July 7, 1942. L. H. DE WYK 2,288,611

MACHINE FOR CONTINUOUS TREATMENT OF CONFINED PLASTICS

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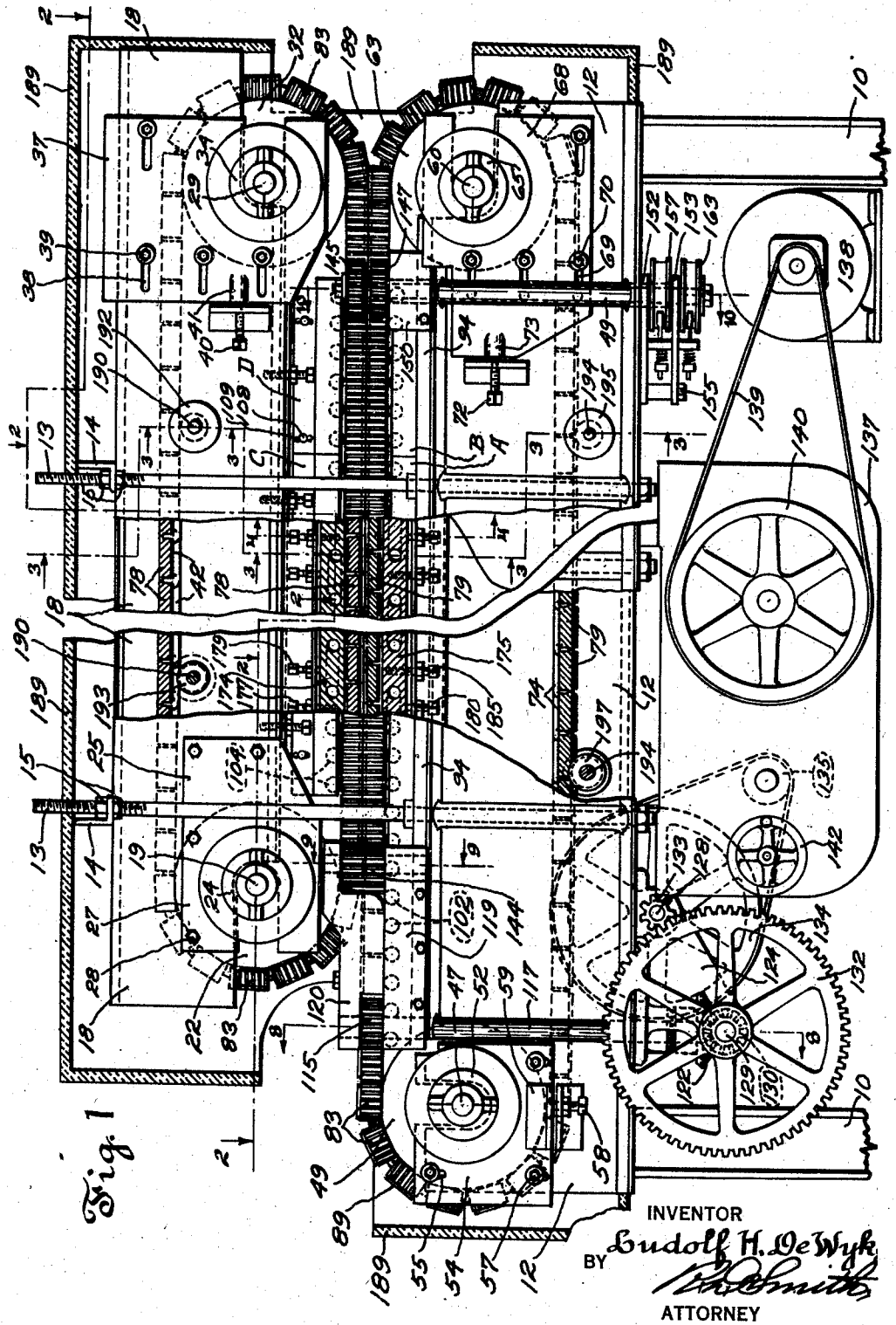


Fig. 1

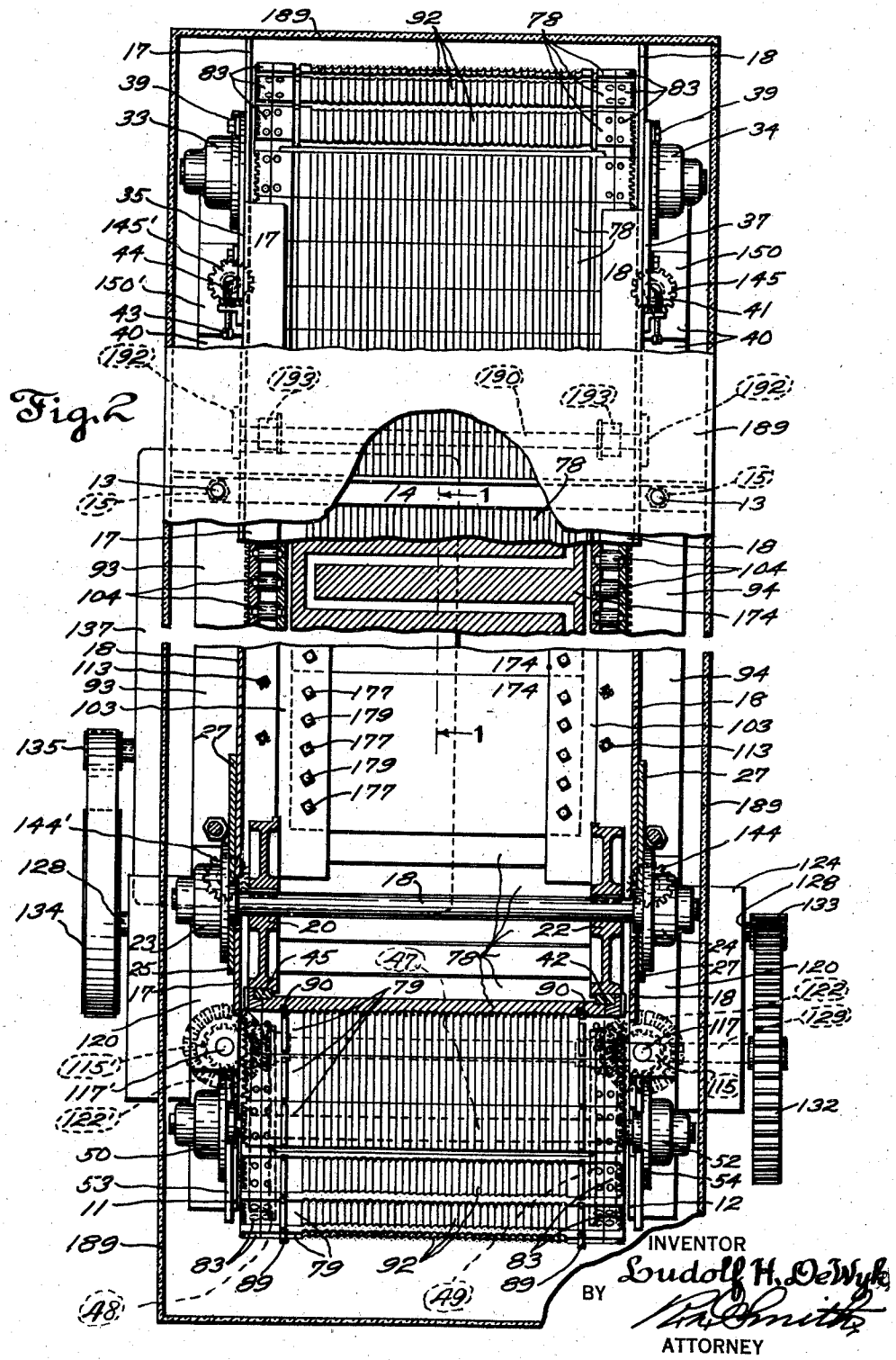
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MACHINE FOR CONTINUOUS TREATMENT OF CONFINED PLASTICS

