

[54] **ROTATIONAL CASTING OR MOLDING MACHINE**

[75] Inventor: **Hans Werner Hagen**,
Unterpfaffenhofen, Germany

[73] Assignee: **Metzeler Aktiengesellschaft**,
Munich, Germany

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[51] Int. Cl. **B29c 5/04**

[58] Field of Search **425/429, 430, 434, 435;**
264/311

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Primary Examiner—Robert L. Spicer, Jr.

Attorney, Agent, or Firm—Michael S. Striker

[57]

ABSTRACT

A rotational casting or molding machine wherein a hollow bifurcated support is driven to rotate about a horizontal axis and each of its prongs carries a stub shaft driven by a mechanism which extends in part through the interior of the support. The shafts are rotatable about a common axis which is normal to the axis of the support and each shaft supports a discrete mold holder frame having an annular or polygonal outline and being coupled to the respective shaft by a set of equidistant connecting elements in the form of stacked leaf springs. The leaf springs allow for thermally induced movements of the frames in the axial direction of the shafts but hold the frames against angular movement with reference to their shafts. One end portion of each package of leaf springs is fixedly secured to the respective frame or to the respective shaft and the other end portion of each package is longitudinally movably secured to the respective shaft or to the respective frame. The leaf springs are either coplanar with the respective frames or are mounted in such a way that their inner end portions are spaced from the outer end portions as considered in the direction of the common axis of the shafts.

