

[54] **CONTINUOUS CURING APPARATUS**

3,664,797 5/1972 Sorbier 425/444 X

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[21] Appl. No.: **273,367**

Related U.S. Application Data

[60] Division of Ser. No. 45,604, June 12, 1970, Pat. No. 3,714,317, which is a continuation-in-part of Ser. Nos. 775,347, Nov. 13, 1968, abandoned, and Ser. No. 28,290, April 22, 1970, abandoned, which is a continuation of Ser. No. 592,131, Nov. 4, 1966, abandoned.

[30] **Foreign Application Priority Data**

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July 14, 1966 Great Britain.....31657/66
Nov. 10, 1965 Great Britain.....47594/65

[52] **U.S. Cl.**..... **425/233, 425/47, 425/383, 425/385, 425/394, 425/406**

[51] **Int. Cl.**..... **B29d 29/00, B29h 7/22**

[58] **Field of Search**..... 264/231, 280, 347; 425/233, 47, 384, 385, 394, 407, 408, 453, 406

[56] **References Cited**

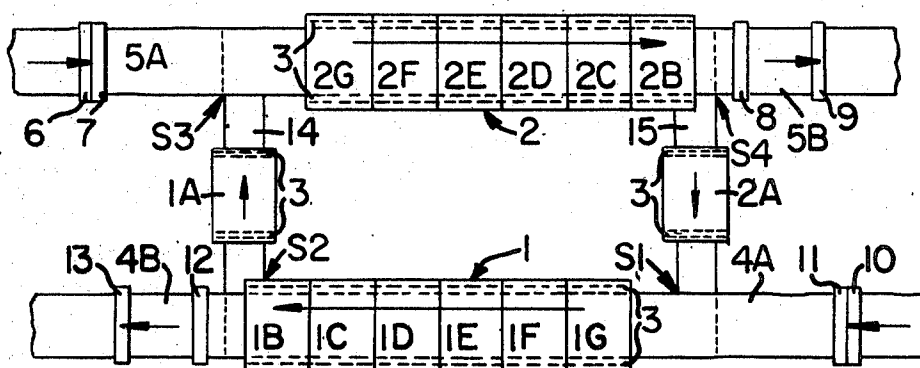
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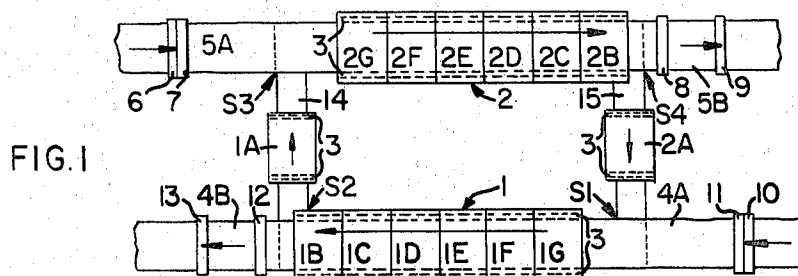
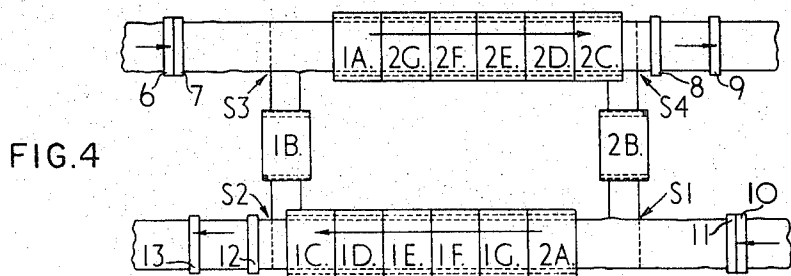
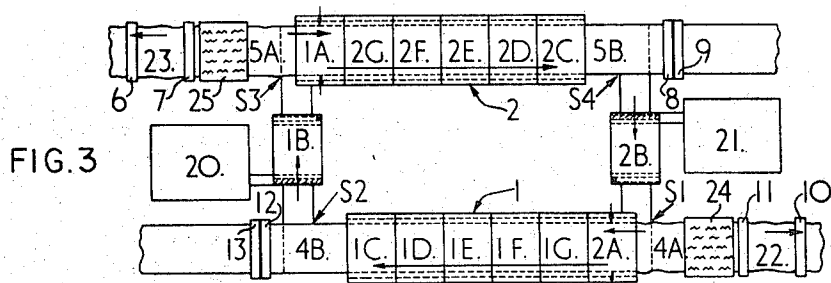
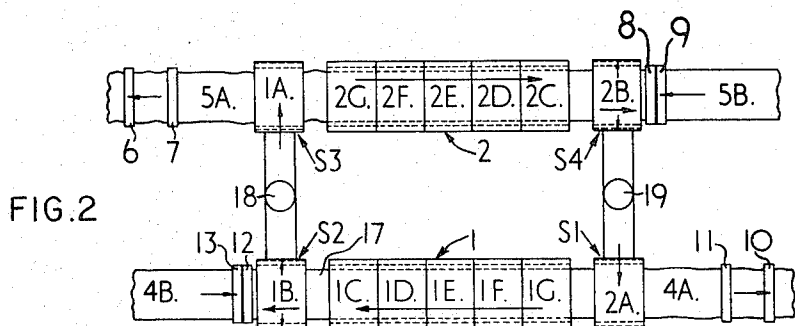
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[57] **ABSTRACT**

An apparatus for heating and compressing an elongated article is provided. The invention comprises the use of a plurality of individual press units which are heated; the press units are moved into heating and compression relationship with opposed surfaces of the article; each press unit is moved successively into engagement with the article and into contacting end to end relationship with the previous press unit, the units being moved relative to the surface only in a direction perpendicular to the surfaces when in contact with the surfaces; the press units and the article are moved stepwise in the direction of the length of the article; the press units are continuously maintained in contact with the article until the end of the heating and compressing cycle; with the press unit finally successively being moved out of engagement with the thus produced elongated article.

