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Beemer et al.

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[54] **RETRACTABLE CASTING CORE BOX WITH ELASTOMERIC JOINT SEAL**

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[52] **U.S. Cl.** **249/179**, 249/152, 249/180, 249/183

[51] **Int. Cl.** **B28b 7/30**

[58] **Field of Search** 249/178–182, 249/183, 152, 153, 173

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Primary Examiner—Robert D. Baldwin

Attorney, Agent, or Firm—Christie, Parker & Hale

[57] **ABSTRACT**

A retractable core for use with an outer form in producing concrete castings includes a rectangular wall-forming box having a hollow interior and an opening at its bottom to allow access to its interior. The walls of the box are separated symmetrically into four quadrants, and the lines of separation between quadrants are sealed by a compressible elastomer. A retracting mechanism inside the box is connected to each quadrant. In use, concrete is poured over the box, and after the concrete cures, the retracting mechanism pulls each quadrant toward the center of the core to compress the elastomeric seal and thereby shrink the size of the core. The casting is then lifted over the core. Each quadrant is mounted on a separate set of elastically bendable support arms which deflect during retraction of the core and the subsequent return of the core to its initial wall-forming position.

16 Claims, 15 Drawing Figures

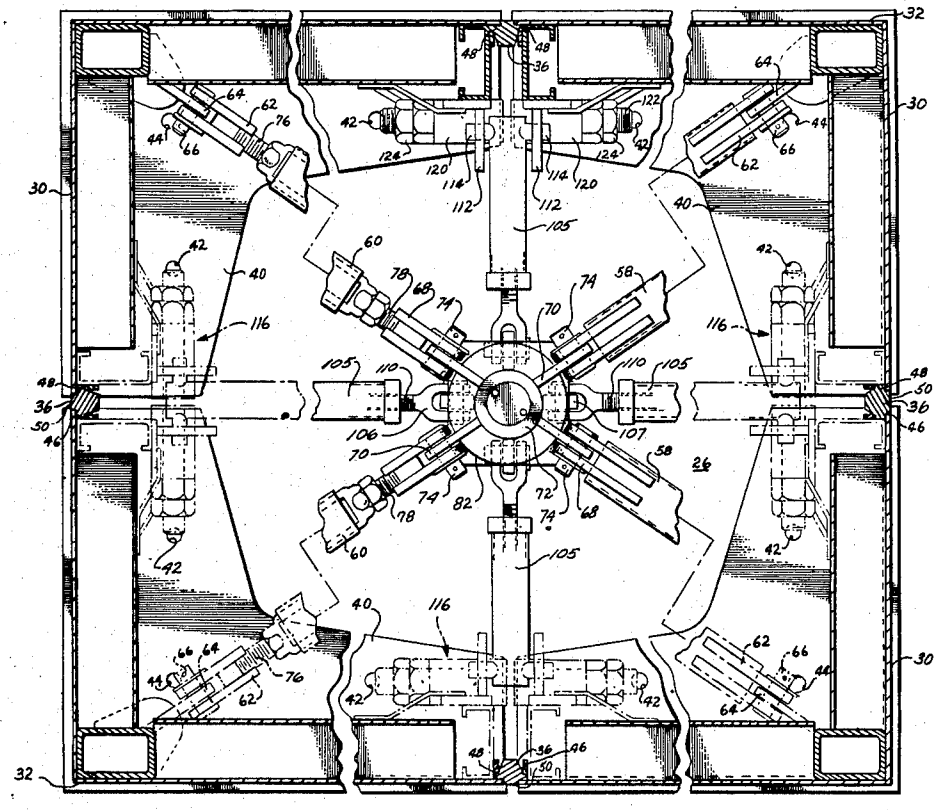


FIG. 1

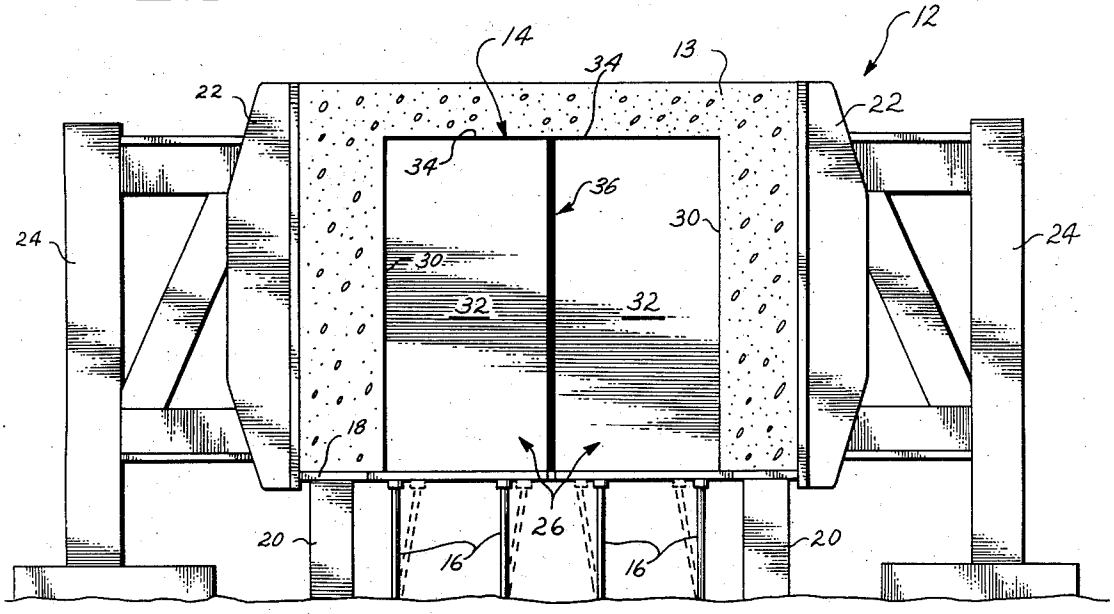
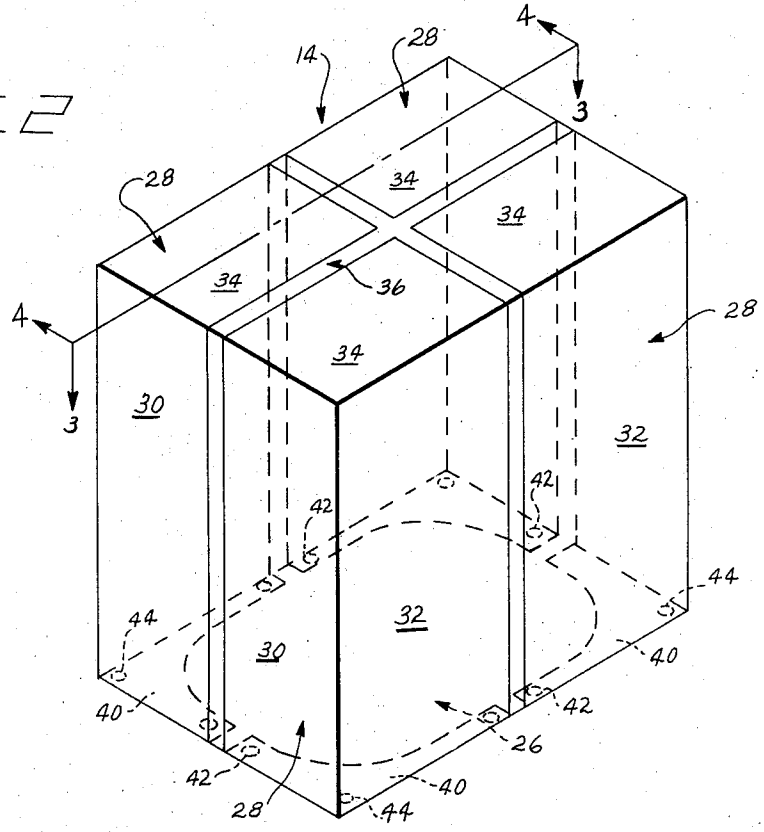

