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Hamon

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[54] **SHEET FORMING DEVICE**

[76] Inventor: **Maurice Hamon,** 58, rue Capouillet, Brussels, Belgium

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[52] **U.S. Cl.** **425/343,** 425/336, 425/369, 425/370, 425/371

[51] **Int. Cl.** **B29c 17/02**

[58] **Field of Search** ... 425/343, 335, 336, 369, 370, 425/371, 396, 412, 423, 200, 201; 198/203

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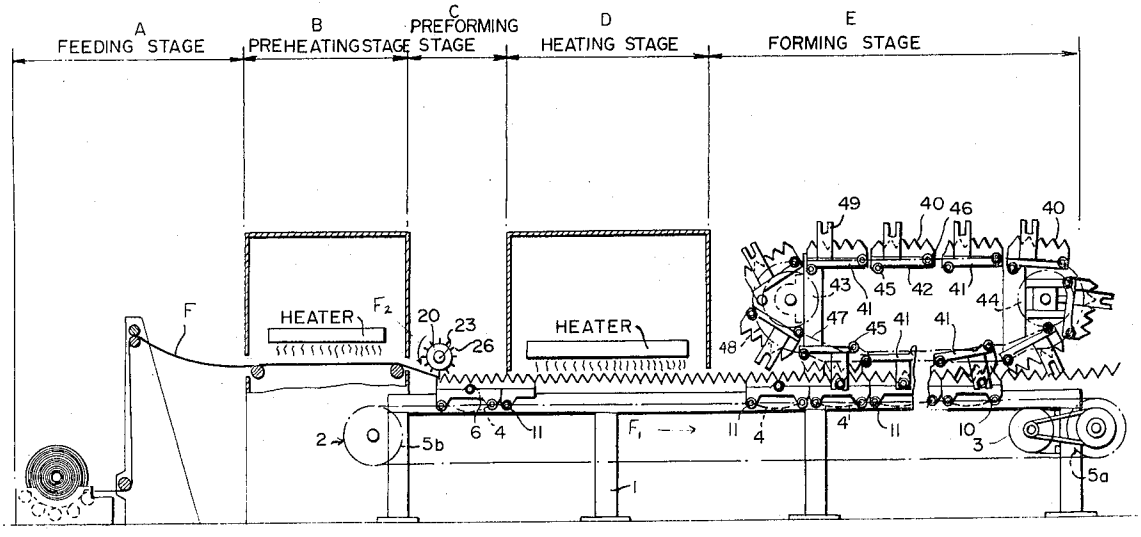
Primary Examiner—Robert L. Spicer, Jr.
Attorney, Agent, or Firm—Stowell & Stowell

[57] **ABSTRACT**

Apparatus is provided for continuously and in accurate register forming sheet material from, for example, a roll supply thereof characterized in that sheet forming is carried out by at least first and second cooperating dies with means associated with one of the dies for driving the other in synchronous register. The apparatus may also include a third die set which is likewise driven in synchronous register.