4 Claims, 20 Drawing Figures





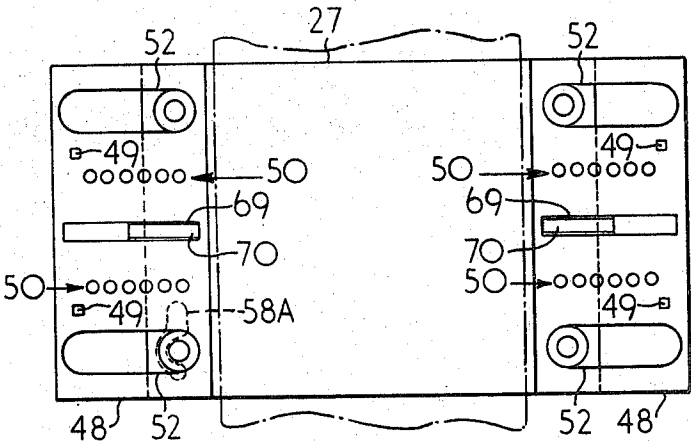


FIG. 6

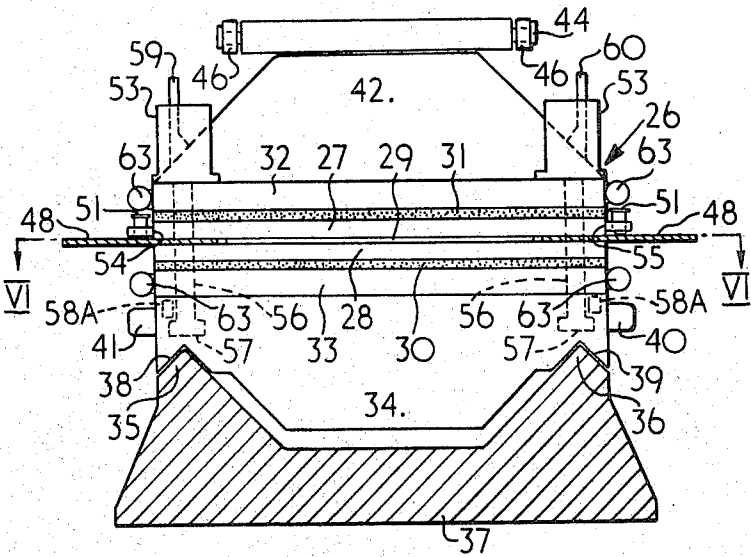


FIG. 5

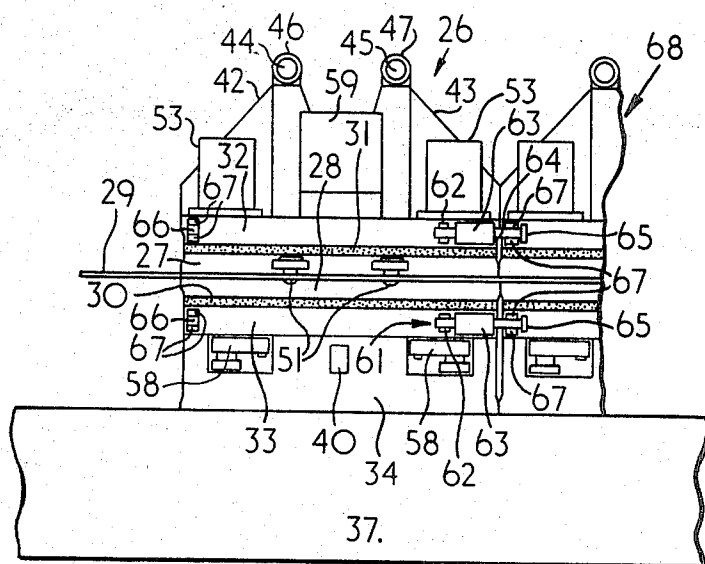


FIG. 7

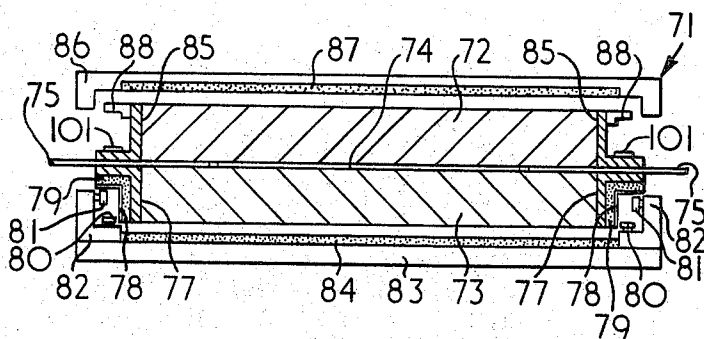


FIG. 8

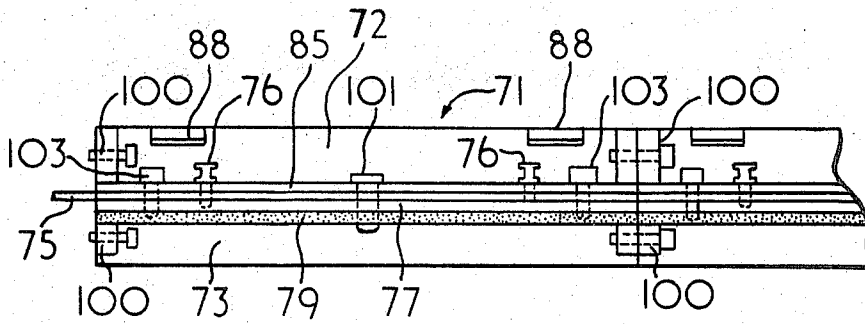


FIG. 9

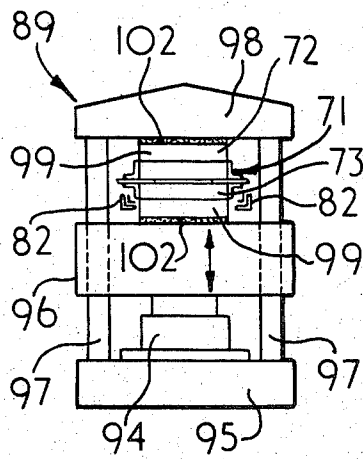


FIG. 10

FIG. 11

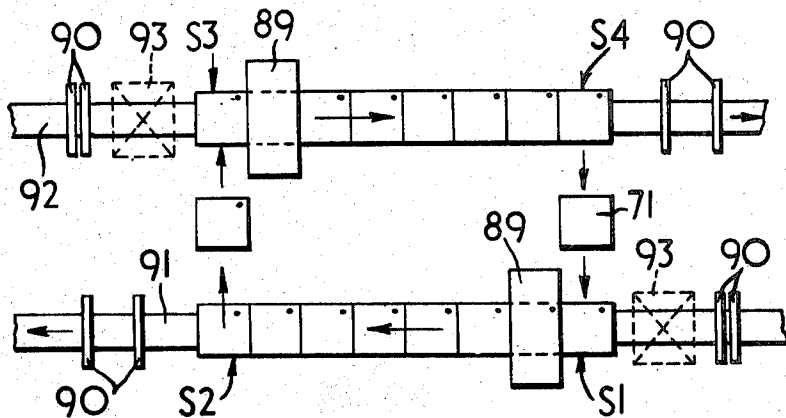


FIG. 13

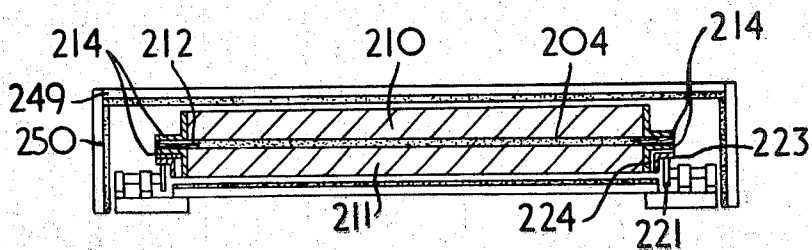


FIG. 14

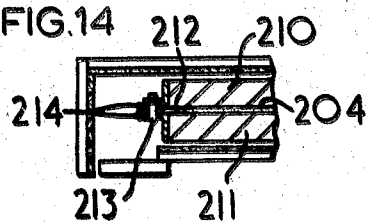
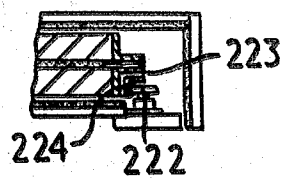


FIG. 15



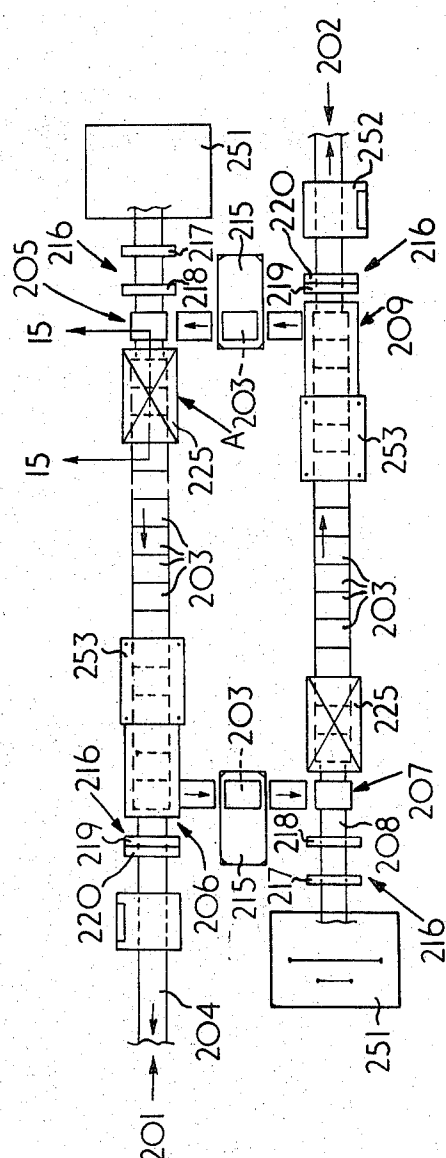
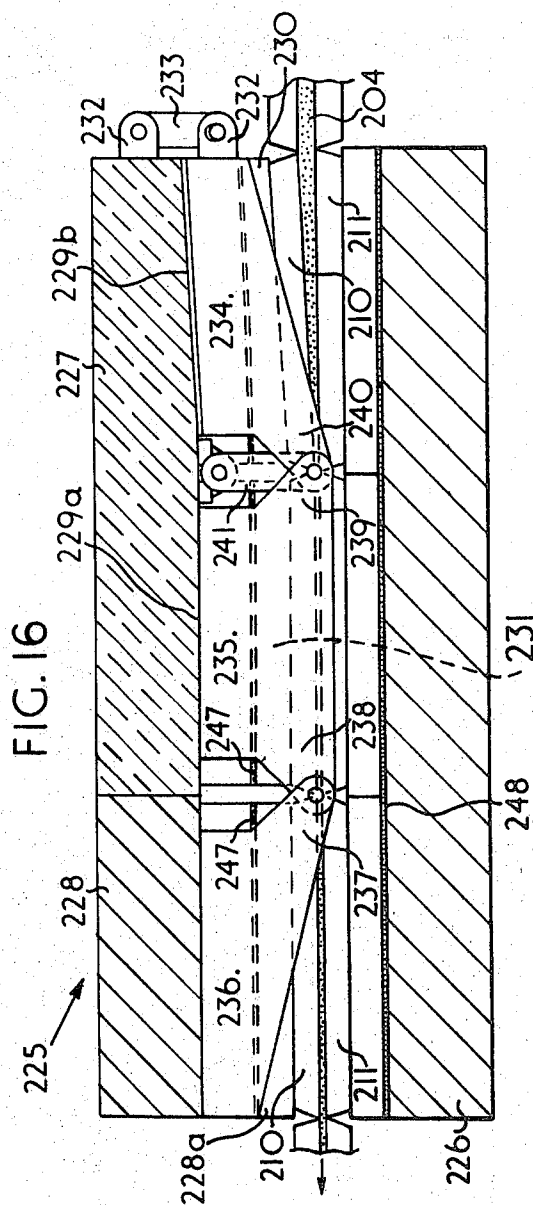


FIG. 12



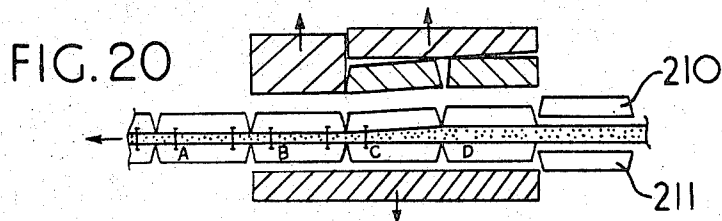
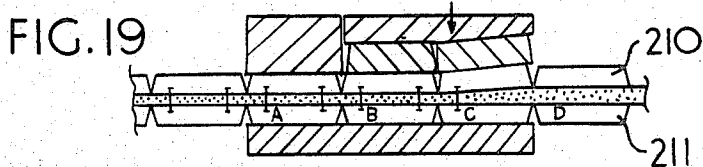
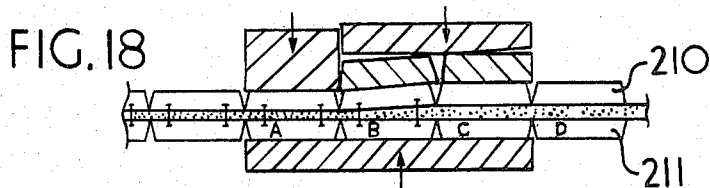
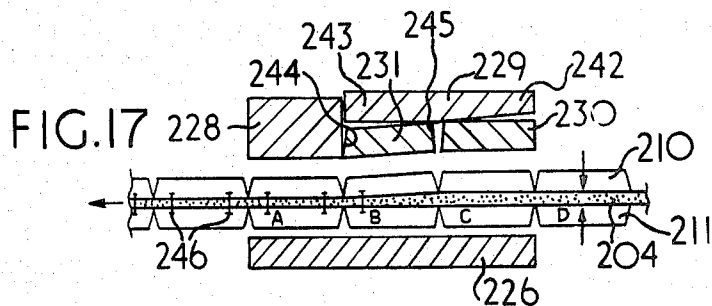


