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(19) **United States**(12) **Patent Application Publication**
Kirchmer et al.(10) **Pub. No.: US 2007/0187522 A1**(43) **Pub. Date: Aug. 16, 2007**(54) **COMPOSITE RAILROAD TIE AND METHOD OF MANUFACTURE**

(60) Provisional application No. 60/516,697, filed on Nov. 3, 2003.

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Robert Kirchmer, Broken Arrow, OK (US); **Eugene McIntosh**, Tempe, AZ (US)**Publication Classification**(51) **Int. Cl.**
E01B 21/04 (2006.01)(52) **U.S. Cl.** **238/84**

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GABLE & GOTWALS**100 WEST FIFTH STREET, 10TH FLOOR**
TULSA, OK 74103 (US)(57) **ABSTRACT**(21) Appl. No.: **11/402,500**(22) Filed: **Apr. 12, 2006****Related U.S. Application Data**

(63) Continuation-in-part of application No. 11/114,620, filed on Apr. 26, 2005, which is a continuation-in-part of application No. 10/837,978, filed on May 3, 2004.

An improved mold and method of manufacture for an improved railroad tie or other structural member. The improved railroad tie or structural member being fabricated using an injection molding process with various thermoplastic resins and fillers. The improved mold used has a cooling cavity which helps cool the structural member while still in the mold. The improved insert allows an automated molding system to be used for greater production rates.

