

Nov. 6, 1923.

1,472,902

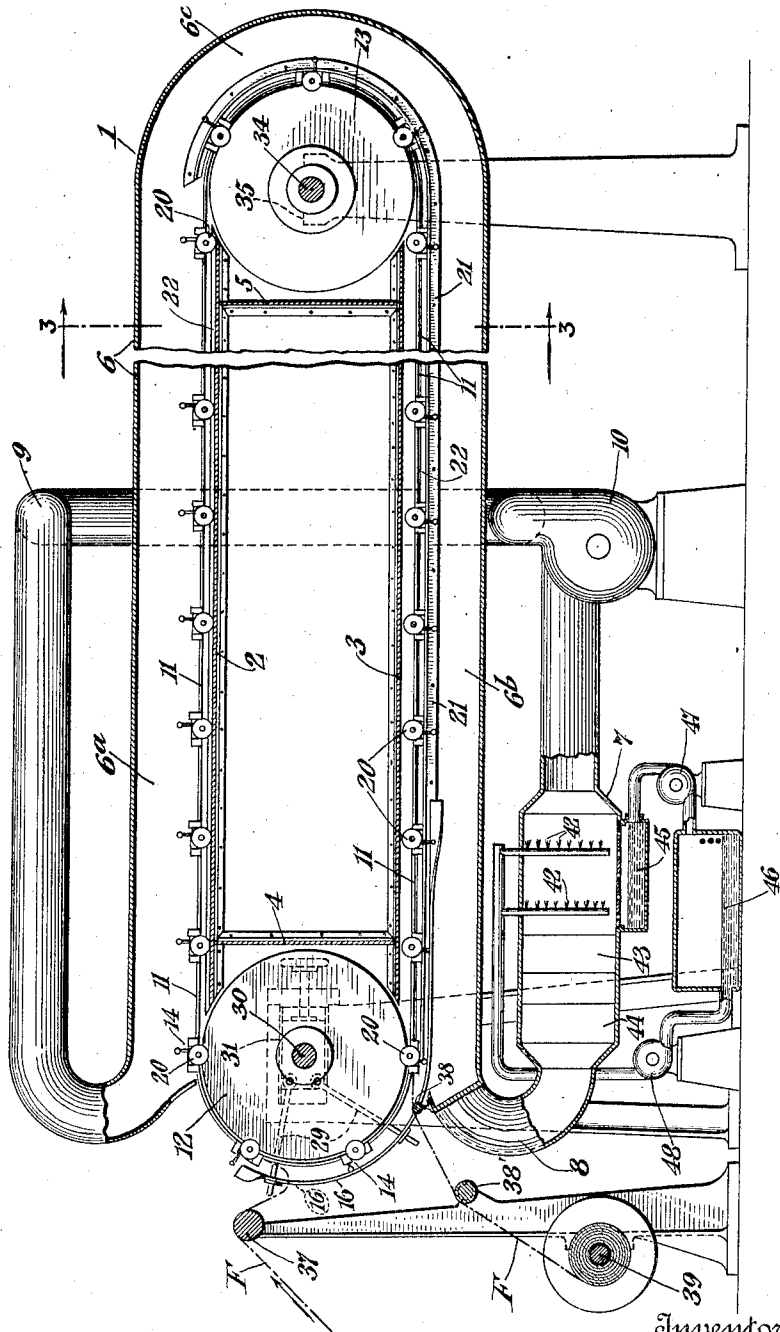
C. A. BULKELEY

DRIER

Filed Jan. 26, 1920

4 Sheets-Sheet 1

Fig. 1.



Inventor

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By his Attorney *J.B. Squair.*

Nov. 6, 1923.