12 Claims, 7 Drawing Figures

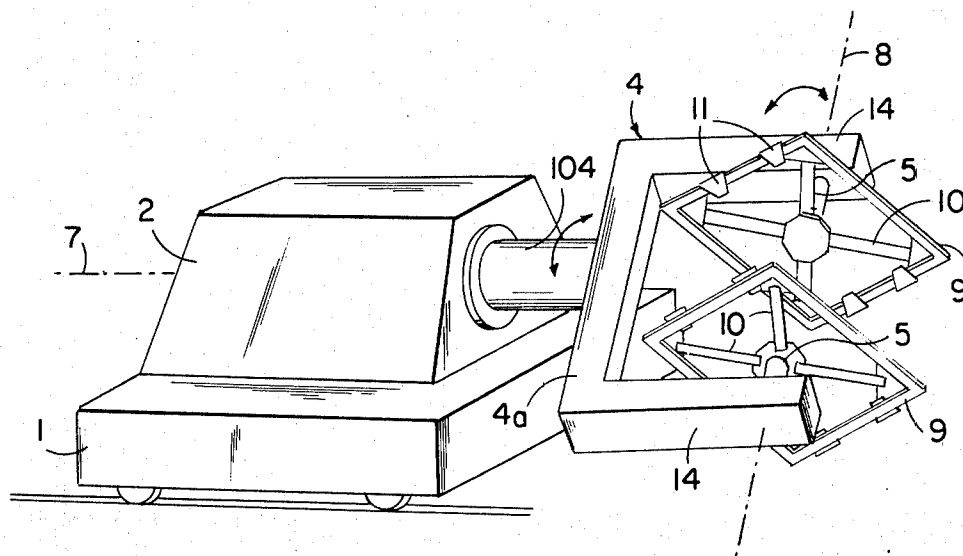


FIG. 1

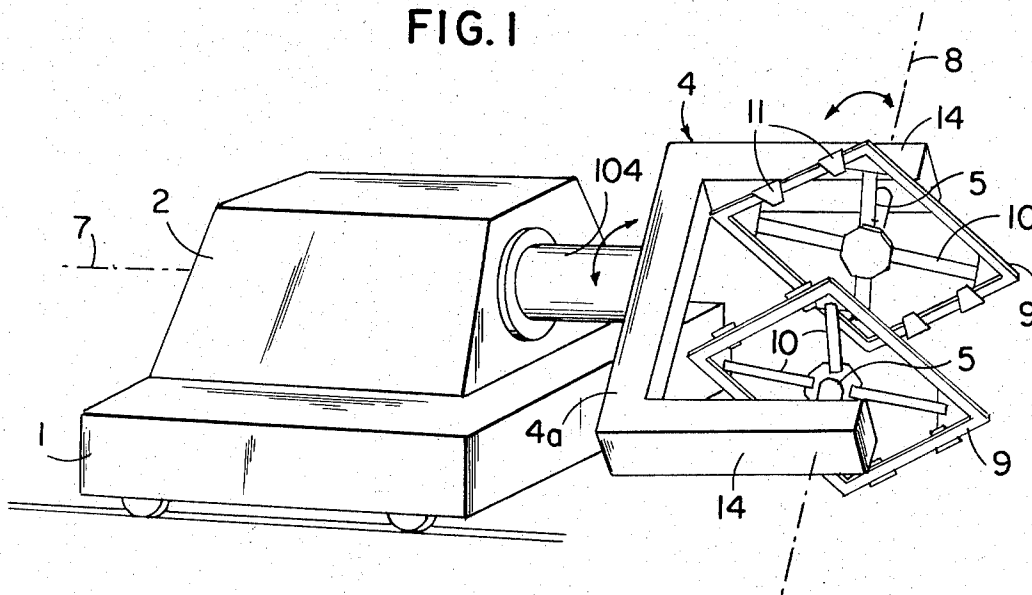