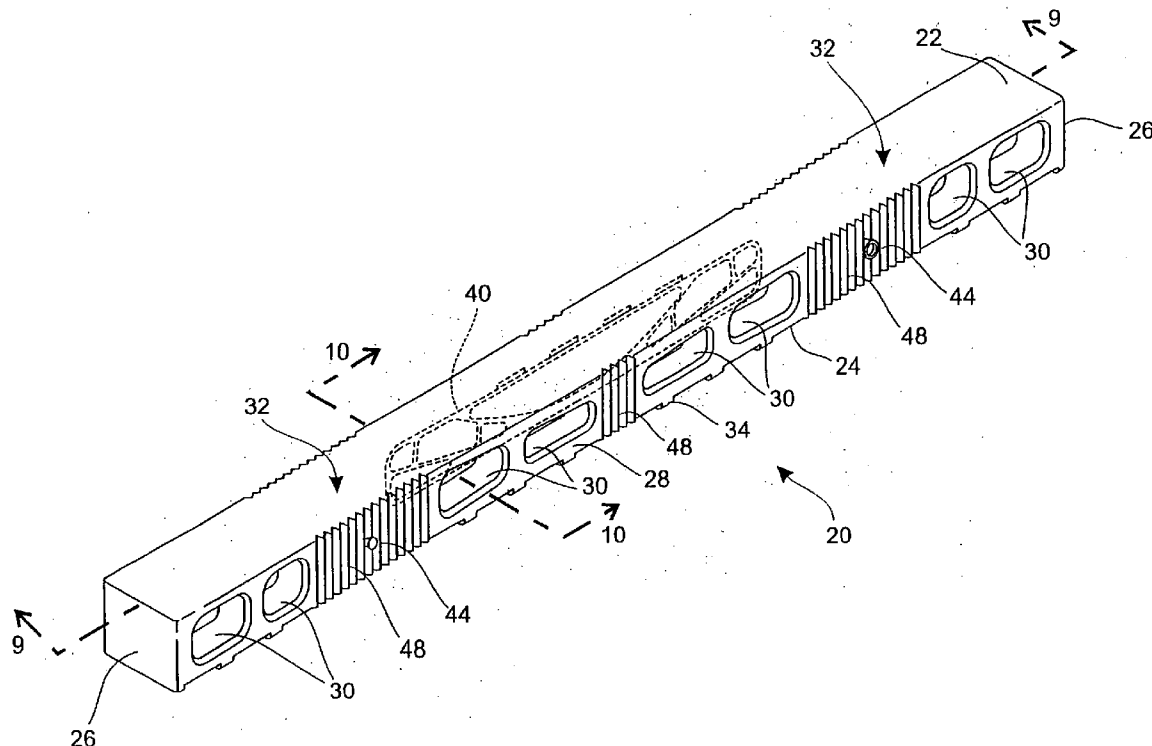


FIG. 1

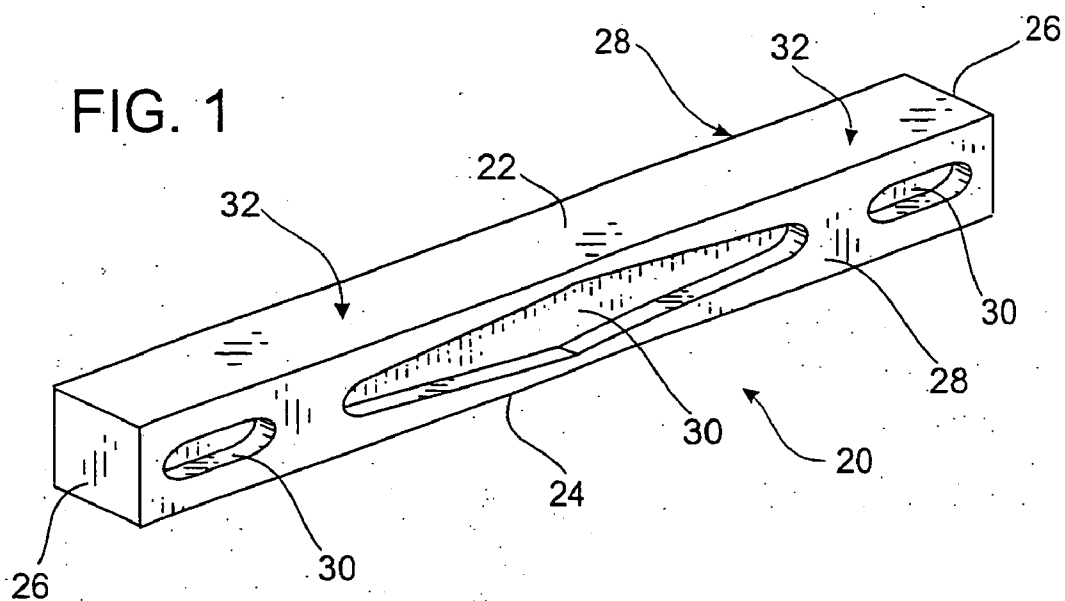


FIG. 2