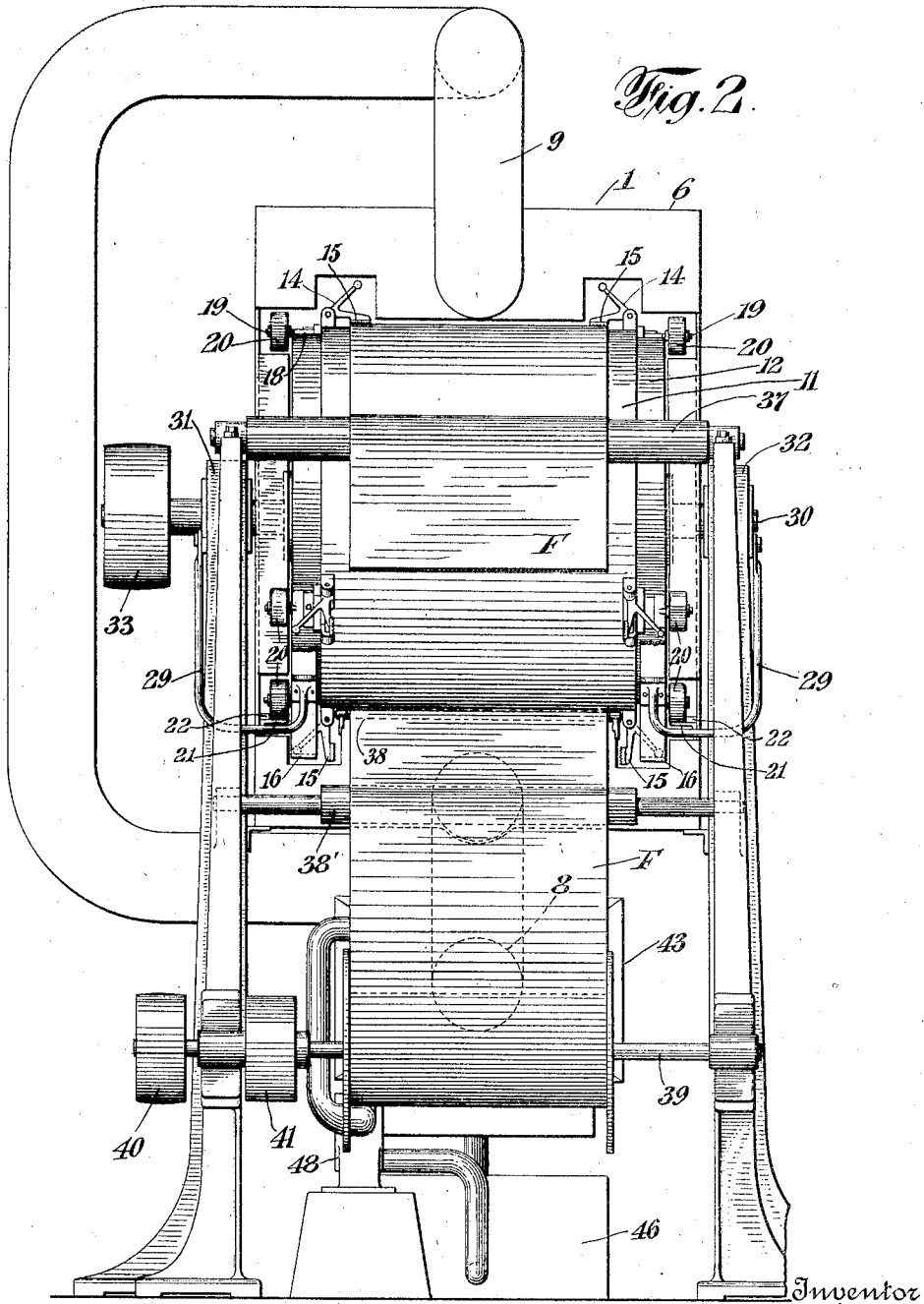
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DRIER

Filed Jan. 26, 1920

4 Sheets-Sheet 2



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Nov. 6, 1923.