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FIG. 2


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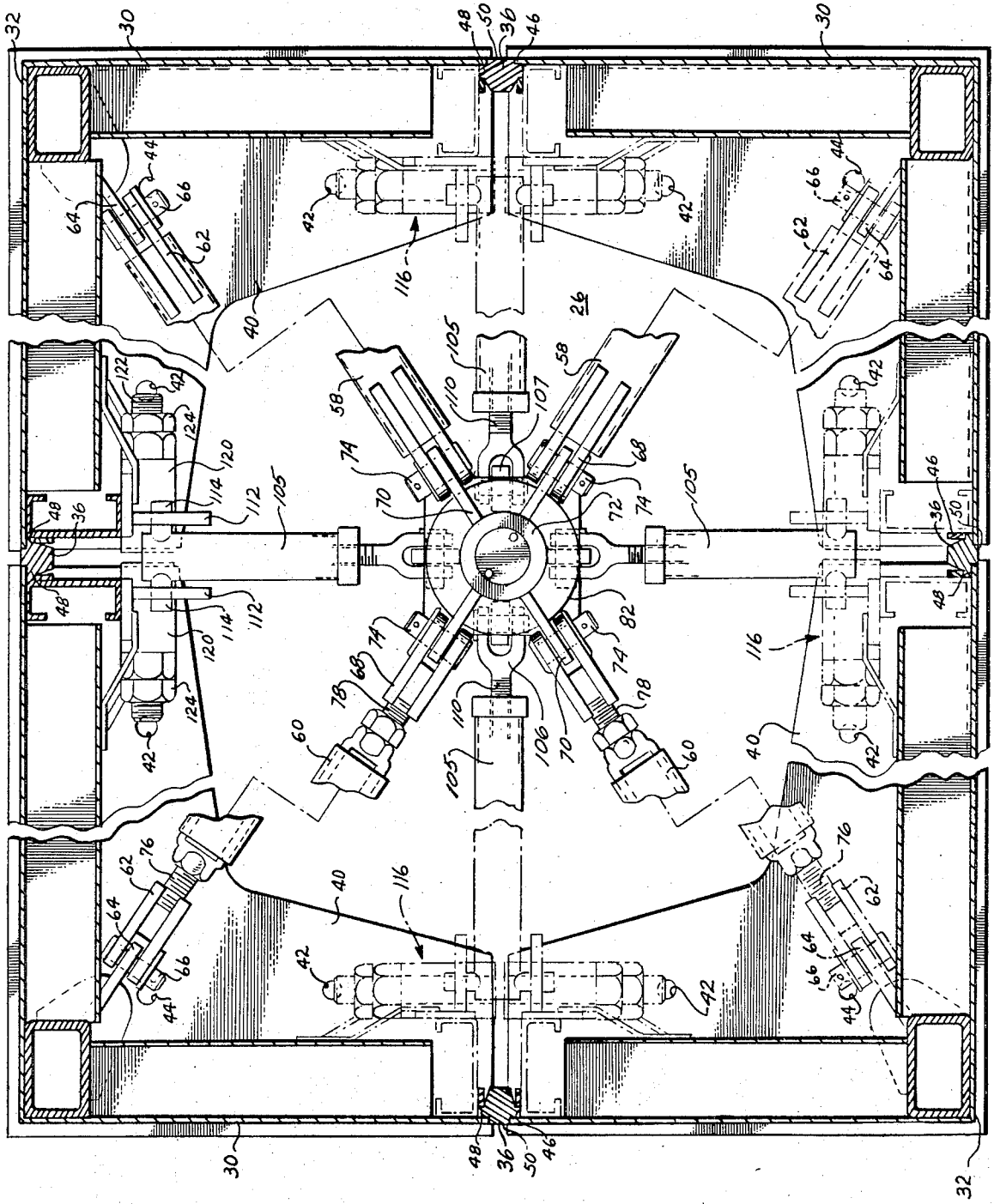