FIG. 4

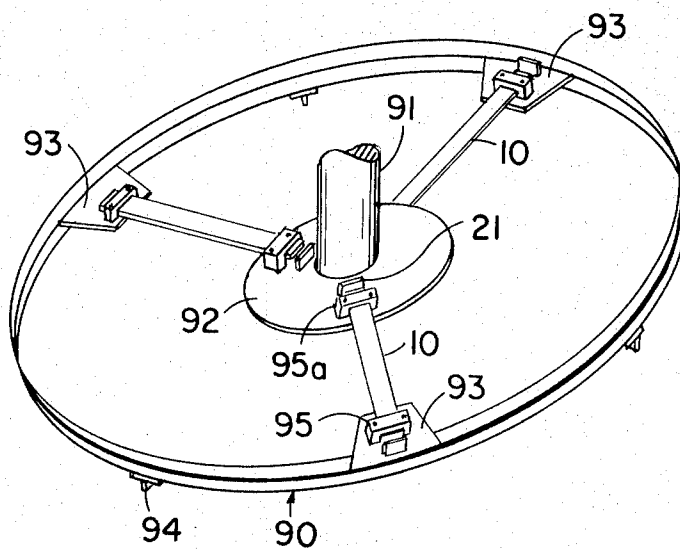
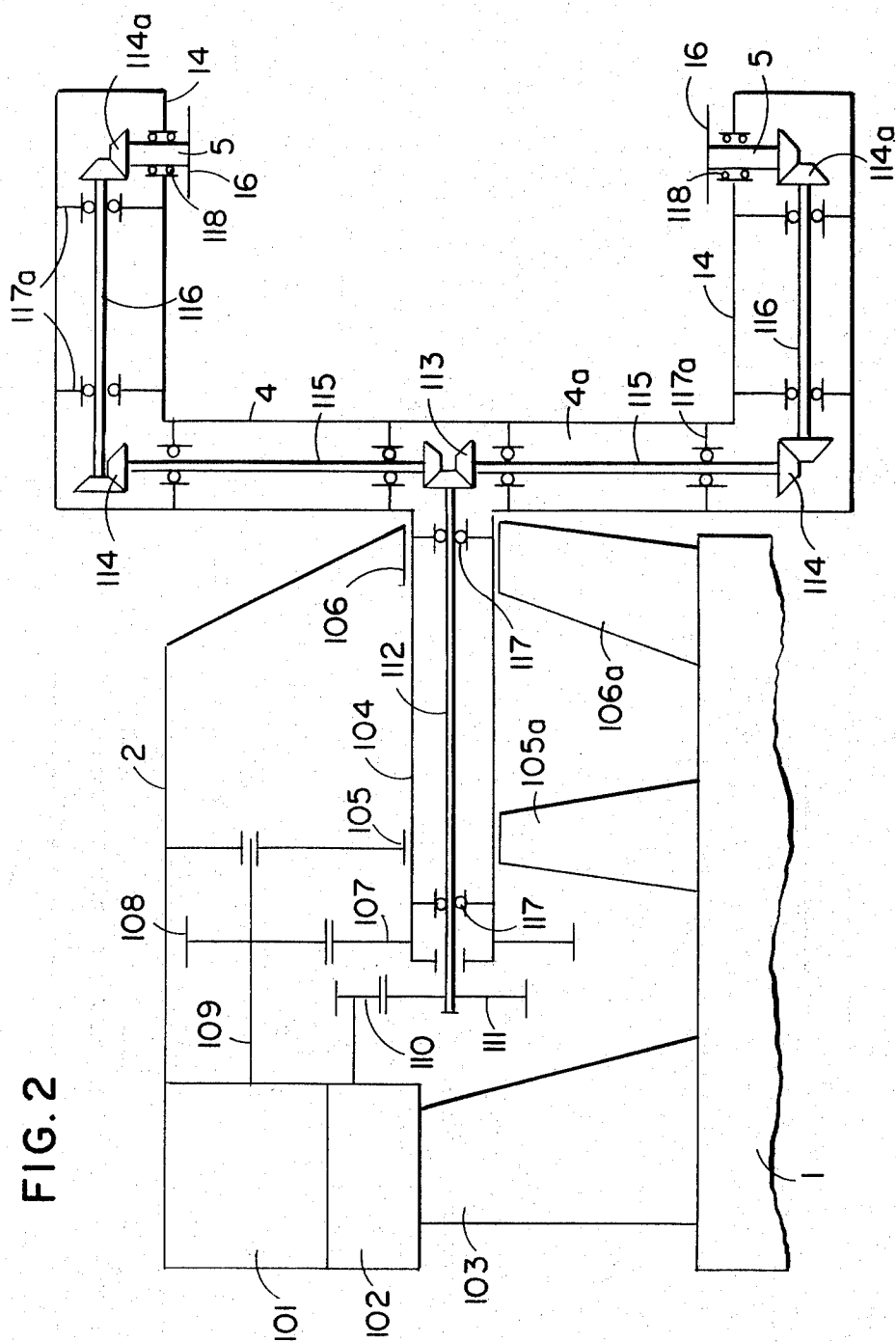