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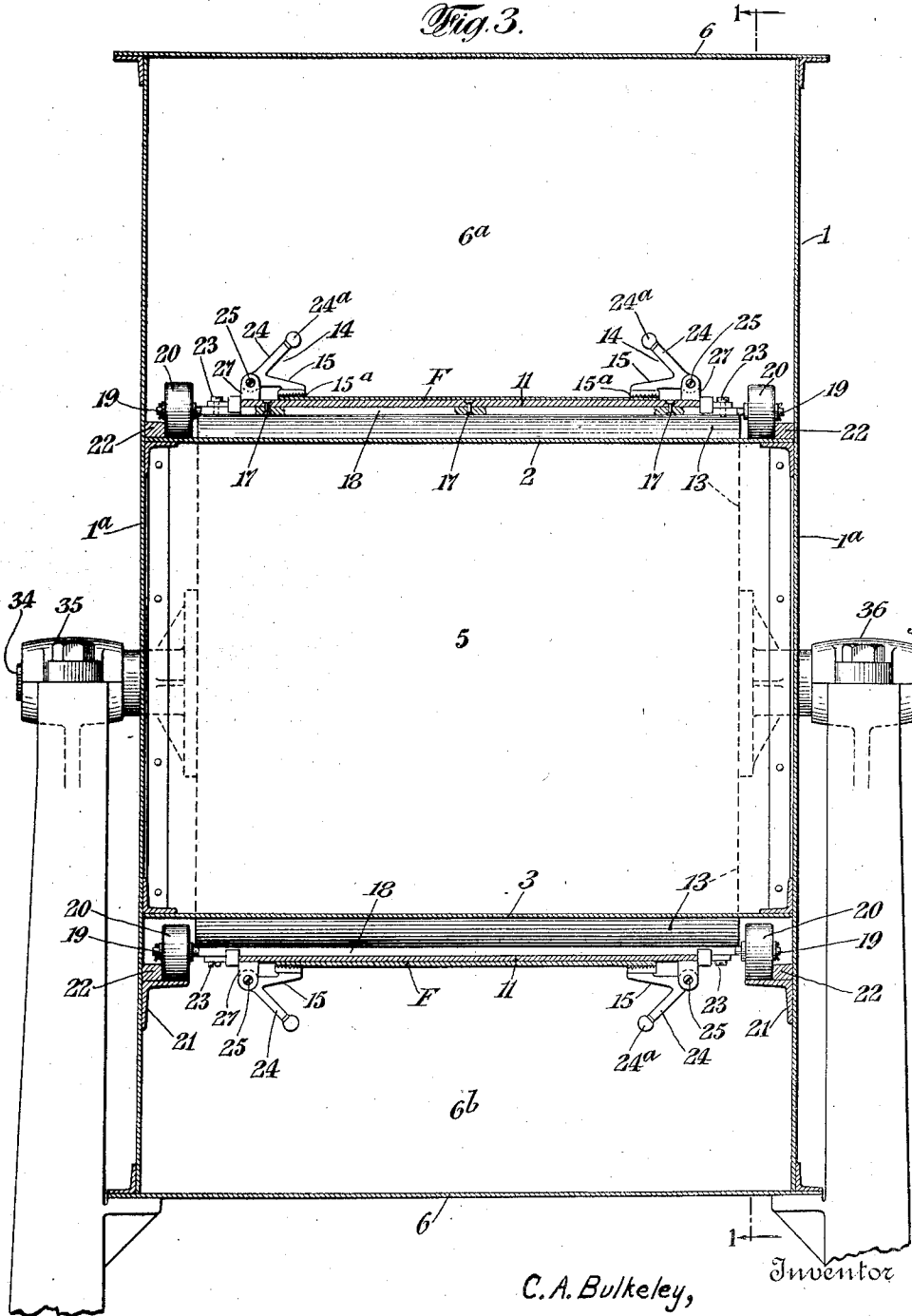
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DRIER

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4 Sheets-Sheet 3

Fig. 3.