FIG. 3

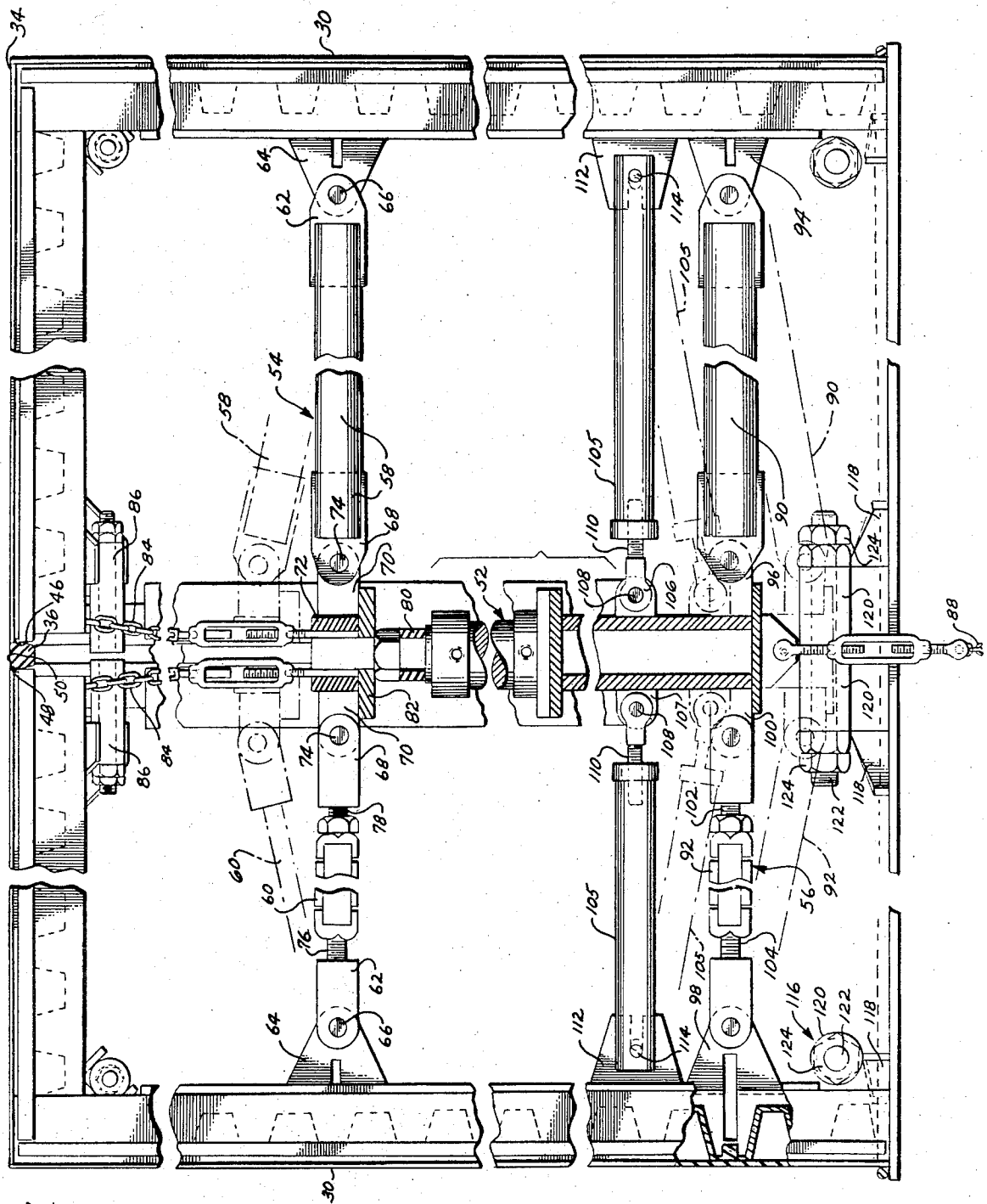


FIG. 4

FIG. 5

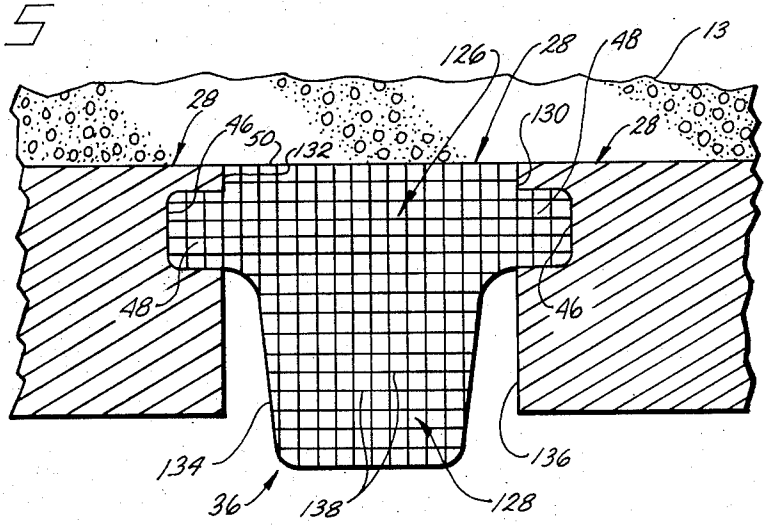


FIG. 6

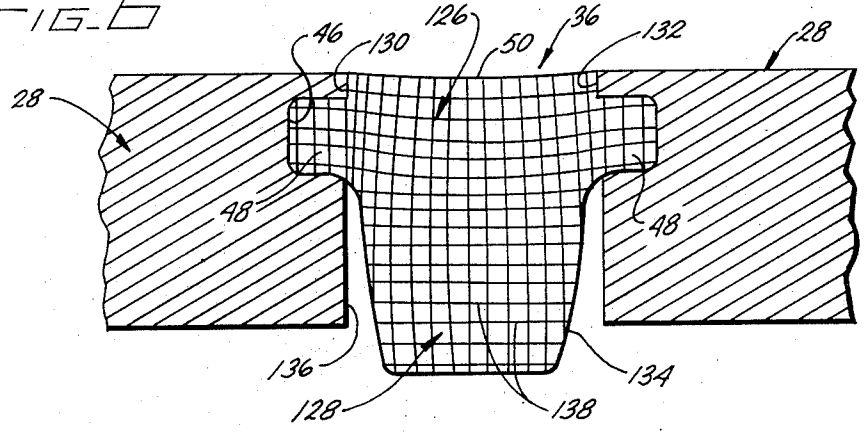


FIG. 7

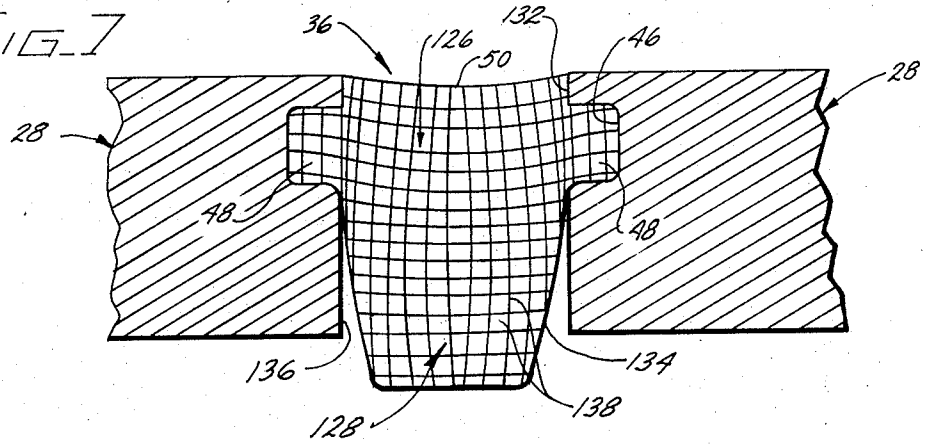


FIG. 9

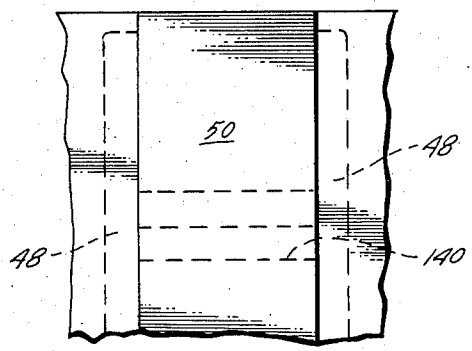


FIG. 11

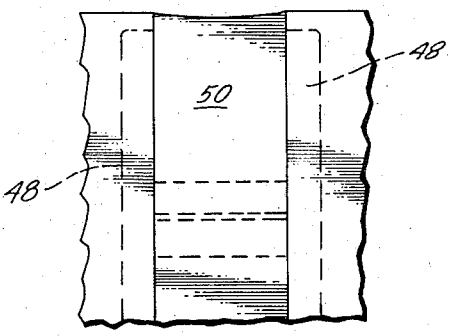


FIG. 8

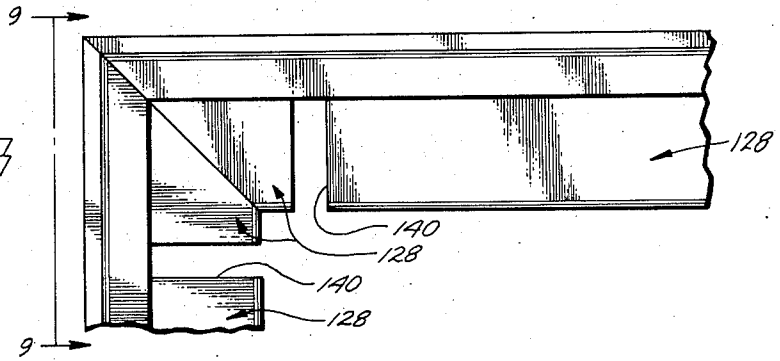
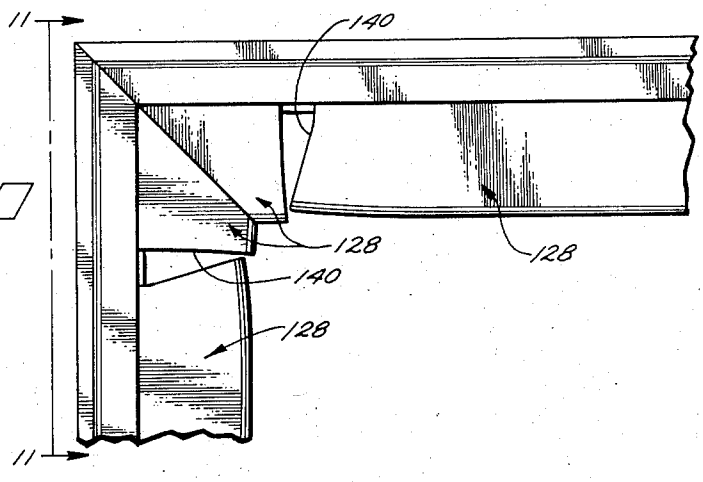