FIG. 2



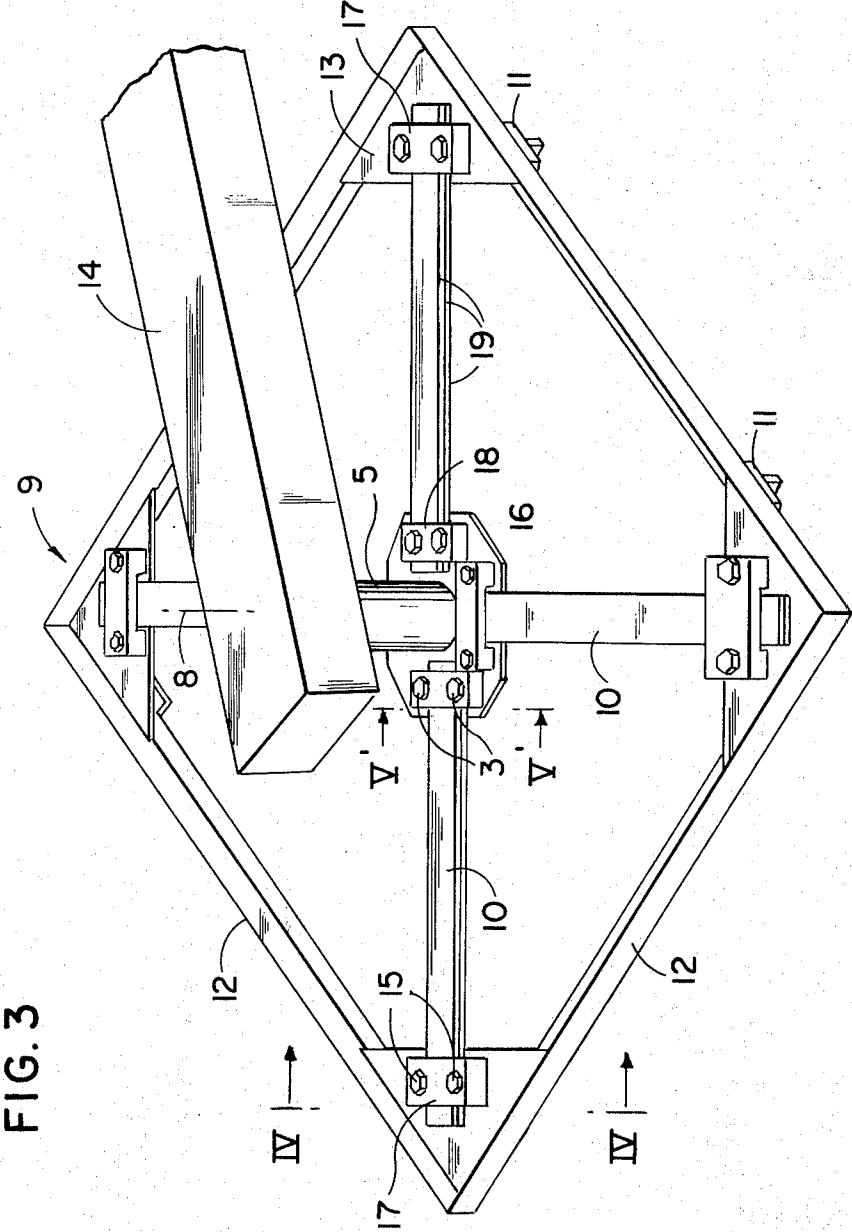


FIG. 5

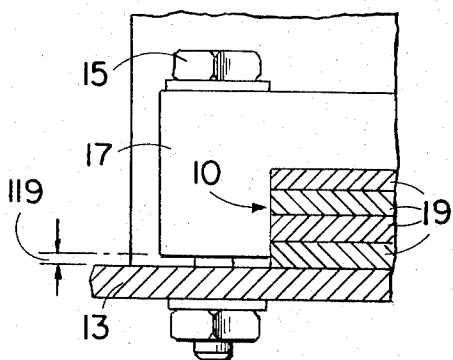


FIG. 6

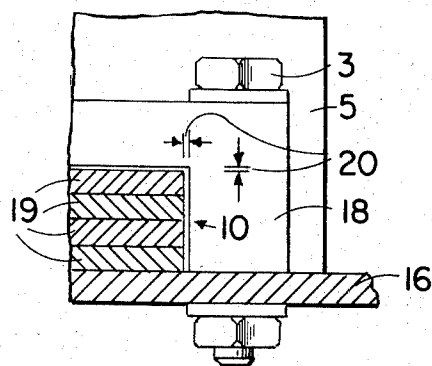
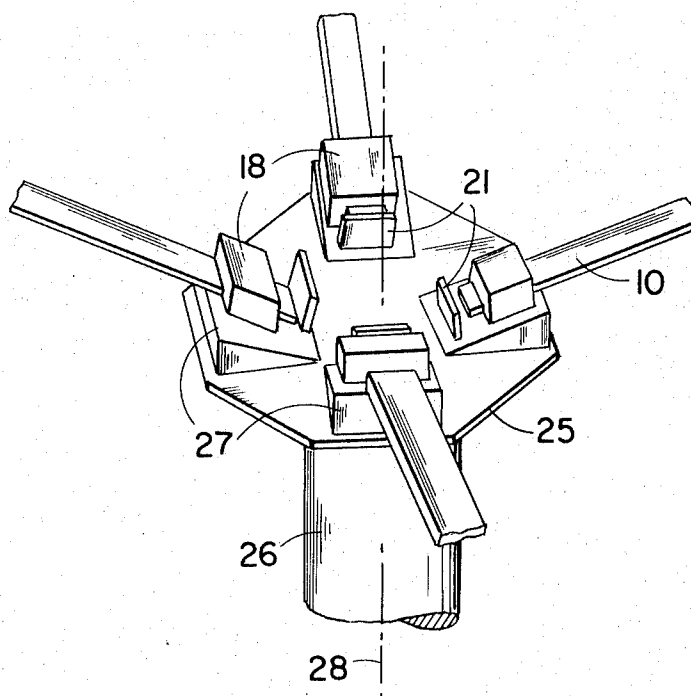


FIG. 7



ROTATIONAL CASTING OR MOLDING MACHINE

BACKGROUND OF THE INVENTION:

The present invention relates to rotational casting or molding machines of the type wherein one or more open or closed molds are rotated about several axes to form hollow bodies of synthetic plastic material.