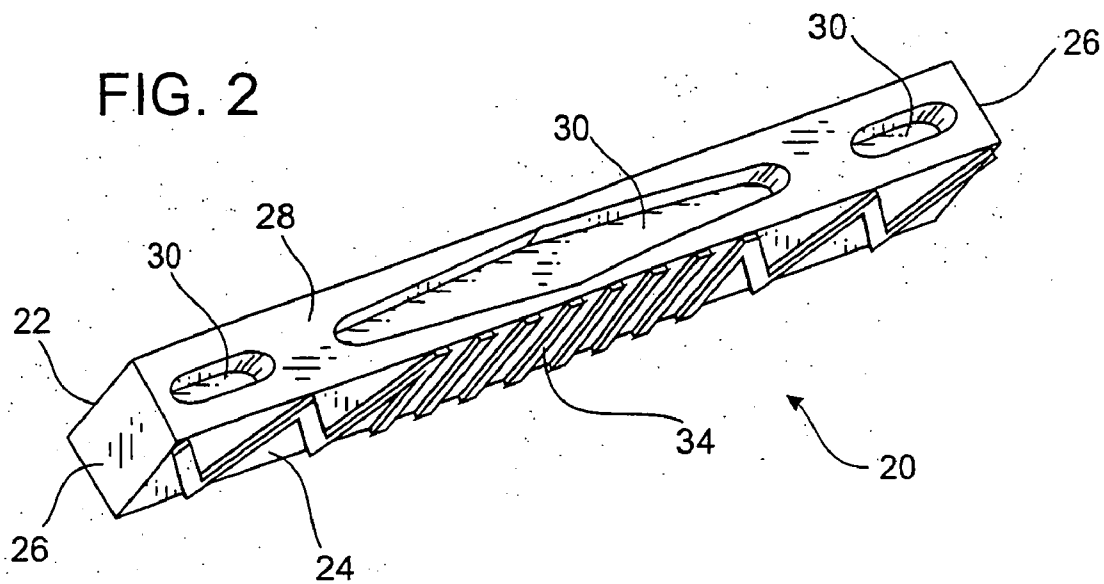


FIG. 3

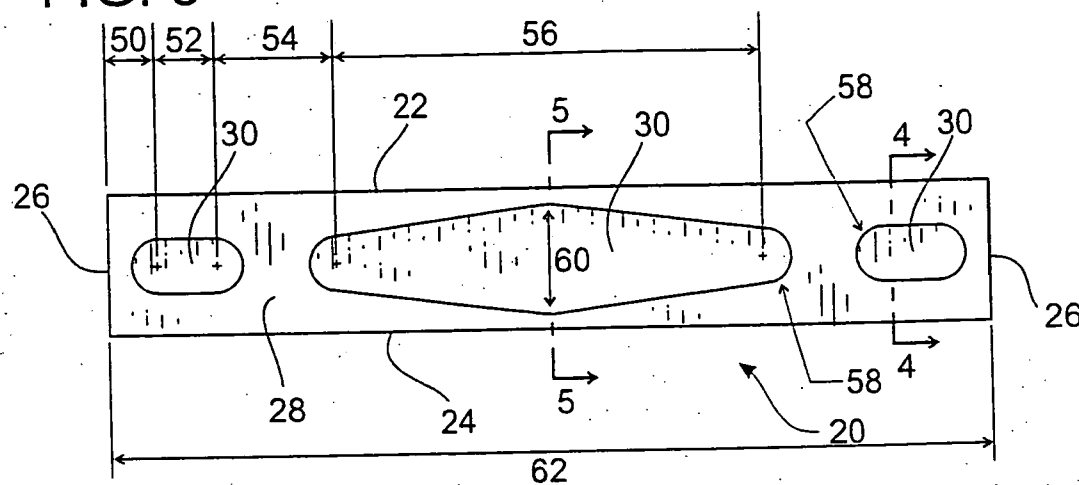


FIG. 4

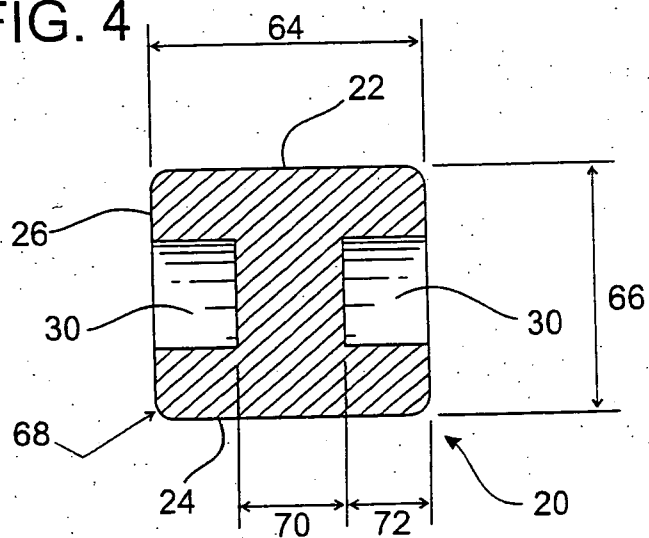
