April 16, 1957 C. G. HOCKETT 2,788,841

APPARATUS FOR PLEATING AND HEAT-TREATING PAPER

Filed June 21, 1954 3 Sheets-Sheet 1

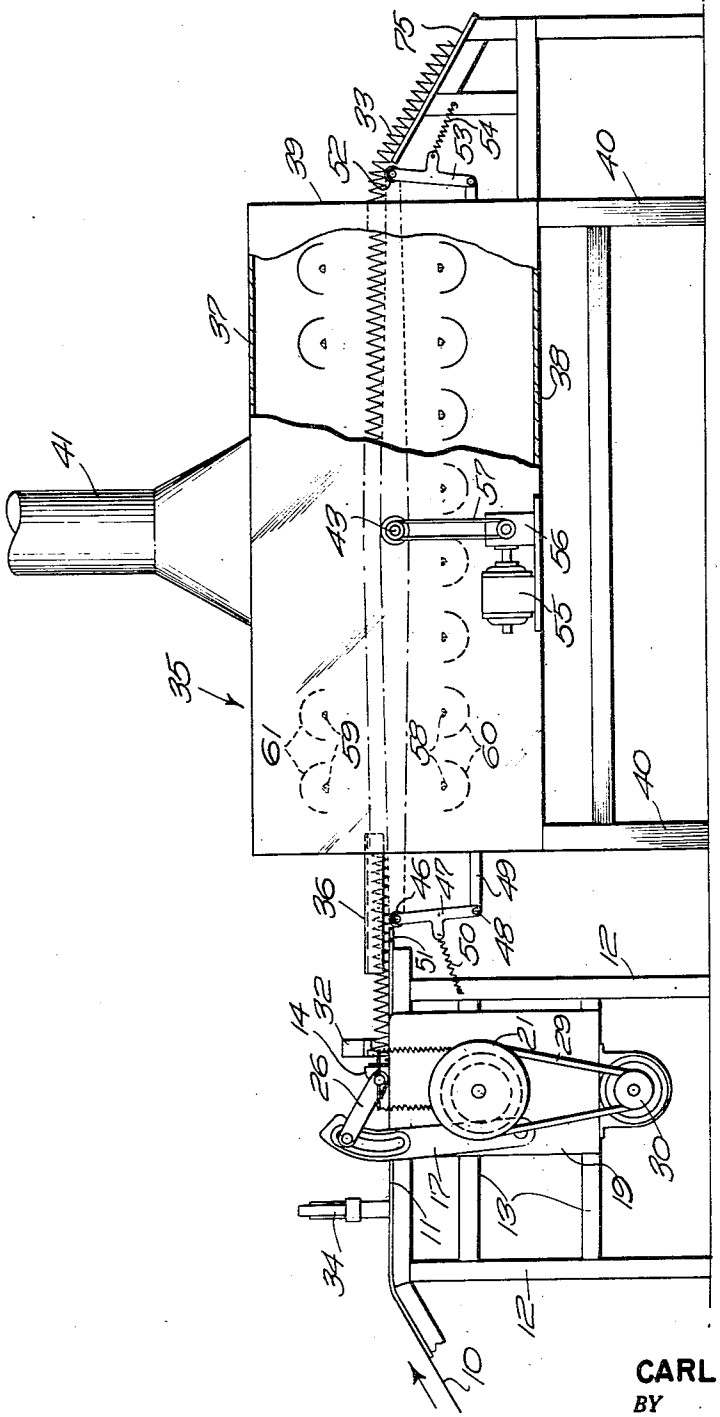