In presently known machines of such character, a hollow mold receives a charge of plastic material (e.g., thermoplastic material) which is distributed along its internal surface while the mold rotates about several axes. The mold is heated during rotation so that the introduced charge is in a flowable state to insure a desired distribution of plastic material in all portions of the thus obtained hollow article. The mold is thereupon cooled so that the material of the article sets and the latter is ready for removal from the mold cavity for further processing or for transport to a storing or packing station. In a mass-producing rotational casting or molding machine, the mold must be repeatedly heated and cooled at frequent intervals. Such heating and cooling of the mold entails repeated intensive heating and cooling of those parts of the machine which are fully exposed and indirect heating or cooling of the parts which are exposed only in part or are confined in the interior of the machine. For example, various bearings, gears, pinions, cams, packings and other parts which are normally confined in the housing of the machine are subjected to a less intensive heating or cooling action than the parts which are exposed to the heating or cooling action to the same extent as the mold for plastic material. Such differences in heating and cooling action upon different parts of the machine result in widely different thermally induced expansion or contraction with the result that the relatively moving parts must be mounted with a substantial amount of clearance to avoid jamming during heating to elevated temperatures. It was found that such thermal effects (heating and/or cooling) result in substantial distortion, expansion, contraction and/or relative movements between the parts of the machine so that the parts are subjected to substantial stresses. This renders it necessary to construct the parts of high-quality material as well as to mount the movable parts with large clearances; therefore, such machines are not only expensive but their operation is not as precise as is often desirable or necessary in connection with the production of certain hollow plastic articles.

It was further found that the aforesaid preventive measures cannot prevent frequent damage to or total destruction of parts in machines which are designed for the production of relatively large plastic articles, for example, of articles which are being produced in molds having a volume of several cubic meters and weighing one or more tons. In such machines, excessive clearances between relatively movable parts can generate uncontrollable forces even if the parts are manufactured of expensive high-quality materials. The torque transmitting parts and/or the mold holding frames of such large machines have a very short useful life which entails lengthy interruptions in operation with attendant losses in output.

SUMMARY OF THE INVENTION

An object of the invention is to provide a novel and improved rotational casting or molding machine

wherein the differences between the heating or cooling of one or more mold holding forms and other parts of the machine are compensated for in a novel and improved way so as to prolong the useful life of the machine and to insure that the forms can be utilized for long periods of time.

Another object of the invention is to provide novel and improved means for mounting the mold holding form or forms in a rotational casting or molding machine in such a way that the differences between thermal stressing of forms and other parts of the machine do not unduly affect their useful life.

A further object of the invention is to provide a machine which can be operated with forms of any practical size and/or shape.

An additional object of the invention is to provide a machine wherein the form or forms for one or more molds can be rotated at a selected speed irrespective of the extent of their deformation in response to heating or cooling within a wide range.

The invention resides in the provision of a rotational molding or casting machine which comprises a housing or an analogous supporting structure which can accommodate some or all elements of various drive means, a bifurcated or otherwise configured support which is rotatably mounted in the housing, at least one shaft is mounted on the support without the housing and is rotatable about an axis which is inclined relative to the axis of the support, driven means for rotating the support and for rotating the shaft relative to the support, mold supporting means including at least one mold holding or carrying frame of polygonal, oval or circular outline, and coupling means for connecting the frame to the shaft. The coupling means includes at least one but preferably several elongated elastic connecting elements which extend substantially radially of the shaft and permit relative movement between the frame and the shaft in response to differences in thermally induced expansion or contraction of the frame and the shaft. The connecting elements preferably comprise leaf springs which compel the frame to share all angular movements of the shaft but allow the frame to move axially to the shaft.