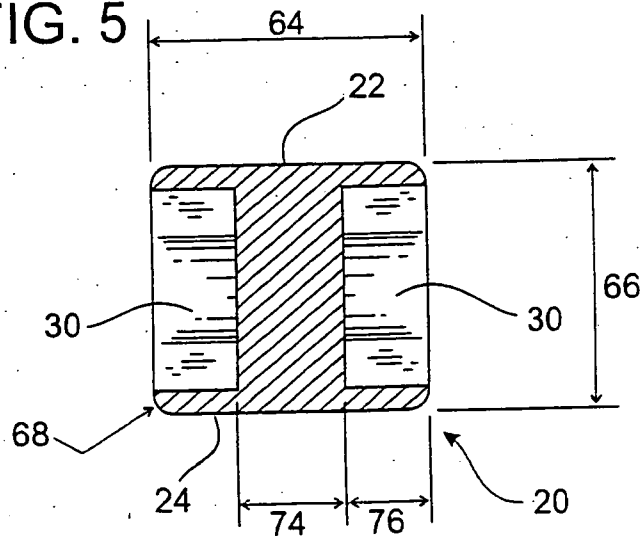
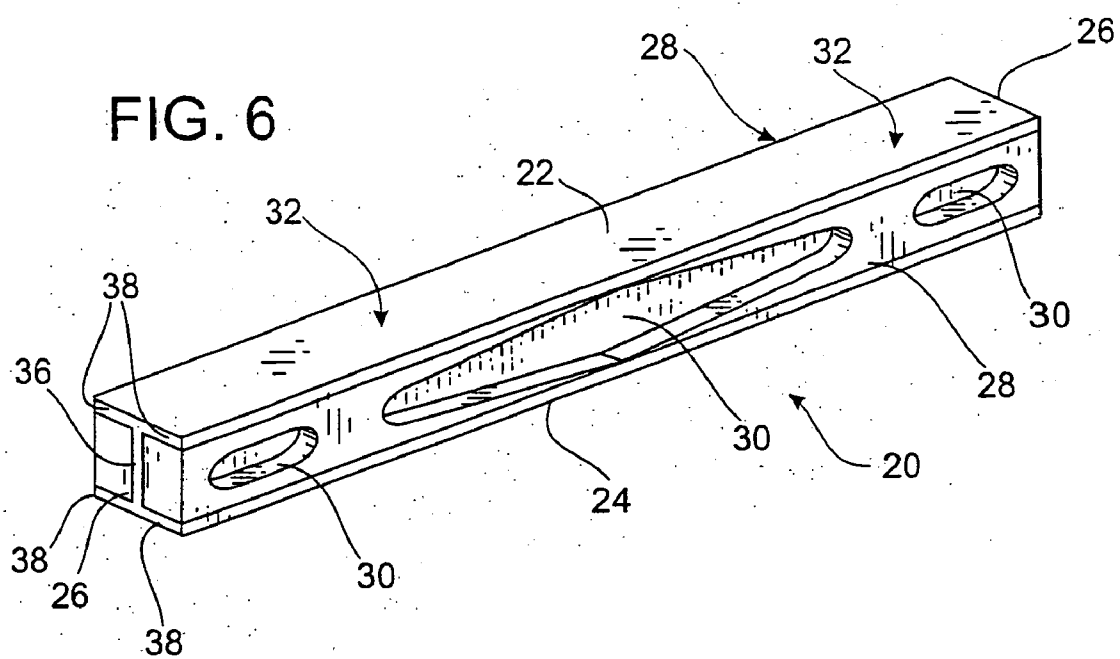