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Fig. 2

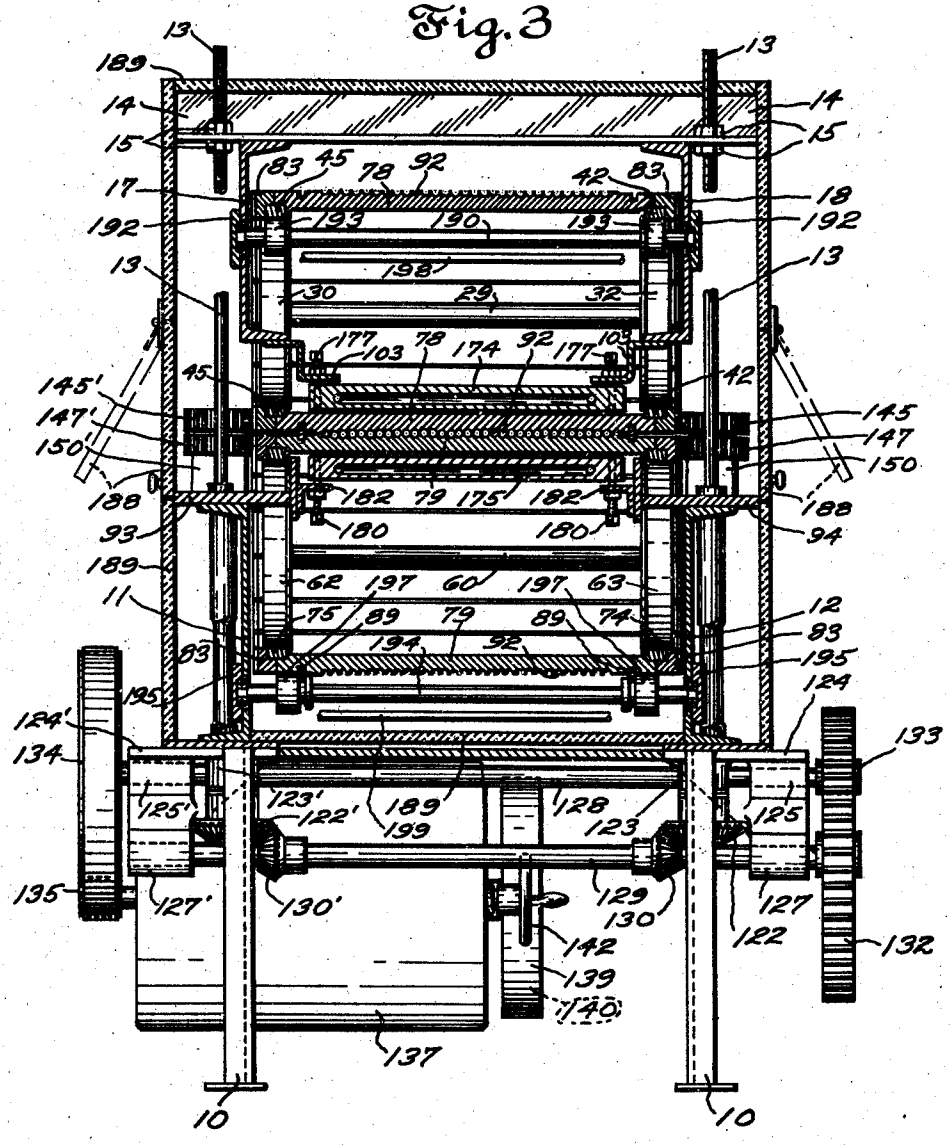


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Fig. 3



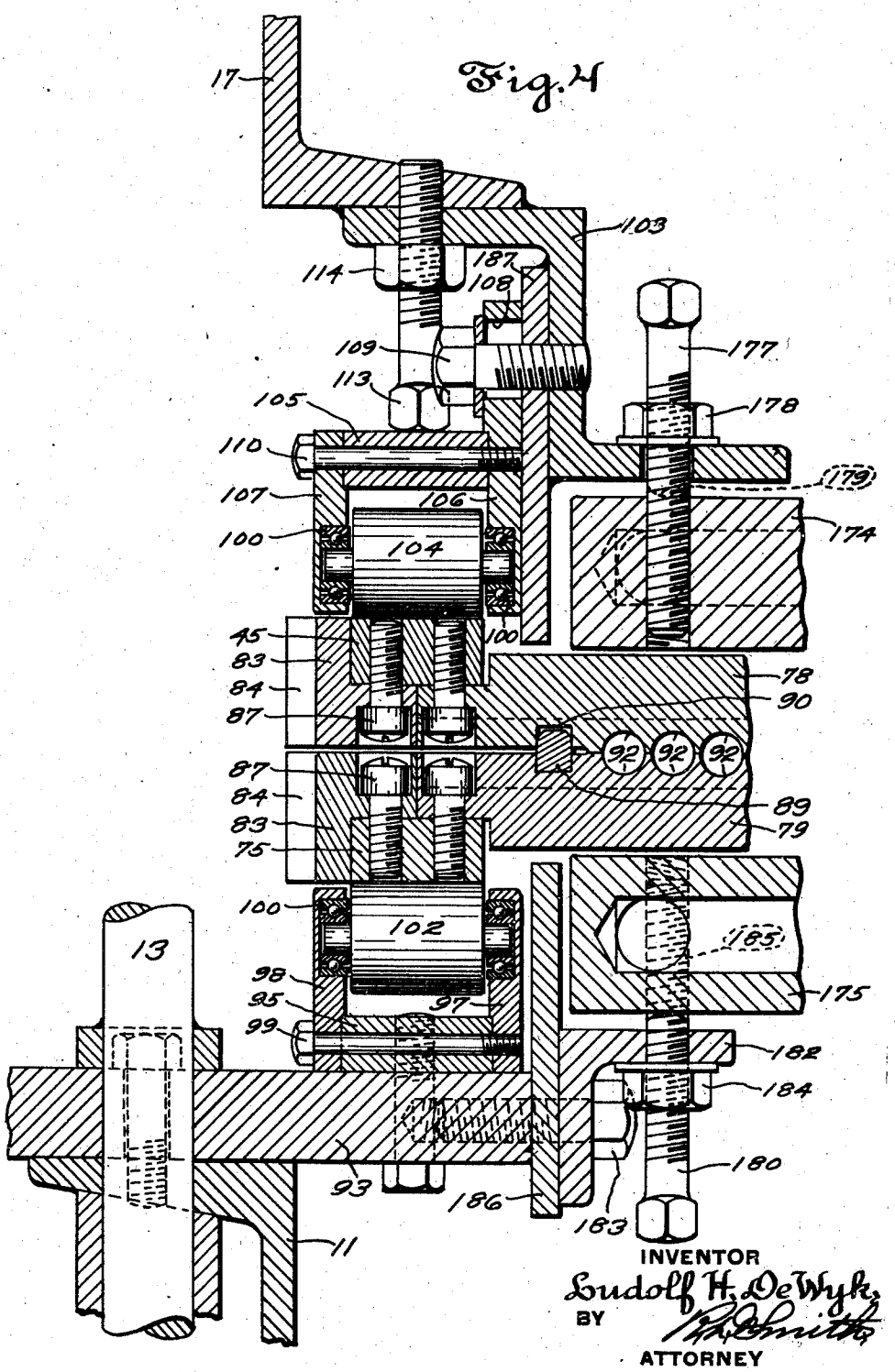
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Fig. 4



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MACHINE FOR CONTINUOUS TREATMENT OF CONFINED PLASTICS

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Fig. 5

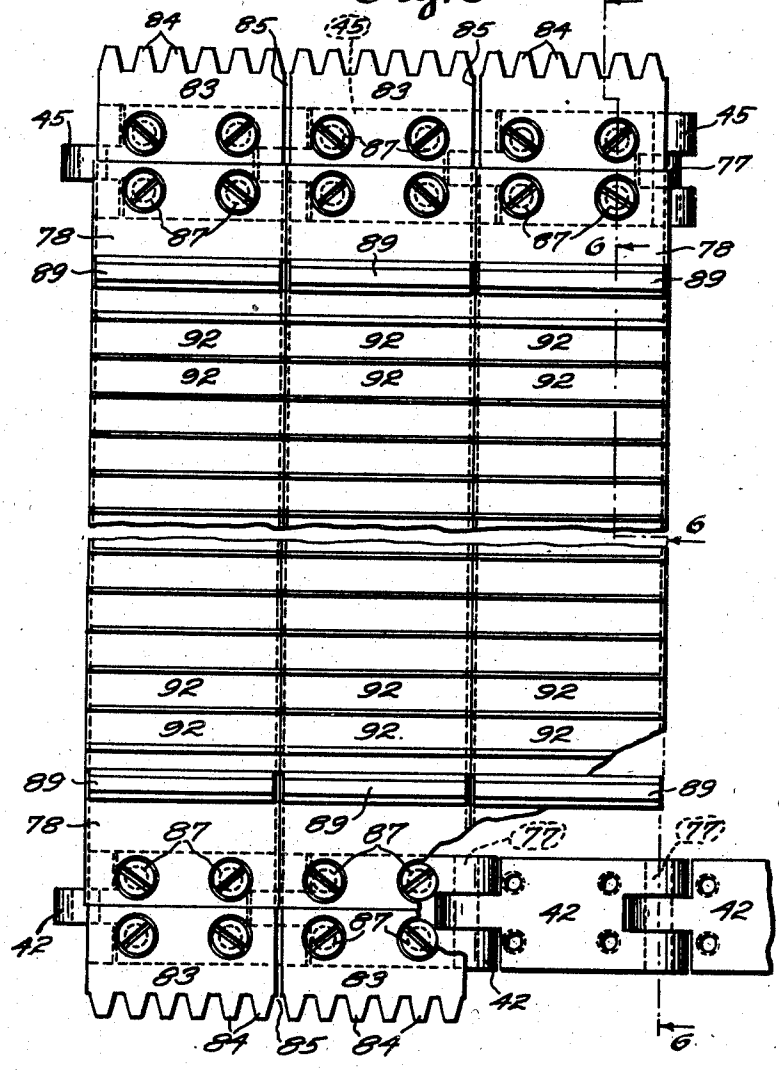
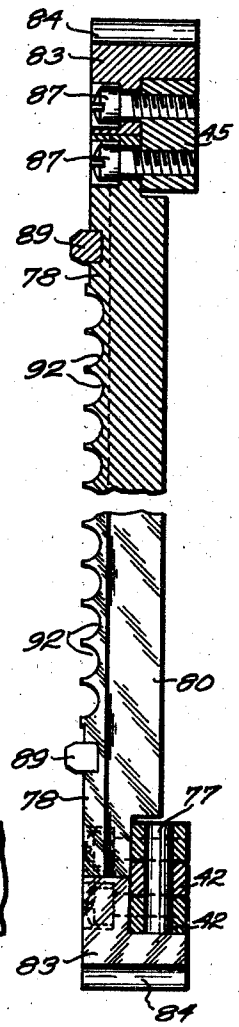