The novel features which are considered as characteristic of the invention are set forth in particular in the appended claims. The improved machine itself, however, both as to its construction and its mode of operation, together with additional features and advantages thereof, will be best understood upon perusal of the following detailed description of certain specific embodiments with reference to the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a perspective view of a rotational casting or molding machine which embodies one form of the invention;

FIG. 2 is a schematic central longitudinal vertical sectional view of the machine with the mold carrying frames omitted;

FIG. 3 is an enlarged perspective view of one of the mold carrying frames shown in FIG. 1;

FIG. 4 is a perspective view of a modified mold carrying frame;

FIG. 5 is an enlarged fragmentary sectional view as seen in the direction of arrows from the line V—V of FIG. 3;

FIG. 6 is an enlarged fragmentary sectional view as seen in the direction of arrows from the line VI—VI of FIG. 3; and

FIG. 7 is a fragmentary perspective view of a further machine.

DESCRIPTION OF THE PREFERRED EMBODIMENTS:

FIG. 1 illustrates a rotational casting or molding machine comprising a wheel-mounted base 1 for a housing 2 which supports the hollow shaft 104 of a bifurcated substantially U-shaped hollow support 4. The shaft 104 can be driven to rotate about an axis 7 and the support 4 comprises a web 4a which is connected with the shaft 104 and two parallel prongs or arms 14 the outer end portions of which carry driven stub shafts 5 rotatable about a common axis 8 which is preferably normal to and crosses the axis 7 of the shaft 104. The stub shafts 5 support and rotate holding or carrying frames 9 for suitable molds (not shown) which can be made of copper, aluminum or other material having a high thermal conductivity. FIG. 1 illustrates two polygonal frames 9 the details of which are shown in FIGS. 3, 5 and 6. The means for connecting the frames 9 to the respective stub shafts 5 comprise elastic connecting elements 10. The frames 9 are provided with suspending or attaching devices 11 for molds. The space between the two frames 9 of FIG. 1 can accommodate a single mold or two or more molds. Such molds share the angular movements of the support 4 about the axis 7 and the angular movements of stub shafts 5 about the axis 8.

FIG. 2 illustrates the details of the drive means for the shafts 104 and 5. The housing 2 accommodates two driving units 101, 102 which respectively serve to rotate the shaft 104 and the stub shafts 5. As shown, the shaft 104 is hollow and certain components of the drive means for the stub shafts 5 are mounted in the interior of the shaft 104 as well as in the interior of the hollow support 4. The driving units 101, 102 are mounted one above the other and are carried by a suitable upright or pedestal 103 which is secured to the base 1. The hollow shaft 104 of the support 4 is rotatable in bearings 105, 106 which are mounted in brackets 105a, 106a supported by the base 1. The rear or inner end portion of the shaft 104 is connected with a gear 107 which meshes with a gear 108 secured to a shaft 109 which receives torque from the driving unit 101. The latter can constitute a variable-speed transmission whose output shaft (109) drives the gear 108 at a desired speed.

The output shaft 102a of the driving unit 102 carries a gear 110 in mesh with a gear 111 on a shaft 112 which is rotatable in bearings 117 provided therefor in the interior of the shaft 104. A system of bevel gears 113 receives torque from the shaft 112 and transmits torque to two further shafts 115 which are mounted in the web 4a of the support 4. The outer end portions of the shafts 115 transmit torque to shafts 116 by way of bevel gears 114. The shafts 116 are rotatable in the arms 14 of the support 4 and transmit torque to the respective stub shafts 5 by way of additional bevel gears 114a. The shafts 115, 116 are mounted in bearings 117a which are preferably similar to the bearings 117 for the shaft 112. Such bearings may include antifriction roller bearings. The stub shafts 5 are preferably mounted in stronger antifriction bearings 118 such as twin roller or ball bearings. The exposed free ends of the stub shafts 5

carry retaining plates 16 which serve to support the inner ends of elastic connecting elements 10.