FIG. 21

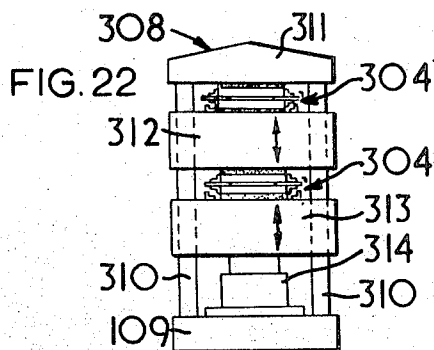
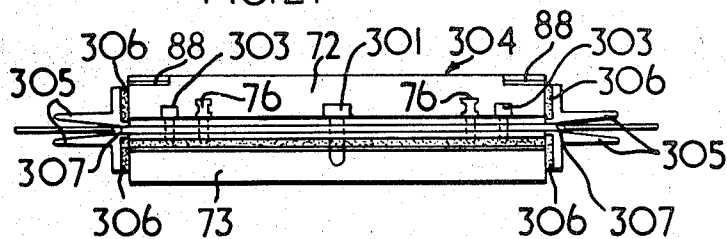


FIG. 23

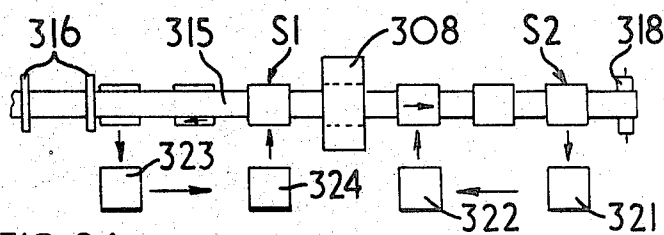
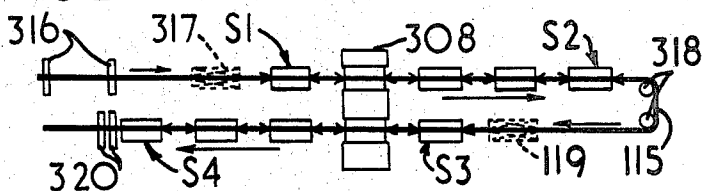


FIG. 24



CONTINUOUS CURING APPARATUS

RELATED U.S. APPLICATIONS

This application is a division of my copending application Ser. No. 45,604 now U.S. Pat. No. 3,714,317, filed June 12, 1970 which is in turn a continuation-in-part of my copending applications Ser. No. 775,347, filed Nov. 13, 1968 (now abandoned), and 28,290 filed Apr. 22, 1970 (now abandoned), the latter application being a continuation of my now abandoned application Ser. No. 592,131, filed Nov. 4, 1966.

This invention relates to the curing of elongated articles, and in particular to the curing of rubber and plastic belting and like elongated articles.

The production of extremely long belting is of ever increasing importance, being necessary for moving pedestrian sidewalks and ramps which are being installed in increasing numbers in areas which have heavy pedestrian traffic. Exemplary of such uses is to avoid the necessity of forcing passengers at airports from walking from the terminal building to the departure gates and in providing upward ramps at modern sports stadiums. It will be clearly appreciated that a continuous belt of considerable length is required for such moving sidewalks and ramps. Uniformity in these belts is most important, as variations may result in a space between the sides of the moving sidewalk housing and the belt. In such a case, it is possible that a person's leg could become trapped, resulting in serious injury.

The method for curing elongated belting generally used in the prior art comprises the use of large upstroke presses, usually steam heated. A moving table is arranged to run the full length of the press and is of heavy box section design for minimum deflection. The platens are made from steel plate accurately machined and polished on the working surfaces.

The platens are divided into a number of chests. With the exception of the two end chests, the remainder are inter-connected to allow efficient circulation of steam or water. Conveniently the two end chests are isolated from the remainder, so that they can be maintained at a lower temperature to provide for an overlap between each press charge.

It is extremely important in the prior art process that the temperature of the platens is constant and controllable to ensure uniformity of cure. It is also important that the belt receives uniform compression over the whole platen area to obtain maximum adhesion of the plies and covers, and also to produce a belt of uniform cross-section, which is essential for correct tracking of the belt in service. Without correct tracking the aforementioned dangerous problem of a gap between the belt and the side track may result.

Hydraulic gripping and stretching gear is also fitted to the press so that stretch can be applied prior to curing to limit the amount of elongation which will occur in service, stretch being maintained during curing.

The uncured belting is supported in a roll adjacent to the press and a leader consisting of a piece of cured belting is attached to the end by means of belt fasteners. At the same time the temperature of the press platens is adjusted to the required temperature.

Longitudinal molding irons (full press length) of the required thickness to allow the necessary compression of the uncured belt are placed on the bottom platen. A sufficient number of these irons are used to form a frame to give the final width of the belt, when lateral

pressure, either mechanical or hydraulic, is applied from the sides of the press.

The end of the leader is drawn through the press to a position where the cured belt is eventually formed into a roll.

The first charge of the belt is drawn centrally into the press. Stretching equipment consisting of clamps fitted at each end of the press (one being movable) are closed onto the belt and a predetermined percentage of stretch applied. The press is closed on low hydraulic pressure, and lateral pressure is applied to the belt edges, followed after an interval by the application of high pressure. The hydraulic pressure, rate of application, delay and cure cycles will vary according to the type and grade of belt, for example, from 12 minutes at 50 psi steam for a thin belt to 48 minutes at 30 psi steam for a belt one inch thick.

At the end of the cycle the press is opened, the lateral pressure released and the belt is drawn through the press, leaving approximately 12 inches of the end of the charge at the exit end of the press.

The process is then repeated until the required length of belting has been cured.

It will be readily appreciated that there are practical difficulties which present serious drawbacks to the conventional method of the prior art to which no satisfactory solution has hitherto been found.

The use of a single press means that the method is essentially a "batch" process in that when any particular length of article has been cured, the press must be opened and the cured portion of the article withdrawn from the press, thereby drawing behind a portion of uncured material with the boundary between cured and uncured material being advanced to the forward end of press before the latter is closed and the curing cycle repeated. This method is not only time consuming, but furthermore difficulties arise in the exact alignment of the uncured portion while within the press, resulting in problems of double-curing or under-curing of the end of the portions cured in each batch treatment.

A further major disadvantage of the conventional method is that considerable time is wasted due to the fact that the curing process must be interrupted when the press is opened and not resumed until the press is closed on the succeeding portion of uncured material. The fact that the prior art "batch" process does not allow continuous production and therefore restricts the amount of belting which can be produced in a particular time period, is very unsatisfactory, especially in view of the large capital cost of the machinery used.

Further disadvantages arise from the size and weight of the presses and particularly, of the moving parts. In a conventional form of press, known as the "column type," a typical platen size is 32 feet $\times$ 84 inches, giving an effective length of 28 feet, and an effective width of 80 inches. In this press, the moving table is actuated by 24 hydraulic rams, each of 15 $\frac{3}{4}$ inches diameter, and the total weight of the presses is 420 tons. Another form of press, known as the "plate frame walk-in type," has a typical platen size of 36 feet $\times$ 65 inches, giving an effective length of 30 feet and an effective width of 60 inches. Again, a large number of hydraulic rams are used to actuate the moving table and the total weight of the press is 300 tons.

It will be thus appreciated that conventional presses are large, heavy and expensive items. To increase output, presses with even larger platens have been pro-

posed. However, the larger the press, the more difficult and expensive it is to ensure that the platens are accurately machined and assembled and that uniform compression occurs over the whole of the platen area.

An object of this invention is therefore to provide an improved process and apparatus for curing rubber and plastic belting and other elongated articles.

A further object of this invention to provide belting of excellent uniformity, and which can be produced with greater economy than previously possible through the provision of a continuous belting process.

The objects of this invention are achieved through the apparatus and method of the present invention. In its broadest aspect, the present invention provides a method of curing an elongated article, comprising pressing the article in a press comprising a number of press units, the press units being successively engaged with the article at a first station and moving in engagement with the article to a second station where the press units are successively disengaged and returned to the first station.

In a particular embodiment of the invention, on completion of a curing operation and being disengaged from the article at the second station, the press units are employed to execute a further curing operation in the course of returning to the first station. The further curing operation may comprise transfer of the press units to, and successive engagement of the press units with, an article at a third station and movement of the press units in engagement with this article to a fourth station where the press units are successively disengaged and transferred to the first station.

To avoid gaps between cured portions of the article, the press units are moved into contacting end to end relationship, and also the movement of the press units, relative to the article, is in a direction perpendicular to the surface of the article once the press units are in contact with the article.

When curing certain articles of a plastic consistency, it has been found that as a press unit is moved into contact with the article, a small amount of material forming the article is pushed out at the rear edge of the unit. The next press unit has to compress this extra material and as a result more material is pushed out at the rear edge of this next unit. This action becomes progressive.