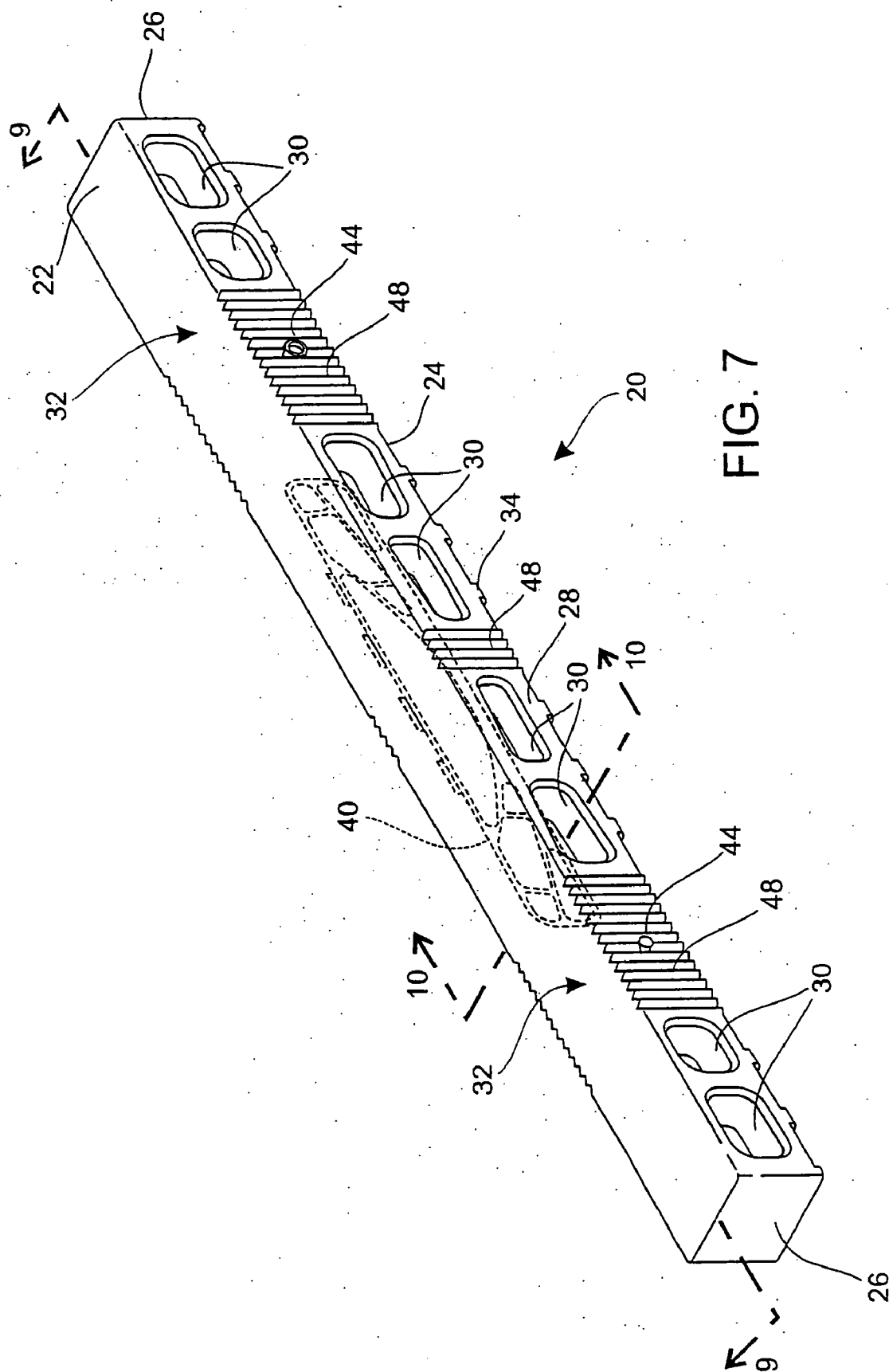
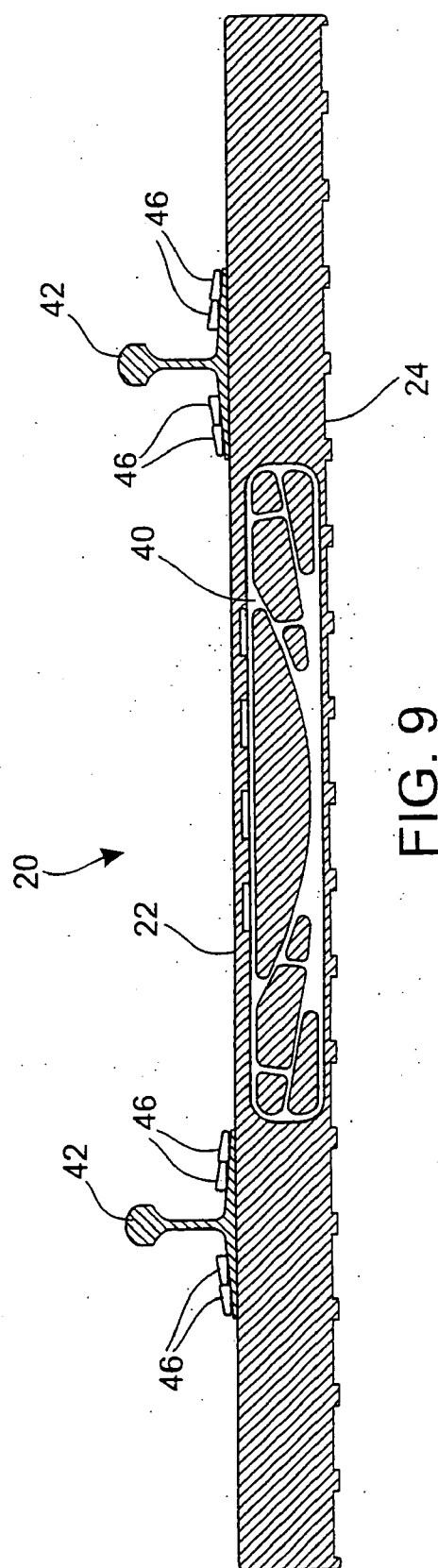
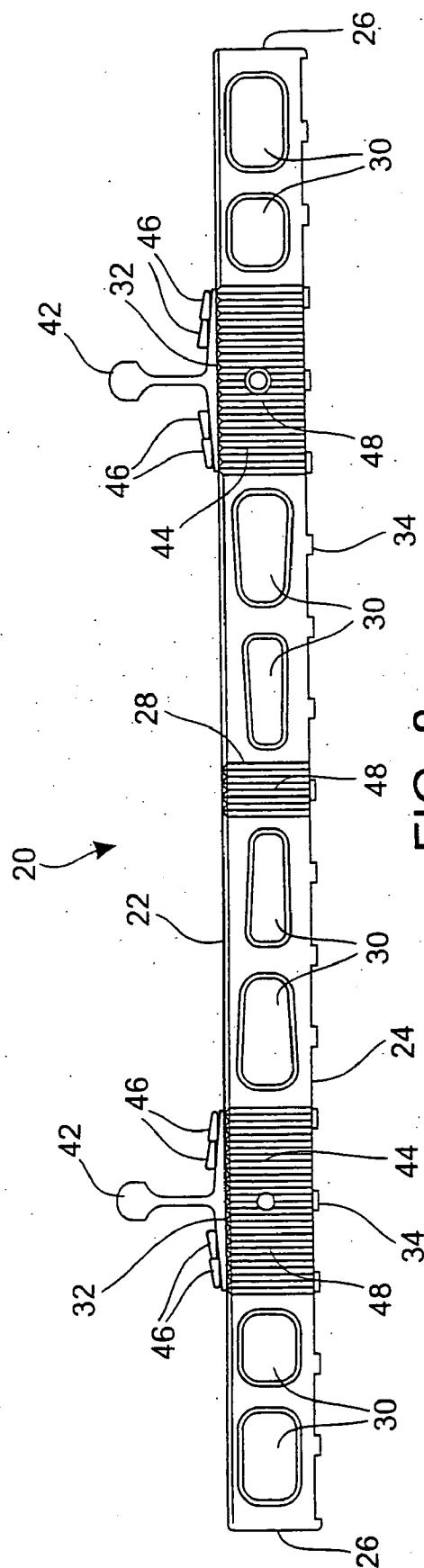