13 Claims, 8 Drawing Figures



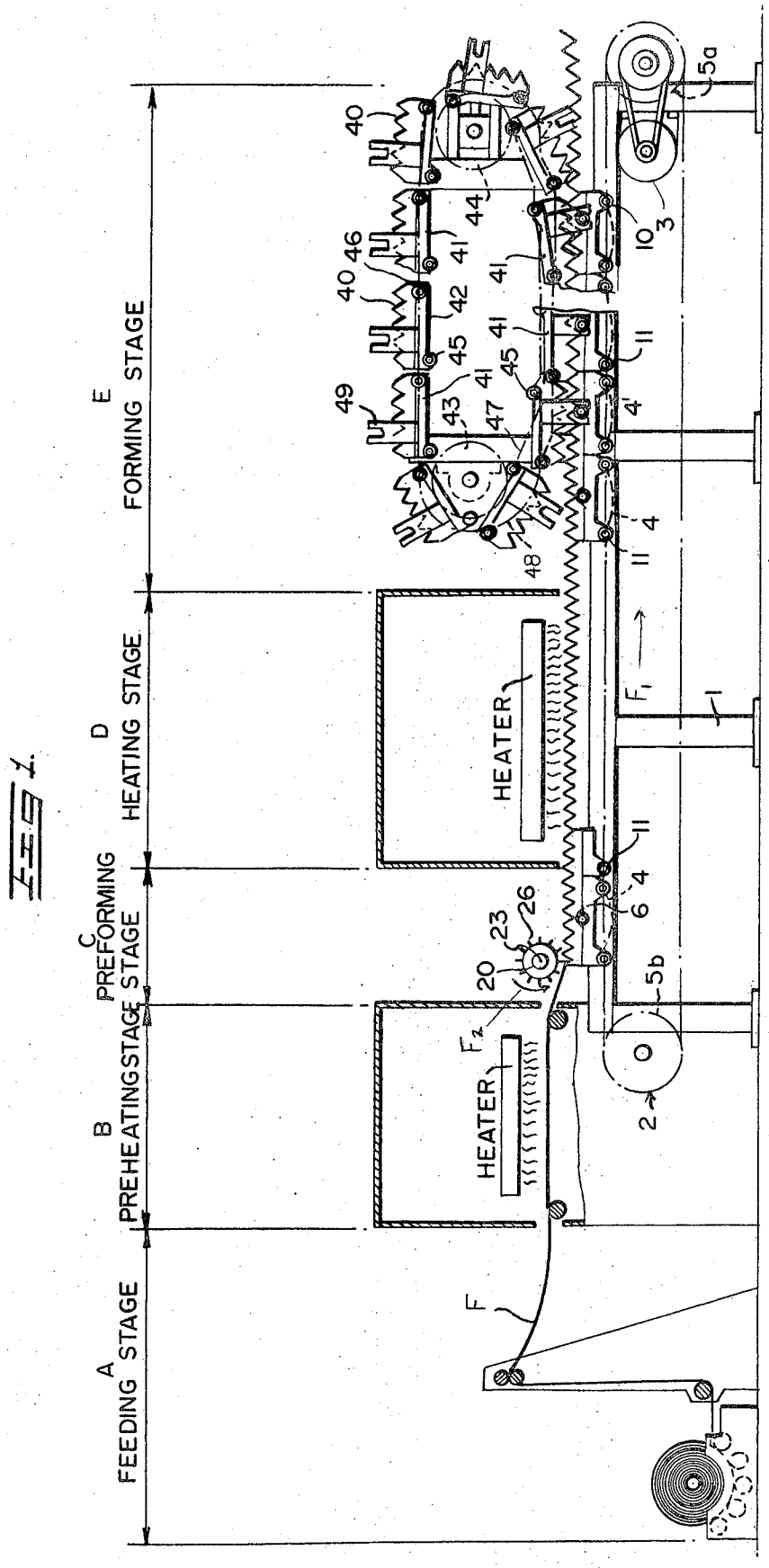

A FEEDING STAGE
B PREHEATING STAGE
C PREFORMING STAGE
D HEATING STAGE
E FORMING STAGE
HEATER
HEATER
F
F1
F2
1
2
3
4
4'
5a
5b
6
10
11
20
23
26
40
41
42
43
44
45
46
47
48
49

FIG 1.

Fig 2

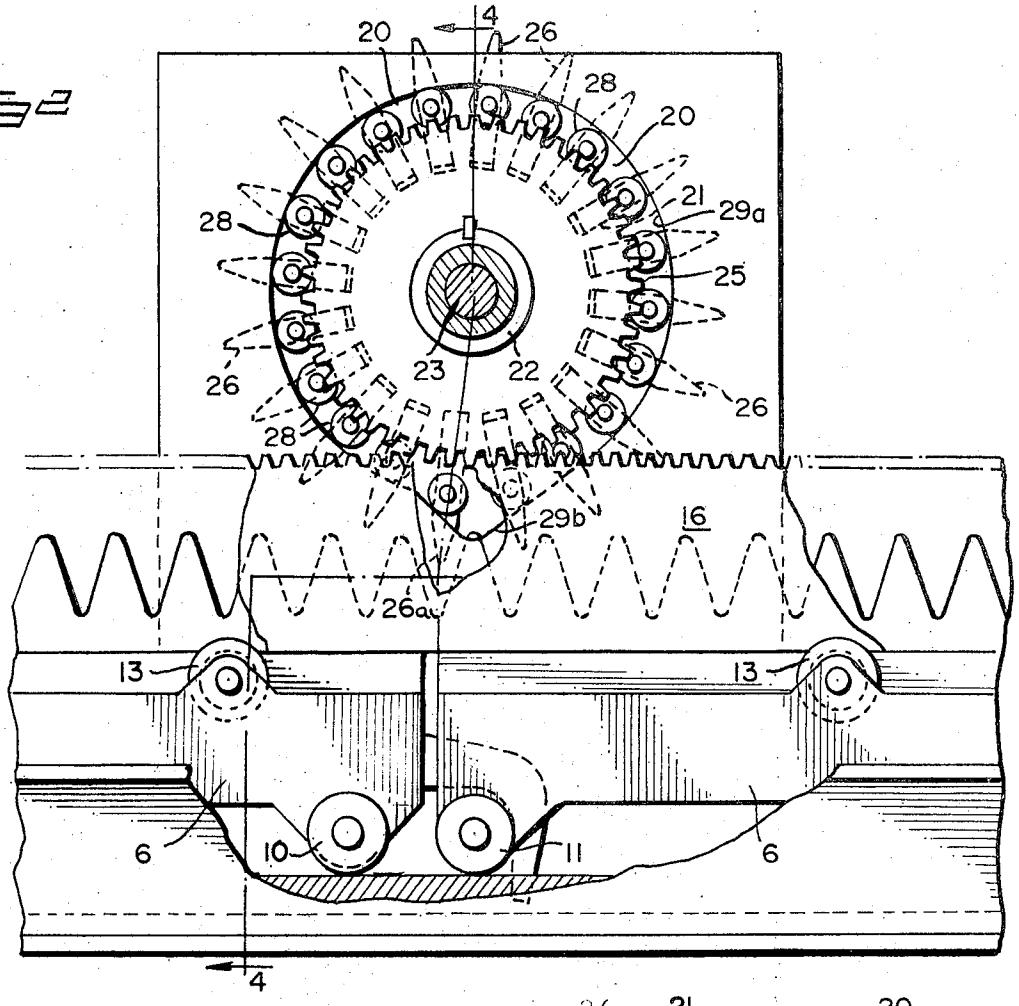
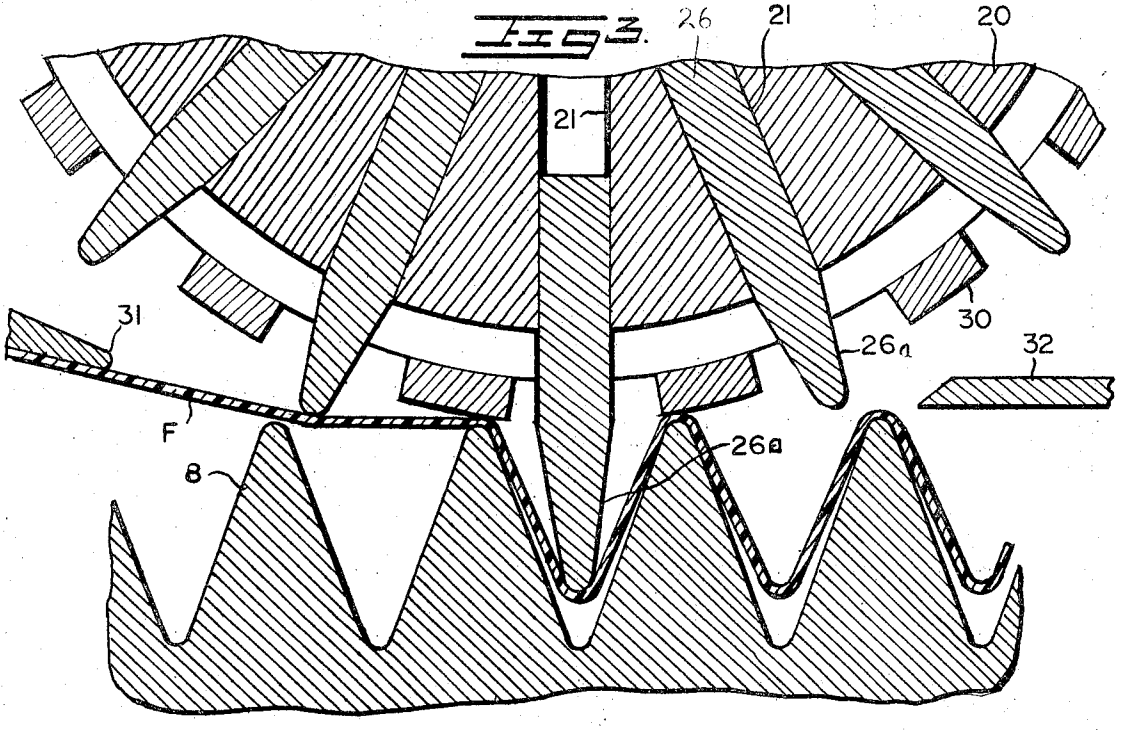