By moving the press units into contact with the article in a particular manner, expulsion of material can be avoided. Thus according to a further embodiment of the invention, pressure is applied by the press units to successive contiguous portions of an elongated article to be cured, the pressure exerted on each portion of the article by its respective press unit initially substantially greater in the region of the forward end of the said portion of the article than in the remainder of that portion of the article. Pressure is then applied or increased in the remainder of that portion of the article in a progressive manner from the forward end to the rearward end thereof, the pressure being applied or increased in the region of the rearward end of the said portion of the article substantially simultaneously with the initial exertion of pressure in the region of the forward end of the next following contiguous portion of the article.

The invention can be used for curing articles other than belting and like material. Thus the invention can be used in the manufacture of laminated material, such as plywood, and boarding such as fibre-board, insulat-

ing board and other products which require pressure and heat treatment during production.

In this specification the term "curing," and derivatives thereof, refers to heat treatment to produce a change of state and specifically in relation to rubber and similar materials refers to vulcanisation thereof. A further example is the application of pressure and heat to convert material in one form into another, as for instance to convert a pasty or liquid material to a solid self-supporting form.

Various embodiments of the invention will now be described by way of example, in conjunction with the accompanying diagrammatic drawings, in which:

FIGS. 1 to 4 are plan-view representations of a sequence of successive steps in the curing of two lengths of conveyor belting in two parallel presses;

FIG. 5 shows a transverse cross-section through a continuously heated press unit, having its own compressive force-applying means, in engagement with an article being cured;

FIG. 6 shows a section of the line VI—VI of FIG. 5;

FIG. 7 shows a longitudinal cross-section through part of two adjacent press units of the type shown in FIGS. 5 and 6, each having its own compressive force-applying means;

FIG. 8 shows a transverse cross-section through a press unit designed for intermittent heating and for use with fixed presses;

FIG. 9 shows a longitudinal cross-section through part of two adjacent press units of the type shown in FIG. 8 showing the platens clamped end to end;

FIG. 10 shows a vertical cross-section through a single daylight fixed press having re-heating means in the form of hot plates, for the platens of the press units, a press unit being shown in position;

FIG. 11 is a plan view representation of a stage in the course of continuous curing of two conveyor belts side by side at the same level, employing single daylight fixed presses;

FIG. 12 shows another plan view of two curing units of a different form;

FIG. 13 shows a cross-sectional view taken on the line 13—13 in FIG. 12;

FIGS. 14 and 15 illustrate fragmentary cross-sectional views illustrating further details;

FIG. 16 shows a pressing station A in FIG. 12 in a side elevational view at right angles to a length of belting being cured;

FIGS. 17, 18, 19 and 20 show diagrammatic cross-sectional views taken on the line 17—17 in FIG. 12 illustrating a sequence of movements during operation of a pressing station, and in which a series of clamps is indicated for maintaining pressure on an article being cured after the article emerges from the pressing station;

FIG. 21 is a longitudinal cross-section through a press unit otherwise similar to that of FIGS. 8 and 9, but designed to be spaced apart from adjacent press units during a curing operation;

FIG. 22 is a vertical cross-section through a double daylight fixed presses, two press units shown in position;

FIG. 23 is a representation of a stage in the course of continuous curing of a single length of conveyor belting using double daylight fixed presses;

FIG. 24 is a representation of an elevation of the apparatus shown in FIG. 23.

The invention is described herein with particular reference to the curing of conveyor belting, but as indicated above, the invention is applicable to the curing of rubber and plastics and other elongated articles in general.

In the arrangement shown in FIG. 1 two identical presses 1 and 2 each consist of a number of identical press units, in the present example six press units, the units of press 1 extending between a first station S1 and a second station S2 and being 1B, 1C, 1D, 1E, 1F and 1G, and the units of press 2 extending between a third station S3 and a fourth station S4 and being 2B, 2C, 2D, 2E, 2F and 2G. The units of each press are in contiguity with each other, i.e., in end-to-end contact, each have an upper platen (shown in FIGS. 1 to 4) and a lower platen (not shown), the two platens having means (not shown) to urge them towards each other by hydraulic or other suitable power. Edge irons 3 are provided for engagement with the edges of the belting and heating means (not shown), such as steam pipes, provided for raising the unit to a suitable curing temperature and maintaining it at that temperature. At the stage shown in FIG. 1 the pressure applied to urge together the platens of units 1G and 2G which have just been added to the presses 1 and 2 at the first and third stations S1 and S3 respectively, is less than that applied to the platens of the other units of the presses.

The conveyor belting 4 of press 1 consists of a series of portions; an uncured portion 4A which has not yet entered the press, a number of portions (not shown) within the press units and a further portion 4B of cured belting which has left the press. Similarly the conveyor belting 5 of press 2 consists of an uncured portion 5A, portions (not shown) within the press units and a cured portion 5B.

Fixed clamps 7 and 8 and longitudinally movable clamps 6 and 9 are provided for producing and holding the longitudinal tension required during curing. Similarly the tension means for the reinforcement of belting 4 consists of fixed clamps 11 and 12 and longitudinally movable clamps 10 and 13. Each clamp consists of a pair of horizontal jaws, one of which is movable vertically by hydraulic or other means so that the jaws can be closed upon and hold the belt, or opened to allow the belt to pass between them. It will be seen that the fixed clamp of each pair is on the press side of each of the pairs of clamps.

The lower platens (which support the belting) are themselves carried on horizontal tables (not shown in FIGS. 1 to 4). Fixed base members 14, 15 are provided between the stations, on which press units can be transferred from the second station S2 to the third and from the fourth S4 to the first S1. In FIG. 1 press unit 1A, with its edge irons, is supported by fixed base member 14 and is in the course of being transferred from the second station S2 to the third station S3. Similarly press unit 2A, supported by fixed base member 15, is in the course of being transferred from the fourth station S4 to the first station S1.

In FIG. 1 the tension in the reinforcement of the belting 4 is provided by clamps 10 and 13 which are shut firmly on the belting, clamps 11 and 12 being open. Similarly, the tension in the reinforcement of belting 5 is provided by clamps 6 and 9 which are shut firmly on the belting, clamps 7 and 8 being open. The arrow associated with clamps in FIG. 1 show the movement that

took place in the immediately preceding step of the method.

In FIG. 2 the presses 1 and 2 consist respectively of press units 1C, 1D, 1E, 1F and 1G, and 2C, 2D, 2E, 2F and 2G (1G and 2G being still pressed against the belting at a lower pressure than the other units). Press unit 2B has arrived at the fourth station S4, its platens having been separated. The portion 16 of the belting from which unit 2B has been released is in a fully cured condition. Similarly, press unit 1B has arrived at the second station S2, the belting portion 17 being in a fully cured condition. The press units 1A and 2A, which in FIG. 1 were supported by turntables not shown in FIG. 1 but shown in FIG. 2 as 18 and 19, have been turned through 180° on the turntables and forwarded respectively towards the third and first stations, the upper and lower platens of each unit being situated respectively above and below the belting but without yet being closed on the belting.

The belting 4 is now held in tension by clamps 11 and 12 while belting 5 is held in tension by clamps 7 and 8. Clamps 10 and 13 have each been moved to the right, while in an open condition, and similarly clamps 6 and 9 have been moved to the left while open. Clamps 10 and 6 each initially move a distance somewhat less than the width of a press unit, the actual distance moved being such that when clamps 10 and 6, together with clamps 13 and 9, are closed on the belting, and clamps 7, 8, 11 and 12 are opened, clamps 10 and 6 are moved a further distance to bring the total distance moved by these clamps up to that equalling the width of a press unit, and at the same time applying the correct tension to the belting 4 and 5. The relative proportions of the initial movement and the further movement are selected to provide the desired tension in the belting.

With reference to FIG. 3, press 1 now consists of press units 1C, 1D, 1E, 1F, 1G and 2A, and press 2 consists of press units 2C, 2D, 2E, 2F, 2G and 1A, press units 1A and 2A having been added respectively to the tails of presses 2 and 1, their platens closed on the belting and their temperature raised. Press units 1G and 2G, which in FIG. 2 were shown as being at low pressure, now have that pressure increased to that of press units 1C, 1D, 1E and 1F and units 2C, 2D, 2E and 2F respectively. Press units 1B and 2B have been forwarded respectively to turntables 18 and 19 for rotation through 180° and if necessary change of side irons 20 and 21 represent respectively the means for changing the edge irons of the press units between successive curing operations thus making it possible to use the press continuously without stopping production when one belt is completed and one of a different thickness and width is started and making it possible to press two different sizes of belt on the two presses. The rotation is made to avoid the steam lines or other connections becoming crossed. The main steam line (not shown) feeding presses 1 and 2 preferably lies between the two presses, and if rotation through 180° of the press units being transferred were not made, it would result in the steam lines of the transferred press units being on the outer side of the press with consequent inconvenience in operation.

As described previously, clamps 6 and 10 are shown as having been moved a further short distance respectively from clamps 7 and 11, as indicated by the arrows touching clamps 6 and 10. Before this movement was made clamps 6 and 10 were shut firmly on the belting

and consequently the belt portions 22 and 23 are subjected to a tension substantially the same as the tension in the belting within the press. 24 and 25 represent preheating means to preheat the uncured belting before it is fed to the presses and thereby to increase the output of the presses, but this is an optional feature and the success of the method of the invention is not dependant upon it.

FIG. 4 shows the press units in the same order as shown in FIG. 3, but iron-changing means 20 and 21 and the heaters 24 and 25 are not shown.