FIG. 1

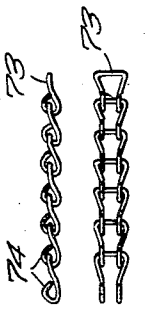


FIG. 7

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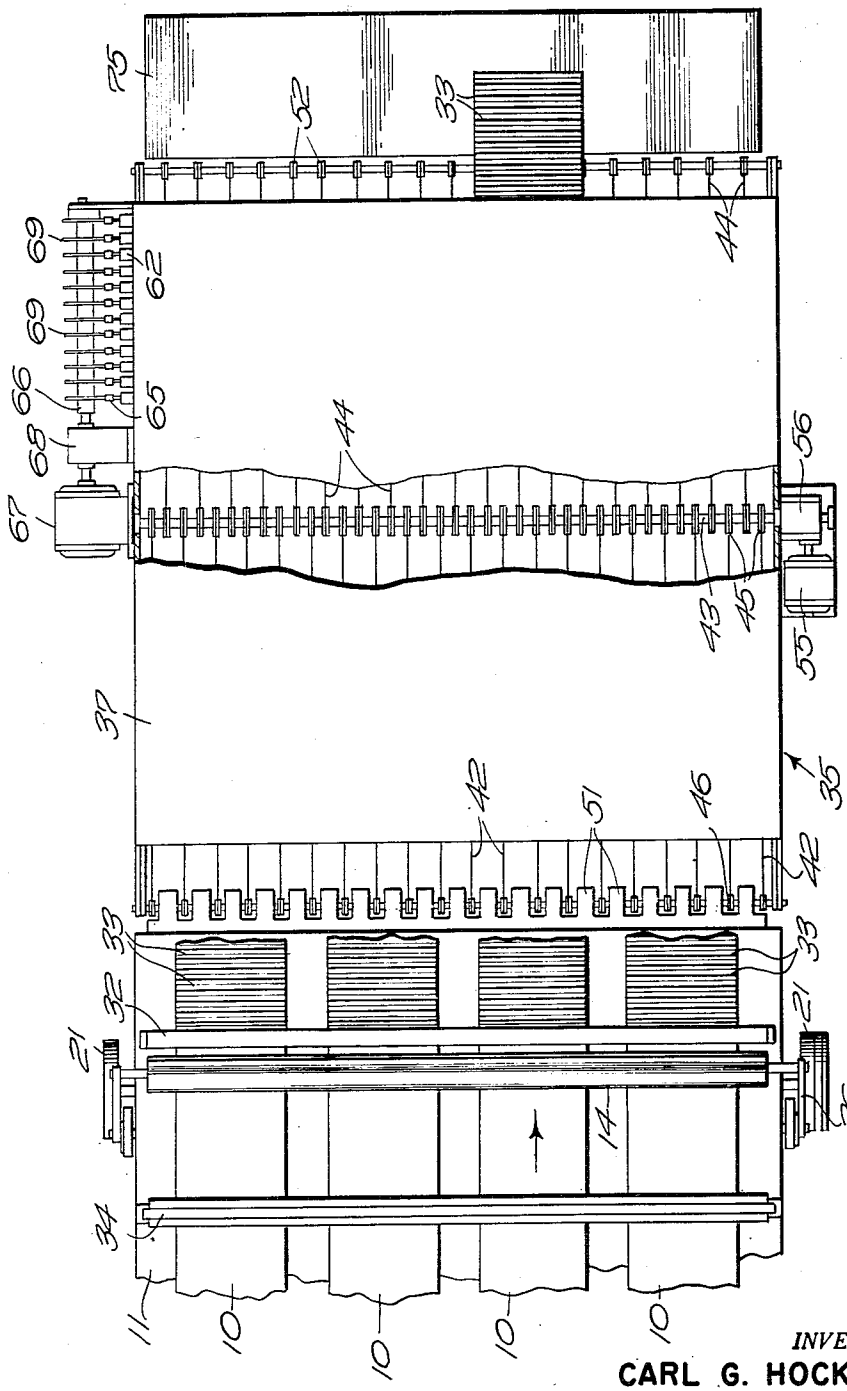