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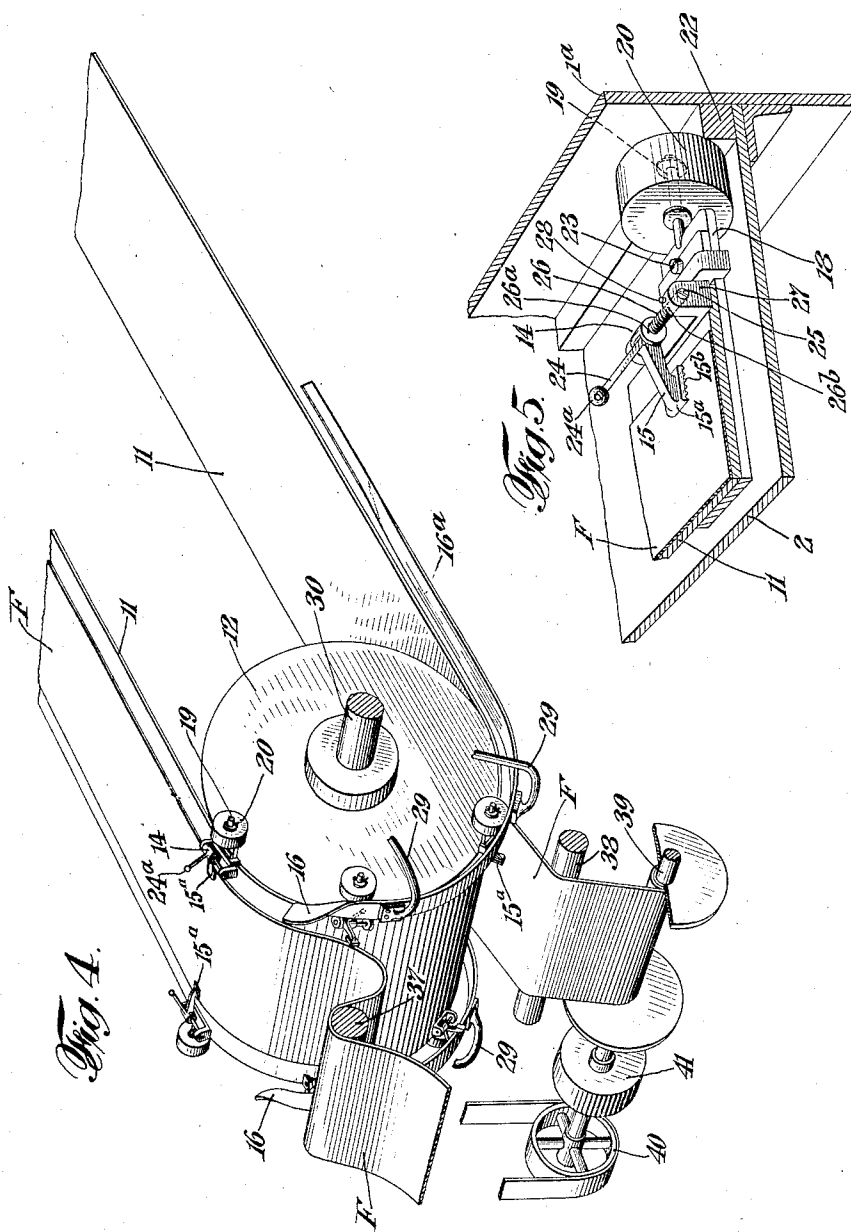
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C. A. BULKELEY

DRIER

Filed Jan. 26, 1920

4 Sheets-Sheet 4



C. A. Bulkeley, Inventor

By his Attorney *H. Squair.*

UNITED STATES PATENT OFFICE.

CLAUDE A. BULKELEY, OF WILMINGTON, DELAWARE, ASSIGNOR TO E. I. DU PONT DE NEMOURS & COMPANY, OF WILMINGTON, DELAWARE, A CORPORATION OF DELAWARE.

DRIER.

Application filed January 28, 1920. Serial No. 354,033.

To all whom it may concern:

Be it known that I, CLAUDE A. BULKELEY, a citizen of the United States, and a resident of Wilmington, in the county of New Castle and State of Delaware, have invented a certain new and useful Drier, of which the following is a specification.

This invention relates to apparatus for drying endless-sheet material constantly fed thereto, the illustrated apparatus being particularly useful in the treatment of photographic films to dry the freshly coated wet emulsion thereon. I do not restrict the invention to apparatus for drying film, but since it finds advantageous application in the film-drying art, I describe it with more particular reference to that art.