4
20
26
28
20
21
29a
28
25
23
22
26
26
28
29b
16
26a
13
13
6
10
11
6
4

Fig 3.


26
21
20
21
31
30
26a
32
F
8
26a

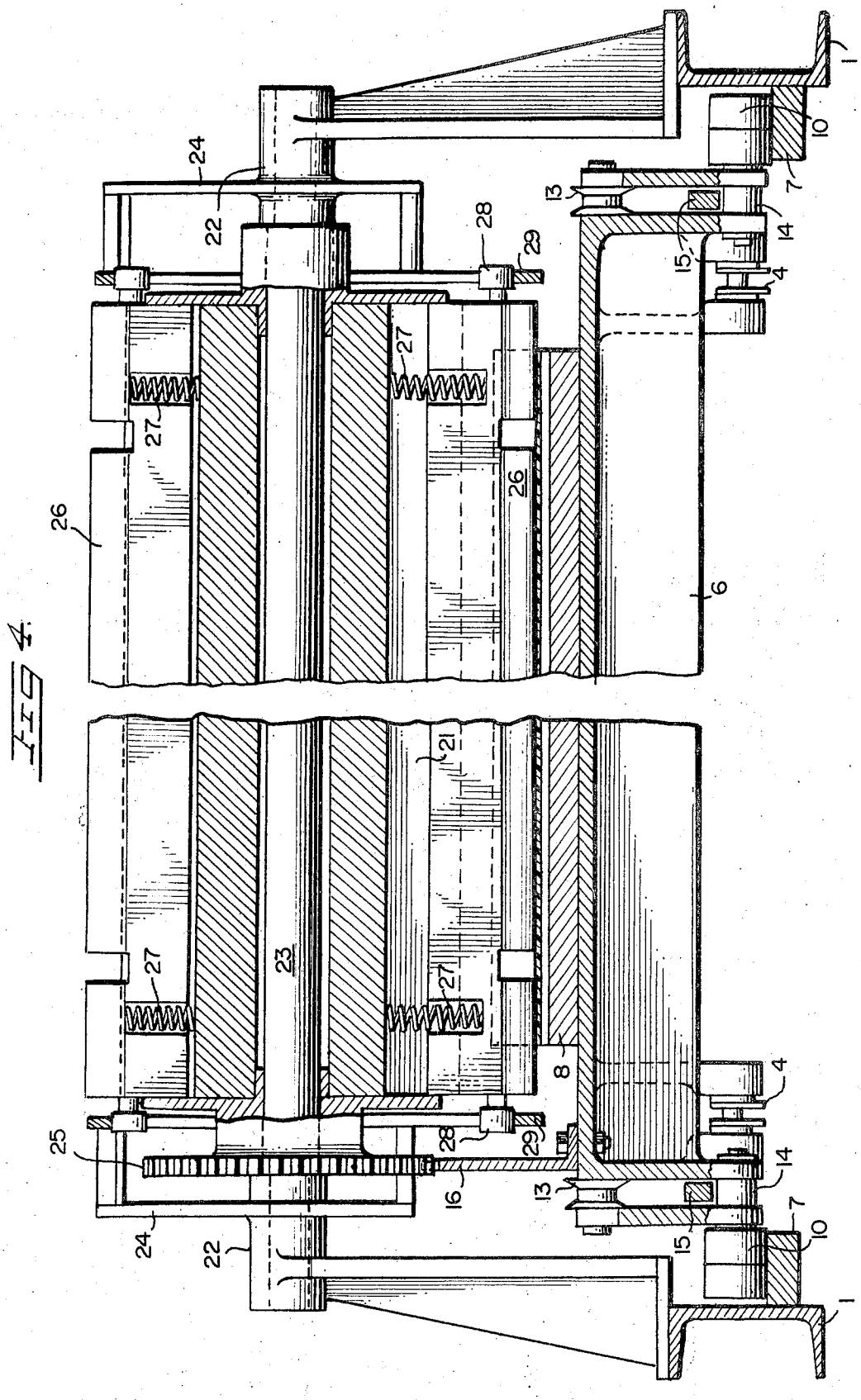


FIG 4.