The stage illustrated in FIG. 4 is that immediately following the movement (by means of hydraulic or other power) of belting 5 and its press units 2C, 2D, 2E, 2F, 2G and 1A towards the right of the drawing by an amount equal to the width of a press unit. This movement has been accompanied by opening clamps 7 and 8 so as to release the belting and moving clamps 6 and 9 towards the right by a distance equal to the width of a press unit. Similarly, movement of the belting 4 and its press units 1C, 1D, 1E, 1F, 1G and 2A towards the left-hand side of the drawing has been accompanied by opening clamps 11 and 12 and moving clamps 10 and 13 towards the left by a distance equal to the width of a press unit.

It will be seen that the disposition of the press units of presses 1 and 2, the press units in transfer across the fixed base members 14 and 15 and the tension clamps 6, 7, 8, 9, 10, 11, 12 and 13 is the same in FIG. 4 as in FIG. 1 and that the cycle illustrated in FIGS. 1-4 has resulted in the emergence from the press of one fully cured portion of width equal to the length of a single press unit. Consequently, the first stage of the next cycle of the method is represented by FIG. 2 and so on.

In the specific process described above each cycle results in the whole of the belting portions within press units being cured to the same extent and at any particular stage of the cycle the contiguous portions within the press units constituting the press at that time are in states of cure which range from the almost fully cured state of the portion in the press unit at the head of the press near stations S2 or S4 to a state of only very slight, if any, cure of the portion within the press unit at the tail of the press near stations S1 or S3. It will be seen, therefore, that the conditions of temperature and pressure used to effect cure are preferably selected so that a belting portion in any particular press unit reaches the fully cured state at the time when its press unit is to be detached from the head of the press. Where the material being cured is one which is susceptible to "over cure," care has to be taken to select conditions which avoid that state.

If found convenient, the press units can move during transfer between presses, on a semi-circular path between the two base members or on a path which is partly curved and partly straight. In that event, the rotation of the units through 180° during transfer from the second or fourth to the third or first station respectively is effected by the curved path and turntables can be dispensed with.

As shown in FIGS. 5 to 7 a press unit 26 comprises horizontal rectangular platens 27 and 28 between which is located a portion 29 of conveyor belting. The press unit 26 further comprises insulation layers 30 and 31 to reduce the loss of heat from the platens during curing and tables 32 and 33 which ensure a uniform compressive force on the conveyor belting during cur-

ing, the arrangement being such that the platens are sandwiched between the insulating layers which are themselves sandwiched between the tables.

The lower table 33 is supported by a support member 34 slidably located on rails 35 and 36 formed on fixed base member 37. The rails 35 and 36 are located in corresponding grooves 38 and 39 formed in support member 34, so that the whole press unit may slide along the fixed base member 37 during curing. Motive power to cause the press unit to slide thus is derived from an external fluid pressure operated means and is applied to the press units through drive brackets 40 and 41.

Upper table 32 is secured to two support brackets 42 and 43 extending upwardly from the table having mounted at their upper ends axles 44 and 45 one on each bracket, extending at right angles to the sides of the press unit, two pairs of wheels 46 and 47 being rotatably mounted, one pair on each axle, to engage overhead guide rails (not shown) at second station S2 or fourth station S4 at the end of a curing operation.

To control the width and thickness of the portion of belting 29 being cured, and to produce straight edges thereon, the press unit 26 is provided with two edge irons 48 in the form of plates having straight edges and adapted to be positioned with one edge of each iron in engagement with one edge of the portion of belting 29. The edge irons each have formed therein two openings 49 to provide locating sockets for fluid pressure operated means (not shown) to urge the irons into engagement with the belting, two series of apertures 50 being provided to co-operate with pins 51 associated with the upper platen 27 to hold the edge irons in the required position after engagement with the belting as described above. Two further apertures 52 in the form of slots adjacent each end of the iron are provided for a purpose to be described.

The press unit 26 is provided with four similar piston and cylinder assemblies 53 operable by fluid pressure to draw together the two platens, thereby exerting compressive forces on the belting 29 being cured. The piston and cylinder assemblies are all mounted on the upper rectangular table 32, one near each corner thereof in order that at least one assembly should be located adjacent each edge of the opposite side edges 54 and 55 (FIG. 5) of the upper platen 27.

Each piston and cylinder assembly 53 comprises a piston rod 56 attached at one end to a piston (not shown) and having an abutment 57 at the other end, the piston rod being arranged to extend through the apertures 52 formed in the edge irons 48, and corresponding alignable apertures in the tables 32, 33, insulation layers 30, 31, platens 27, 28 and the support member 34.

In FIG. 5, the piston rod 56 is shown fully extended outwardly from the cylinder. In order that, on admission of fluid pressure to the cylinder and withdrawal of the piston rod into the cylinder, the platens may be urged together, removable means in the form of a swingable locking piece 58A (only one being shown in FIG. 6) is provided for each piston and cylinder assembly to engage the abutment 57 and prevent withdrawal thereof so that the tables 32, 33 and thereby the platens 27, 28 are squeezed between the cylinders and the abutments of the assemblies 53.

Control panels 59 and 60, one on each side of the press unit 26 are provided to control the supply of fluid pressure to the various cylinders on the unit, valves

(not shown) on the panels being operated by rods and cams (not shown) at appropriate points in the course of any given curing operation.

The various connections necessary for the supply of steam, cold water, hydraulic power and other requirements to the press units are made to the inner side of the press units with respect to the closed circuit path which they follow, by means of flexible pipes (not shown) and a services conveyor.

In the apparatus shown in FIGS. 5 to 7 adjacent press units are secured end-to-end during curing of the belting by means of two fluid-operated latch mechanisms 61 on each press unit, mounted horizontally, one on each side edge of each table adjacent one end of each side edge. Each latch mechanism comprises a hinge 62 on which a cylinder 63 is mounted, swingable in the plane of the table. A piston (not shown) is located in each cylinder 63, and has a piston rod 64 with an abutment 65 at the free end thereof. Each latch mechanism further comprises a latch portion 66 in the form of two separate raised members 67 arranged so that piston rod 64 can pass between them by swinging cylinder 63 on hinge 62. When fluid pressure is supplied to cylinder 63, the piston is urged toward the hinge end of the cylinder 63, and abutment member 65 engages raised members 67 of the adjacent press unit 68 thereby urging the units together.

Edge irons 48 are each provided with a rectangular guide slot 69 extending parallel to the end edges of the edge iron, in each of which is located a corresponding guide lug 70 attached to lower platen 28, this provision being to ensure that the edge irons are always positioned parallel to the side edges of the platens, thereby ensuring substantially straight edges are formed on the belt through-out its length.

A curing operation employing the apparatus shown in FIGS. 1 to 7 will now be described.

In FIG. 1, press unit 1A, which for the purpose of describing this sequence of operations will be considered to be the press unit 26 of FIG. 7, but as will be explained more fully hereafter may be of a modified design, is shown midway between the second station S2 and the third station S3. At this point unit 1A is turned through an angle of 180° on turntable 18 (FIG. 2) and then is moved towards station S3 where the belting 5A is located between platens 27 and 28. Unit 1A then moves up to unit 2G as shown in FIG. 2, latch mechanism 61 secures it to unit 2G and edge irons 48 engage the sides of the belt, and are located in position by pins 51. Assemblies 53 close the platens on the belt under low pressure. The platens, being continuously steam-heated are already hot, and curing begins. Curing proceeds under increasing pressure from piston and cylinder assemblies 53 as the belt and attached press units move slidably and stepwise through the press supported on the fixed guide member 37 as already described, in conjunction with the appropriate clamping operations of clamps 6, 7, 8, 9, 10, 11, 12 and 13.

During curing, appropriate adjustments to fluid pressures and other control operations are effected by engagement of the controls of panels 59 and 60, for example by levers and cams suitably positioned as the press unit slides along fixed base member 37.

As unit 1A reaches station S4, the pressure on the platens is released, the latch mechanism disengaged, the edge irons released, and wheels 46 and 47 engage fixed overhead guide rails (not shown) causing the

upper part of the press unit to be disengaged from the belt. The parts of the press unit are then moved sideways, to station S1, being turned through an angle of 180° during such movement, ready to engage with the belt 4, thus completing one curing operation.

FIGS. 8 and 9 show a modified press unit arranged to be heated intermittently and used in conjunction with means independent of the press unit for applying a suitable compressive force to the belt.

As previously described, pressure is applied to the platens progressively, in that initially the pressure is relatively low, then being increased up to a maximum compressive force which is set by various requirements, for example to squeeze the rubber into the interstices of the tensile member, and to produce a uniform surface. However, it has been found that this maximum compressive force need not be applied throughout the remaining curing time of the belting. It is sufficient for the compressive force to be built up during the first part of the curing cycle, and may be reduced thereafter for the remainder of the operation, to a magnitude sufficient to overcome pressure produced between the platens, for example by the formation of steam from moisture present in the article being cured.

It is therefore possible to pass the press units, one at a time, through a fixed press which builds up the maximum compressive force on the press units, after which latches are engaged, to lock the platens together. The press units then pass from the press, the latches retaining the platens together and thus maintaining pressure on the belt. Depending upon the material being cured, there may be a variation in the pressure between the platens, and this pressure may even reduce to zero by the end of the cycle.

While such fixed presses need to be of substantial construction, as they only have to accept one press unit at a time the size of the fixed presses can be much smaller than conventional belting presses.

FIGS. 8 and 9 illustrate a press unit, 71 for use with a fixed press and for intermittent heating. Press unit 71 comprises platens 72 and 73 between which is located a portion 74 of a length of conveyor belting. Edge irons 75 similar to the irons 48 employed in the press 26 depicted in FIGS. 5 to 7 are provided, with edge iron pins 76 associated with upper platen 72 co-operating with a series of apertures (not shown) formed in each edge iron as previously described in connection with edge irons 48.

Lower platen 73 is provided with a pair of right-angled mild steel angles 77 one limb of each of which is secured to one side edge face of the platen. The other limb extends laterally from the platen 73, with its upper surface in the same plane as that of the belt-contacting surface of platen 73.