FIG. 2

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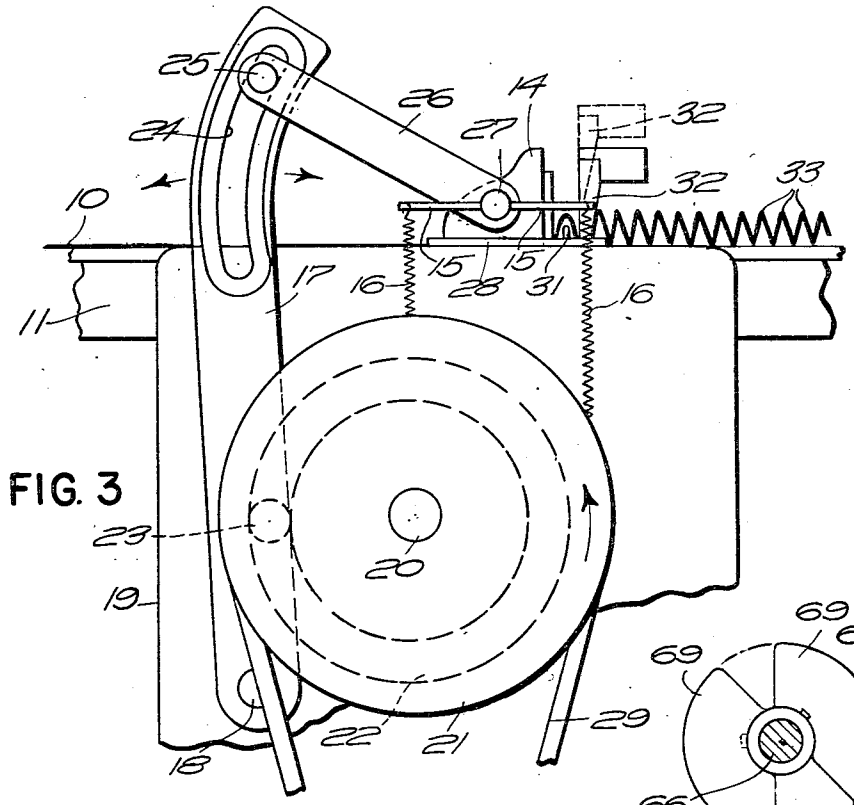
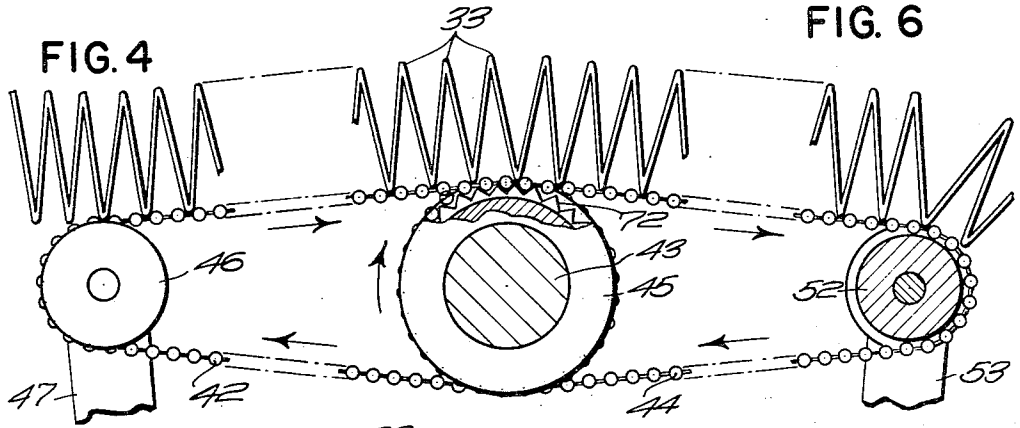


FIG. 3

FIG. 6

FIG. 4



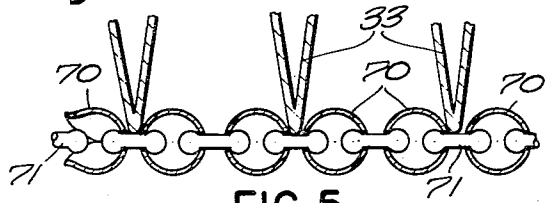


FIG. 5

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United States Patent Office 2,788,841 Patented Apr. 16, 1957

2,788,841

APPARATUS FOR PLEATING AND HEAT-TREATING PAPER

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Application June 21, 1954, Serial No. 438,017

4 Claims. (Cl. 154—30)

This invention relates to apparatus for advancing, pleating, and heat-treating lengths of paper, and more particularly to improved conveying means for advancing pleated paper through an oven or heat-treating area.