FIG. 5









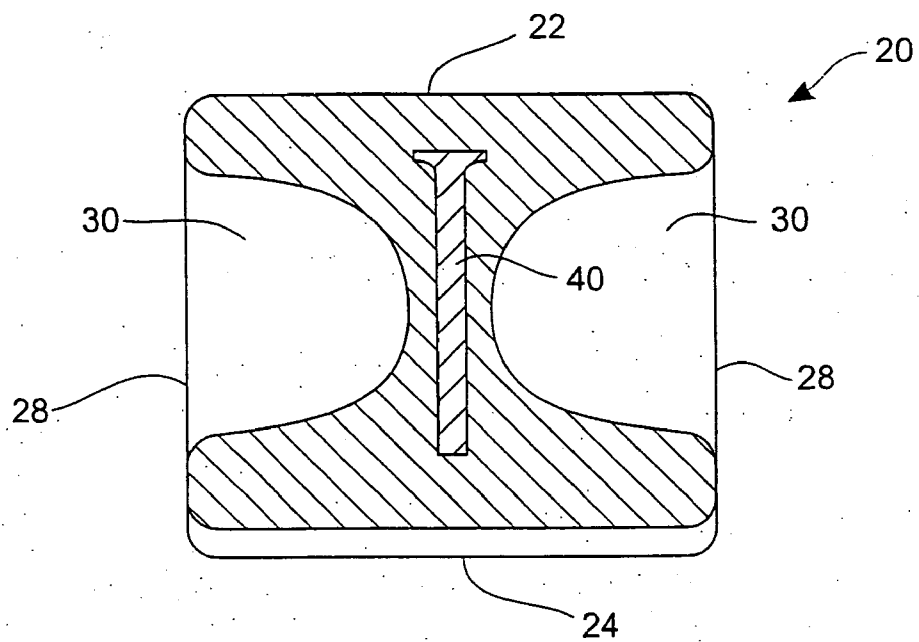


FIG. 10

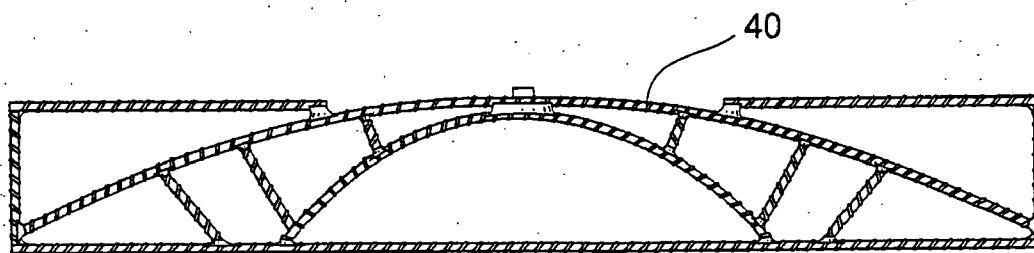