Fig. 6



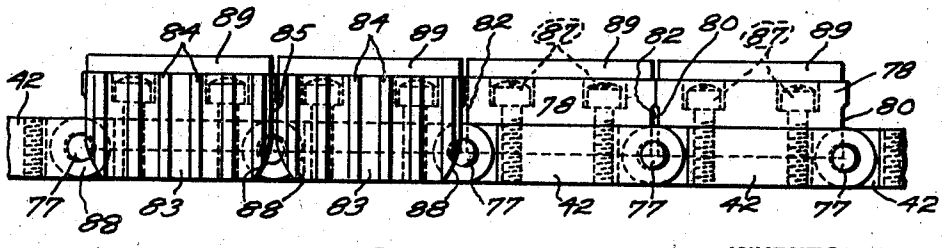


Fig. 7

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Fig. 8

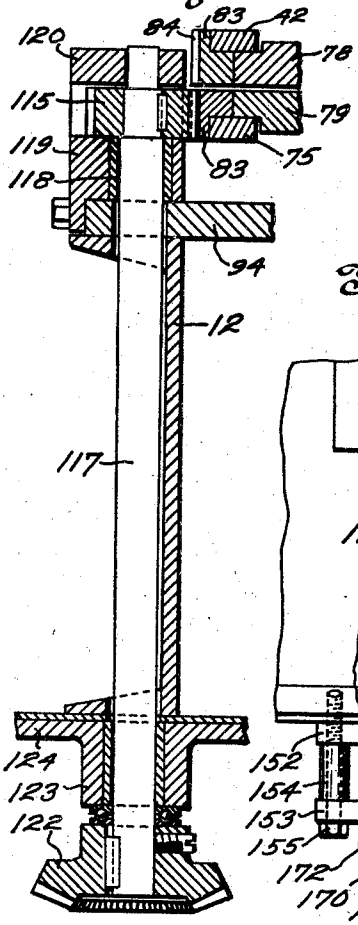


Fig. 9

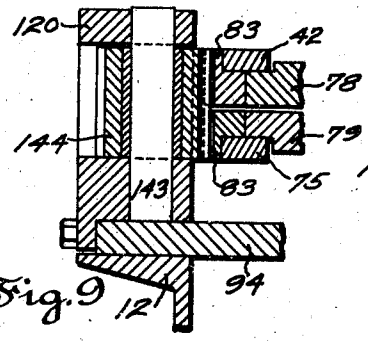


Fig. 10

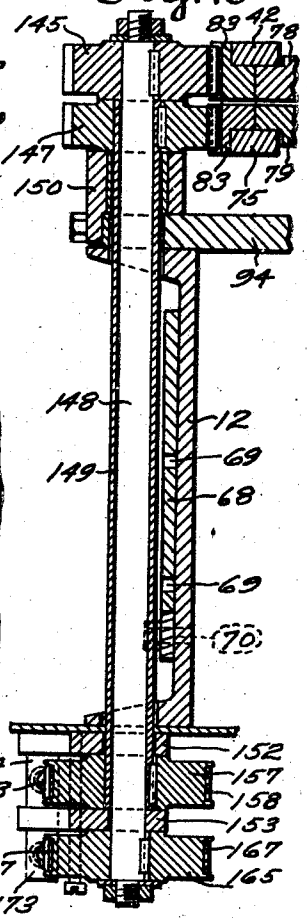


Fig. 11

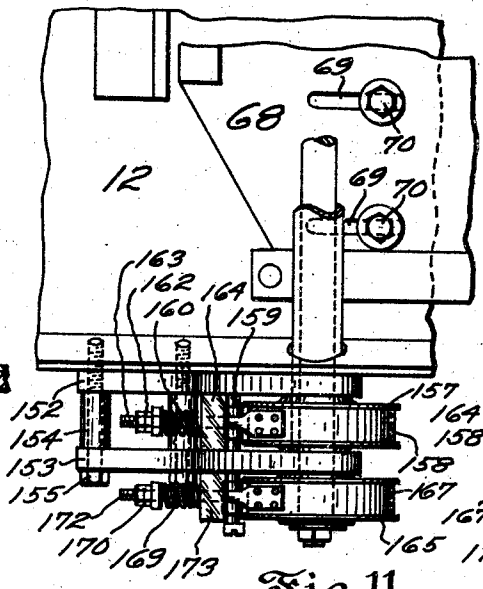


Fig. 13

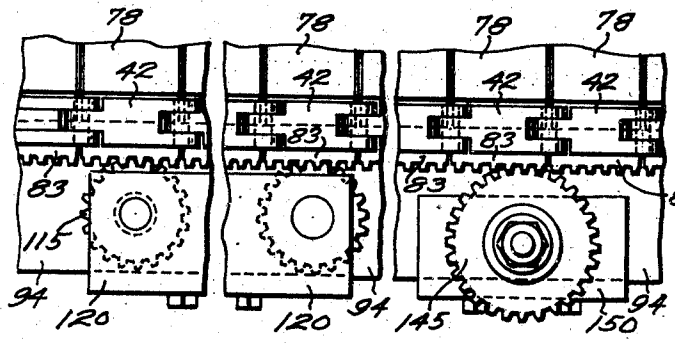
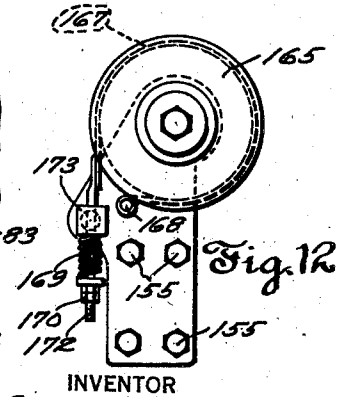


Fig. 12



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Patented July 7, 1942

2,288,611

UNITED STATES PATENT OFFICE

2,288,611

MACHINE FOR CONTINUOUS TREATMENT OF CONFINED PLASTICS

Ludolf H. De Wyk, Ansonia, Conn., assignor to The Sponge Rubber Products Company, Shelton, Conn., a corporation of Connecticut

Application November 20, 1936, Serial No. 111,769

17 Claims. (Cl. 18—6)

This invention relates to machines of the type which incorporate a train or trains of traveling rigid mold sections which may contain cavities to receive, confine and convey plastic material or any unprocessed substance through some heating or processing station for molding, vulcanizing, or otherwise treating such material or substance within the cavities of the mold sections while the sections are traveling.

One object of the invention is to provide means so to support, impel and co-relate such mold sections that they may move in endless procession while any desired number of adjacent sections in a common train are dependably forced into tightly abutting contact despite any looseness which exists or may develop between the associated parts of the apparatus due to wear or to the freedom required for their normal operation.

A further object of the invention is to provide two simultaneously impelled endless trains of mold sections which sections may be connected to links of separate chains that pass around spaced supporting wheels so arranged that a span of one chain is contiguous to a span of another chain whereby a certain number of mold sections of the respectively different trains may perform a portion of their travel in unison while held to adjustably close relationship or in actual face to face contact, with their surface contained cavities registering to form traveling chambers for confining and conveying the material to be processed.

A further object is to provide a driving mechanism adapted to furnish impelling power directly to the mold sections of a single train without utilizing joints between connected chain links for transmitting such power, thereby positively to impel the mold sections of a given train by constantly pushing ahead upon successive mold sections as they pass the driving mechanism.

A further object is to provide a driving mechanism adapted to impel the combined mold sections of two trains simultaneously in a manner which permits restricting the separation of the mold sections of one train from the mold sections of the other train to a varied and predetermined extent while both trains travel in unison through a station for processing expandable material that may be conveyed by and confined within the chambers formed by cavities in the mold sections.

A further object is to provide a retarding mechanism which shall so cooperate with the driving mechanism of a single train of traveling mold sections that the force with which adjacent mold sections of such train shall be held in abutting contact while the machine is running may selectively be determined by adjustment that may be made while the machine is idle or while the machine is running.

A further object is to provide a retarding mechanism which, in cooperation with driving mechanism for a double train of mold sections, is adapted to act independently upon each of two trains of mold sections so that the force with which successive sections of each train are held in abutting contact may be regulated separately with respect to each of the trains at will.

A further object is to eliminate as fully as possible all frictional resistance tending to oppose travel of the mold sections between the driving mechanism and the retarding mechanism and to reduce such resistance to materially smaller proportions than could result from the use of sliding constraint for the mold sections in this portion of their travel.