In the manufacture of photographic films a suitable flexible transparent base is coated with sensitized emulsion. After the coating operation the wet emulsion is dried. A film is, of course, a long continuous sheet, so that a drier for films should be capable of continuously and uninterruptedly handling long sheets of material. Also such a drier should be substantially dust proof, should dry the film uniformly and rapidly, and should have means for holding the film from curling during the drying. I have devised a film drier having the above noted, and other, desirable features.

One object of the invention is to provide a drier with which long sheets of material, such as photographic films, can be continuously, rapidly and progressively dried, such drier being relatively short over-all.

Another object is to provide a drier having means for holding the sheet being dried against curling.

Another object is to provide a drier having conveying means in the character of an endless belt provided with means for clamping the sheet being dried to the belt along its edges, such clamping means being automatically operative to grasp the sheet at its entrance to the drier, hold the sheet during its travel through the drier, and release it at its exit from the drier.

To these ends and also to improve generally upon apparatus of the character indicated, my invention consists in the matters hereinafter described and claimed.

In the accompanying drawings:—

Figure 1 is a longitudinal section, substantially on line 1—1 of Figure 3, of a film drier embodying my invention, a portion of the length thereof being broken out to economize space, and the dehumidifying air conditioner, blower, and related parts being somewhat conventionally shown;

Figure 2 is an elevational view of the receiving and delivery end of the drier, showing the storage mandrel for the finished goods;

Figure 3 is a sectional view taken substantially on line 3—3 of Figure 1, the rear belt drum being indicated in dotted lines;

Figure 4 is a perspective fragmental view of the camtrack and certain of the clips cooperating therewith, together with certain of the parts immediately related thereto, and

Figure 5 is a perspective view of one of the clips and its mounting.

Referring now to the drawings:— The illustrated apparatus comprises a sheet metal box-like structure designated generally as 1. The side walls 1^a of the structure carry upper and lower partitions 2 and 3, respectively, extending fully across the structure and connected by the end partitions 4 and 5, to present a species of closed box within the structure 1 with its sides provided by portions of the side walls 1^a and the box providing a "dead space" within the structure 1. There is thus provided a forward-and-back drying chamber designated generally as 6 and composed of the upper reach 6^a, lower reach 6^b and connecting portion 6^c, the chamber being closed except for suitable entrance and exit passages for the drying air and for the film. With this arrangement the drying air can be introduced at the end of the lower reach 6^b to travel therealong, then along the portion 6^c, and then backward along the length of the reach 6^a. A dehumidifying air conditioner, designated generally as 7 and connected with the lower reach 6^b as at 8, an air return connection as 9, and a blower 10 together provide for the circulation and conditioning of the drying air.

An endless film-carrying belt 11 is carried upon a driven drum 12 and an idler drum 13 arranged at opposite ends of the structure 1, and in operation moves from the drum 12

along the upper reach 6^a and back along the reach 6^b.

Since the structure 1, with its partitions, fully provides the chamber 6, the belt 11 is not used for chamber-forming purposes, as it would be were the partitions 2 and 3 omitted; therefore the clearance between the sides of the belt and the sides of the structure can be made as great as desired, as for rollers, etc., without in any way interfering with the proper separation of the reaches 6^a and 6^b. Clips, designated generally as 14, are carried at each side of the belt and, normally, their fingers 15 are forced toward the belt to clamp the sheet of film F thereon substantially throughout the length of the belt, but as they approach the exit from the chamber they are moved to film-releasing position by cam-tracks 16, one at each side of the belt, and later are released to clamp the film just being introduced.

With this arrangement, a sheet of film F travelling the circuit of the chamber has its emulsion dried by the air current travelling in the opposite direction, the drier air meeting the drier emulsion, and it will be noted that the air moves along the surface of the film and parallel thereto and, so, acts on each portion of the surface with maximum effect, there being no such inequality of action as would occur were the film hung in festoons. The endless belt 11, combined with the clips which hold the film to the belt along the lower span, permits a relatively short over-all length for the apparatus, with the advantage of saving floor space. The clips not only hold the film on the belt for conveying purposes but also they hold the film from curling longitudinally as it has a tendency to do. Also, with the film held firmly to the belt, its proper passage through the chamber without attention while in the chamber is assured, so that it is unnecessary for attendants to open or enter the chamber. Thus entrance or stirring up of dust is avoided.