It has been proposed heretofore to form filter elements of porous paper that is pleated so as to increase the amount of filter paper that can be used in a limited area.

In accordance with the present invention a continuous length of paper of the desired width and which has been treated with a resinous material is advanced in the direction of its length and is provided with transversely extending folds to produce the desired zigzag pleats. The resin-treated pleated paper is then heated to set the resin and thereby increase the stiffness and toughness of the pleated paper. The paper preferably is pleated by advancing it step by step to a pleating position, and then it is advanced through a heat-treated area or oven by employing endless chains to carry the pleated paper therethrough.

It is found that the heat applied to the paper tends to cause the pleats to shift relatively to each other, and that they do not remain uniformly spaced as they travel through the oven. This prevents the paper from being uniformly heated; for if some pleats are crowded closer together than others, those groups that are close together will be less exposed to the heat than those that are spaced further apart, and a non-uniform heat-treated paper will result.

This difficulty is overcome in accordance with the present invention by employing endless conveyer chains for advancing the pleats through the oven and by constructing these chains so that their upper runs will be provided with uniformly spaced projections which will extend between the folded lower portions of the pleats, and thereby maintain the pleats uniformly spaced from each other during their passage through the heat-treating chamber.

The conveyer chains having the uniformly spaced projections just mentioned may be variously constructed, but very satisfactory endless chains for this purpose are formed of beaded chains having round, small metal globes connected one to another by a dumbbell-like metal element. This is found to provide a strong, durable and inexpensive chain having the desired uniformly spaced projections, with depressions therebetween in which the folds of the pleats may rest as the paper is advanced through the oven. This serves to maintain the pleats uniformly spaced during the heat treatment.

The above and other features of the present invention will be further understood from the following description when read in connection with the accompanying drawings, wherein:

Fig. 1 is a side elevation, with parts in section, showing the apparatus of the present invention.

Fig. 2 is a top plan view, with parts in section, of the apparatus shown in Fig. 1.

Fig. 3, on a larger scale, is a side view of the paper advancing, and pleating mechanism of Fig. 1.

Fig. 4, on a still larger scale, is a side view, with parts in section, of the chain advancing means for conveying the pleated paper through the oven.

Fig. 5 is a vertical sectional view through a short length of bead chain having the lower edges of the pleated sheet resting thereupon.

Fig. 6 is a face view of rotating means for controlling the electrical heating elements; and

Fig. 7 is a side view and top view of a ladder type of conveyer chain which may be used in place of the bead chain shown in Figs. 4 and 5.

The apparatus shown in the drawings is designed to pleat and heat-treat a number of sheets of paper **10** simultaneously, four such sheets being shown in Fig. 2. It will be understood, however, that the machine may be made wide enough to treat a much larger number of sheets **10** simultaneously if desired. These sheets **10** are pulled forward from a source of supply, not shown, such as a large roll of paper, in a right-hand direction as indicated by arrows in Figs. 1 and 2. The paper passes upwardly onto the smooth upper surface of a table **11** which is supported at the desired distance from the floor by the table legs **12**, which are connected by the horizontally extending braces **13**. The sheets **10** are pulled forward step by step by reciprocating feed means which is best shown in Fig. 3. This feed means comprises a bar **14** which extends across all of the paper sheets **10** that are to be advanced simultaneously to the pleating means. The lower face of this bar **14** is made rough so that it will frictionally engage the upper face of the sheets **10**, the construction being such that when the feed bar is advanced in a right-hand direction, see Figs. 1, 2 and 3 of the drawing, it will pull each of the sheets **10** forward. To facilitate this, the bar has attached to each end thereof the oppositely extending rods **15** having secured thereto the downwardly pulling springs **16**. The lower ends of these springs are anchored to the machine frame. The arrangement is such that these springs will continuously urge the feed bar **14** downwardly towards the paper sheets **10** to engage each sheet.