A further object is to provide an anti-friction track composed of a series of freely turnable rollers, which track is supported upon the frame of the machine in a manner to be separately removable in different portions of its length and is adapted to support the weight of individual mold sections as they travel, the rollers preferably being so spaced that two of them shall always contribute to the support of a single mold section end portion.

A further object is to provide a similar series of anti-friction rollers supported by and separately adjustable with relation to the frame of the machine in a manner to constrain the traveling mold sections of the upper train with frictionless thrust thereby to confine the same to desired and regulatable proximity to the roller supported mold sections of the lower train as the mold sections of both trains travel in unison through a common material processing station.

A further object is to provide a frame for the machine having one portion that carries supporting wheels for a chain associated with one train of the mold sections, which portion of the frame may bodily be adjusted toward and away from another portion of the frame that carries supporting wheels for a separate chain associated with a different train of mold sections, and which may be so adjusted to a finely regulatable degree, and independently, at each end of a straight-a-way span of the two chains and their associated trains of mold sections.

A further object is to provide bearings for one chain-carrying wheel shaft in each of the relatively adjustable frame portions which shall be adjustable in relation to the frame portion in a manner to regulate the tightness or looseness of its carried chain.

A further object is to provide a bearing for one chain-carrying wheel shaft which shall be adjustable in relation to the frame in a direction to move upwardly or downwardly the traveling mold sections associated with such chain in relation to the traveling mold sections which are associated with the other chain.

A particular object of the present improvements is to provide for the supporting and impelling of interchangeable trains of mold sections so that mold sections of different such trains may have varied proportions of length, breadth and thickness and contain molding cavities of different shapes and sizes, each mold section for this purpose being separately and interchangeably mountable upon and removable from any one of the associated chain links quickly and conveniently.

A further object is separately and removably to mount upon a common chain link with each mold section, and in rigid relation to such link and mold section, a block provided with gear teeth so spaced and arranged that a succession of such blocks may form a traveling rack enmeshable with frame carried power gears and retarding gears.

A further object is to provide only whole teeth upon each of such toothed blocks for meshing engagement with the teeth of power and retarding gears.

A further object is to provide each mold section of one train with a key-like projection adapted to engage and disengage with a corresponding keyway in each mold section of the other train respectively, thereby to maintain a positive lateral alignment of the mold sections of both trains for accurately registering the cavities therein as the mold sections progress through a work processing station.

A further object is to make use of these key-like projections to laterally guide the mold sections during their idling travel in their return journey to the work processing station, so that the working faces of the mold sections may be protected as fully as possible from lengthwise rubbing and wear.

A further object is to support heat delivering units of any kind, for instance steam plates, upon each of the relatively adjustable portions of the frame in such manner that the nearness of these units to their corresponding traveling mold sections may be finely adjusted at will, but shall not be varied by the adjustment of said frame portions relative to each other.

A further object is to mount certain steam plates and certain anti-friction roller tracks in separately adjustable relation upon a common portion of the frame so that such plates and tracks may individually be adjusted in relation to the traveling mold sections of the train which derives its support from the said frame portion.

A still further object is to provide, in addition to the main heating units or steam plates which are closely proximate the path of travel of the mold sections through their work processing station, auxiliary heating units located near the path of idling return travel of the mold sections to their processing station, which auxiliary units may comprise piping connected to receive steam for radiating heat to hold up the temperature of the mold sections during their said return travel.

A still further object is to enclose the machine within a casing which includes heat insulating walls having conveniently openable closures or panels giving access to the interior of the casing to permit inspection and adjustment of all the foregoing mentioned parts of the apparatus whether the machine is running or idle.

The foregoing and other objects will become clear from the following description of a machine which embodies illustrative forms of the improvements and which will now be described with reference to the accompanying drawings. In the drawings:

Fig. 1 is a view in side elevation showing a machine embodying the present invention broken apart to indicate contraction of its true horizontal length, the machine being encased in a heat insulating jacket shown for the most part in section and a portion of the machine being shown in central vertical section on the plane 1—1 in Fig. 2 looking in the direction of the arrows.

Fig. 2 is a view looking downwardly on the machine and is taken in horizontal sections in different parts of the length of the machine on the several planes 2—2—2 etc. in Fig. 1.

Fig. 3 is a view of the machine in end elevation looking from the left at Fig. 1 and showing upper portions of the machine vertically sectioned on the several planes 3—3—3 etc. in Fig. 1, certain track rollers which support the lower mold sections and certain constraining rollers which limit upward displacement of the mold sections being omitted because shown on a larger scale in Fig. 4.

Fig. 4 shows on a much enlarged scale the track rollers and constraining rollers which are omitted in Fig. 3 and is a view taken in section on the vertical plane 4—4 in Fig. 1.

Fig. 5 is a plan view of three of the mold sections and five of the tooth blocks in the uppermost span of the lower chain in Fig. 1 drawn on a scale slightly smaller than that of Fig. 4 and showing a break to indicate contraction of the true length of the mold sections, the end of one section being broken away to expose the chain links.

Fig. 6 is an edgewise view taken in section on the plane 6—6 in Fig. 5 looking in the direction of the arrows.

Fig. 7 is an endwise view of two of the mold sections of Fig. 5, and further shows two of the chain links and two of the toothed blocks in their assembled relationship to the end portions of the mold sections.

Fig. 8 is an enlarged view taken in central vertical section through the driving gear shaft on the plane 8—8 in Fig. 1 looking in the direction of the arrows.

Fig. 9 is a view on a similar scale taken in central vertical section through the train to train transmission gear on the plane 9—9 in Fig. 1 looking in the direction of the arrows.

Fig. 10 is a view on a similar scale taken in central vertical section through the retarding gear shaft on the plane 10—10 in Fig. 1 looking in the direction of the arrows.

Fig. 11 is an elevation of the brake mechanism for the retarding gears looking from the left at Fig. 10 showing this mechanism as viewed in Fig. 1 but drawn on a larger scale corresponding to Fig. 10.

Fig. 12 is a bottom plan view looking upwardly at Fig. 10.

Fig. 13 is a plan view looking downwardly upon the combined mechanisms of Figs. 8, 9 and 10 as these mechanisms are cooperatively assembled in Fig. 1 showing breaks to indicate contraction of the true spacing of these mechanisms, lengthwise of the machine.

The principles of construction and operation featuring the present improvements are of particular advantage in carrying out processes which involve the vulcanizing of plastic materials such as compositions containing rubber or synthetic rubber, into definitely molded forms. Such materials may comprise mixtures which swell considerably in response to heat treatment as is the case with sponge rubber compound. Certain processes which may in part be carried out by the use of the present apparatus are described in United States Patent No. 2,200,262 granted to Frederick M. Daly and Ludolf H. De Wyk.

In molding and vulcanizing processes of this nature, it may be an object to convert a continuous supply of unvulcanized plastic material into a continuous strip or strips of vulcanized sponge rubber having unlimited length. Continually traveling mold sections for this purpose must possess cavities adapted to communicate for forming a continuous confining chamber for the material while it is conveyed through a heat zone. For this purpose, mold sections in a given train of such sections must abut tightly, and mold sections in cooperative trains of such sections must be controlled as to separating under the expanding force of the swelling material confined by the mold sections during its heat treatment.

Prior apparatus has failed in one respect or another to provide as positive mechanical action and as flexible operating adjustment as is desirable in a machine which shall be efficient for the purposes described. The improvements hereof put into the hands of the operator of the machine many cooperative means of adjustment, interchangeability of parts, and operative control so that plastic materials of widely differing characteristics may be vulcanized in a wide variety of forms with efficiency and precision, and at low cost.

With particular reference to Figs. 1, 2 and 3, the lower or fixed frame portion of the apparatus may be of any desired length and is supported at spaced points by any appropriate number of legs 10 and includes two horizontal laterally spaced U-channel beams 11 and 12 extending parallelly throughout the length of the machine and rigidly connected together and braced by tie rods (not shown) or the like, at any suitable points in their length. Penetrating the out-turned edge flanges of each channel beam are upstanding frame posts 13 of which any suitable number may be spaced along the length of the frame. At their tops, the posts 13 at opposite sides of the machine, are rigidly connected and braced by cross bars or angle irons 14 whose height, as supported by each post, may be finely regulated and maintained by nuts 15 having threaded engagement with the posts.

The upper or vertically adjustable frame portion of the apparatus comprises two laterally spaced U-channel beams 17 and 18 having inturned edge flanges and depending from, and made rigid to, the angle irons 14 in any suitable way, as by welding. These beams extend parallelly through the length of the machine above the fixed frame portion or lower beams 11 and 12. Rigidity of the upper frame portion may be increased by tie rods (not shown) connecting and bracing the channel beams 17 and 18 at suitable points along their lengths.

A horizontal shaft 19 carrying spaced wheels 20 and 22 is journaled in anti-friction bearing housings 23 and 24 which are respectively supported in cut-out portions of bearing plates 25 and 27 mounted against oversized cut-out ends of channel beams 17 and 18, respectively, by bolts 28 at the receiving left end of the machine in Fig. 1.