As to the details of the illustrated apparatus:—

The belt 11 carries, substantially equally spaced therealong throughout its length and suitably attached thereto as by rivets 17, a series of cross bars 18 each having an axle 19 at each end, for wheels 20. These wheels travel upon the upper cross partition 2 during the forward travel of the belt and travel upon the rails 21 during the backward travel of the belt, suitable spacing strips 22 being preferably used. This structure provides for the proper support of the belt between the drums.

A clip 14 (Figure 5) is fixed adjacent each end of each cross bar, as by a screw 23. It comprises a bell-crank whose arms 15 and 24 respectively carry the clip block 15^a and the roller 24^a. The bell-crank is urged to

turn about its pivot stud 25 to force the clip block toward the belt and grip the film, being actuated by a spring 26 connected to the bell-crank at 26^a and connected to the stud at 26^b. The tension of the spring may be adjusted by turning the stud in the supports 27 and fixing it by the set screw 28.

The arm 24 is the controller arm of the clip. Each cam track, 16, with which the clips cooperate (Figure 4) is so contoured that as the clip travels parallel to it, and the roller 24^a wipes it (on the face 16^a) the clip block 15^a is gradually lifted from the film to fully release the film somewhat prior to the belt reaching the drum 12, is held in releasing position until it reaches the point where the entering film is meeting the belt, and is then quickly released to grasp the film. The relations of the parts are such that, before the portion of the belt which is immediately associated with one pair of opposite clips leaves the drum 12 the pair of clips next behind clamps the film. In this way it is provided that the section of film between the two pairs of clips is clamped to the belt while the film is being laid onto the belt and curved about the drum 12 to easily conform to the curve thereof, the film, of course, being fed to the belt freely and without any stretching; thus, there is provided sufficient film between the various clips to span the distances between the clips (longitudinally of the belt) without stretching the film when the belt and film pass around the drum 13, the drums being of substantially the same diameter. The clip blocks 15^a are desirably serrated, as indicated at 15^b in a direction parallel to that of the travel of the air. With this provision, not only is the holding ability of the block improved, but also the air can travel beneath the clip block along the surface of the film.

A cam track may be merely a strip of metal suitably bent substantially as shown and may be conveniently located with respect to the drum, as indicated, by brackets 29.

The drum 12 has its shaft 30, to which the drum is fixed, rotatably mounted in bearings 31 and 32 of any desired type and preferably of the "take up" type as shown, to provide for shifting the drum to take up the belt. The drum may be driven by power supplied to the belt pulley 33. The idler drum 13 has its shaft 34, to which it is attached, rotatably mounted in suitable bearings 35 and 36, the shaft projecting through the sides of the structure 1 and being closely surrounded by said sides in a substantially air tight manner.

The film F is desirably continuously delivered over a supporting roller, conventionally indicated at 37, Figure 1, and festooned between said roller and the drum to

place it in proper position to be grasped by the clips and connected to the belt along a portion thereof lying on the drum. The dried film is passed over a supporting roller 38, in substantial alignment with the lower span of the belt, and, if desired, over a second roller 38', and thence to the wind-up mandrel 39. The latter is driven by power applied to the driving pulley 40, though a friction clutch 41 compensating for changes in the diameter of the roll of film.

The air treating apparatus may be of any suitable type. It is conveniently shown as comprising the dehumidifying air conditioner 7 with its sprays of chilled water 42, entrained water eliminator 43 and heater 44; and the spray tank 45, the Baudelot cooler 46 including, as is usual, a series of cooling pipes 46^a placed one above the other and over which the liquid to be cooled flows, and the circulating pumps 47 and 48 for pumping the water from the tank 45 to the cooler 46 and back to the spraying device.