FIG. 10



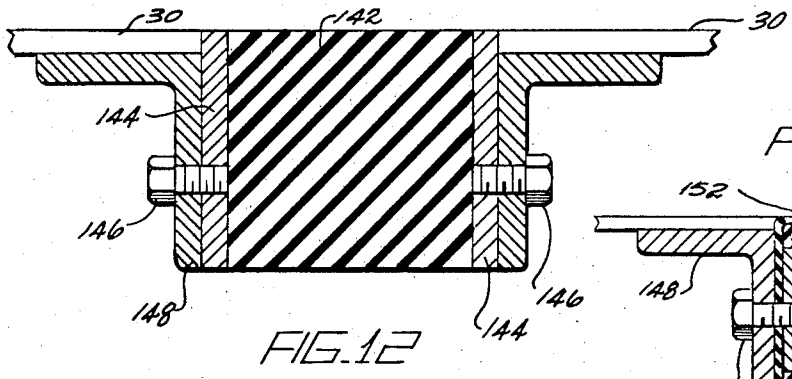


FIG. 12

FIG. 13

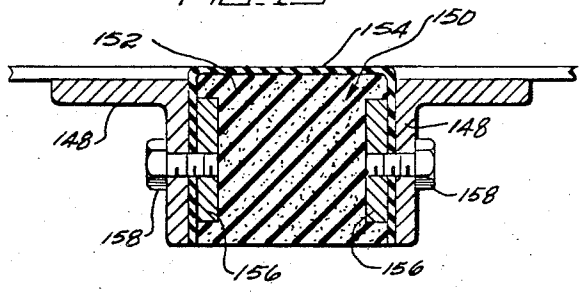
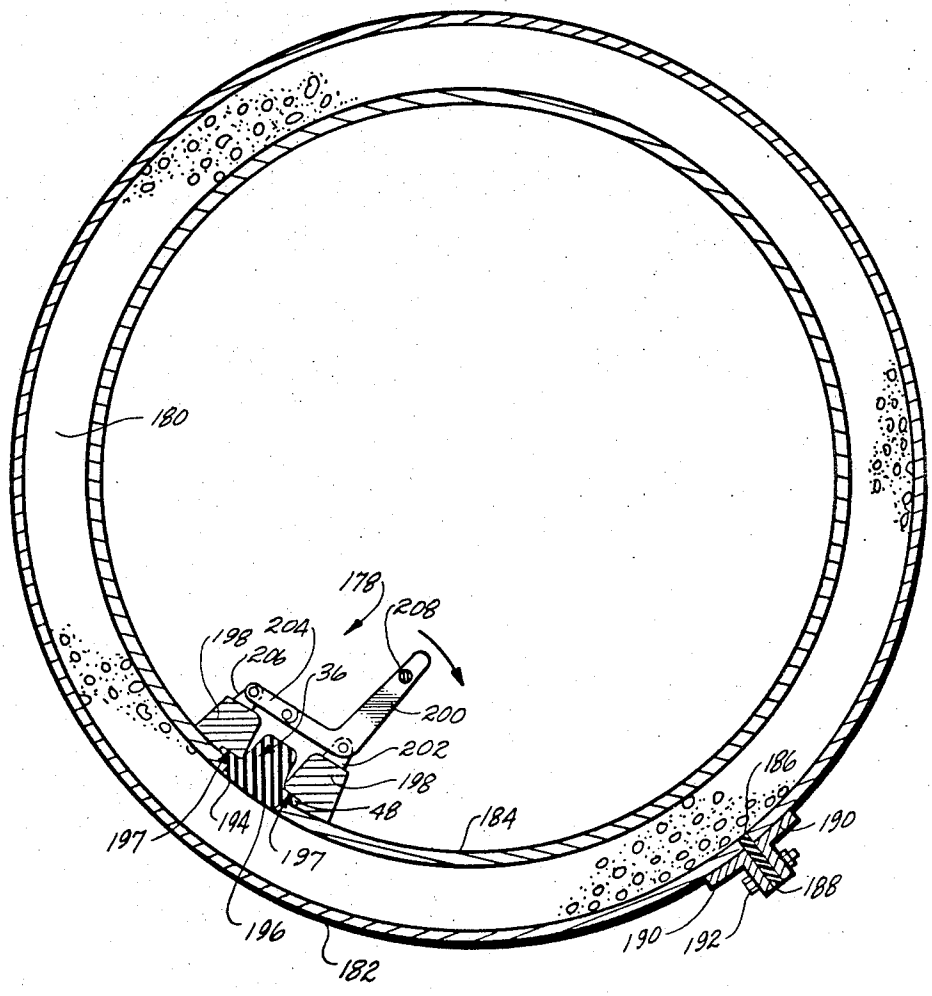


FIG. 15



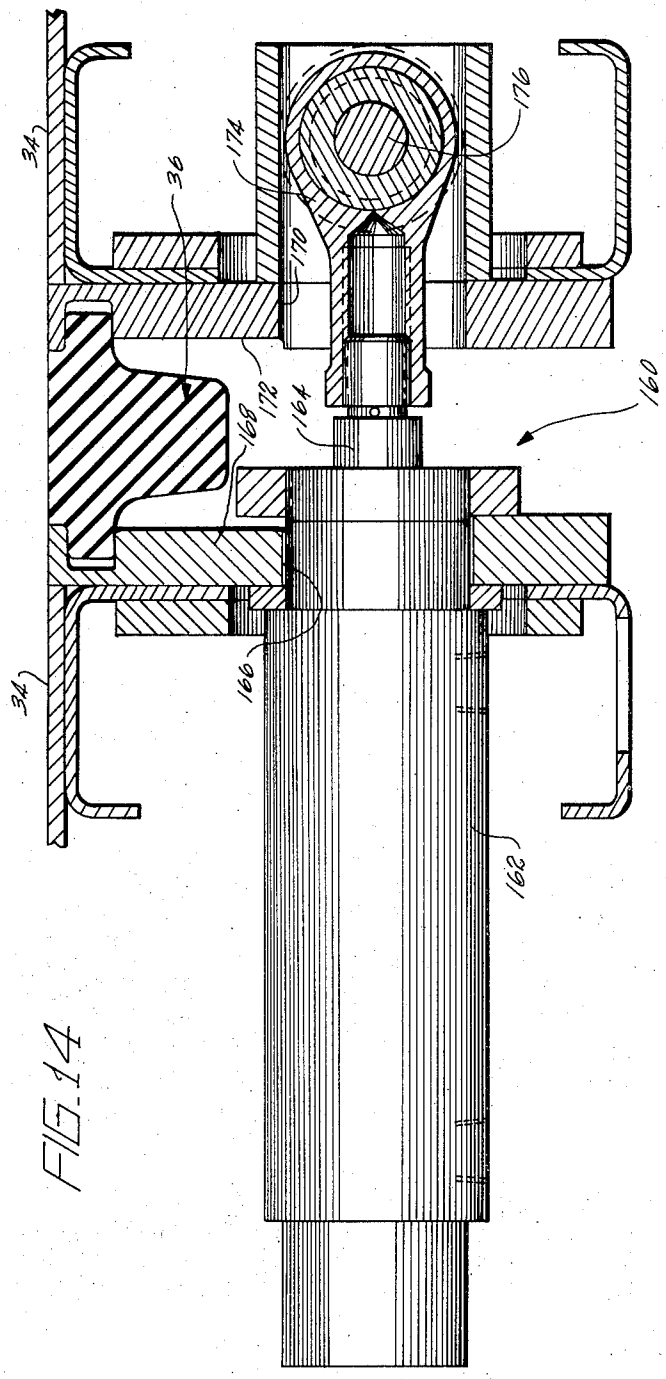


FIG. 14

RETRACTABLE CASTING CORE BOX WITH ELASTOMERIC JOINT SEAL

BACKGROUND OF THE INVENTION

This invention relates to the art of concrete casting, and more particularly to an improved retractable inner form or core for use in casting generally hollow concrete products.

In the art of casting generally hollow concrete products, wet concrete typically is poured over a wall-forming retractable core. An expandable outer form is disposed around the outer periphery of the core, and the natural force of gravity acts on the wet concrete to fill the space between the outer form and the core. After the concrete cures, the outer form is removed, and the walls of the core are retracted so the casting can be stripped from the core. Release and removal of the outer form is a relatively simple task, but considerable difficulty has been experienced in retracting the walls of the core and stripping the casting from the core.

Generally speaking, prior art casting cores include relatively complex retracting mechanisms for collapsing both sides and both ends of the core. Such retracting mechanisms are expensive, require a great deal of labor and time to operate, and generally require substantial maintenance costs.