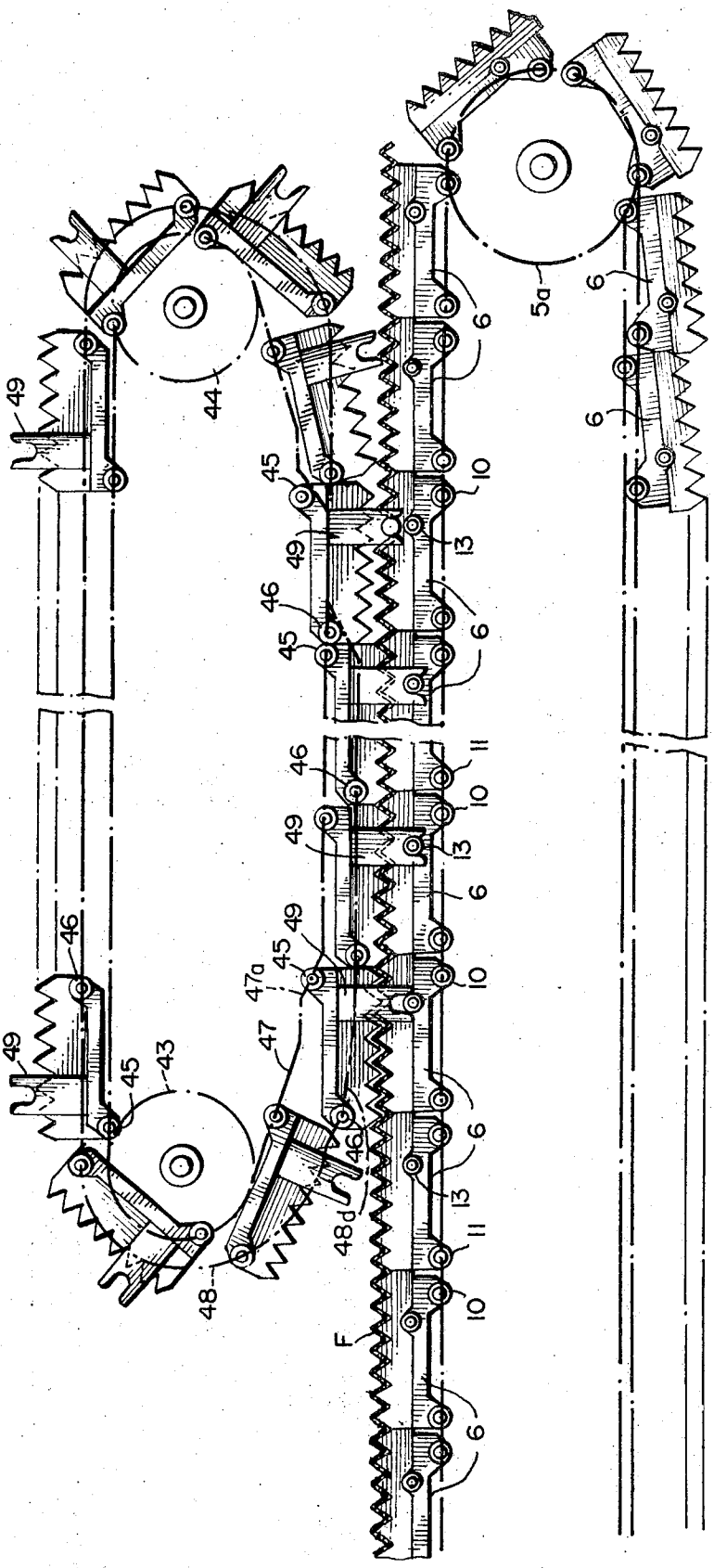


Fig 5.