Although I have described the invention by reference to the illustrated apparatus it will be understood that I do not restrict it thereto.

I claim:

1. In a drier, in combination, an inclosing structure having partition means therein providing a forward-and-back drying chamber, and means for conveying the material to be dried along said chamber; said partition means extending longitudinally of said structure and bridging the same from side to side thereby to form the forward reach and the backward reach of said chamber independently of said conveying means.

2. In a drier, in combination, an inclosing structure having partition means therein providing a forward-and-back drying chamber having separated forward and back reaches, and a single means for conveying the material along the forward reach and the backward reach; said partition means extending longitudinally of said structure and bridging the same from side to side thereby to form the forward reach and the backward reach of said chamber independently of said conveying means.

3. In a drier, in combination, an inclosing structure having partition means therein providing a forward-and-back drying chamber having separated forward and back reaches, means for conveying the material to be dried along said chamber, and provisions for the circulation of a column of drying fluid in said chamber along the reaches in succession; said partition means extending longitudinally of said structure and bridging the same from side to side thereby to form the forward reach and the backward reach of said chamber independently of said conveying means.

4. In a drier, in combination, an inclos-

ing structure having partition means therein providing a forward-and-back drying chamber, means for conveying the material to be dried along said chamber, and provisions for the circulation of drying fluid along the length of said chamber in a direction opposite to that of the travel of said means; said partition means extending longitudinally of said structure and bridging the same from side to side thereby to form the forward reach and the backward reach of said chamber independently of said conveying means.

5. In a drier, in combination, an inclosing structure having partition means therein providing a forward-and-back drying chamber having separated forward and back reaches, means for conveying the material to be dried along said chamber, and provisions for the circulation of a column of drying fluid along the length of said chamber and along the reaches in succession and in a direction opposite to that of the travel of said means; said partition means extending longitudinally of said structure and bridging the same from side to side thereby to form the forward reach and the backward reach of said chamber independently of said conveying means.

6. In a drier, in combination, a structure providing a forward-and-back drying chamber including two joined longitudinally extending passages, a conveyor in the character of an endless belt arranged for the travel of one of its spans in one of the passages of said chamber and its other span in the other passage, and means associated with said belt to travel therewith for holding the material to be dried upon said belt.

7. In a drier, in combination, a structure providing a forward-and-back drying chamber including two joined longitudinally extending passages, a conveyor in the character of an endless belt arranged for travel of one of its span in one of the passages of said chamber and its other span in the other passage, and means associated with said belt to travel therewith for holding the material to be dried upon said belt, said means comprising a series of spaced material-grasping units arranged along each side of the belt.

8. In a drier for sheet material, in combination, conveying means in the character of a belt, and means associated with said belt for holding the sheet to be dried upon the face of said belt.

9. In a drier, in combination, a structure adapted to be horizontally arranged and presenting a drying space extending along the same, conveying means in the character of a belt extending along said space, and means associated with said belt for holding the material to be dried upon the lower face of said belt as the belt travels along said space.

10. In a drier, in combination, a structure providing a forward-and-back drying chamber comprising a forward and a back passage, conveying means in the character of an endless belt having one span arranged in one said passage and the other span in the other passage, and means associated with said belt for holding sheet material to be dried upon the belt; said structure being provided with an entrance to said forward passage, and with an exit from said back passage in proximity to said entrance, whereby the said sheet material may be fed to said conveying means through said entrance, held to said belt during substantially a full round of travel of said belt, and discharged through said exit adjacent the entering portion of the sheet.

11. In a drier for sheet material, in combination, means for supporting the material and on which said material is held, and means associated with said supporting means for clamping the sheet material substantially merely along its side edges, and without material contact with face of said material, and holding them fixed with respect to the supporting means.

12. In a drier for sheet material, in combination, means for conveying the material and on which said material is held, and means associated with said conveying means for clamping the sheet material substantially merely along its side edges, and without material contact with face of said material, and holding them fixed with respect to the conveying means.