A second pair of right-angled mild steel angles 78 of smaller gauge metal than the angles 77 is located in the angle between the limbs of the angles 77, and between the angles 77 and the angles 78 is a right-angled section layer of insulating material 79, to minimise the loss of heat from the platen. The assembly of platen angles and insulation material being secured together to form a unified structure.

Mild steel angles 78 serve as guide and support surfaces for the press unit and engage guide wheels 80 rotatable in a horizontal plane, and support wheels 81 rotatable in a vertical plane mounted on right-angled support brackets 82 fixed to and extending along the

length of the press with a base 83. Between support brackets 82, and fixed to base 83 is a layer of insulation 84, the arrangement being such that the platens are supported by support wheels 81 so that there is an air gap between the upper surface of insulation layer 84 and the lower surface of platen 73.

Upper platen 72 is also provided with a pair of right-angled mild steel angles 85 corresponding to the angles 77, one limb of each of which is secured to one side edge face of the platen 72, the other limb extending laterally with its lower surface in the plane of the belting contacting surface of platen 72.

The platens 72 and 73 of press unit 71 are of such a thickness that their thermal capacity is sufficient for the curing of the belt in the time of the curing cycle, without requiring any further addition of heat. For example it has been found that the thermal capacity of a 3-inch thick platen is more than sufficient for the purpose of vulcanising a 1-inch thick belt.

Heat is supplied to the platens at re-heat stations by bringing the platens into contact with hot metal plates as will be described hereafter. Other satisfactory methods of re-heating the platens include the use of infra-red heating units and direct heating by gas flames of the outer surfaces of the platens which surfaces do not contact articles to be cured.

Employment of an intermittent supply of heat has the advantage that before the platen is brought into contact with the article to be cured, it can be heated to a temperature higher than that normally used for the curing of the article so that heat penetrates from the surface of the article to its centre portion more quickly, thus providing a shorter curing time. The loss of heat from the surface of the platen to the article cools the platen surface so that over-curing of the article can be avoided.

As press unit 71 moves along the press in the course of a curing operation, heat losses from the upper surface of upper platen 72 are minimised by the provision of a stationary canopy 86 extending along most of the length of the press and having a lining 87 of insulating material.

Two lifting lugs 88 are secured to each angle 85 at the side of press unit 71 whereby the upper platen may be lowered and lifted by external means (not shown) as required to engage and disengage the belting 75 at the beginning and end of a curing operation.

A sequence of operations during curing, employing press units as already described with reference to FIGS. 8 and 9 and fixed presses 89 which incorporate platen reheating apparatus (see FIG. 10) will now be described with reference to FIG. 11.

In Fig. 11 the arrangement and general mode of operation of press units 71 (only one being numbered), clamps 90 for tensioning the belts 91 and 92 and pre-heat stations 93 for pre-heating the belt are as previously described with reference to FIGS. 1 to 4.

At the first station S1 in FIG. 11, the belt 91 is located between the platens 72 and 73 of press units 71 (FIG. 10). Edge irons engage the edges of the belt and the press unit is secured to its adjacent unit by screw-threaded unit clamping means 100 operated by external means. Locating pins 101, one on each side of each press unit and passing through apertures formed in angles 77 and 85 ensure accurate alignment of the platens. The press unit is then moved on wheels 81 and guided by wheels 82 to fixed press 89 (see FIG. 10)

where by operation of piston and cylinder assembly 94 mounted on base 95, movable lower table 96 slidably mounted on guide members 97 is urged towards upper table 98 thereby causing hot plates 99, insulated from the tables by insulating layers 102, to engage the platens and the press unit to be lifted off wheels 81.

While the press unit 71 is under compression in fixed press 89, platen clamping means in the form of four platen clamping screws 103, two at each side edge of the press unit and passing through angles 77 and 85, are operated by external means so that on emergence of the press unit from the fixed press the platens are retained at substantially the proximity they assumed in the fixed press.

After a predetermined interval the press unit leaves the fixed press 89 and moves in stages in a manner similar to that already described in connection with FIGS. 1 to 4, towards the second station S2. Curing continues as heat is conducted from the platens to the portion of belting with which they are engaged, while the unit rides along on supporting wheels 81 under the canopy 86.

At the second station the unit is released from its adjacent unit by releasing the unit clamping means 100, compression is released by releasing clamping screws 103, and locating pins 101 and edge iron pins 76 are disengaged all by external means (not shown), and the upper platen lifted away from the belt by means of lugs 88. The lower part of the unit is moved away from the belt, and the whole unit transferred to the third station S3 but without being turned round since this is unnecessary because no flexible connections such as steam pipes are made to the press unit. At the third station S3, the sequence of operations just described is repeated and the press unit moves with the belt 92 to the fourth station and thence back to the first station again.

As previously stated, where curing certain articles of a plastic consistency, there is a tendency for material to be squeezed out from between the platens, at the rear end of the press unit. FIGS. 12 to 22 illustrate an embodiment of the invention in which pressure is applied by the press units to successive contiguous portions of the article being cured, in such a manner that pressure is applied, or increased, in the rearward zone of one portion as pressure is applied to the forward zone of the next succeeding portion. The press units are arranged so that successive platens are in end contact with one another, and squeezing out of material is thus avoided.

As seen in FIG. 12, there are first and second identical curing units 201. 202 each comprising a plurality of identical press units 203 extending between two stations in contiguous head to tail relationship and in engagement with respective portions of reinforced rubber conveyor belting.

The press units 203 are successively brought into alignment with a length of belting 204 at a position 205, and successively engaged with successive contiguous portions of the length of belting 204 at a pressing station 225 constituting a first station of the first curing unit 201 and move in engagement with the belting to a second station 206 at the other end of the first curing unit where they are successively disengaged from the belting and transferred through a position 207 to a pressing station 225 constituting a first station of the second curing unit 202. Here the press units are successively engaged with successive contiguous portions of

another length of belting 208 and moved in engagement with the belting to a second station 209 at the other end of the second curing unit where they are then successively disengaged from the belting and returned to the position indicated by numeral 205 to commence another identical sequence of operations.

As shown in FIG. 13, each press unit 203 comprises a pair of thick metal platens 210, 211 for engagement with the belting 204 and 208. Holding means in the form of a series of clamps (not shown) are moved to prevent separation of the platens and thereby maintain any desired compressive forces on the belting during a curing operation as the press unit passes between the first and second stations of the two curing units 201 and 202.

To control the width and thickness of the portion of belting being cured by each press unit 203 and to produce straight edges on the belting, each press unit is provided with two edge irons 212 in the form of metal slats have straight side edges and arranged to be positioned with one edge of each iron in engagement with one edge of its respective portion of belting. Angle members 214 are attached to the sides of the platens 210, 211 to provide support and location for the edge irons.

Power operated means (not shown) independent of the press units is provided to force the edge irons 212 into engagement with the edges of the belting after the platens 210, 211 have engaged the belt at the commencement of each curing operation at the first stations 225. To maintain the separation of the edge irons and therefore to control the width of the belting throughout each curing operation, each press unit is provided with locking means for the edge irons comprising a pair of locking pins 213 (see FIG. 14) mounted at each side of the press unit, each pin being seated in aligned holes formed in a first pair of right angled mild steel angles 214. The mild steel angles are secured in back-to-back relation, one to each side edge of each platen so that in the assembled state of the platens they constitute a T-shaped structure, the pins 213 being seated in holes formed in the two limbs one from each mild steel angle, which are back-to-back.

Each locking pin 213 is locatable in any one of a series of apertures formed in its associated edge iron 212 at a corresponding position along the length thereof, the apertures of each series being spaced apart across the width of the edge iron. When the edge irons have been forced to have their required separation at the first station 225, they are maintained at this separation by locating the locking pins in the apertures in the edge irons appropriate to this separation.

Generally, in other respects, the press units 203 are similar in form to the press units 71 illustrated in FIGS. 8 and 9, and therefore further detailed descriptions of the press units 203 is not considered necessary.

Two iron change units 215 are provided between the two curing units 201, 202, one at each end thereof, where the edge irons required in the curing of one belt are changed, if necessary, for those required for the other belt. Thus, if desired, the two belts 204 and 208 may be of different widths and thickness.

As each belt passes through its respective curing unit, it is maintained under a predetermined steady longitudinal tensile load by means of tension units 216 located one at each end of each press.

Each tension unit 216 comprises a longitudinally fixed clamp 218, 219, and a longitudinally movable clamp 217, 220. By engagement of the clamps with and disengagement of the clamps from the belt and movement of the movable clamps, at appropriate times, the belt is moved stepwise through the curing unit under substantially constant tension.

The operation of the clamps of the tensioning units 216, is as the operation of the clamps 6 to 13 of the arrangement illustrated in FIGS. 1 to 4 and will not be further described, it being understood that the purpose of the units 216 is to provide for tensioning of the belting 204 and 208, and maintaining such tension, while permitting movement of the belting through the curing units 201 and 202.

To support and guide the press units for longitudinal movement with the belting during curing, support and guide wheels are provided at spaced apart positions along both sides of each press. The support wheels 221 (see FIG. 13) are mounted for rotation about horizontal axes parallel to the planes in which the press unit platens 210, 211 lie and engage support surfaces extending along the length of each press unit, one of each side thereof. Guide wheels (not shown) are mounted for rotation about vertical axes and engage guide surfaces also extending along the length of each press unit one on each side thereof.