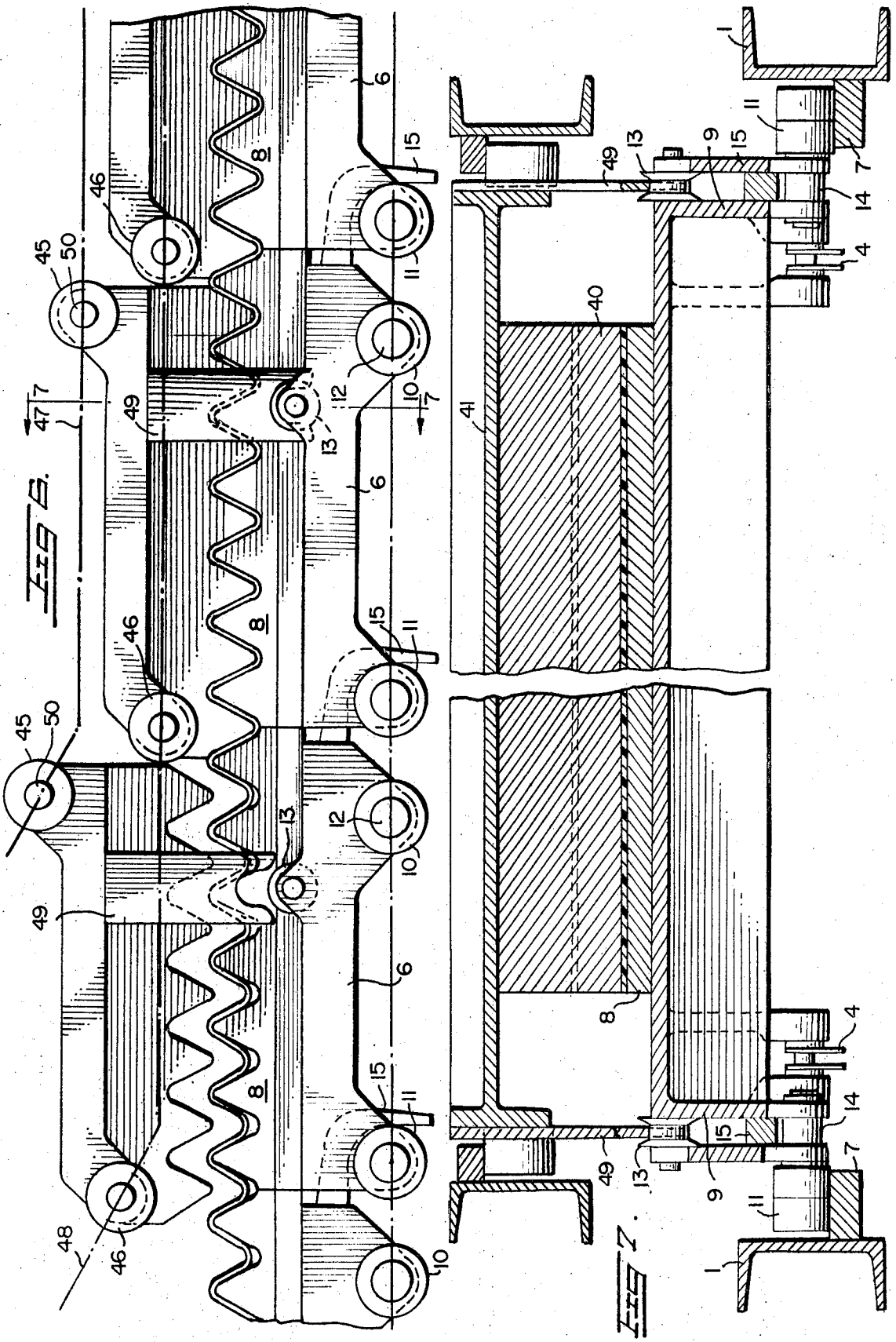


Fig. 6.

Fig. 7.

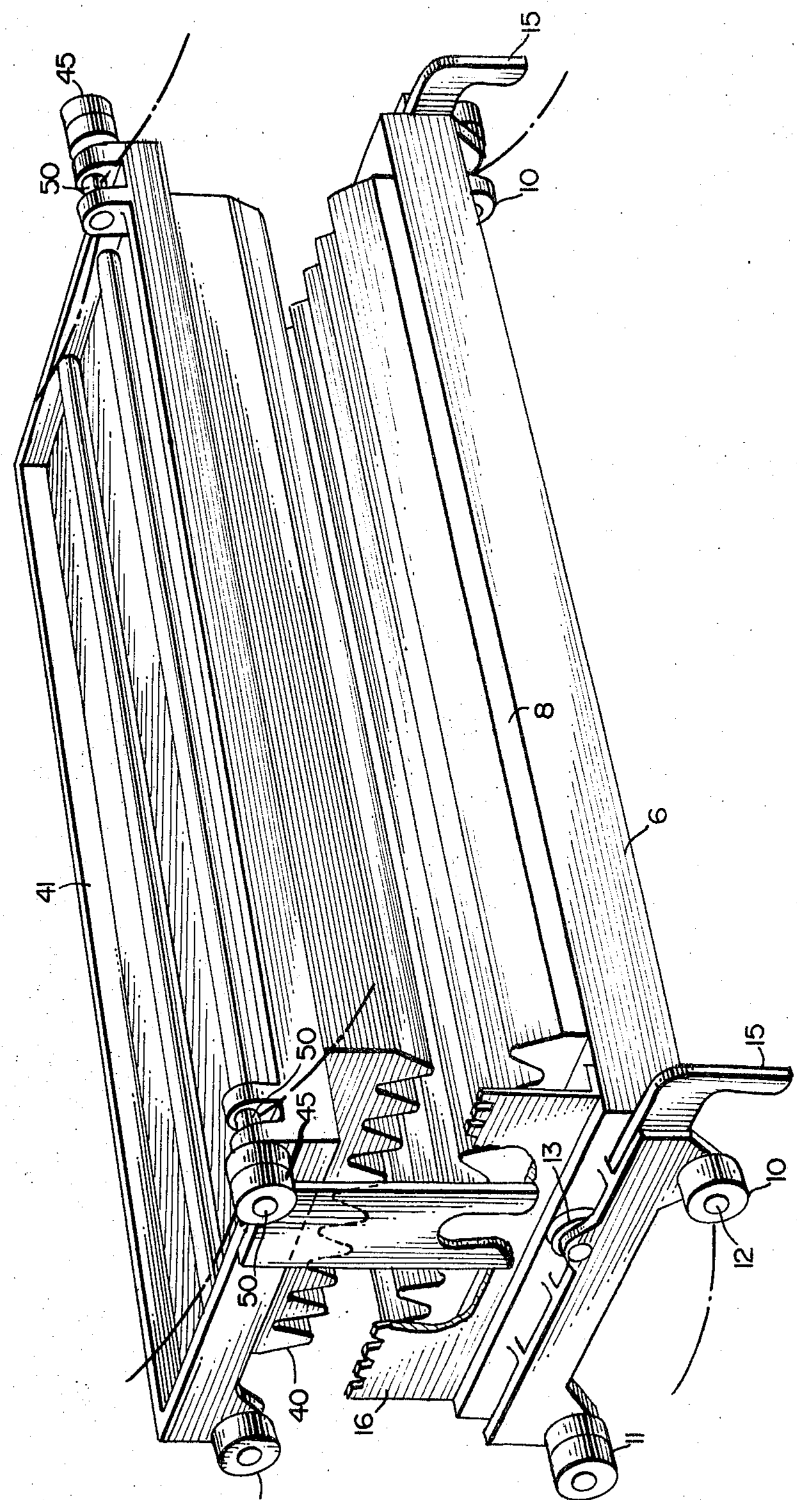


FIG. 7

SHEET FORMING DEVICE

Related subject matter is disclosed and claimed in my application Ser. No. 251,620, filed even date herewith for FILLING SHEETS FOR LIQUID-GAS CONTACT APPARATUS.