A back and forth movement is imparted to the feed bar **14** by the upwardly extending rocking arms **17**, disposed at each side of the machine and which are pivoted adjacent their lower ends upon the pivot pins **18** secured to metal walls **19** fastened to the supporting table above mentioned. The arms **17** rock back and forth as indicated by the arrows in Fig. 3, and the desired rocking movement is imparted to an arm **17**, at each side of the supporting table, by a shaft **20** which extends entirely across the apparatus shown in Fig. 2 and has secured thereto adjacent each end a cam wheel **21** having formed in one face thereof a slightly off-center cam slot **22**. In this slot projects a pin **23** which is rigidly secured to an intermediate portion of a rocking arm **17**. The upper portion of each arm **17** is shown as having the curved slot **24**, adapted to adjustably receive a bolt **25** employed to pivotally secure one end of a link **26** to the arm **17** at a desired distance from the pivotal support **18**. The other end of the link **26** is secured at **27** to an end of the feed bar **14**.

This construction serves to impart a back and forth movement to the bar **14**. During the forward movement of such bar, it rests firmly upon the sheets of paper **10**, under the downward pull of the springs **16**, to advance the paper; but during the return stroke, this bar is elevated by a lifting plate **28** adjacent each end of the bar. The shaft **20** is driven by any suitable means such as the belt **29** and motor **30**, see Figs. 1, 2 and 3, and the length of strokes imparted to the bar **14** can be varied by varying the distance of the bolt **25** from the pivot pin **18**.

As the paper sheets **10** of the desired width are ad-

vanced in the direction indicated by the arrows by the feed bar 14, an initial upward fold may be imparted to each sheet 10 by a reciprocating blade 31, see Fig. 3, which blade moves up adjacent a vertically movable paper arresting bar 32. The movement of this blade 31 is so timed that it will move upwardly a short distance to initiate a pleat-forming fold 33 in each sheet of paper and then downwardly in time to clear the advancing feed bar 14. As this feed bar continues to move towards the arresting bar 32, it presses the folded sheet 33 against such bar to form the desired pleat. Then the bar 32 is moved upwardly from its full line position of Fig. 3 to its dotted line position, to allow the pleat 33 just formed to pass under the bar 32, then the bar 14 is moved in a left-hand direction preparatory to starting another forward feeding stroke. In this manner the pleats 33 are formed one by one in each of the sheets 10 across the work supporting table 11. It is found that the reciprocating blade 31 may be omitted in pleating some types of paper.

The sheets of porous paper 10 are pleated as just described in a continuous length, but in order to form the desired filter element a selected number of pleats, such for example as twenty, will be employed in each element. It is, therefore, desirable to perforate the advancing paper sheets 10 at a selected distance along their length so that these perforations will indicate where the formed pleats are to be parted. To this end a reciprocating perforating bar 34 is provided which is operated periodically to perforate the paper sheets 10, following a predetermined number of strokes of the feed bar 14.

The sheets of paper 10 should be formed of paper having the desired porosity for the contemplated filter use, and these sheets are preferably treated with a resinous material such as a phenol formaldehyde resin applied by means of a suitable carrier, such as water or alcohol. The sheets 10 are preferably advanced to the above described pleating mechanism while in a slightly moist condition, as this will cause them to bend transversely more readily than a sheet which is practically free of moisture. The sheets 10, before they are supplied to the apparatus shown, are preferably passed between ribbed rolls, not shown, which will produce slightly discernible channels longitudinally of each sheet. The purpose in providing these shallow channels, say one or two hundredths of an inch (.01" or .02") deep, is to facilitate the flow of oil or air during the filtering operation along such channels.

As the pleats 33 are formed and pass under the raised bar 32, they are advanced by the push of the feeding bar 14 towards the heat-treating oven 35, and as they approach this oven, they preferably slide under the guide bars 36 which are preferably L-shaped in cross-section and serve to keep these pleats properly aligned as they approach the oven. The oven 35 may be of any desired length, and as shown has the upper wall 37, lower wall 38, and end walls 39. The oven is supported at the desired distance from the floor by the legs 40, and one end of the oven has a paper receiving opening and the other end a discharge opening. All walls are preferably insulated to reduce the loss of heat, and the gases produced as a result of heat-treating the resin-impregnated paper escape from the oven through the discharge stack 41.