FIG. 11

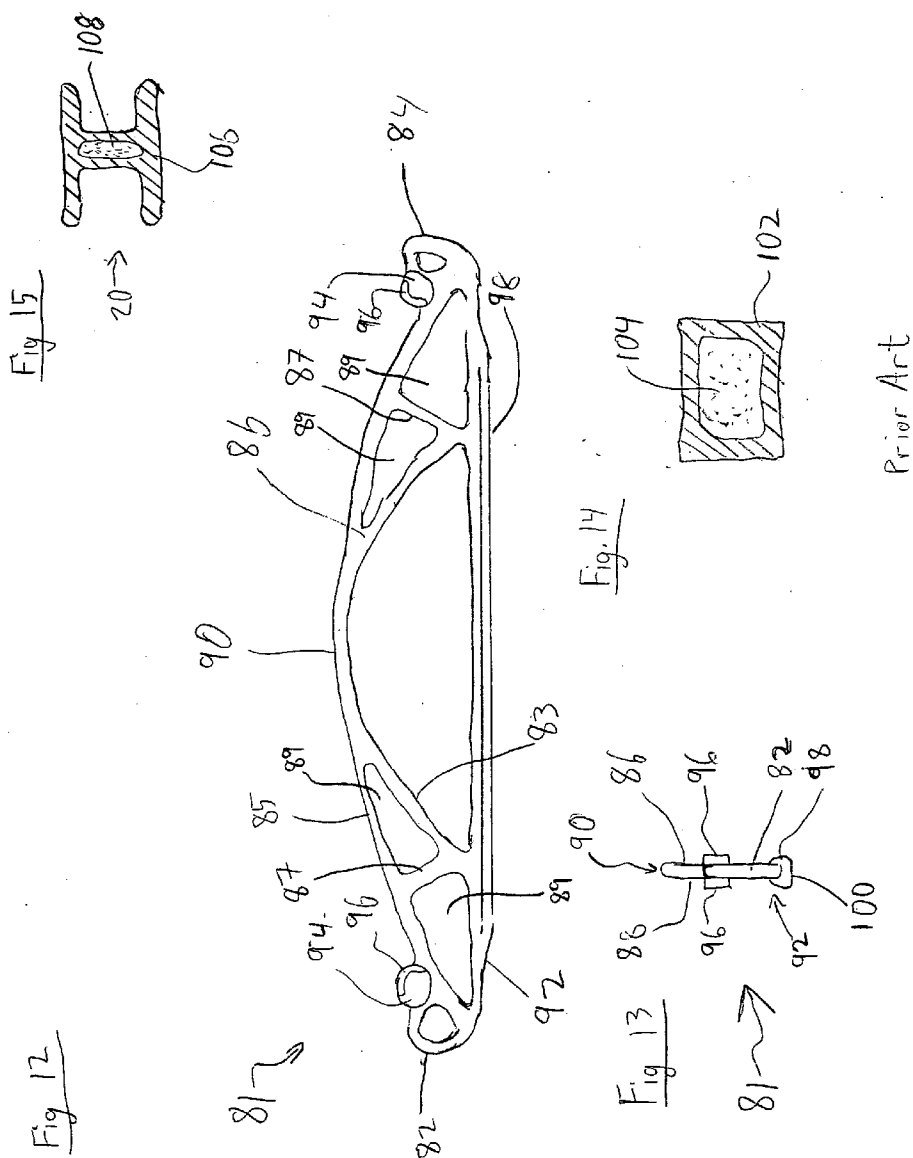
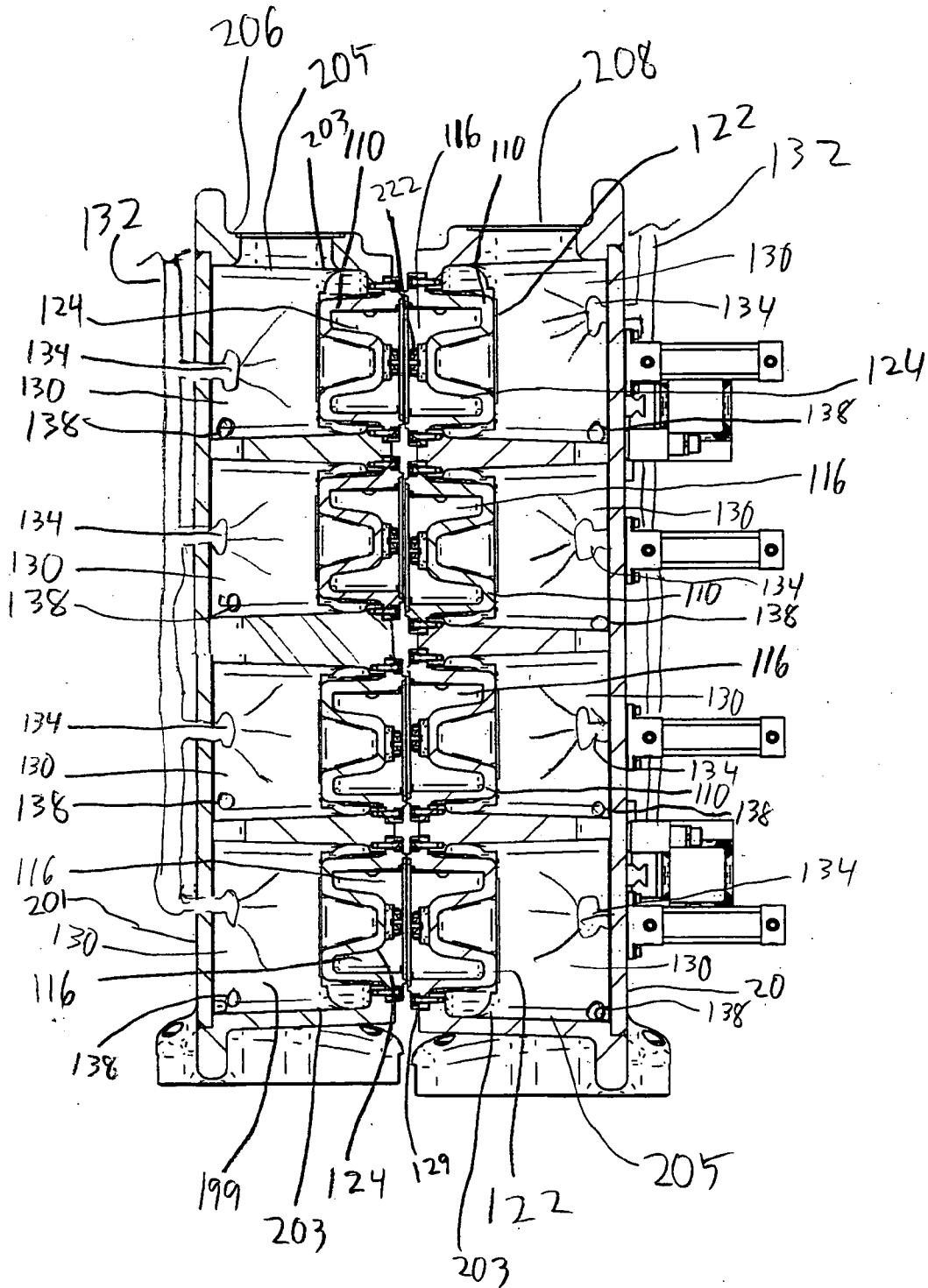


