fixing zone 11.

Each stretching spindle comprises a guide screw way. In the first quarter of the total length L of the stretching spindle the increase of pitch of the guide screw way is zero. In the last quarter of the total length L, there is provided a degressive pitch, i.e., a decrease of pitch. In the intermediate range the spindle pitch increases progressively so that in the last third of the total length L the maximum value of the pitch exists.

In this design of the stretching spindles, in the first quarter of the total length L substantially uniaxial transverse stretching is effected. In the two further quarters simultaneous longitudinal stretching and transverse stretching is effected. In the last quarter, with continuous transverse stretching, a longitudinal shrinking takes place so that fixing starts. Finally, there is provided, within the fixing zone 11, a transverse shrinkage. A corresponding stretching diagram is shown in Figure 3, in which above the

x-axis indicating the length of the stretching spindle, and consequently the path of the strip, there is indicated on the y-axis the transverse stretching degree  $R_b$  and the longitudinal stretching degree  $R_l$ .

5 In the first quarter of the length of the stretching spindle substantially uniaxial transverse stretching takes place. Within the fourth quarter of the stretching spindle the longitudinal stretching reaches its highest value and subsequently decreases again  
10 within the stretching zone. Figure 4 shows the corresponding course of the area stretching relation, consequently of the product  $R_b \times R_l$ . In each case, the instantaneous value of this area stretching relation on the y-axis is plotted against the spindle  
15 length  $L$  on the x-axis. The area stretching relation reaches a maximum value in the last quarter of the stretching spindle. The maximum value may be selected according to the specific requirements and in compliance with the stretching article desired.

20 It is also possible to provide in the first quarter of the length of the stretching spindle also an increase of pitch up to the double the initial pitch so that in the first quarter of the stretching spindle a comparatively small longitudinal stretching takes place. In any  
25 case one can influence the longitudinal stretching relation and the transverse stretching relation to a large extent and one can adapt particularly the quotient to specific requirements.

Figure 2 shows a modified embodiment of the  
30 invention which comprises within the stretching zone 10 two stretching spindles 4, 4'. The stretching spindles 4 are positioned divergently in regard to one another. In the initial range of the stretching  
35 spindles 4 the increase of pitch is zero or has only a small value. A section of progressive increase of pitch follows. The stretching spindles 4' are arranged in parallel with one another and possess a progressive or a degressive pitch, respectively. Also  
40 in the fixing zone 11 one may provide fixing spindles 12 which comprise a constant or a degressive pitch. In the place of fixing spindles having a constant pitch, it is also possible to provide transportation of the clamps by means of conveying chains.

This embodiment according to Figure 2 makes  
45 possible further modifications of the stretching procedure. If one provides on the stretching spindles 4' a degressive pitch and on the fixing spindles 12 a constant pitch, stretching according to Figure 5 occurs. In the first quarter of the stretching spindles  
50 4 substantially exclusively transverse stretching takes place. The stretching reaches its maximum value at the end of the stretching spindle 4. Along the length of the stretching spindles 4' the degree of longitudinal stretching decreases again, whereas the  
55 degree of width stretching remains constant. A transverse shrinkage within the fixing zone follows.

Figure 6 shows the stretching operation for a machine having stretching spindles 4 and 4' as well as fixing spindles 12. While at the beginning of the  
60 stretching spindles 4 exclusively transverse stretching takes place, in the range of the stretching spindles 4' exclusively longitudinal stretching takes place. A simultaneous shrinkage follows.

A further modification of the invention is possible  
65 in such a manner that following the stretching

spindles 4 there are arranged fixing spindles 12 having degressive pitch. The course of the stretching operation is illustrated in Figure 7. Within the stretching zone a simultaneous stretching is  
70 achieved, whereby in the initial range of the stretching zone transverse stretching prevails. A simultaneous shrinking follows.

The above explanations clearly demonstrate that it is possible to influence the stretching operation in  
75 regard to details in a manner not possible up to now. It is possible to shift the main emphasis of the transverse stretching and of the longitudinal stretching and to influence also the fixing. Thereby a plurality of possibilities of effecting the physical  
80 properties of the stretched product, result. Primarily, it is possible to influence the homogeneity of the characteristic values or to select preferred directions according to specific requirements.

## 85 CLAIMS

1. Device for simultaneous biaxial stretching of strips of thermoplastic plastics, which comprises  
90 clamps arranged for gripping both longitudinal edges of the strip in an inlet zone, a stretching zone, and a fixing zone; the clamps being movable along guideways by screw-threaded spindles situated in parallel with the guideways; the spindle screw-  
95 thread pitch in the first quarter of the length of the stretching zone remaining constant or increasing from an initial pitch to maximally double the initial pitch, and the maximum screw pitch occurring in the last quarter of the length of the stretching zone..
- 100 2. Device according to claim 1, wherein the screw pitch decreases in the last quarter of the stretching zone subsequent to said maximum value.
3. Device according to claim 1 or 2, wherein the desired maximum area stretching degree is  
105 achieved before the end of the stretching zone.
4. Device according to one preceding claim, wherein a decrease of pitch in the last quarter of the length of the stretching zone is selected such that the instantaneous area stretching ratio within this length  
110 range remains constant or decreases.
5. Device according to any preceding claim, wherein the thread pitch of spindles in the fixing zone arranged after the stretching zone is not constant.
- 115 6. Device according to claim 5, wherein the pitch of the fixing spindles is carried out, by sectors, increasing, decreasing, or constant.
7. Device for simultaneous biaxial stretching plastics strip substantially as described with refer-  
120 ence to and as shown in Figure 1 or 2.