FIG. 3 illustrates the details of one of the frames 9. This frame 9 has a square outline and comprises four angle bars 12 of preferably L-shaped profile the ends of which are welded to each other by means of triangular corner plates 13 or analogous stiffening and retaining means. These plates retain the outer ends of the aforementioned elastic connecting elements 10 each of which consists of a package of four overlapping leaf springs 19 (see FIGS. 5 and 6). The planes of the leaf springs 19 are preferably normal to the axis 8 so that the connecting elements 10 insure that the frame 9 rotates at the exact speed of the respective stub shaft 5. The leaf springs 19 are flexible in directions which are parallel with the common axis 8 of the stub shafts 5 so as to allow for axial movements of the frame 9 in response to heating or cooling. The outer end portions of the elastic elements 10 are connected with the plates 13 by means of U-shaped straps 17 and the inner end portions of such elastic elements are connected with the retaining plate 16 of the respective stub shaft 5 by similar straps 18. The straps 17, 18 may be welded or separably secured to the respective retaining plates 13, 16. FIG. 5 shows that each strap 17 constitutes a rigid U-shaped body which is bolted to the respective plate 13 by threaded fasteners 15. At least one leg of the strap 17 is shorter than the combined thickness of four leaf springs 19 so that this leg defines with the adjacent surface of the respective plate 13 a narrow clearance or gap 119. This means that the fasteners 15 cause the lowermost leaf spring 19 to bear directly against the plate 13 with a force which is determined by the extent to which the fasteners 15 urge the strap 17 toward the plate 13. Such mode of mounting insures that the outer end portions of the leaf springs 19 are frictionally held against movement relative to each other as well as relative to the parts 13 and 17.

FIG. 6 illustrates the manner in which the inner end portions of leaf springs 19 are mounted on the retaining plate 16 which is carried by the respective stub shaft 5. The U-shaped strap 18 is dimensioned in such a way that, when it is firmly but separably secured to the retaining plate 16 by means of bolts 3 or analogous fasteners, it surrounds the uppermost leaf spring 19 as well as the edge faces of the four leaf springs with a certain amount of clearance as indicated at 20. Consequently, the inner end portions of the leaf springs 19 are movable lengthwise relative to the strap 18 to this allow for relative movement between the stub shaft 5 and the frame 9 in the direction of the axis 8. The extent of lengthwise movement of elastic connecting elements 10 in a direction toward the axis 8 is limited by the external surface of the stub shaft 5. As mentioned above, the fasteners 3 press the legs of the clamp 18 firmly against the adjacent surface of the retaining plate 16.

FIG. 4 illustrates a modified mold holding or carrying frame 90 of substantially circular outline (this frame may form a true circle or it may have an oval outline). The stub shaft 91 corresponds to one of the stub shafts 5 and carries a retaining plate 92 corresponding to the plate 16 of FIG. 3. The frame 90 is coupled with the retaining plate 92 by means of three equidistant radially extending elastic connecting elements 10 each of which may include a stack of overlapping leaf springs, the same as shown in FIGS. 5 and 6. The outer end portions of the elastic elements 10 are fixedly secured to retain-

ing plates 93 of the frame 90 by means of U-shaped straps 95 corresponding to the strap 17 of FIG. 5. The inner end portions of the connecting elements 10 are movably coupled to the retaining plate 92 by means of U-shaped straps 95a similar to the strap 18 of FIG. 6. The straps 95a and 95 may be welded or separably secured to the respective retaining plates 92, 93. The frame 90 carries suspending or attaching devices 94 for one or more molds, not shown.

The stub shaft 91 or the retaining plate 92 is provided with fixedly mounted abutments 21 for the inner end portions of elastic connecting elements 10. Such abutments limit the extent of lengthwise movement of the elements 10 toward the axis of the stub shaft 91.

FIG. 7 illustrates a portion of a second machine wherein each stub shaft 26 (only one shown) carries a polygonal retaining plate 25 for the inner end portions of four equidistant elastic connecting elements 10 which are further secured to an annular or polygonal mold carrier frame. In contrast to the connecting elements 10 of FIGS. 1 to 6 which, in their unstressed condition, are located in the planes of the respective frames, the elastic connecting elements 10 of FIG. 7 are located in planes which make acute angles with the axis 28 of the stub 26 so that these connecting elements form what may be termed a skeleton cone or pyramid the axis of which coincides with the axis 28. The inner end portions of the coupling elements 10 are placed on top of wedge-shaped inserts or platforms 27 which are permanently or separably mounted on the retaining plate 25 and cooperate with U-shaped straps 18 permitting the inner end portions of the respective coupling elements to move toward or away from suitable abutments 21 provided on the retaining plate 25 or on the platforms 27. It was found that the mounting of connecting elements 10 as shown in FIG. 7 (i.e., so that their inner end portions are spaced from their outer end portions as considered in the direction of the axis 28) further enhances the movability of the respective frame with reference to the stub shaft. This is attributed to more pronounced flexibility of connecting elements 10 in directions to allow for movement of the annular or polygonal frame in the direction of the axis 28.