The prior art casting cores generally include several retractable wall sections which interfit to form the inner wall surfaces of the core. Some prior art casting cores include retractable corner sections which interfit with separate retractable side and end wall sections. A chief disadvantage of these prior art devices is that wet concrete permeates the joints between the interfitting wall sections. The concrete hardens in the joints as the casting cures. This makes it difficult to remove the core from the casting and to clean the core afterwards. Moreover, the joints create irregularities in the interior surface of the casting, which requires considerable hand grinding or filling with grout to produce a smooth cast product.

SUMMARY OF THE INVENTION

This invention provides a retractable casting core which is relatively simple in construction and operation, and has low production and maintenance costs.

Briefly, the retractable core includes wall-forming means having an outer surface shaped to define the contour of the hollowed interior of a concrete casting. The wall-forming means includes movable wall sections arranged to form a hollowed interior. A compressible elastomer seals the space between the wall sections. The hollowed interior of the core houses retracting means connected to each wall section. The wall retracting means are operative to apply a force on each wall section in a direction to move the wall section so as to compress the joint seal and allow the wall sections to retract inwardly from the hollowed interior of the concrete casting. The casting can then be lifted over the core.

The elastomeric seal avoids the prior art use of complicated mechanisms to retract interfitting wall panel sections. The wall sections of the this invention are retracted simultaneously by a simple retracting mechanism of suitable design. Moreover, the joint seal provides an impervious barrier to fluidous concrete which contacts the core, the eliminates the problem of such concrete permeating joints between wall sections of the core.

In a preferred form of the invention, the wall-forming means is shaped as a hollowed rectangular box to form a rectangular hollowed area in the casting. The box preferably has an opening in its bottom for access to its interior. The box is separated substantially symmetrically into four quadrants, and the lines of separation between quadrants are sealed by the compressible elastomer. A separate retracting arm is connected to the interior of each quadrant, and as the arms are retracted in unison toward the center of the box, the quadrants apply a substantially uniform compression force on the seal and thereby collapse substantially uniformly from the interior of the casting. Alternately, the retracting mechanism can be separate activators adapted to bridge certain parts of the seal and be retracted to squeeze the seal substantially uniformly throughout its length.

A preferred seal is configured so that pressure applied by the retracting walls of the core is directed at a point eccentric to the centroid of the seal to prevent the seal from bulging beyond the outer surfaces of the core. Thus, the seal offers no resistance to the concrete casting when the casting is removed from the core. This prevents the seal from being worn away and thereby forming irregularities in the inner wall of the cast product.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other aspects of the invention will be more fully understood by referring to the following detailed description and the accompanying drawings, in which:

FIG. **1** is a schematic elevation view showing a retractable casting core during casting operations;

FIG. **2** is a schematic perspective view showing the casting core and an elastomeric seal between wall sections of the core;

FIG. **3** is a sectional plan elevation view taken on line **3—3** of FIG. **2**;

FIG. **4** is a fragmentary sectional elevation view taken on line **4—4** of FIG. **2**;

FIG. **5** is a fragmentary schematic sectional elevation view showing the cross-sectional shape of the elastomeric seal prior to retraction of the wall sections of the core;

FIG. **6** is a fragmentary schematic sectional elevation view showing the seal of FIG. **5** at an intermediate stage of the retracting operation;

FIG. **7** is a fragmentary schematic sectional elevation view showing the joint seal of FIG. **5** at a final stage of the retracting operation;

FIG. **8** is a fragmentary elevation view, partly in section, showing the configuration of the elastomeric seal at a corner of the core prior to retraction of the wall sections of the core;

FIG. **9** is a fragmentary elevation view taken on line **9—9** of FIG. **8**;

FIG. **10** is a fragmentary elevation view, partly in section, showing the corner section of the seal of FIG. **8** at a final stage of the retracting operation;

FIG. **11** is a fragmentary elevation view taken on line **11—11** of FIG. **10**;

FIG. **12** is a sectional elevation view showing an alternate embodiment of a compressible joint seal;

FIG. **13** is a sectional elevation view showing a further alternate embodiment of a compressible joint seal;

FIG. 14 is a fragmentary plan elevation view, partly in section, showing alternate retracting means in the case of FIG. 1; and

FIG. 15 is a sectional elevation view showing an alternate retractable casting core for use in making concrete pipe.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIGS. 1 and 2, a concrete mold assembly 12 forms a generally hollow pre-cast concrete product 13. A presently preferred use of mold assembly 12 is in the manufacture of pre-cast modular building units, such as steel reinforced concrete rooms for use in construction of multi-story dwelling units, such as hotels, town houses, and apartments. However, the invention can be applied to the manufacture of a variety of other cast concrete products, particularly generally hollow products of rectangular configuration, such as septic tanks, burial vaults, and the like.

The present invention is directed to a generally rectangular retractable casting core 14 which forms the hollowed interior of casting 13. The core is supported on a set of upright supports arms 16 which are made of resilient spring steel to allow them to deflect slightly, as described in detail below.

A horizontally disposed pallet 18 spans the outer perimeter of the core at a level continuous with the base of the core. The pallet is supported on upright piers 20.

The outer perimeter of the pallet is enclosed by an expandable outer form which includes a pair of opposed upright end wall sections 20 spaced from the end walls of the core, and a pair of opposed side wall sections (not shown in FIG. 2 for clarity) spaced from the side walls of the core. The ends of the side wall sections are joined with the ends of end wall sections 20 so the outer form provides a rectangular, hollow, box-like wall-forming apparatus which encompasses the outer perimeter of the pallet.

The outer form and the core combine to form a rectangular mold into which wet concrete is poured to form concrete product 13. After the concrete cures, the outer form is removed from the casting. Each end wall section 20 is mounted on an upright support 24 which facilitates movement of the end wall section from the casting. The side wall sections of the outer form are mounted on identical movable upright supports (not shown for clarity).

After removal of the outer form, the casting is stripped from the core. In accordance with the present invention, core 14 is retracted and the concrete casting is then lifted over the core.

Construction of core 14 is understood best by referring to FIGS. 2, 3, and 4. The core comprises a generally rectangular box having an opening 26 in its bottom to allow access to its interior. The end walls and side walls of the box are each divided in half, and the top of the box is divided into four equal parts, with the lines of separation dividing the box symmetrically into four equal quadrants 28. Each quadrant is a separate wall-forming corner section having a separate end wall section 30, side wall section 32, and top panel section 34.

Each quadrant is mounted on a separate set of the support arms 16.

The space between quadrants is sealed by a narrow compressible elastomeric joint seal 36. The joint seal follows the lines of separation of the box. Thus, it is X-shaped when the box is viewed in plan view, and it follows the vertical centerline of each side wall and end wall of the box.

The bottom of each side wall and end wall has a separate horizontally disposed ridge 40 projecting into the interior of the box to define a marginal lip which encompasses the lower interior portion of the box. The lip defines the substantially elliptical-shaped perimeter of opening 26. Each ridge 40 is separated from its adjacent ridges to allow room for each quadrant to move relative to the others. A pair of holes 42 extend through the two end portions of each ridge, and a separate hole 44 extends through the corner portion of each ridge. The tops of support arms 16 extend through holes 42 and 44 to support the inner core in its operative position during casting of the concrete.

A separate marginal groove 46 is formed in each edge of each quadrant. Grooves of adjacent quadrants are disposed side-by-side and cooperate to hold the joint seal in place. As shown best in FIGS. 3 and 4, the seal has a pair of opposed outwardly projecting elongated shoulders 48 along its sides. The shoulders are fitted into corresponding grooves in each pair of adjacent quadrants. When the core is in its casting position (shown in FIGS. 3 and 4) in readiness for pouring of the concrete, the seal is maintained in a non-bulging condition, with its outer surface 50 flush with the outer surfaces of the quadrants.

The shoulders make a tight friction fit in their corresponding grooves. Prior to use of the core, the wall sections of the quadrants ae retracted inwardly toward the center of the core to an operating point at which a slight pre-compression force is constantly applied to the seal. FIGS. 3 and 4 show the seal at its operating point in readiness for pouring of the concrete. The seal is maintained in a non-bulging condition, with its outer surface 50 flush with the outer surfaces of the quadrants. The pre-compression force prevents the cement slurry from penetrating the area between the seal and the edge of each wall section.