A similar shaft 29 carrying spaced wheels 30 and 32 is journaled in anti-friction bearing housings 33 and 34 respectively supported in cut-out portions of bearing plates 36 and 37 which have horizontally elongated slots 38 engaged by bolts 39 to hold the bearing plates 35 and 37 in horizontally adjustable position on the oversized cut-out ends of channel beams 17 and 18 respectively at the delivery right end of the machine in Fig. 1.

The adjustor screw 40 carried on beam 18 bears on a projecting boss 41 of bearing plate 37 to force the latter toward the right in Fig. 1 for regulating the tightness of a chain of links 42 which passes around and is supported by wheels 22 and 32. A similar adjustor screw 43 is similarly carried by the beam 17 and acts in a similar manner upon boss 44 on bearing plate 35 to force the latter toward the delivery end of the machine in Fig. 2 for regulating the tightness of a chain of links 45 which passes around and is supported by wheels 20 and 30.

A similar shaft 47 carrying spaced wheels 48 and 49 is journaled in anti-friction bearing housings 50 and 52 respectively supported in cut-out portions of bearing plates 53 and 54 which have vertically elongated slots 55 engaged by bolts 57 to hold the bearing plates 53 and 54 in vertically adjustable position on the oversize cut-out ends of channel beams 11 and 12 respectively at the receiving or left end of the machine in Fig. 1.

The adjustor screw 58 is carried on beam 12 and bears on a boss 59 of bearing plate 54 to raise the latter or permit it to be lowered in Fig. 1, and a similar adjustor screw (not shown) is carried by the beam 11 and acts in a similar manner upon the bearing plate 53 to raise the latter or permit it to be lowered.

A similar shaft 60 carrying spaced wheels 62 and 63 is journaled in anti-friction bearing housings 64 and 65, respectively supported in cut-out portions of bearing plates 67 and 68, which have horizontally elongated slots 69 engaged by bolts 70 to hold bearing plates 67 and 68 in horizontally adjustable position on the oversize cut-out ends of channel beams 11 and 12 respectively at the delivery or right end of the machine in Fig. 1. The adjustor screw 72 bears on a projecting boss 73 on bearing plate 68 to force the latter toward the right in Fig. 1 for regulating the tightness of a chain of links 74 which passes around and is supported by wheels 49 and 63. A similar adjustor screw (not shown) is similarly carried by the beam 11 and acts in a similar manner upon the bearing plate 64 to force the latter toward the delivery end of the machine in Fig. 2 for regulating the tightness of a chain of links 75 which passes around and is supported by wheels 48 and 62.

In Figs. 5, 6 and 7, there is most clearly shown

on an enlarged scale the construction of the chain links which is common to all of the four chains above referred to, the pivotal connection between all adjacent links including a pivot pin 77. The looseness of this pin in its bearing holes in the links is shown on an exaggerated scale in Fig. 7 to illustrate a point of the construction which is of importance in the operation of my improved machine.

Extending crosswise the machine and mounted at one end upon a link 45 or 75 and at the other end upon a link 42 or 74 are mold sections 78 of a lower train and similar complementary mold sections 79 of an upper train, each of which sections comprises a bar-like structure whose maximum width occurs across its face which contains the mold cavities and which width is as great or slightly greater than the minimum possible center distance between successive pins 77, 77 when the play in the pin bearings has been taken up in that direction which shortens the chain. Elsewhere in the thickness of the mold section this width is slightly reduced as at 80 (Figs. 6 and 7). Thus adjacent mold sections in a common train will be assured the ability to abut positively against each other at the edges of their faces which contain the mold cavities rather than at some other point in the thickness of the sections.

The crevices 82 thus afforded between the adjacent mold section portions 80 further serve to prevent processed material from lodging between sections in a way to interfere with tight abutting of adjacent sections of a common train as they travel together through the work processing station.

The present improvements provide driving mechanism and retarding mechanism, the details of which are shown on an enlarged scale in Figs. 8 to 13 inclusive, and whose purpose it is to apply in opposed directions the forces which act to keep the mold sections of a common train in tightly abutting contact independently of looseness in the fit of pivot pins 77 while the mold sections are conveying material through a processing station between the driving and retarding mechanisms. These mechanisms will hereinafter be explained in fuller detail.

Upon each chain link, at the end of its supported mold section, is rigidly mounted an L-shaped block 83 in which is cut a number of preferably whole gear teeth 84 whose contours may be those of the teeth of a rack. The tooth spacing is such with reference to the adjacent edges of the L-shaped blocks that the pitch spacing between the end teeth of two adjacent blocks is equal to the pitch spacing between adjacent whole teeth on a single block. This pitch spacing is determined by the placement of the blocks 83 upon their respective chain links and by the inter-abutting of adjacent mold sections, there being preferably a small space 85 between adjacent blocks about equal to the crevice 82 between the mold sections as shown in Fig. 7. This further makes possible an economical method of producing the toothed blocks 83 by cutting apart a rack in which has been milled a continuous series of ordinary gear teeth, the thickness of the cutting saw equaling the space 85. Fig. 6 shows most plainly the manner in which the end of the mold section 78 or 79, and likewise the toothed block 83, are rigidly secured to the same chain link by similar cap screws 87 having threaded engagement with the link and having their heads sunk within counterbores in the exposed surfaces of the mold section and of the block. The mold section and/or the toothed block may thereby selectively and independently be removed from the link for replacement or repair. This construction is preferably common to all of the mold sections and toothed blocks in the two endless trains of such sections and blocks which are respectively associated with the separate chains of links. Each toothed block has relieved or cut-back corners at 88 which afford the clearance to permit angular inclination of adjacent toothed blocks relative to each other as they are carried by the chain around each of the chain supporting wheels as shown in Fig. 1.

While the working faces of the mold sections may be recessed to form molding cavities of any desired shape, size and relationship, the molding cavities, shown in Figs. 5, 6 and 7, comprise closely adjacent half round grooves 92 disposed end to end in adjacent mold sections of a common train and parallel with the direction of travel of the train, thereby forming continuous grooves when the adjoining edges of the mold sections abut. For insuring exact lateral register of these half round grooves in the mold sections of one train with the corresponding half round grooves in the mold sections of the other train, each mold section of the lower train, near each of its ends, is equipped with a fixed key 89 adapted to engage with a corresponding keyway 90 in the opposed surface of each mold section of the upper train. The keyway is preferably deeper than the projecting portion of the key so that a small clearance exists between the top of the key and the bottom of the keyway when these parts are fully engaged. If the two trains of mold sections are so related that the junctions between mold sections of one train are staggered with relation to the junctions between the mold sections of the other train, each key will engage with a portion of the two aligned keyways in adjacent mold sections, so that this key and keyway engagement will perform the further important function of keeping the molding grooves of adjacent mold sections in a single train in accurate end to end alignment with one another.

With particular reference to Figs. 1, 2 and 4, there will now be described the support tracks which extend lengthwise of the processing station for bearing the weight of the horizontally traveling lower train of mold sections, and also the superimposed constraining tracks, of similar construction and corresponding length, which prevent the mold sections of the upper train from being lifted away from designed closeness to the sections of the lower train by the expansive power of such vulcanizable plastics as sponge rubber composition when confined and heated within the mold chambers formed by cavities 92. Extending lengthwise of the machine and secured upon the top flange of each of channel beams 11 and 12, respectively, are running plates 93 and 94. A sectional run of trough-like structure giving bearings to a series of freely turnable track rollers, extends lengthwise of each running plate and is fixed to the top thereof and comprises a base strip 95 and upstanding side strips 97 and 98, secured to the base strip 95 by through bolts 99. In each of the side strips are seated a series of ball bearings 100 respectively supporting the rollers 102. The latter partly occupy the trough between the side strips. The links 74 and 75 of the lower chain ride upon

the track rollers 102 and the latter are preferably so spaced that at least two of them may contribute to the support of each link in the chain. This arrangement, together with flexibility in the train of mold sections produced by the pivot joint between links, relieves each pair of rollers from supporting more than half the weight of the mold section plus the weight of one link and one rack block end portion. The base strip 95 and/or side strips 97, 98, may be divided longitudinally into any suitable number of lengthwise sections such as A and B in Fig. 1, each section being separately removable to permit the servicing or renewal of certain rollers or bearings without disturbing those which do not require attention. Case strips 95 are secured to running plates 93 and 94 by bolts 96.

Extending lengthwise of the machine and secured against the bottom flange of each of channel beams 17 and 18, are Z-bars 103 to which a similar, but inverted, sectional run of trough-like structure is secured. This structure gives bearings to a series of freely turnable rollers 104 superimposed above the rollers 102 and is composed of a top strip 105 with separate side strips 106 and 107. The side strip 106 contains vertically elongated slots 108 penetrated by the bolts 109 having threaded engagement with the Z-bars 103. Sectional lengths of the top strip 105 and of the side strips 106 and 107 are rigidly but removably held together by the through bolts 110. In each of the side strips is seated a series of ball bearings 100, like those in the strips 106 and 107, respectively carrying the lift limiting rollers 104 which partly occupy the inverted trough between the side strips. The top strip 105 may be adjustably forced and held downward by the heads of vertical adjustment screws 113 which have threaded engagement with the Z-bars 103 and with the lower flange of the frame beam, being held from accidental turning by the lock nuts 114.