To support and guide the press units for longitudinal movement with the belting during curing, support and guide wheels are provided at spaced apart positions along both sides of each press. The support wheels 221 (see FIG. 13) are mounted for rotation about horizontal axes parallel to the planes in which the press unit platens 210, 211 lie and engage support surfaces extending along the length of each press unit, one on each side thereof, whereas the guide wheels 222 (see FIG. 15) are mounted for rotation about vertical axes and engage guide surfaces also extending along the length of each press unit one on each side thereof.

The support and guide surfaces of each press unit are constituted by a second pair of angle members 223 mounted one of each side of the lower platen 211 of each press unit 203 and insulated from the first mild steel angle 214 secured thereto, by a layer 224 of insulating material.

Similar means is provided for supporting and guiding the press units 203 during transfer from one curing unit to the other.

The pressing stations 225, which respectively constitute the first station of each curing unit will now be described.

As shown in FIG. 16, each pressing station 225 comprises thrust means for simultaneously applying pressure through three successive press units within the pressing station to three contiguous portions of the belting. It is sufficient however, for the success of the invention for a pressing station to accommodate only two press units as will be explained hereafter.

The thrust means comprises a vertically movable base member designated as a whole by the reference numeral 226 and equal in length to three press units, on which the platens of three press units are supported while in the pressing station, and first and second vertically movable press heads each designated as a whole by the respective reference numerals 227, 228. The vertical movement of the base member 226 lifts the press units off their support wheels 221 (not shown in

FIG. 16) so that the wheels are not subjected to loads arising from the pressure applied to the belting in the pressing station. Pressure is applied to the belting within the three press units by vertically downward movement of the press heads 227, 228.

The press heads 227, 228 are fluid pressure operated. The first press head 227 comprises two portions, a parallel portion 243 and a tapered portion 242. Each portion is approximately equal in length to one press unit and the tapered portion 242 is at the end at which the belting enters. Mounted below the press head 227 are two pressure plates 230 and 231. The pressure plates are in two parts, an upper part and a lower part, the lower part being heated and insulated from the upper part by a layer of insulation 247. The pressure plates 230 and 231 are of the same thickness and are of constant thickness.

Mounted below press head 228 and rigidly attached thereto is a pressure plate 228a, comprised of two parts, upper and lower, separated by an insulation layer 247. The overall thickness of press head 288 and pressure plate 228a is the same as that of the parallel portion 243 of the press head 227 plus pressure plate 231.

The manner in which the two pressure plates 230, 231 of the first press head are mounted below will now be described:

At the end of the first press head 227 at which the belt 204 enters the pressing station, the rearward end of the first pressure plate 230 is pivotally connected to the first press head 227 by a link joint at each side thereof, each link joint comprising two hinge members 232 one rigidly secured to the first pressure plate and the other rigidly secured to the press head and a rigid link 233 interconnecting the two hinge members and pivotally secured thereto at each end.

Three pairs of side plates 234, 235, 236 are rigidly secured one plate to each side of the first and second pressure plates 230 and 231 and one plate to each side of the second pressure plate 228a respectively.

The side plates 234, 235, 236 extend downwardly to the level of the belt 204 being cured, where they are pivotally interconnected, as described below.

The rearward ends 237 of the side plates 236 of the pressure plate 228a are pivotally connected to the forward ends 238 of the side plates of the second pressure plate 231 of the first press head 227. The pivot is at the level of the belting but this can be varied as described later. Thus a downward movement of the second press head 228 effects a similar downward movement of the forward end of the second pressure plate 231 of the first press head 227.

The rearward ends 239 of the side plates 235 of the second pressure plate 231 of the first press head 227 are pivotally connected to the forward ends 240 of the side plates 234, of the first pressure plate 230 of the first press head, and the two joints therebetween are each supported by a support arm 241 pivotally connected at one end to the two side plates 234, 235 at the joint therebetween, and pivotally connected at its other end to the upper tapered thrust member midway along the length thereof.

The first and second pressure plates 230, 231 positioned below the tapered and parallel portions 242 and 243 respectively, are each of the same length as one press unit, so that for a given downward movement of the first press head 227, the second pressure plate 231 will experience a generally uniform thrust over its

whole upper surface, whereas although the first pressure plate 230 will receive substantially the same thrust at its forward end as the second pressure plate, the thrust decreases towards the rearward end of the first pressure plate where it is comparatively small. As a result of the pivotal mounting of the said first and second pressure plates, the downward thrusts applied to the upper platens 10 of the press units below the two pressure plates correspond to the thrusts received by the two pressure plates themselves.

To ensure that the links 233 only support the pressure plate 230 and do not apply any pressure thrusts on actuation of the press head 227, when the press head 227 is raised there is a small gap between the top surface of the pressure plate 230 and the undersurface of the press head 227. Also one of the pairs of hinge members 232 has the pivot holes slightly elongated to allow some vertical movement between the pressure plate 230 and the press head 227.

The second press head 228 applies a substantially uniform thrust to the upper platen 210 of its respective press unit.

To allow the pivotal movements of the two pressure plates, 230, 231 of the first press head 227, forward and rearward edges of the pressure plates are spaced apart as shown in FIG. 16. Alternatively they can be chamfered.

The operation of the pressing stations will now be described with reference to FIGS. 17 to 20 of the drawings. FIGS. 17 to 20 are purely diagrammatic and many parts shown in FIG. 16 have been omitted for clarity.

The belting 204 and press units compressing platens 210, 211 move stepwise through the pressing stations 225, moving forward by the length of one press unit in each step, the two press heads 227, 228 executing one complete downward and upward movement before the belt and press units move on.

FIG. 17 illustrates the situation with both press heads raised and the belting and press units having moved forward the distance of one press unit. When the belting and press units are correctly positioned, the press heads come down into contact with the press units (FIG. 18). On further movement of the press heads, press unit C and its respective portion of uncured belting is compressed first between the first pressure plate 230 and the base member 226 (see FIG. 19). This causes the belting 204 to achieve at the forward end of the press unit C the thickness required in the fully cured belting, but at the rearward end the belting is hardly compressed, if at all.

Next, the pressing station is opened and the press unit C, with the belting, is moved one press unit length further into the pressing station (see FIG. 20) to the position of press unit B in FIG. 17, and a further press unit D takes its place between the first pressure plate and the base member.

It is believed that it is not necessary for this specification to include drawings showing the press unit C undergoing the next stage of compression in the pressing station, because press unit C is then as shown in FIG. 20, in the position occupied by press unit B in FIGS. 17 to 19, and undergoes the sequence of operations executed on press unit B in FIGS. 17 to 19. Accordingly, this next stage will be described with reference to press unit B in FIGS. 17 to 19.

When the first press head 227 is forced downwardly, as shown in FIGS. 18 and 19, the press unit B is com-

pressed at its rearward end substantially simultaneously with the initial exertion of compressive forces on the next following contiguous portion of belting by the forward end of the next following press unit.

Thus the belting within the press unit B is brought to its required final thickness at the stage illustrated in FIG. 19, and clamps are suitably tightened to maintain the desired compressive forces on the belting.

Since the initial exertion of appreciable compressive forces at the rearward end of the press unit within the pressing station does not occur until the press unit is positioned below the second pressure plate 231 of the first press head 227 (see press unit B in FIGS. 18 and 19), and this occurs substantially simultaneously with the initial exertion of compressive forces on the forward end of the next following press unit (see press unit C in FIG. 18 and 19), the tendency for soft hot rubber to be squeezed out from between the platens at the rearward end of the press unit is smaller than when there is no simultaneous compression at the forward end of the next following press unit.

On commencing curing of a length of belting, some rubber may tend to be squeezed out from between the forward ends of the platens of the first press unit on the belt, but if this occurs the short length of affected belting can be discarded and from then onward the problem will not arise again with the remainder of that length of belting.

The second press head 228 engages each press unit 203 successively but since the belting in the press units has by then already been subjected to substantially the required degree of compression, very little or no further compression occurs at this stage. However, by virtue of the arrangement of the pivoted side plates 234, 235, 236, the forward end of the second pressure plate 231 of the first press head 227 is always at substantially the same distance from the base member 226 of the pressing station as the second press head 228 and therefore during the initial exertion of compressive forces on the rearward end of any given press unit, the compressive forces at the forward end thereof are maintained and there is no tendency for soft hot rubber to be squeezed in a forward direction in this stage.

The second press head 228 constitutes means, independent of the first press head 227 to urge the forward end of the second pressure plate 231 towards the belting being cured, and the maintenance, when required, of compressive forces at the forward end of each press unit is the main function of the second press head. Accordingly if desired the second press head can be dispensed with and replaced by equivalent means such as fluid pressure operated ram acting on the forward ends of the side plates 235 of the second pressure plate 231. However, the second press head 228 does also serve to maintain uniform compressive forces over the whole area of belting within the press unit which is engaged by the second press head at any given time. Thus, provision of the second press head allows the clamps which are provided for each press unit to be of relatively light construction, and to be designed to act on the press unit platens around the edges thereof only. Although such clamps are adequate to maintain pressure on the belting after it has passed through the pressing station, on their own the clamps would be incapable of maintaining uniform pressure on a portion of belting when the preceding contiguous portion of belting is being compressed in a pressing station, since in such circum-

stances the pressure of hot fluid rubber can be sufficient to cause buckling of the platens of a press unit which is clamped only at its edges.

Further, by holding its associated press unit in firm head to tail relationship with the next following press unit, the second press head 228 also serves to prevent the two press units separating longitudinally under the pressures of hot fluid rubber and thereby effectively stretching the belting. Thus the inclusion of a second press head in the pressing stations although not essential is nevertheless desirable.

Heat is supplied to the platens of the press units during the time that they are under compression in the pressing stations 225, so that each press unit is reheated at the beginning of each curing operation.