The present invention relates to apparatus and installations embodying same for forming surface configurations on sheets or sheet material on rolls and in particular such forming of thermoplastic sheet materials.

Throughout the specification and claims the terms "sheet" or "sheets" means extended surface sheet-like materials in the form of webs delivered from sheet manufacturing apparatus or in the form of rolls or stacks of cut material.

BACKGROUND OF THE INVENTION

Apparatus for forming sheet material into regular or irregular corrugations is known in the art. For example, machines are known which include a pair of die elements, one comprising a fixed die and the other movable into and out of sheet forming position, thereby operating in the manner of a press between which the sheet to be formed or re-formed is positioned. Such press-like forming apparatus permits accurate register of the opposed die elements; however, the operation of such apparatus is discontinuous in nature thereby reducing the efficiency and militating against high speed operation.

While continuous sheet forming or re-forming apparatus is known, such prior art continuous forming apparatus often subject the sheets to rough deformations often resulting in torn sheets, particularly at high speeds thereby limiting protection and decreasing efficiency.

It is a primary object of the present invention to provide apparatus and installation including such apparatus which overcome the aforementioned drawbacks and deficiencies in prior art sheet forming apparatus.

It is a further object to provide an improved sheet forming apparatus having synchronous register at the forming dies and which is particularly adaptable to continuous high speed operation.

In general, the apparatus may be defined as of the type including at least two forming implements or organs driven in synchronism between which passes a sheet to be formed and wherein the die carrying elements are locked with their counterpart die carrying elements over at least a portion of closed ways. The apparatus also includes means which insure synchronous register in the sheel forming zone or area by driving only one of the forming organs or dies and interconnecting the other of the forming organs or dies for drive by the first thereof.

Other novel characteristics of the invention comprise:

Apparatus wherein each die element is supported by a carrier tray secured to at least one endless chain driven in a closed path to present a top run and a bottom run wherein the trays are caused to be located in a contiguous manner with each other during their top run positions and discontiguous and unlocked from each other during their bottom run positions;

Apparatus including forming organs which cooperate with the tray carried die elements with the forming organs comprising a plurality of forming slats slidably mounted in the peripheral surface of a rotating drum,

the axis of which is positioned parallel and transverse of the top run of the die carrying tray elements and wherein each of the trays is provided with a rack which cooperates with a toothed wheel affixed to the drum and through which the drum is caused to rotate in synchronism with the movement of the tray carried rack;

The apparatus may also include further sheet forming dies supported by trays secured to endless chains adapted to travel in a closed path having upper and lower runs with the lower run being parallel to and positioned over a portion of the top run of the other tray carried first die elements; and

Apparatus including guide means adapted to bring the upper and lower tray carried die elements into opposed register and additional driving means carried by each of the trays to cause the trays to move in meshed synchronism.

The invention also relates to sheet forming installations for deforming particularly thermoplastic materials including a feeding stage, at least one heating stage and at least one forming stage wherein each of the at least one forming stages includes the novel apparatus generally defined hereinabove.

Other characteristics and advantages will be more particularly described in reference to the accompanying drawings given only by way of example wherein:

FIG. 1 is a partially diagramatic view of the overall apparatus comprising the present invention:

FIG. 2 is an enlarged fragmentary elevational view with parts broken away, of the preforming device;

FIG. 3 is a still further enlarged detailed sectional view showing the specific operation of the preforming device;

FIG. 4 is a detailed vertical sectional view taken along the line 4—4 of FIG. 2;

FIG. 5 is an enlarged partial schematic view, showing greater detail of the coordinated mechanisms employed in the forming stage;

FIG. 6 is a still further enlarged elevational view of the coordinated components in various stages of operation as illustrated in FIG. 5;

FIG. 7 is a detailed vertical sectional view taken along the line 7—7 of FIG. 6; and

FIG. 8 is a perspective view of a pair of die elements shown in FIGS. 1, 5, 6 and 7.

Forming apparatus according to the present invention is described as incorporated in a more complicated installation which is shown in FIG. 1 and includes a sheet feeding stage A, a sheet preheating stage B, a sheet preforming stage C, a sheet heating stage D and a final sheet forming stage E.

The feeding, preheating and heating stages are generally conventional and will not therefore be described in detail. It is, however, mentioned that the feeding stage includes a roll of thermoplastic material F to be formed and is provided with driving means having automatic unrolling speed regulating means for the roll of sheet material F so as to avoid any risk of accidental web or sheet breakage. As regards the preheating and heating stages B and D, they are composed of heating soleplates, the temperature of which may be regulated as and when required.

The forming stage itself includes a frame 1 on which is mounted a first kinematic chain assembly 2. The assembly is driven by motor-reducer or motor-regulator set 3 connected to at least one driving cog-wheel 5a for endless chain 4. The chain 4 is trained about at least

one idler wheel 5b. In the present invention, two parallel chains 4 and consequently two pairs of cog-wheels are provided. The pair of chains 4 mount trays 6 which are guided along roller-paths 7 integral with the frame as to be more fully described in reference to FIGS. 4, 7 and 8.