The main purpose of the elastic connecting elements 10 is to compensate for differences in the heating and/or cooling of the molds and frames on the one hand and the remaining parts of the machine on the other hand. Thus, the connecting elements 10 will compensate for differences in the expansion or contraction of stub shafts 5, 26 or 91 on the one hand and the expansion or contraction of the frames and molds on the other hand.

It is clear that the improved machine is susceptible of many additional modifications. For example, the inner end portions of the connecting elements 10 can be fixedly secured to the respective stub shafts and the outer end portions of such elements are then movable lengthwise with reference to the respective frames. Also, each frame may comprise a plate-like body which is fixedly or movably secured to the outer end portions of the elastic connecting elements 10. If the frame is a plate-like body, the connecting elements 10 are preferably inclined in a manner as shown in FIG. 7.

Furthermore, the bifurcated support 4 can be replaced with a frame-like or otherwise configured support.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can, by applying current knowledge, readily adapt it for various applications without omitting features which fairly constitute essential characteristics of the generic and specific aspects of the above-described contribution to the art and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the claims.

What is claimed as new and desired to be protected by Letters Patent is set forth in the appended:

1. Rotational molding or casting machine, comprising a housing; a support rotatably mounted in said housing; at least one shaft mounted in said support for rotation about an axis which is inclined relative to the axis of said support; coupling means including at least one elastic element connected to said shaft and extending substantially radially thereof; and mold supporting means including at least one mold holding frame connected to said elastic element, said elastic element permitting relative movement between said frame and said shaft in response to differences in thermally induced expansion or contraction of said frame and said shaft.

2. A machine as defined in claim 1, wherein said coupling means is constructed and mounted to prevent movements of said frame relative to said shaft about the axis of said shaft.

3. A machine as defined in claim 1, wherein said coupling means is constructed and mounted to allow for movements of said frame in the axial direction of said shaft.

4. A machine as defined in claim 1, wherein said connecting element has a first end portion fixedly secured to said frame and a second end portion secured to said shaft for movement in the radial direction of said shaft.

5. A machine as defined in claim 1, wherein said connecting element has a first end portion fixedly secured to said shaft and a second end portion longitudinally movably secured to said frame.

6. A machine as defined in claim 1, wherein said shaft comprises first retaining means and said frame comprises second retaining means, said connecting element having a first end portion fixedly secured to one of said retaining means and a second end portion secured to the other of said retaining means for movement substantially radially of said shaft, and further comprising abutment means for limiting the extent of lengthwise movement of said second end portion with respect to said other retaining means.

7. A machine as defined in claim 1, wherein said connecting element comprises a package of overlapping leaf springs.

8. A machine as defined in claim 1, wherein said frame has a polygonal outline including a plurality of corner portions each having a plate-like first retaining member, said shaft comprising a second plate-like retaining member and said connecting element including a first end portion secured to one of said first retaining members and a second end portion secured to said second retaining member.

9. A machine as defined in claim 1, wherein said frame is located in a predetermined plane and said connecting element is at least substantially coplanar with said frame in the undeformed condition thereof.

10. A machine as defined in claim 1, wherein said connecting element has a first end portion secured to said shaft and a second end portion secured to said

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frame, said end portions being spaced apart as considered in the axial direction of said shaft.

11. A machine as defined in claim 1, wherein said support carries two coaxial shafts and said mold supporting means comprises a discrete frame for each of said shafts, said coupling means comprising a plurality of equidistant elastic connecting elements each having

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an inner end portion secured to the respective shaft and an outer end portion secured to the respective frame.

12. A machine as defined in claim 1, wherein said support comprises two arms each of which rotatably supports one of said shafts, said frames being located between said arms.

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