When there is any tendency of the links 42 or 45 of the upper chains to rise, owing to expanding action of material being processed within the chambers of the mold sections, or owing to buckling action which might be occasioned by straight-a-way impelling and opposing forces applied to the train of mold sections while passing through their processing station, these links of the upper chain will be held downwardly by rollers 104 at each side of the machine but these rollers will offer practically no frictional resistance opposing the designed straight-line travel of any link in the chain while passing through the processing station.

The top strip 105 and/or side strips 106, 107, may be divided longitudinally into any suitable number of sections, such as C and D in Fig. 1, which will permit the servicing or renewal of certain rollers or bearings without disturbing those which do not require attention, and will further permit independent vertical adjustment of different such sections.

With particular reference to Figs. 1, and 8 to 13 inclusive, the driving and retarding mechanisms by which impelling power and opposing resistance is applied directly to the toothed blocks 83 during their travel through the processing station (considered as the portion of the machine occupied by contiguous stretches of the chains) will now be described. The spur gear 115 is fixed on a vertical shaft 117 and constantly meshes with one or another toothed block 83 carried by links 74 of the lower chain, and is rotated clockwise in Fig. 13 by power, thereby constantly acting to impel these blocks from left to right in Figs. 1 and 13 as the teeth 84 on the successive blocks come into mesh with the teeth on gear 115. The shaft 117 is given bearing in a bushing 118 in the bearing block 119 which is bolted to the outer edge of the running plate 94 and also in the bearing cap 120 which is bolted downwardly against the bearing block.

Power is delivered to the shaft 117 through a bevel gear 122 fixed on the bottom end of this shaft which latter is provided with a lower bearing 123 in the frame bracket 124. This bracket is constructed to also afford bearings 125 and 127 respectively for two horizontally extending shafts 128 and 129 extending crosswise the machine as shown in Fig. 3. The horizontal shaft 129 rotates the bevel pinion 130 which meshes with the bevel gear 122 and is driven through the engagement of its carried spur gear 132 with a spur pinion 133 fixed to the horizontal shaft 128. At its opposite end, shaft 128 carries the pulley 134 which is belted to a smaller pulley 135 of the variable speed transmission unit contained within the casing 137 beneath the frame of the machine. The variable speed transmission is powered from the motor 138 by means of the belt 139, best shown in Fig. 1, which drives the constant speed pulley 140 of the transmission unit whose further details are not here shown because well understood in the art. The speed transmitted to the machine may be varied by rotatively adjusting the hand wheel 142.

As the set of parts illustrated in Fig. 8, for delivering power to the train of mold blocks carried by the links 74 of the lower chain, is duplicated by a similar set of parts on the opposite side of the machine, as best shown in Figs. 2 and 3, for driving the opposite ends of the mold sections carried by the links 75 of the other lower chain, it will not be necessary to describe in detail this duplicate set of parts. They are represented in Figs. 2 and 3 by the same respective numerals primed, and in Fig. 3 it is clearly shown that the bevel gear 122' is driven by a second bevel pinion 130' carried on the same shaft 129 with the bevel pinion 130 formerly described.

Held in both the bearing block 119 and the bearing cap 120 is a short vertical shaft 143 upon which is freely turnable the spur gear 144 which is long enough to mesh simultaneously with gear teeth 84 on blocks 83 both of the lower chain and of the upper chain as best shown in Fig. 9. In this manner the power delivered to the toothed blocks of the lower chain links 74 and 75 which have passed the spur gears 115 and 115' is transmitted to the toothed blocks of the upper chain links 42 and 45 so as to force the latter constantly toward the right in Fig. 1 in unison with the toothed blocks of the lower chain links and thence on through the processing station. It will be understood that a mechanism which duplicates that of Fig. 9 is present at the location in Fig. 2 indicated by the same reference characters primed so that equal driving action is imparted to each end of the mold sections 78 and 79 at each side of the machine in Fig. 2.

Referring particularly to Figs. 1, and 10 to 13 inclusive, a retarding mechanism is shown which, with selectively regulated force, constantly and separately acts to hold back the traveling toothed blocks of each of the upper and lower trains which are being pushed ahead, or toward the right in Fig. 1, by the driving gears 115 and 143. This retarding mechanism consists of concentri-

cally arranged upper and lower spur gears 145 and 147, the former of which is fixed to the top of a central vertical shaft 148 and the latter of which is fixed to a hollow or tubular shaft 149 surrounding shaft 148 and independently turnable relative thereto. Hollow shaft 149 is rotatably journaled in the bearing block 150 which is bolted to the outer edge of the running plate 94 and both shafts extend downwardly through clearance holes in the flanges of frame beam 12 to beneath the lower flange of this beam.

Against the bottom of this flange, the two bearing plates 152 and 153 are rigidly mounted in vertically spaced relation by hollow posts 154 through which extend the bolts 155 having threaded engagement with the lower flange of the frame beam. Plate 152 provides a rigid bearing for the hollow shaft 149 and plate 153 affords a rigid bearing for the solid inner shaft 148 therebelow. A friction pulley 157 is fixed on the lower extremity of the hollow shaft 149 and is retarded in its rotative movement with a force adjustable by the friction brake band 158. In Fig. 11 this band is shown to have one end secured to a fixed anchor stud 159 and is drawn taut about the friction pulley 157 by the force of a compression spring 160 whose power may be adjusted by the nuts 161 having threaded engagement with the rod-like terminal 162 of the brake band which is guided in the rigid frame post 164. A second friction pulley 165 is fixed on the lower extremity of the solid inner shaft 148 and is retarded in its movement with an adjustable force by the brake band 167. In Fig. 12 this band is shown to have one end secured to a fixed anchor stud 168 and is drawn taut about friction pulley 165 by the force of a compression spring 169, whose power may be adjusted by the nuts 170 having threaded engagement with the rod-like terminal 172 of the brake band which is guided in the rigid frame post 173.

As in the case of the spur gears 115 and 115' of the driving mechanism, all of the parts shown in Figs. 10, 11 and 12 are duplicated at the positions represented by their corresponding numerals primed in Fig. 2, on the opposite or left side of the machine in Figs. 2 and 3, for separately holding back the toothed blocks 83 which are rigid with the opposite ends of the mold sections and which it will not be necessary to describe in detail because of their similarity in construction and operation.

For delivering heat to the mold sections of both trains as they travel through the processing station between the driving mechanisms and retarding mechanisms, any form of electrical resistance, gas burners, or other suitable type of heat generating unit may be employed. There is herein illustrated a series of plate sections 174 and 175 containing communicating passages for steam to provide a vulcanizing heat. These plate sections combine to extend substantially the full length of the straight-a-way span of the traveling trains of mold sections from entrance to exit of the processing station. In order to efficiently radiate heat to the mold sections of both the upper and lower trains, an upper series of steam plates 174 and a lower series of steam plates 175 are provided. The upper steam plates 174 are disposed with their bottom surfaces closely adjacent the mold sections in Fig. 3 and these plates are supported by pull screws 177 having threaded engagement therewith at each side of the machine, which screws pass through clearance holes in the Z-bars 103 and are retained in adjusted position by the nuts 178. Push screws 179 bear down against the top of steam plates 174 and have threaded engagement with Z-bars 103. Thus the upper steam plates 174 may be vertically adjusted and held in adjusted position independently of the vertical adjustment of the upper track rollers 104, while both said plates and rollers derive their support in common from the upper frame beams 17 and 18. It will be observed that if these upper frame beams be bodily raised or lowered upon their supporting posts 13 the relationship of the steam plates 174 to the rollers 104 will not be changed.

Similar lower steam plate sections 175 are supported by the ends of screws 180 having threaded engagement with the angle irons 182 which are rigidly held on the running plates 93, 94, by the bolts 183 screws 180 being locked in position by the nuts 184. Pull screws 185 having threaded engagement with steam plates 175 pass through clearance holes in angle irons 182 and maintain the vertical adjustment of the steam plates effected by push screws 180. As further shown in Fig. 4, a vertically disposed partition 187 separates the edges of the upper steam plates from the upper roller trough strips 106, and a similar partition 186 separates the edges of the lower steam plates 175 from the lower roller trough strips 97.

To assist in preventing objectionable sag of the trains of mold sections and of the toothed blocks and chain links with which they respectively return in unison from the right or delivery end of the machine to the left or receiving end of the machine in Fig. 1, after passing around the carrier wheels, there is provided in the upper portion of the machine any desirable number of freely rotatable cross shafts 190, pivoted at each end in ball bearings mounted in caps 191 removably secured by bolts or otherwise to the outer surfaces of the upper frame beams 17 and 18. Each of shafts 190 carries two flanged wheels 191 upon whose peripheries the chain links 42 and 45 ride in freely rolling contact as they successively pass these wheels in their return travel toward the left in the uppermost stretches of the upper chains in Fig. 1. The flanges on these wheels as well as the flanges on upper carrier wheels 20, 22, 30 and 32, retain the links in accurate alignment lengthwise of the machine during their return travel to the processing station.