Each tray has a plane upper face on which is fixed a die element 8 which, in the illustrated case, has a corrugated form. Each die element 8 may be fixed to its respective tray 6 for instance by screws so as to be easily interchangeable.

From the plane upper face, two lateral wings 9 extend downwards and support front guide-rollers 10 and back guide-rollers 11, with the rollers 11 arranged in the back of the tray having a sensibly greater thickness than that of the front rollers 10, and this, for a purpose which will clearly appear hereinafter. The tray driving chains 4 are secured to the trays at the level of the front guide-rollers 10 and about axes 12 coaxial to these rollers. Slightly behind the front rollers 10, each tray has secured thereto, at its upper part, two grooved rollers 13 of V section or type which are intended to cooperate with forks carried by the trays of the forming stage of the apparatus which will be described hereinafter. Each tray is further provided, on either of its lateral faces, with a roller 14 arranged at its back part and projecting hook 15 at its front part. Further, each tray supports a rack 16 on its upper plane face, along a lateral side edge of the die element 8.

FIG. 2, 3 and 4, show the detailed preforming stage which comprises a rotating drum 20 having a series of regularly spaced radial slits 21 formed therein. The drum is mounted for rotation by bearings 22 on a shaft 23 mounted between two side-plates 24 of the frame. The drum 20 is integral with a cog-wheel 25 which meshes with the racks 16 carried by each of the trays at the moment when the latter reaches the preforming stage. In the radial slits of the drum are slidably mounted slats 26 having tapered outer edges or ends 26^a which are pushed outwards by resilient elements 27 such as, for example, helical springs. Each of the slats 26 carries two guide-rollers 28 resting against paired cams 29, FIG. 4, rigidly mounted with respect to the frame. FIG. 2 shows the profile of one of these cams, which in its larger part 29^a is circular and maintains the slat in the bottom of its housing contrary to the action of the springs.

The cam 29 has, in the vicinity of its lower part, a depression 29, the depth of which corresponds to the distance at which each slat 26 must penetrate into the corrugations of the opposite die element.

The drum 20 also carries plugs 30 arranged in the spaces between the slats, which plugs apply pressure to the sheet material and maintain the sheet material on the upper edges of the die corrugations.

Ramps 31 and 32 are provided before and after the drum in order to ensure correct feeding and guiding of the sheet material on both sides of the preforming stage.

The forming stage E, which is one of the important parts of the installation, will be described in reference to FIGS. 1, 5, 6, 7 and 8. There are shown the lower trays 6 made contiguous and locked with each other by means of the hooks 15 of adjacent trays in mesh on the rollers 14. This stage of the installation is completed by a second set of die elements 40, the form of which is complementary to that of the lower dies, with the die elements 40 being also carried by trays 41 which are themselves fixed on two endless chains 42. The chains 42 mesh with pairs of idler cog-wheels 43, 44. The die elements 40 are, as set forth above, fixed in a removable manner on their trays, which also support two sets of guide-rollers 45, 46, the front rollers 45 having a thickness about twice that of the back rollers 46 so as to effect independent guiding for both sets of rollers.

In FIGS. 1 and 5 are represented by chain-dotted lines the respective layouts of the roller-paths of the sets of rollers 45 and 46 with the layout 47 corresponding to the front rollers 45 and the layout 48 corresponding to the back rollers 46. Each tray also supports, on either of its lateral faces, a fork 49 which is intended to engage a roller 13 carried by a lower tray 6. The endless chains 42 are fixed on each upper tray in the vicinity of the front rollers, around axes 50.

Referring now to the various drawings, the operation of the installation will now be described to provide a better understanding of the parts played by the various units heretofore described.

First of all, the sheet material, after having been heated in the preheating stage B to an adequate temperature to permit it to be deformed (60° to 100° C for instance), reaches the preforming stage C. The lower trays 6 moving in the zone of the arrow F_1 reach this stage after being fixed or coupled to each other by means of hooks 15 arranged at their upper part, these hooks coming in mesh on the rollers 14 arranged at the lower part of the preceding tray. The trays thus form a rigid system along the top side of the endless chain run thereby providing perfect continuity of the profile. In the vicinity of the preforming stage, the rack 16 of a given tray comes in mesh with the cog-wheel 25 integral with the drum 20, which rotates the latter in the direction of the arrow F_2. During this rotation, the slats 26 pushed by their springs 27 penetrate in the successive corrugations of the die elements 8. This action ensures the introduction of a sufficient quantity of sheet material into the trough of the corrugations of die elements 8. It has been found that the filling of the troughs occurs pracitcally without tensioning the sheet and consequently without risk of breakage of the sheet. The plugs 30 tend to maintain the sheet material on the top surface of the die corrugations and make the operation easier. At the end of the preforming process, the sheet material already pre-corrugated passes into the heating stage D where it is subjected to a temperature of about 100°to 180° C., for instance, so that it can easily be deformed when reaching the final forming stage.