In use, after the concrete casting 13 has cured, the walls of the core are retracted inwardly from the interior of the casting to allow the casting to be lifted over the core. The core is retracted by a retracting mechanism in the interior of the core. The retracting mechanism can take a variety of forms without departing from the scope of the invention. Preferably, the retracting mechanism applies a retracting force to the corner of each quadrant to compress joint seal 36 substantially uniformly along its entire length. Thus, each end wall section 30 and side wall section 32 of each quadrant moves inwardly a substantially uniform distance from corresponding interior walls of the casting. This allows the casting to be easily slipped over the top of the core.

Joint seal 36 is made of a non-porous, compressible elastomer, such as a synthetic rubber. The preferred elastomer is of 40 to 80 Shore A Durometer hardness, oil resistant neoprene. Such a material is rugged during use, and is thus able to withstand the constant compression and expansion to which it is subjected. It is also impervious to attach by the cement with which it comes in contact. Porous or sponge rubber is not desired, because it is not rugged, and the pores of such material become permeated with the cement slurry, which would cause the seal to eventually break down in use. The preferred non-porous hard rubber elastomer is

substantially volumetrically incompressible, i.e., the joint is resilient, or deformable, but its volume remains substantially constant when it is deformed. Thus, the joint bulges when compressed between the edges of the wall sections.

The cross-sectional configuration of the seal is such that a major portion of its mass is located inwardly of the axis on which pressure is applied by the adjacent wall sections. This configuration prevents outer surface **50** of the seal from bulging beyond the outer surfaces of the walls of the core when compressed. A bulging elastomer would be abraded away by the interior side walls of the concrete casting when it is lifted over the top of the inner core. Thus, the outer surface **50** of the elastomer soon would take a concave shape during subsequent molding operations with wet concrete. An inwardly projecting convex ridge would thus be formed in the center of all four inside walls of the casting, which would require considerable hand grinding to remove.

The remaining characteristics of the joint seal are described in detail below.

FIGS. **3** and **4** show a presently preferred retracting mechanism, which includes a vertically extending hydraulic cylinder **52** aligned with the vertical centerline of the interior of the core. A swivel-mounted upper spider **54** is at the top of the cylinder, and a swivel-mounted lower spider **56** is at the bottom of the cylinder. The upper and lower spiders are shown in their fully extended positions positioning the walls of the core in their operative positions in preparation for molding operations.

Upper spider **54** includes a pair of horizontally disposed and radially extending, elongated fixed retraction arms **58** extending to the corners of a pair of quadrants on one side of the inner core, and a second pair of horizontally disposed and radially extending elongated adjustable retraction arms **60** extending to the corners of the two quadrants on the other side of the core. Arms **58** and **60** are the same elevation. The outer ends of each arm **58, 60** carries a respective fixed yoke **62** which fits around a respective bracket **64** at the corner of each quadrant. Each yoke is secured to the bracket by a separate transverse pivot pin **66** so the outer ends of the retraction arms **58, 60** swivel about their respective brackets.

The inner end of each retraction arm **58, 60** carries a respective fixed yoke **68** which fits around a respective radially extending fixed bracket **70** rigidly secured to a fixed annular collar **72** at the top of hydraulic cylinder **52.** Each yoke **68** is secured to its corresponding bracket **70** by a respective transverse pivot pin **74,** so the inner end of each arm **58, 60** is able to pivot relative to its corresponding bracket.

The inner and outer ends of each adjustable arm **60** have corresponding externally threaded shank portions **76, 78,** respectively. The outer end of each shank threads into a corresponding internally threaded portion of outer yoke **62,** and the inner end of each shank threads into a corresponding portion of inner yoke **68.** Thus, the effective length of retraction arms **60** is adjustable, which enables the retraction arms of the upper spider to be set at the same effective length as those of the lower spider, and provides means for adjusting the amount of pre-compression force of the joint seal. Moreover, the adjustment facilitates mounting of the upper spider in the interior of the core.

Hydraulic cylinder **52** includes a vertically extending and contractable piston arm **80** at its top. A fitting **82** rigidly coupled to piston arm **80** carries collar **72.** Thus, extension of piston arm **80** drives the collar up, which causes retraction arms **58, 60** to swivel at their ends and move upwardly to the diagonal position shown in phantom lines in FIG. **4.**

The hydraulic cylinder is suspended within the core by a pair of upwardly extending chains **84** reeved over corresponding horizontally disposed drums **86** mounted in the upper interior portion of the core. The chains extend downwardly from the drums to a point where they are fixed to hold the cylinder at an elevation which maintains arms **58, 60** in a substantially horizontal position during casting operations. A single chain **88** extends downwardly from the bottom of the cylinder **52** to a point where it is fixed so as to maintain the cylinder in a fixed position in the interior of the core.

Lower spider **56** includes a pair of radially extending and horizontally disposed fixed retraction arms **90** secured to corners of a pair of quadrants, and a pair of radially extending and horizontally disposed adjustable retraction arms **92** secured to corners of the other pair of quadrants. Fixed arms **90** are identical in construction to those of upper spider **54.** Their outer ends are pivotally mounted to separate brackets **94** secured to the corners of the quadrants. The inner ends of fixed arms **90** are mounted to swivel about a radially extending bracket **96** fixed to the bottom of hydraulic cylinder **52.**

Adjustable arms **92** are identical in construction to those of upper spider **54.** Their outer ends are pivotally mounted to separate brackets **98** secured to the corners of the quadrants. The inner ends of the adjustable arms are mounted to swivel about separate radially extending brackets **100** fixed to the bottom of cylinder **52.** The inner and outer ends of adjustable arms **92** have corresponding externally threaded shank portions **102, 104,** respectively, to facilitate adjustment of the arms.

The lower spider also includes four radially extending and horizontally disposed orthogonal retraction arms **105** extending outwardly in mutually perpendicular directions from the bottom of cylinder **52.** Orthogonal retraction arms **105** are located immediately above retarction arms **90, 92.** The ends of the orthogonal retraction arms bridge the four joints in the outer walls of the quadrant to provide stiffness for the bottom of the core. The inner end of each arm **105** includes a yoke **106** fitted around a respective radially extending fixed bracket **107** secured to the lower portion of cylinder **52.** Each yoke is secured to the bracket by a separate transverse pivot pin **108** so the inner ends of arms **102** can swivel about their respective brackets. Each yoke **106** has a separate externally threaded shank portion **110** threaded into an internally threaded portion in the inner end of the arm to facilitate adjustment of the effective length of the arms.

The outer end of each arm **105** is fitted between a corresponding pair of inwardly projecting brackets **112.** The pair of bracekts associated with each arm are rigidly fixed to the interior walls of an adjacent pair of the quadrants. A separate transverse pivot pin **114** pivotally mounts the outer end of each arm between its corresponding brackets.

The joints at the bottom of the core are stiffened by separate stiffening assemblies **116.** Each stiffening assembly includes a pair of brackets **118** rigidly secured

to opposite sides of the joint formed betweeen the outer edges of adjacent quadrants. Each bracket mounts a separate horizontally extending, cylindrical fitting **120** having an internally threaded bore extending through it. The bores of each adjacent pair of fittings are concentrically aligned, and an elongated externally threaded shaft **122** extends through the aligned bores. A separate nut **124** is threaded onto each end of shaft **122.** The nuts are tightened to apply the desired amount of compression force.

In using the retractable inner core, the hoisting chains **84** are initially adjusted to fix the elevation of the hydraulic cylinder so that the arms of the upper and lower spiders are in a horizontal plane (as shown in FIG. **4**) in readiness for casting operations. The bottom chain **88** is fixed to hold the hydraulic cylinder in a fixed vertical position.