In the lower portion of the machine, similar shafts 194 are freely rotatable in ball bearings mounted in caps 195 removably secured by bolts or otherwise to the outer surfaces of the lower frame beams 11 and 12. Each of shafts 194 carries two grooved wheels 197 upon whose peripheries the ends of mold sections 83 of the lower train ride in freely rolling contact as they successively pass wheels 197 in their return travel toward the left with the bottom-most stretches of the lower chains in Fig. 1. The keys 89 engage with the grooves in the peripheries of wheels 197 and thus cooperate with the flanges on lower carrier wheels 48, 49, 62 and 63, to retain the trains of mold sections in accurate alignment lengthwise of the machine during their return travel to the processing station.

It should be noted that since the pulley wheels 20, 22, 30, 32, 48, 49, 62, and 63 are not sprocket wheels, each chain of mold sections 78 and 79 is free to slip around the periphery of each such wheel at the bight of the chain and hence were it not for the support offered by rollers 193 and 197 in the idling or return reaches of each chain,

the very great combined weight of the mold sections in said reaches of the chains would be converted into a pulling tendency which might stretch the working reach of each chain which contains the material being processed sufficiently to produce objectionable cracks between successive mold sections traveling between drive gear 115 and brake gears 145, 147 since these brake gears are only frictionally restrained.

While the entire heat retaining casing 189 for the machine is not shown in any one figure of the drawings, it will be understood preferably to comprise a complete enclosure for all parts of the apparatus above the machine legs except for a small permanent opening adapted to admit material to be processed into the traveling cavities of the mold sections at the left or receiving end of the machine in Fig. 1 and a permanent small opening for discharging the vulcanized or processed material from the right or delivery end of the machine in Fig. 1, and as many openable closures 188 may be provided in the heat retaining jacket 189 as are needed to give access to various points in the machine.

The feature which consists in the location of lower chain carrying wheels 48 and 49 well to the left of upper chain carrying wheels 20 and 22 in Fig. 1, provides a constantly moving material receiving platform in that part of the lower train of mold sections which extends outwardly beyond the upper train of mold sections toward the left in Fig. 1. This moving platform is well illustrated at the bottom of Fig. 2 to be ample for supporting the material to be conveyed into the processing station while exposing it to inspection and adjustment by the operator, who may thus insure that the material to be processed is suitably prepared to enter the work processing station before it is conveyed thereinto and out of his control.

In addition to the steam plates 174 and 175, I have found it to advantage to provide means for delivering heat to the mold sections 78 and 79 during their return travel to the processing station. Such means may consist of steam conveying pipes which zig-zag crosswise of the machine and extend any desirable portion of the length of the machine at a suitable level or levels proximate the idling or return path of travel of the mold sections. A fragment of such steam conveying pipes is indicated at 198 in Fig. 3 for radiating heat upwardly to the mold sections 78 and another fragment of such steam conveying pipes is indicated at 199 in the same figure for radiating heat upwardly to the mold sections 79. Exhaust steam from the heating plates 78, 79, may be caused to pass through such auxiliary pipe lines or other means for heating the mold sections during their returning travel to the processing station may be employed. In general, it is found that in a machine of given length, the rate of production may be increased on a given kind of work by running the machine faster when the mold sections are kept at elevated temperature during their return travel to the processing station.

While no particular kind of raw material and finished work is herein illustrated as that designed to be operated upon or processed by the machine herein disclosed, the operation of the machine will be briefly described with reference to a partial carrying out of the processes for molding and uniformly vulcanizing continuous and unlimited lengths of compositions containing rubber or synthetic rubber comprising a mixture adapted to swell considerably when subjected to a vulcanizing heat as is the case with sponge rubber compound, which are described in the hereinbefore mentioned Patent No. 2,200,262. Many other kinds of materials may be employed and many different forms of resulting product may be manufactured in improved form and with increased efficiency by a machine embodying the present improvements.

In operation mold sections 78 and 79 are maintained suitably warmed by heat delivered by steam plates 174 and 175 and by the steam piping 198 and 199 when electric motor 138 is running which drives the pulley 135 at variable speed through transmission mechanism (not shown) within the housing 137. The speed of pulley 135 is determined by manual adjustment of the transmission regulating hand wheel 142. Thus power is delivered at selective speed to pulley 134, shaft 128, pinion 133, gear 132, shaft 129, and bevel pinions 130 and 130'. These parts are best shown in Figs. 1, 2 and 3. The upright shafts 117 and 117' are thereby rotated respectively clockwise and counterclockwise and at uniform speed in Fig. 2 so that spur gears 115 and 115' constantly impel toward the right in Fig. 1 the successive toothed blocks 83 on opposite ends of the mold sections 79 as these toothed blocks are conveyed into mesh with the spur gears by the chain links 74 and 75.

As the toothed blocks 83 progress they come into mesh with gears 144 and 144' on respectively opposite sides of the machine, and which are also in mesh with the similar toothed blocks of an upper train of mold sections 78 as the last said blocks are conveyed into mesh with gears 144 and 144' by the chain links 42 and 45. Thus, from the receiving or left end of the machine in Fig. 1 to the work delivering or right end of the machine in Fig. 1, all of the mold sections 78 in the upper train and 79 in the lower train are constantly pushed forward in unison by power applied at the entrance to the processing station. Near the exit of the processing station the movement of the toothed blocks toward the right in Fig. 1 is constantly opposed in the case of the upper train of mold sections 78 by the retarding gears 145 and 145' whose rotation is respectively opposed by the brake band 187 and by a similar brake band (not shown) on the other side of the machine, and in the case of the lower train of mold sections 79 by the retarding gears 147 and 147' whose rotation is respectively opposed by the brake band 188 and by a similar brake band (not shown) on the other side of the machine (see Fig. 10). Thus the mold sections in both trains are kept powerfully thrust together during their travel through the processing station from gears 144 and 144' to gears 145, 145', 147 and 147'. In this travel also, mold sections 78 and 79 are kept actually or nearly in face to face contact by the lower track rollers 102 and by the upper series of constraining rollers 104 which in no way oppose the straight line travel of these mold sections in unison from left to right in Fig. 1.

The moving platform comprised of the mold sections 79 which are constantly advancing from the left extremity of the machine toward the gears 144 and 144' in Fig. 1 is adapted to receive a continuous supply of unvulcanized sponge rubber composition in the form of separate strips which may be continuously deposited in the respectively adjacent grooves 92 at the bottom of Fig. 2 and be thereby conveyed into the processing station.

The space on this moving material receiving platform enables unprocessed material to be introduced to the grooves 92, or mold cavities, in various ways. Thus, a continuous width of composition sheet may first be fed onto this platform and severed into strips respectively occupying the adjacent grooves by causing such sheet to run under a preferably cooled roller whose periphery may be constantly pressed downwardly against the upper faces of mold sections 79 as indicated in the Patent No. 2,200,262 hereinbefore referred to, or successive short lengths of unvulcanized strip may be placed in or fed into the grooves or molding cavities 92 to completely fill them lengthwise as they advance toward the processing station. For fuller disclosure of apparatus which may be employed to feed and deliver unprocessed material into the cavities 92 in the exposed upper faces of mold sections 79, reference may be had to United States Patent No. 2,218,527.

As the material so applied to the upper surface of mold sections 79 is carried onward, the mold sections 78 of the upper train close down upon the mold sections 79 and form closed chambers of continuous length completely or partially confining and isolating the strips of material in each groove from one another depending upon the downward adjustment of the constraining rollers 104. While so confined, the heat delivered by steam plates 174 and 175 to mold sections 78 and 79 respectively, first softens the composition, then causes it to expand and to completely fill the molding chambers, or if the vertical setting of rollers 104 permits, to overflow its containing chamber and join with the softened composition in an adjacent chamber when its expansion has slightly separated the normally contacting faces of mold sections 78 and 79, by forcibly lifting the upper mold section 78 slightly, and to then become vulcanized into separate or laterally joined strips of sponge rubber which are delivered continuously from the right end of the machine in Fig. 1 as the upper and lower mold sections separate, in the form of a uniformly vulcanized product of continuous unlimited length and of any desired cross-sectional shape conforming to whatever shape may be possessed by cavities such as 92 in the opposed surfaces of the mold sections.

Because of the positive and accurate control of the relationship of the traveling mold sections, surface perfection of the finished product is achieved, uniform porosity, hardness and cross-sectional size and shape of body structure are produced in the vulcanized product, and the output of the machine is accomplished more rapidly and with less cost than has been possible to any apparatus heretofore known for turning out this type of product or for carrying out the processes for which my improved machine is designed.

Features herein disclosed pertaining to construction and mode of operation of the mold sections as mere carriers of work to be processed are claimed in our copending application divisional herefrom, Serial No. 401,629, filed July 9, 1941.

The improvements as defined in the following claims are susceptible of embodiment in mechanical parts and arrangements of parts differing greatly from the particular parts and arrangements set forth in the drawings and description hereof to illustrate the invention and consequently the language of the claims will be understood as inclusive of equivalent parts and arrangements which might be substituted for those herein chosen for seizing upon the principles of these improvements.