The heat is transferred to the platens of the press units by contact between the platens and heated portions of the thrust means. Thus certain portions of both the base member 226 and the press heads 227, 228 are continuously heated by electricity, steam, or any other convenient source of heat. The supply of heat to two press heads and to the base member is limited to the lower portions and upper portions respectively thereof, which engage the press units. The heated portions of the press heads are insulated from the remainder thereof by insulation layers 247, as previously described, to minimise heat loss, and a similar insulation layer 248 is provided below the heated portion of the base member.

Heat losses from the press units on emerging from the pressing station 225 during a curing operation are minimised by providing tunnels 249 each having a lining 250 of insulating material (see FIG. 13). The tunnels closely surround the press units and extend along the length of their respective curing unit 201, 202 so that the press units pass therethrough during each curing operation.

The supply 251 (FIG. 12) of uncured belting at one end of each curing unit may be simply in the form of a roll of uncured belting mounted for rotation on an axle, or, the curing unit may be positioned at one end of a belting production line in which case the uncured belting enters the press immediately after it has been assembled from, for example, a rubber-frictioned textile reinforcement and superimposed rubber covering layers.

On emerging from its respective curing unit the belting passes through a trim unit 252 (FIG. 12) for the removal of rubber flashing, and after cooling is ready for service.

If it is found desirable, a reheating station 253 (see FIG. 12) may be provided near the end of each curing unit to supply heat to the platens of the press units shortly before the press units reach the second station of the respective curing unit and are removed from the belting. Heat is supplied to the platens of the press units in the reheating stations by contact between the platens and heated metal blocks.

Also, leakage of soft hot rubber from between the forward and rearward ends of the press units may be further reduced by the provision of two steel bands (not shown) of the same width as the belt, sandwiching the belt between them during curing and moving along the press with the belting. Thus, pressure is applied to the belting through the steel bands by the platen of the press units. The belts are at all times supported for their full area by the pressure plates.

Each steel band is in the form of an endless loop which is held in the correct position relative to the belting by the press units and which on emerging from the press with the cured belting is guided back to the other end of the press by large diameter pulleys or rollers.

Alternatively, instead of the steel bands described above, means may be provided for positively forcing the platens of successive press units together in a longitudinal direction so that the forward end of one press unit is more firmly engaged with the rearward end of the next press unit and so on, so that leakage of rubber between the said ends is minimised. This may be achieved simply by arranging that the pivotal joints between the side plates **236** of the second press head **228** and the side plates **235** of the second pressure plate **231** of the first press head **227** are higher with respect to the base member **226** than the corresponding joints between the side plates of the two pressure plates **230**, **231** of the first press head.

The advantages provided by the modifications, as described above in relation to FIGS. **12** to **20** is as follows:

First, by reducing or eliminating the squeezing out of soft hot rubber from between the platens of the press units at the forward and rearward edges thereof the operation of the press as a whole is improved since rubber squeezed out from one press unit tends to interfere with the operation of adjoining press units. Further the quality of the cured article produced by the curing units is improved, since formation of irregularities and ribs on the surfaces thereof by rubber squeezed out from between the platens, is avoided.

Secondly, because there is a gradual transition from small or zero compressive forces at one end of a pressing station to relatively large compressive forces at the other end thereof, an appreciable step in belt thickness is never formed by the curing units as it is in conventional belt presses, and therefore kinking of the belt reinforcement and associated irregularities in the belt surface are avoided.

The use of steel bands sandwiching the belt between them to reduce further the leakage of soft hot rubber from between the press unit platens and to give an improved finish to the belt, is associated with the advantage referred to in the preceding paragraph. Such steel bands cannot be employed in presses where any appreciable step in belt thickness is produced during curing, since such a step would cause kinking of the steel bands which would rapidly become useless.

The present abutting forward allows such steel bands to be used, and when they are used they eliminate the formation of thin films of rubber flashing on the upper and lower surfaces of the belt through leakage of rubber between the abutting forward and rearward edges of the platens of successive press units which might occur. Unlike the rubber flashing which is formed at the edges of the belt as a result of rubber leaking between the platens and the edge irons, which is easily removed in the trim units, films of rubber on the upper and lower surfaces of the belt are not easily removed and therefore it is a clear advantage to avoid their formation.

The press unit **304** shown in FIG. **21** is designed for use in the apparatus represented in FIGS. **23** and **24**, using the double daylight fixed press of FIG. **22**. This apparatus is intended to be used where it is not convenient to provide for simultaneous cure two belts having more or less the same curing time and length, as is desirable for the apparatus described above. The press

unit **304** is a modification of the press unit **71** of FIGS. **8** and **9** in that it is arranged so that during a curing operation units of this type are spaced apart from one another along a length of the article being cured. Consequently there is no screw-threaded unit clamping means corresponding to that of press unit **71** (FIG. **9**). At each end of press unit **304** there are provided four substantially L-shaped end pieces **305**, each secured to an end surface of one of the platens through an intermediary insulation layer **306** by one of the limbs of the L, the other limb serving to extend longitudinally of the belt contacting surface of the platen but being shaped so that these extended surfaces provided by adjacent end pieces slope away from each other.

Insulated from the hot platens by the insulating layers **306**, the end pieces **305** remain relatively cold (water cooling being used if required), and thereby ensure that at each end of the press unit, there is a strip **307** of the belt, extending across the belt which is under compression but which is substantially unheated thus preventing hot viscous rubber from being squeezed out from the ends of the unit and avoiding consequent irregularities on the surface of the belt at the ends of the press unit.

Other features of press unit **304** are substantially the same in structure and function as those of press unit **71** of FIGS. **8** and **9** and are numbered accordingly.

Fixed press **308** comprises a horizontal base **309**, side members **310** secured thereto in vertical positions, a fixed upper table **311** secured to the upper ends of side members **310**, an upper moving table **312** and a lower moving table **313** both slidably located on side members **310** between the base and the fixed upper table, and a fluid-operated piston and cylinder assembly **314** located between the lower moving table and the base.

As shown in FIGS. **23** and **24** the belt **315** extends in an upper run through tensioning clamps **316**, belt pre-heat station **317**, a first station **S1**, the upper daylight of double daylight fixed press **308**, through a second station **S2** to rollers **318**, and in a lower run from rollers **318** through pre-heat station **319**, third station **S3**, the lower daylight of double daylight fixed press **308** through fourth station **S4** and tensioning clamps **320**. Thus the first and second stations are at one level and the third and fourth stations at another level and the belt is arranged to move in two runs, one above the other, one run between the first and second stations and the other run between the third and fourth stations.

Tensioning clamps **316** and **320** operate in the same way as clamps **6**, **7**, **8** and **9** of FIGS. **1** to **4**. On engaging the belt at station **S1** press unit **304** with pre-heated platens moves to the upper daylight of fixed press **308** where it is compressed by operation of piston and cylinder assembly **314** and its platens clamped together. The press unit then moves stepwise to station **S2** where it is disengaged from the belt, transferred laterally to iron charging station **321** and then to re-heat station **322** which is at the level of the lower run of the belt where its platens are re-heated. At station **S3** it engages a substantially uncured portion of the belt **305**, thereby filling in an uncured 'gap,' passes to the lower daylight of fixed press **308** where it is compressed again, its platens clamped together and it begins another curing operation. At station **S4** the press unit is again disengaged from the belt and transferred via iron charging station **323** and re-heat station **324** to the upper run and back to station **S1**, where another cycle of operations begins.

As a result of the sequence of operations just described, in a press comprising a series of press units, the belting leaving station S2 is in the form of a series of fully cured portions separated by uncured portions shorter in length by a small amount than a press unit. The further curing operations on the lower run of the belt cure these uncured portions of the belt, thus producing a fully cured belt.

The embodiments of the invention described above have several major advantages over previous systems of curing. They can be operated continuously without the need to stop when one length of belt is completed and another started; the belt being manufactured is continuously under pressure until curing is completed: changing of the means to form the edges of the belt and determine the thickness is easily carried out automatically if required; difficulties caused by partial curing at the end of a stationary press are eliminated; pre-heating can be more expeditiously effected; the labour required is reduced and more accurate belts can be produced owing to the alignment facilities provided and the greater ease with which it is possible to manufacture and maintain the surfaces of the press units in a truly flat condition compared with the large surfaces required for existing presses.

I claim

1. A curing press unit for curing elongated articles comprising a plurality of press units each having a pair of platens, a first station having press means for bringing press units in curing relationship with successive portions of an article to be cured, means for moving press units in curing relationship with an article to be cured in a stepwise manner through the curing unit, a second station for successively moving the press units out of curing relationship with the article at a second station, means for the press unit to move the platens of two successive press units in a direction perpendicular

to the surface of an article being cured in such a manner that in a first stage of operation of the press means the forward end of a platen of one press unit is pressed against said article so as to incline the platen relative to the longitudinal direction of the article, and in a second stage of operation of the press means the rearward end of said platen is pressed against said article to dispose said platen parallel to the other platen of the pair of platens, the press means having means such that simultaneous with the second stage of operation the neighboring forward end of a platen of the next successive unit is pressed against said article.

2. A curing press unit according to claim 1 in which the press means comprises first and second pressure plates for engagement with two successive press units, the pressure plates being pivotally mounted so that the forward end of each pressure plate can be moved towards the article being cured independently of the rearward end thereof.

3. A curing unit according to claim 2 in which the press means comprises a thrust member for urging the pressure plates into engagement with the press units, the thrust member comprising a tapered portion for engagement with the first pressure plate and an untapered portion for engagement with the second pressure plate, and auxiliary press means being provided independent of the tapered thrust member to urge the forward end of the second pressure plate towards the article being cured.

4. A curing unit according to claim 3 in which the auxiliary press means comprises a press head pivotally connected to the forward end of the second pressure plate and arranged to exert a substantially uniform compressive thrust on the press unit immediately ahead of the press unit engaged by the second pressure plate.

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