After the casting has cured, and the outer form is removed, the inner form is retracted by initially pressurizing hydraulic cylinder **52.** This causes the piston arm **80** to extend upwardly, and also causes a lower portion of the cylinder to move downwardly. This movement of the cylinder drives arms **58, 60** of the upper spider upwardly to the position shown in phantom lines in FIG. **4,** and also drives arms **90, 92, 102** of the lower spider downwardly to the position shown in phantom lines in FIG. **4.** This movement of the hydraulic cylinder shortens the effective length of the upper and lower spiders to pull the side and end walls of the core inwardly. The entire length of the elastomeric joint seal is squeezed substantially uniformly as the walls of the core are retracted, so that all walls of the core are retracted substantially the same distance. A 1-inch stroke of the hydraulic cylinder pulls the walls inwardly about 5/8ths of an inch, which is sufficient to allow the casting the clear the outer walls of the core when lifted over the core.

The major portion of the body of the joint seal bulges toward the interior of the core during retraction of the side walls, and its outer surface **50** moves inwardly to a slight concave curvature. Thus, the seal is not abraded away when castings are lifted over the core.

After the casting is removed, the piston arm of the hydraulic cylinder is contracted to move the arms of the upper and lower spiders to their initial horizontal positions. This moves the outer walls of the core back to their operative positions in readiness for the next casting operation.

Referring to FIGS. **5** through **7,** the geometric cross-sectional configuration of the preferred joint seal **36** prevents the seal from bulging beyond the exterior of the wall sections when the seal is squeezed by the wall sections. The cross-sectional configuration of the seal includes a minor portion **126** which is confined between pressure-applying edges of the wall sections, and a major portion **128** which protrudes toward the interior of the core and therefore away from the inner wall of casting **12.**

The confined minor portion **126** has opposed short outer edges **130** which project away from shoulders **48** and intersect the non-bulging outer surface **50** at the corners of the seal. Edges **130** are compressed between corresponding pressure-applying edges **132** of the wall sections. The minor portion **126** also includes shoulders **48,** which are disposed in the pressure-applying grooves **46** of the wall sections, and the portion of the seal between the shoulders.

The protruding major portion **128** has outer edges **134** which are spaced from corresponding adjacent non-pressure-applying edges **136** of the wall sections. The spacing between edges **134** and wall section edges **136** is such that even when the seal is compressed to its maximum amount, as shown in FIG. **7,** edges **134** of the seal are substantially prevented from contacting edges **136** of the wall sections. The purpose of this result is described in detail below.

FIGS. **5** through **7** show schematic views of the cross-sectional area of the joint seal, in which grid lines **138** on the seal illustrate the flow characteristics of the rubber in the seal when the seal is compressed from its initial casting position (FIG. **5**), through an intermediate position (FIG. **6**), to a final stage (FIG. **7**) in which maximum pressure is applied to the seal by the wall sections. When the wall sections are retracted, they apply pressure at a point eccentric to the centroid of the seal. The eccentric loading is on the side of the centroid occupied by concrete casting **12,** and this eccentric loading causes the rubber in the seal to flow toward the protruding major portion **128** of the seal. This prevents the seal from bulging beyond the plane of the outer surfaces of quadrants **28.** Grid lines **138** become distorted when the seal is compressed, and thereby illustrate these flow characteristics of the rubber in the seal.

When eccentric loading is applied, a non-uniform internal pressure distribution builds up in the seal. The rubber in the confined minor portion of the seal experiences a relatively high pressure build-up during such loading. The rubber in the protruding major portion **128** of the seal is a freely flowable mass, and the internal pressure build-up in this area is relatively low during loading. Thus, the rubber in minor portion **32** flows to the low pressure zone of the seal during loading. The distorted grid lines show how this mass flow takes place. The rubber in the confined high pressure area of the seal must flow somewhere when loading is applied, and the eccentric loading directs the flow of rubber in the confined pressure receiving area toward the protruding low pressure area of the seal. Since the latter portion of the seal is a freely flowable mass, it is capable of accepting the mass of rubber flowing from the eccentrically loaded area of the seal. Thus, as the minor portion **126** becomes progressively squeezed between the pressure-applying edges of the wall sections, the protruding portion of the seal progressively expands in size to accommodate the mass flow from the squeezed portion of the seal.

Thus, the eccentric loading of the seal induces flow away from the inner walls of the concrete casting **12,** and therefore prevents outer surface **50** of the seal from bulging beyond the outer surfaces of the wall sections of the core.

As explained previously, the protruding major portion of the seal is shaped so its edges are prevented from coming into contact with the adjacent inner edges of the wall sections when the wall sections are retracted their maximum amount (shown in FIG. **7**). If the walls come in contact with protruding portion **128,** internal pressure will build up in the protruding major portion, which would then inpair its free flow characteristics. This would prevent the protruding portion from freely accommodating the rubber flowing from the pressure-receiving minor portion, and could cause at least a portion of outer surface **50** to bulge beyond the plane of the wall sections.

When the seal is squeezed between the wall sections, protruding portion **128** expands volumetrically. Thus, lengthwise expansion of this portion of the seal must be accommodated at the corners of the inner core. FIGS. **8** through **11** show a preferred method of accommodating lengthwise expansion. A pair of slotted areas **140** are formed in protruding portion **128** near the corners of the core.

As shown best in FIG. **10,** lengthwise expansion of protruding major portions **128** fills the spaces provided by slotted areas **140.** This prevents internal pressure build-up in the protruding portion of the seal, and thereby maintains the free flow characteristics of the seal to prevent the seal from bulging beyond the plane of the wall sections.

While the construction of the seal shown and described above is a preferred one, we contemplate that, alternately, compressible joint seals of other shapes and composition can be used in place of seal **36** without departing from the scope of the invention. FIG. **12** shows an alternate joint seal **142** which is rectangular in cross-section, and made of a compressible elastomer such as neoprene. A separate elongated metal attaching strip **144** is bonded to each side of the seal. The attaching strips are tapped for screws **146** for use in securing the attaching strips to corresponding L-shaped brackets **148** on opposite sides of the space between wall sections.

FIG. **13** shows a compressible seal **150** which is retangular in cross-section, and includes a major portion **152** of sponge rubber, with a peripheral strip **154** of sheet rubber covering the outer surface and both sides of major portion **52.** Preferably, the sheet rubber strip is made of relatively hard neoprene. The sides of the sponge rubber portion are recessed to receive opposed metal attaching strips **156** which are tapped for screws **158** for use in securing the attaching strips to brackets **148.**

In use, both seal **142** and seal **150** bulge beyond the outer surfaces of the adjacent wall sections during compression, but in many applications, such as in the casting of concrete vaults or the like, such bulging may not be undesirable. Moreover, each seal is relatively easily replaceable, and therefore new seals can be substituted whenever abrasion becomes excessive.

It is contemplated that, alternately, a variety of retracting means may be used to retract the wall sections of the core without departing from the scope of the invention. As described above, it is preferred to retract the walls of the casting core by pulling inwardly on the corner of each quadrant. The retracting mechanism shown in FIGS. **3** and **4** can be modified, for example, by connecting the upper and lower spiders to a rigid centrally disposed vertical rod (not shown), and then twisting the rod on its axis by retracting suitably positioned hydraulic cylinders (not shown) coupled to the rod so the spiders pull the walls of the core inwardly and compress the seal.

FIG. **14** shows an alternate retracting device **160** to be used for retracting the walls of casting core **14.** The retracting device shown in FIG. **14** extends across a portion of the seal at the joint between two adjacent top panels **34** of the core. Retracting device **160** includes a hydraulic cylinder **162** with a retractable piston arm **164** bridging a portion of seal **36** inside the core. The hydraulic cylinder is rigidly secured to one side of the seal, preferably by threading it into an internally threaded bore **166** in an elongated gate member **168** extending along one side of the space between adjacent wall sections. The end of the piston arm extends through an opening **170** in a gate member **172** on the other wall section, and is coupled to a fitting **174** joined to an elongated fixed rod **176** extending the length of the seal.