In the forming stage, as illustrated, the upper discs 40 which are in the central part of the bottom side of their closed way are in mesh with the lower die elements 8 and are respectively made contiguous and locked together by the engagement of the forks 49 on the rollers 13 of the lower trays. Consequently, the upper trays 41 are directly driven by the lower trays 6, which ensures perfect synchronization of the motion of the trays 6 and 41. The upper die elements 40, via the forks 49, mesh and disengage on the lower die elements 8 via the rollers 13 and such meshing and disengagement is caused by the two sets of respectively front and back rollers 45 and 46 carried by each tray 41 which are guided by different roller-paths. Different roller-paths are possible due to the lateral displacement of these two sets of rollers. When the roller-path profiles are chosen properly, the upper trays can be progressively brought (FIGS. 1,

5 and 6) to a position at which they are parallel to the lower trays but spaced at some distance from the latter. It is then necessary to provide two nearly parallel-racks 47*a*, 48*a* for the sets of front and back rollers to provide the upper tray with a vertical movement component with respect to the opposite tray, while remaining parallel to the latter. During this vertical movement, which is of course accompanied by a horizontal displacement at a speed equal to that of the lower trays, the forks **49** come in mesh on the rollers **13** and the upper die element **40** engages in the opposite lower die element **8.** As this engagement strictly occurs perpendicular to the surface of the dies, there is no risk that the sheet material be subjected to tear producing stresses. From the moment at which the two die elements thus engage, the fornt and back rollers **45, 46** of the upper trays are no longer guided.

The length of the bottom side of the upper conveying element is so chosen that the plastic sheet material maintained closely pressed between the two sets of dies moves a sufficient time to enable it to cool within the dies and to stabilize in the deformed configuration.

At some distance before the wheels **44,** the rollers **45** and **46** of the upper trays again contact their respective guiding surfaces so that the trays **41** move progressively away from the lower trays **6** while maintaining horizontal alignment, then when trays **41** are distant enough from trays **6,** they incline to allow the disengagement of the forks as they rotate around the wheels **44.** The lower trays then turn about the driving wheels **5**a which causes the disengagement of the hooks **15** from the rollers **14**; thereafter, the lower roller-paths are shaped to guide only the wider back rollers **11** and release of the front rollers **10** so that all along the bottom run the chains are tightened and the trays assume an inclination such as shown in FIGS. **1** and **5.**

The sheet material so formed is then directed to a cutting and storing stage or it may be subjected to other suitable treatments.

The advantages of the aforesaid forming apparatus which consists in either the preforming stage or the forming stage or both stages are essentially the following:

a perfectly regular and precise form can be given to sheet material in a continuous manner, the precision and the regularity essentially resulting from the fact that the additional forming means are driven in strick synchronism, and in a very simple manner;

The dies **8, 40** and the drum **20** are very simply changed which enables adaption of the machine to the fabrication of a large variety of profiles which may differ as regards their form and their pitch;

The provision of a preforming stage is realized to ensure that a sufficient quantity of sheet material is supplied in the corrugations of the dies **8** before the forming operation itself, avoiding sheet breakage or tearing;

What is claimed is:

1. Continuous sheet material forming apparatus comprising:

a a plurality of first die elements;

b a plurality of complementary die elements;

c means for moving the first die elements in an endless path;

d means for connecting the complementary die elements for motion in an endless path at least a portion of which is parallel and opposed to the endless path of the first die elements;

e means carried by the first die elements and the complementary die elements for interlocking said elements during opposed parallel portions of their endless paths of travel whereby the first die elements impart motion to the complementary die elements; and

f including additional sheet material forming means cooperating with said first die elements, wherein said additional forming means comprise a drum mounted for rotation on an axis parallel to and transverse of the endless path, a plurality of slats slidably and radially mounted on said drum, resilient means urging the slats radially outwardly and means for rotating the drum in synchronism with the movement of the first die means.

2. The invention defined in claim **1** wherein each of the first die elements and each of the complementary die elements is supported by a tray.

3. The invention defined in claim **2** wherein the trays are secured to endless kinematic chains.

4. The invention defined in claim **2** including cooperating latching means between successive trays, and means for maintaining said latching means in the latched position during the said at least a portion of their endless paths.

5. The invention defined in claim **4** wherein the cooperating latching means comprises a hook mounted on one end of each tray and a hook receiver carried at the opposite end.

6. The invention defined in claim **5** wherein the hook receivers comprise rollers.

7. The invention defined in claim **4** further including sets of front and back guiding elements carried by each tray and cooperating with guide ways therefor.

8. The invention defined in claim **7** wherein the guiding elements and guide ways maintain the trays for the first die elements horizontal along the said at least a portion of their endless path.

9. The invention defined in claim **1** wherein the means for rotating the drum in synchronism with the movement of the first die means includes a rack integral with each of the first die elements and a cogwheel secured to the drum and adapted to engage with the first die element carried racks.

10. Continuous sheet material forming apparatus comprising:

a a plurality of first die elements;

b a plurality of complementary die elements;

c means for moving the first die elements in an endless path;

d means for connecting the complementary die elements for motion in an endless path at least a portion of which is parallel and opposed to the endless path of the first die elements;

e means carried by the first die elements and the complementary die elements for interlocking said elements during opposed parallel portions of their endless paths of travel whereby the first die elements impart motion to the complementary die elements;

f including additional sheet material forming means cooperating with said first die elements, wherein said additional forming means comprise a drum mounted for rotation on an axis parallel to and transverse of the endless path, a plurality of slats slidably and radially mounted on said drum, resilient means urging the slats radially outwardly and

means for rotating the drum in synchronism with the movement of the first die means; and

g plugs mounted on the periphery of said drum between the radial slats adapted to apply holding pressure on the sheet material to be formed.

11. The invention defined in claim **1** wherein the means carried by the first die elements and the complementary die elements comprise forks secured to each of one of said elements and a cooperating roller carried by each of the other of said elements.

12. The invention defined in claim **1** wherein said continuous sheet material forming apparatus comprises the sheet forming stage of an installation including at least one sheet material feeding stage and at least one sheet material heating stage.

13. The invention defined in claim **12** wherein the installation also includes a preheating stage for the sheet material and a preforming stage preceding the heating stage and the forming stage.

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