The pleated sheets 10 are advanced through the oven by a number of endless chains. These chains preferably are arranged in two distinct groups; one set of chains designated by 42 extend in a left-hand direction, viewing Figs. 1 and 2, from a central driving shaft 43, and the other set of chains 44 extend in a right-hand direction from such driving shaft. Each endless chain 42 passes around a driving pulley 45 secured on the shaft 43. These chains also pass around chain-tensioning idler pulleys 46 at the other end of such chains. Each idler pulley 46 is rotatably supported at the upper end of a swinging arm 47 which is pivotally supported at 48 from a fixed arm 49, and each arm 47 is continuously urged in the chain-tightening direction by a coiled spring 50. In this manner the desired amount of tension is maintained at all times on each chain 42. As the pleated sheets move along the top of the table 11 towards the feed chains 42, they slide upon a guide plate 51 which is notched as shown in Fig. 2. These notches serve to clear the idler pulleys 46. The other set of chains 44 are maintained under the desired tension by idler pulleys 52 supported at the upper end of the arms 53, which arms are urged in the chain-tightening direction by the springs 54. The chain driving shaft 43 may be driven by a motor 55 through reducing gears in the gear box 56 and having extended upwardly therefrom the driving chain 57. It is found that the two sets of paper-advancing chains; namely, set 42 extending in a left-hand direction from the power shaft 43, and set 44 extending in a right-hand direction from such power shaft, provide a very satisfactory means for advancing the pleated sheets through a relatively long oven. It is also found that when one set of chains is staggered with respect to the other, as shown in Fig. 2, the chains do not mark the paper to any noticeable degree; whereas if one set of chains supports the pleats throughout the entire length of the oven, such chains will tend to mark the lower folded edge of the pleated sheets.

The oven 35 may be heated by any suitable means, such as gas, heated air, or electricity; and in the construction shown it is heated by a series of transversely extending electrically heated rods 58 disposed below the conveyer chains, and electrically heated rods 59 disposed above such chains. The heated rods, which may be of well-known construction, extend in a straight line across the oven and each lower rod 58 has associated therewith an arcuate reflector 60 adapted to direct the heat upwardly towards the pleated paper. The upper rods are provided with the reflectors 61 adapted to direct the heat of such rods downwardly towards the paper. It is important that the heat supplied by these rods 58 and 59 be accurately controlled so as to properly cure without over-curing the pleated paper passing through the oven. To accomplish this, each rod 58 and 59 is preferably under the control of a switch that may be housed in a box 62, see Fig. 6. These boxes 62 are arranged along one side of the oven as shown in Fig. 2, and the switch in each box is under the control of a rocking arm 63 which is pivoted to its box at 64. The outer end of each arm 63 is provided with a roller 65. Extending parallel to the group of boxes 62 shown in Fig. 2 is a power shaft 66 which may be driven by the electric motor 67 and reducing gears in the gear box 68. On the shaft 66 are provided pairs of semicircular segments 69 adapted to control the respective rocking arms 63. There are two of these segments 69 for each switch-controlled arm 63, and these segments may be adjusted about their supporting shaft 66 so that they will form an operating surface extending through any desired angle ranging from 180° to 360°, so that as the power shaft 66 is rotated it will hold the switch within each box 62 closed throughout an angle of from 180° to 360° as desired, and thereby control the period during which current is supplied to each heating element 58 and 59 during a complete rotation of the shaft 66.

The conveyer chains 42 and 44 are preferably bead chains having the construction best shown in Figs. 4 and 5; and it is desirable to form such chains of stainless steel so that they will give good service in the oven and will not corrode. Each of these chains preferably has the construction best shown in Fig. 5 and comprising spherical shells 70 which are connected one to the other by a dumbbell connecting bar 71, this being a well-known bead chain construction. These bead chains may be bought in long lengths, and in order to form an endless chain 42 and 44 all that is necessary is to cut

from the endless length of such bead chain a desired length, place the chain about the operating pulleys above described and then connect one end of the chain to another by simply pressing the lips of a sphere **70** inwardly to engage the ball-like end of an element **71**. In this connection, see the left-hand ball **70** in Fig. 5, the protruding lips of which can be bent into engagement with the rod **71**. Each driving pulley **45** secured to the power shaft **43** is preferably provided with an annular chain-receiving groove, the bottom of which is preferably recessed as indicated by **72** so as to form pockets that will receive the beads **70** and provide a non-slip drive between the pulleys **45** and chains **42** and **44**.