Preferably, several such retracting devices bridge the bottom, top, and intermediate portions of each vertical leg of the seal shown in FIG. **2,** and several such retracting devices also bridge inner and outer portions of each horizontal leg of the seal shown in FIG. **2.** All hydraulic cylinders are suitably coupled to a central hydraulic system (not shown), and the walls of the core are retracted by pressurizing the cylinders in unison to retract their respective piston arms, and thereby compress the seal substantially uniformly along each of its vertical and horizontal legs.

While the rectangular casting core **14** described above is a preferred use of the present invention, we contemplate that other retractable casting forms can be used in accordance with the present invention. For example, FIG. **15** shows a mold assembly **178** used in the vertical method of making a concrete pipe **180.** The mold assembly includes a vertically disposed, cylindrical outer form or shell **182,** and a cylindrical inner form or core **184** disposed concentrically inside the outer form. Outer form **182** has a longitudinal split **186,** and the split is sealed by a suitable elastomeric seal **188** disposed between opposed L-shaped flanges **190** rigidly secured to opposite sides of the split. The flanges are releasably secured together along the length of the split by suitable longitudinally spaced apart fastening means, such as bolts **192.**

The inner form has a longitudinal split **194** which is sealed by elastomeric joint seal **36.** Preferably, seal **36** has an arcuately curved outer surface **196** which is continuous with the circumference of the outer surface of the inner form. Shoulders **48** of the seal are seated in longitudinally extending opposed slots **197** formed between the interior wall of the inner form adjacent the split and opposed recessed portions of a pair of gate members **198** extending the length of the inner form along both sides of the split.

The inner form is retracted by a suitable retracting mechanism which bridges gate members **198.** By way of example, FIG. **15** shows a retracting mechanism which includes an L-shaped crank arm **200,** the corner of which is pivotally secured to an apertured lug **202** rigidly secured to one gate member, and a lever arm **204** having one end pivotally secured to a lug **206** on the other gate member. The other end of lever arm **204** is pivotally secured to the crank arm leg which bridges the seal. Preferably, several such retracting mechanisms are spaced apart along the length of the seal. An elongated rod **208** extending the length of the form is welded to the free end of each crank arm and in use, the rod is rotated, by suitable drive means (not shown), in the direction of the arrow in FIG. **15** to pivot the crank arms, and move the gate members toward each other to compress the seal and thereby retract the inner form.

I claim:

1. A retractable casting core for use with an outer form in the casting of generally hollow concrete products, the casting core comprising wall-forming means in the form of a hollowed rectangular box having an outer

mold surface which forms the contour of a hollowed interior of a concrete casting, the outer mold surface of the wall-forming means being separated into wall sections cooperating with each other to form the contour of the concrete casting interior, the wall-forming means having one open end for access to a hollowed interior portion of the retractable casting core, the box being spearated substantially symmetrically into four quadrants with a compressible elastomeric joint seal being disposed along each line of separation between the quadrants, and means in the hollowed interior portion of the casting core for applying a force to retract each of the wall sections inwardly away from the interior of the casting, the wall retracting means directing a component of its retracting force in a direction transverse to the joint seal which borders each wall section to compress the seal to allow the wall sections to move toward each other as they move inwardly from the interior of the casting, the retracting means also directing a component of its retracting force in a direction eccentric of the centroid of the seal such that the seal is substantially prevented from bulging beyond the outer surface of the wall sections.

2. Apparatus according to claim **1** in which the elastomeric seal is made of a non-porous elastomer.

3. Apparatus according to claim **1** in which the elastomeric seal is substantially volumetrically incompressible.

4. Apparatus according to claim **1** in which the wall retracting means comprises at least one elongated retraction arm connection to each quadrant, and means for retracting each retraction arm.

5. Apparatus according to claim **1** in which each quadrant includes an upstanding end wall, an upstanding side wall which meets the end wall to form an upright corner of the box, and a top panel above the side wall and end wall.

6. Apparatus according to claim **5** in which each wall retracting means comprises a separate elongated retraction arm connected to the upright corner of each quadrant, and means for retracting each arm.

7. Apparatus according to claim **5** in which the retraction arms comprise a spider arrangement crossing at the central axis of the interior of the box, each arm being mounted to swivel about a horizontal axis, and in which the retraction arms are located in the upper interior portion of the box, and a second set of retraction arms, each of which arms is connected to an upright corner of a respective quadrant, the arms in the second set being in a spider arrangement so that they cross at the central axis of the interior of the box, and are disposed in the lower interior portion of the box, and including an extendable and contractable, vertically extending arm disposed on the central axis of the interior of the box and connected between the first and second sets of spiders, whereby extension and contraction of the vertical arm pulls the upper and lower spiders inwardly to retract the quadrants of the inner core.

8. Apparatus according to claim **1** in which each wall section is mounted on a separate set of elongated movable supports.

9. A retractable casting core for use with an outer form in the casting of generally hollow concrete products, the casting core comprising wall-forming means having an outer surface for forming the contour of a hollowed three-dimensional interior of a concrete casting, the wall-forming means having a side portion which forms a closed mold surface and is defined by intersecting first and second planes, and a top portion forming a mold surface which is integral with the side portion and is defined by a third plane which intersects the first and second planes so the combined side portion and top portion of the wall-forming means provide a continuous three-dimensional mold surface, the top and side portions being separated into wall sections cooperating with each other to form the contour of the concrete casting interior, the wall sections cooperating to form a hollowed interior area of the retractable casting core, a compressible elastomeric joint seal between the wall sections, and means in the hollowed interior area of the casting core for applying a force to retract each of the wall sections inwardly away from the interior of the concrete casting, the wall retracting means directing a component of its retracting force in a direction transverse to the joint seal which borders each wall section to compress the seal to allow the wall sections to move toward each other as they move inwardly from the interior of the casting.

10. Apparatus according to claim **9** in which the wall-forming means is shaped as a hollowed rectangular box, with one open end for access to a hollow interior of the box, and in which the box is separated substantially symmetrically into four quadrants, the joint seal being aligned with each line of separation between the quadrants.

11. Apparatus according to claim **10** in which the wall retracting means comprises at least one elongated retraction arm connected to each quadrant, and means for retracting each retraction arm.

12. Apparatus according to claim **10** in which the wall-forming means is engaged with the joint seal to direct a component of its retracting force in a direction eccentric to the centroid of the seal such that the seal is substantially prevented from bulging beyond the outer surface of the quadrants.

13. A retractable casting core for use with an outer form in a concrete mold assembly, the retractable casting core comprising wall-forming means for providing an outer surface to form the contour of a hollowed three-dimensional interior of a concrete casting, the wall-forming means being divided into a plurality of separate wall sections having cooperating outer surfaces which form the three-dimensional contour of the concrete casting interior, the wall sections cooperating to form a hollowed interior portion of the casting core, the separate wall sections being spaced apart from one another to define a plurality of lines of separation spaced around the wall-forming means, a compressible elastomeric joint seal disposed in the lines of separation between the separate wall sections, and means in the hollowed interior portion of the casting core for applying a retracting force to the wall sections to move each wall section relative to the other wall sections inwardly toward the interior of the casting core and away from the casting, the wall retracting means directing a component of its retracting force in a direction transverse to the joint seal in each lines of separation between the wall sections to compress the joint seal to allow the wall sections to move toward each other as they move inwardly from the interior of the casting.

14. Apparatus according to claim **13** in which the retracting means also directs the component of its retracting force eccentric to the centroid of the seal such

that the seal is substantially prevented from bulging beyond the outer surface of the wall sections.

15. Apparatus according to claim **13** in which the wall sections are symmetrically arranged around the retractable casting core, and in which the retracting means retract the wall sections in unison.

16. Apparatus according to claim **15** in which at least one elongated retracting arm is connected to each wall section, and including means for retracting the retracting arms in unison.

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