13. In a drier for sheet material, in combination, an element for conveying the material and on which the material is held, means for clamping the material in fixed relation to the element, such means including a clip associated with the element adjacent its edge to travel with said element and comprising a support and a two-armed member having a connection with said support providing for one of said arms moving to and from said element to clamp and release the material, and means arranged in the path of travel of the other arm of said lever for immediate cooperation with and actuation of the same thereby to control the movement of said first-named arm.

14. In a drier for sheet material, in combination, an element for conveying the material and on which the material is held, means for clamping the material in fixed relation to the element and including a clip associated with the element adjacent its edge and comprising a support, a bell-crank pivoted on said support with its pivotal axis parallel to the edge of said element whereby one arm of said bell-crank can swing to and from said element and the material to clamp and release the same, the other arm of said bell-crank being in the character of a cam-fol-

lower, and means for controlling the movements of said bell-crank and in the character of a cam-track located in the path of the said cam-follower to be followed thereby.

15. In a drier for sheet material, in combination, means for conveying the material and comprising a pair of spaced drums and a belt carried by said drums and conforming to a portion of the surface of each drum, means for fixing the material with respect to said belt, such means comprising operated material-clamping units spaced longitudinally of the belt and carried therewith, and means for controlling the operation of said units, such controlling means being constituted and arranged, and said units being relatively arranged, to provide for the moving into clamping position of two of said longitudinally spaced units while at least one of said units is upon a drum and spaced from the other unit a substantial distance circumferentially of the drum.

16. In a drier for sheet material, in combination, means for conveying the material and comprising a pair of spaced drums and a belt carried by said drums and conforming to a portion of the surface of each drum, means for fixing the material with respect to said belt, such means comprising operated material-clamping units spaced longitudinally of the belt and carried therewith, and means for controlling the operation of said units, such controlling means being constituted and arranged, and said units being relatively arranged, to provide for the holding of the material to the belt by one unit, and the moving of another and longitudinally spaced unit into clamping position while such two units are upon one of the drums, thereby to provide for the fixing with respect to the belt of that length of said material lying between said two units, while said length lies curved upon such drum.

17. In a drier for strip material, in combination, a structure providing a longitudinally extending drying chamber having an entrance and an exit adjacent each other, an endless belt conveyor arranged longitudinally in said structure with its spans one in proximity to said entrance and the other in proximity to said exit, means for clamping a strip of material to the belt along the strip and substantially throughout the length of the belt, and means to control the action of said clamping means to clamp the strip adjacent the entrance to said chamber and release the strip adjacent the exit of said chamber; whereby the strip may enter the chamber, make substantially a round of travel with the belt, and leave the chamber.

18. In a film drier, in combination, a structure providing a forward-and-back drying chamber comprising a forward and a back passage, an endless belt conveyor arranged in said structure with its spans ar-

ranged one in the forward passage and one in the back passage, means for clamping a strip of film to the belt along the edges of the film and substantially throughout the length of said belt, and means for controlling the action of said clamping means to clamp the film adjacent the entrance to said chamber and release the film adjacent the exit from said chamber.

19. In a film drier, in combination, a structure providing a forward-and-back drying chamber comprising a forward and a back passage, an endless belt conveyor arranged in said structure with its spans arranged one in the forward passage and one in the back passage, means for clamping a strip of film to the belt along the edges of the film and substantially throughout the length of said belt, means for controlling the action of said clamping means to clamp the film adjacent the entrance to said chamber

and release the film adjacent the exit from said chamber, and means for circulating drying fluid in said chamber.

20. In a film drier, in combination, a structure providing a forward-and-back drying chamber comprising a forward and a back passage, an endless belt conveyor arranged in said structure with its spans arranged one in the forward passage and one in the back passage, means for clamping a strip of film to the belt along the edges of the film and substantially throughout the length of said belt, means for controlling the action of said clamping means to clamp the film adjacent the entrance to said chamber and release the film adjacent the exit from said chamber, and means for circulating drying fluid in said chamber in a direction counter to the direction of travel of the belt.

In testimony whereof I affix my signature.

CLAUDE A. BULKELEY.