I claim:

1. In apparatus of the character described, in combination, a forwardly movable train of carriers for material to be processed, pivotal joints connecting said carriers in a manner to limit the relative movement of adjacent carriers to swinging movement about a common pivot, said joints being loose enough to permit a small degree of lost motion between adjacent carriers lengthwise of said train, a processing station traversed by said train of carriers, driving mechanism stationed at the entrance to said processing station powered to move continuously in a single direction and acting in order on successive carriers in a manner constantly to thrust a group of said carriers forwardly through said processing station, and retarding mechanism stationed at the exit from said processing station constructed and arranged to engage said group of carriers successively in order and in a manner constantly and yieldingly to oppose forward movement thereof, thereby to hold in tight abutting contact the said group of carriers while the same are moving through said processing station.

2. In apparatus of the character described, the combination defined in claim 1, in which each of said carriers has a body containing grooves aligned with the direction of travel of said train of carriers through said processing station and separated by ridges correspondingly aligned, each of said ridges being formed between the adjacent grooves in a manner to present an outwardly disposed edge of sufficient sharpness to sever and divert into said grooves substantially all of the substance of a severable material when such material is firmly pressed against said edges and toward said grooves.

3. In apparatus of the character described, the combination defined in claim 1, in which each of the said carriers has a body containing grooves for holding material to be processed and extending from edge to edge of said carrier in the direction of travel of the said train of carriers through the said processing station which body portion is widest from edge to edge across its surface containing said grooves and undercut to less width elsewhere thereby to insure crackless continuity of said grooves end-to-end when adjacent carriers are forced into abutting contact during their travel through the processing station for molding continuous lengths of material.

4. In apparatus of the character described, the combination defined in claim 1, together with means to predetermine and vary the force with which the said retarding mechanism constantly and yieldingly opposes the said forward movement of the said group of carriers.

5. Apparatus for impelling a train of mold sections and simultaneously holding in tight abutting contact successive mold sections of said train, including in combination with said mold sections, rack teeth mounted to travel with each of said mold sections and arranged in order lengthwise of said train, a toothed gear powered and arranged to rotate in a fixed location and to engage successively with said rack teeth in a manner to push said train of mold sections progressively beyond said location, and a resistive gear rotatably mounted at a station spaced beyond said location lengthwise of said train a distance greater than the combined reach of a plurality of said mold sections and constructed and arranged to engage successively with said rack

teeth in a manner to oppose travel of said train past said station thereby to cause successive mold sections to be thrust tightly together while traveling from said location to said station.

6. Apparatus for impelling in adjacent lengthwise paths of travel neighboring trains of mold sections in face-to-face matching relation and for simultaneously holding in tight edge-to-edge abutting contact a group of successive mold sections in each of said trains, including rack teeth mounted to travel with each of said mold sections of each of said trains and ordered lengthwise of each train, gear means mounted and powered to rotate in a fixed location and to engage successively with said rack teeth in each of said trains in a manner to push both of said trains constantly and in unison beyond said location in their said paths of travel, and resistive gear means operative at a station spaced beyond said location along the said paths of travel of said trains a distance greater than the combined reach of said group of mold sections in each train and constructed and arranged to engage successively with said rack teeth of both trains in a manner to oppose travel of both trains past said station thereby to cause said group of mold sections of each of said trains to be thrust tightly together edgewise while traveling in matching relation to the said sections of the other train between said location and said station.

7. Apparatus as defined in claim 6, in which the said powered gear means and the said resistive gear means are constructed and arranged cooperatively with the said rack teeth to permit relative sliding movement therebetween crosswise the said paths of travel of the said trains thereby to permit the said groups of mold sections of respectively different trains to travel in variable face-to-face proximity to one another past both of said gear means while held thereby in tight edge-to-edge abutting contact.

8. Apparatus for impelling in adjacent lengthwise paths of travel neighboring trains of mold sections in face-to-face matching relation and for simultaneously holding in tight edge-to-edge abutting contact a group of successive mold sections in each of said trains, including rack teeth mounted to travel with each of said mold sections of each of said trains and arranged in order lengthwise of each train, a gear mounted to rotate in a fixed location and to mesh simultaneously with rack teeth of both of said trains in a manner to cause one of said trains to advance in unison with the other of said trains beyond said location in said paths of train travel, and a plurality of resistive gears each operatively mounted at a station spaced beyond the said location along said paths of travel a distance greater than the combined reach of said group of the mold sections in each train, and each meshing with rack teeth of respectively different trains in a manner independently, simultaneously and continuously to oppose travel of each of said trains past its said station.

9. In combination with apparatus as defined in claim 8, means constructed and arranged in operative association with the said plurality of resistive gears in a manner to vary and determine independently the force with which each of said gears acts upon the said rack teeth of each of the said trains.

10. In material processing apparatus, in combination with two trains of material-confining traveling mold structures, pivotal joints connecting said mold structures in a manner to limit the relative movement of adjacent structures to swinging movement about a common pivot, said joints being loose enough to permit a small degree of lost motion between adjacent structures lengthwise of said trains, gear teeth carried by each of said structures and arranged to form separate racks of said gear teeth traveling respectively with each of said trains, a driving gear arranged to mesh with the teeth of only one of said trains of structures, a transmission gear arranged to mesh simultaneously with the teeth of both of said trains of structures, and a retarding gear spaced from said driving gear in the direction of train travel by a distance at least as great as the combined extent of a plurality of said structures and arranged to mesh with the teeth of one of said trains of structures.

11. In combination with apparatus as described in claim 10, a support frame for the apparatus, a series of freely turnable rollers arranged and positioned to provide antifrictional support for the weight of the said chain links and carriers in the path of travel thereof between the said driving means and the said brake means, and a superimposed series of freely turnable rollers supported on said frame in a manner to be vertically adjustable in relation thereto and arranged and positioned positively to limit with anti-frictional resistance the lifting displacement of said chain links and carriers to a pre-determinable extent of displacement.

12. Apparatus for conveying material to be processed, including in combination, two endless and laterally spaced chains of links, a train of rigid bars each spanning the space between said chains and detachably connected at each end to a different one of said links and carrying a molding cavity on one face adapted to communicate with a molding cavity on the corresponding faces of adjacent bars in the same train, a single pivotal joint constructed and arranged to connect together each two successive links in said chains in a manner to limit the relative movement of adjacent links to swinging movement about a common axis, said joints being loose enough to permit a small degree of lost motion between adjacent carriers lengthwise of said chains, each of said bars further having a maximum width from edge to edge across its said face at least as great as the minimum center distance between successive pivotal joints, and further having a reduced width in portions other than said face, and means constructed and arranged to force said edges of adjacent bars into abutting contact with each other in the region of said molding cavities, as permitted by said looseness of said joints while said train and chains travel in unison for conveying material.

13. Apparatus as described in claim 12, in which the said bars are rigidly and removably secured at each end in such relation respectively to adjacent links of the same chain that adjacent bars can abut in a plane normal to their path of travel and substantially centrally aligned with the said single loose pivotal joint which connects the adjacent links to which said adjacent bars are respectively secured.

14. In a processing machine, in combination with upper and lower trains of material conveyers constructed and arranged to be pushed in mating contact together through a processing station, means to direct a foremost stretch of said lower train into a path of travel advanced longitudinally with respect to the path

of travel of said upper train thereby to maintain a platform-like traveling portion of said lower train of conveyers clear of said upper train and exposed at the front thereof in a manner to receive material to be processed, means to direct said upper train into meeting proximity to said lower train at a point along said paths of travel located between said platform-like portion of the lower train and said processing station, power impelled driving means stationed at the front end of said platform-like portion of the lower train in a location spaced forwardly from said point of meeting of said trains and constructed and arranged to push successively on the conveyers of only said lower train in a manner to thrust all of the conveyers in the said platform-like train portion constantly toward said point of meeting of the trains, together with means stationed between said point of meeting and the processing station constructed and arranged to transmit movement from the conveyors of said lower train to the conveyors of said upper train.

15. In a processing machine, in combination with two neighboring trains of mold sections having working faces containing molding cavities and supported and arranged to move in endless procession while certain mold sections of said neighboring trains progress face to face along a path of processing travel, keys carried respectively by the mold sections of one of said trains projecting from the working faces thereof and aligned with said path of travel, the mold sections of the neighboring train having keyways respectively sunk in their working faces spaced laterally from the molding cavities therein, each of said keyways being shaped and disposed to receive a portion of each of two of said keys in a manner to hold the molding cavities of both trains of mold sections in true register and alignment while advancing in said processing path of travel.

16. In a processing machine, the combination defined in claim 15, in which the said working faces of the mold sections are relieved in an area between the said molding cavities and the said keys and/or keyways thereby to provide space between opposed working faces of the mold sections of neighboring trains to accommodate excess material forced out of said molding cavities during the said processing travel thereby to prevent said excess material from holding apart the unrelieved portions of said working faces.

17. In a processing machine, the combination defined in claim 15, together with rotatable support means disposed along a return path of travel of the train of key equipped mold sections constructed and arranged to engage laterally with successive keys and simultaneously bear the weight of successive mold sections as the latter pass said support means.

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