The bead chains having the beads **70** slightly spaced as shown in Fig. 5 permit the folded lower edges of the pleats **33** to enter the depressions between two beads as shown. This serves to keep the pleats uniformly spaced from each other as they are advanced through the oven; whereas if the conveyer chains did not have the spaced projections provided by the beads, the pleats **33** would be free to shift towards or from each other during the heat treatment. The bead chains shown, by keeping the pleats uniformly spaced in the oven, cause the pleats to be uniformly heat-treated.

The conveyer chains having evenly spaced projections extending upwardly from their upper run are preferably bead chains, as above described, but need not be so constructed, as ladder chains such as shown in Fig. 7 may be used, and wherein the chain is formed of U-shaped wire loops **73**. The ends of the wires are bent to form the eyelets **74** that embrace the central bar portion of the next loop **73** as shown. The upwardly projecting eyelets **74** will serve to keep the paper pleats **33** properly spaced similar to the manner in which the beads **70** perform this desirable function.

The number of pleats **33** formed per inch and the height of such pleats can be controlled by adjusting the length of the stroke of the feed bar **14** and the speed at which the chains **42** and **44** are driven by the gears in the box **56**. The temperature of the electrical heating rods **58** and **59** is controlled as desired by angularly adjusting the disc segments **69** upon their operating shaft **66**. The pleated, heat-cured paper strips upon leaving the oven **35** slide down the discharge board **75**, at which time they may be parted from the continuous pleated sheet at the perforated lines formed by the perforating blade **34**.

It will be seen from the foregoing that by employing the type of conveyer chains herein described the paper pleats will be held uniformly spaced while they pass through the heat-treating oven. This will cause the pleats to be uniformly spaced upon leaving the oven and will permit the heat of the oven to act uniformly on all of the pleats.

Having thus described my invention, what I claim and desire to protect by Letters Patent is:

1. Apparatus for advancing, pleating and heat-treating a length of paper, comprising paper-feeding means, mechanism for pleating the paper transversely of its length so as to form the pleats with sharply folded edges, a heat-treating area, endless conveyer chains adapted to engage the lower sharply folded edges of the previously pleated sheet and advance the pleats through said area, and said chains having evenly spaced projections upon their upper run and adapted to enter between said pleats and restrict their relative movement as the pleats are moved by the chains through said area.

2. Apparatus for advancing, pleating and heat-treating a continuous length of paper, comprising paper-feeding means, mechanism for pleating the paper transversely of its length so as to form the pleats with sharply folded edges, a heat-treating oven, endless conveyer chains adapted to engage the lower sharply folded edges of the previously pleated sheet and advance the pleats through the oven, and said chains having projections that extend upwardly from their upper runs to enter between said pleats and restrict their relative movement as the pleats are moved by the chains through the oven.

3. Apparatus for advancing, pleating and heat-treating a continuous length of paper, comprising paper-feeding means, mechanism for pleating the paper transversely of its length so as to form the pleats with sharply folded edges, a heat-treating area having electrically heated rods disposed above and below the path of the pleated paper, endless conveyer chains adapted to engage the lower sharply folded edges of the pleated sheet and advance the pleats along said path, and said chains having projections that extend upwardly from their upper run to enter between said pleats and restrict their relative movement as the pleats are moved by the chains along said run.

4. Apparatus for advancing, pleating and heat-treating a length of paper, comprising paper-feeding means, mechanism for pleating the paper transversely of its length so that the pleats will extend upwardly and having sharply folded upper and lower edges, a heat-treating oven, endless conveyer chains comprising bead chains adapted to engage the lower folded edges of the pleated sheet and advance the pleats through said oven, and the beads of the chains being spaced so that said folded edges will enter the depressions between the beads and the beads will restrict the relative lateral movement of the pleats as they are advanced by the chains through the oven.

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