Fig. 16



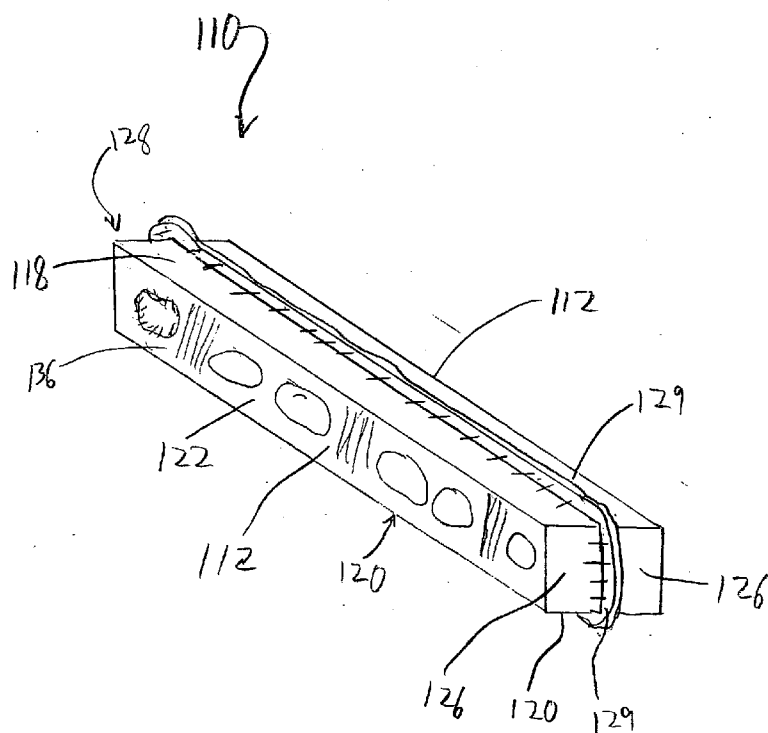


Fig. 17

Figure 18

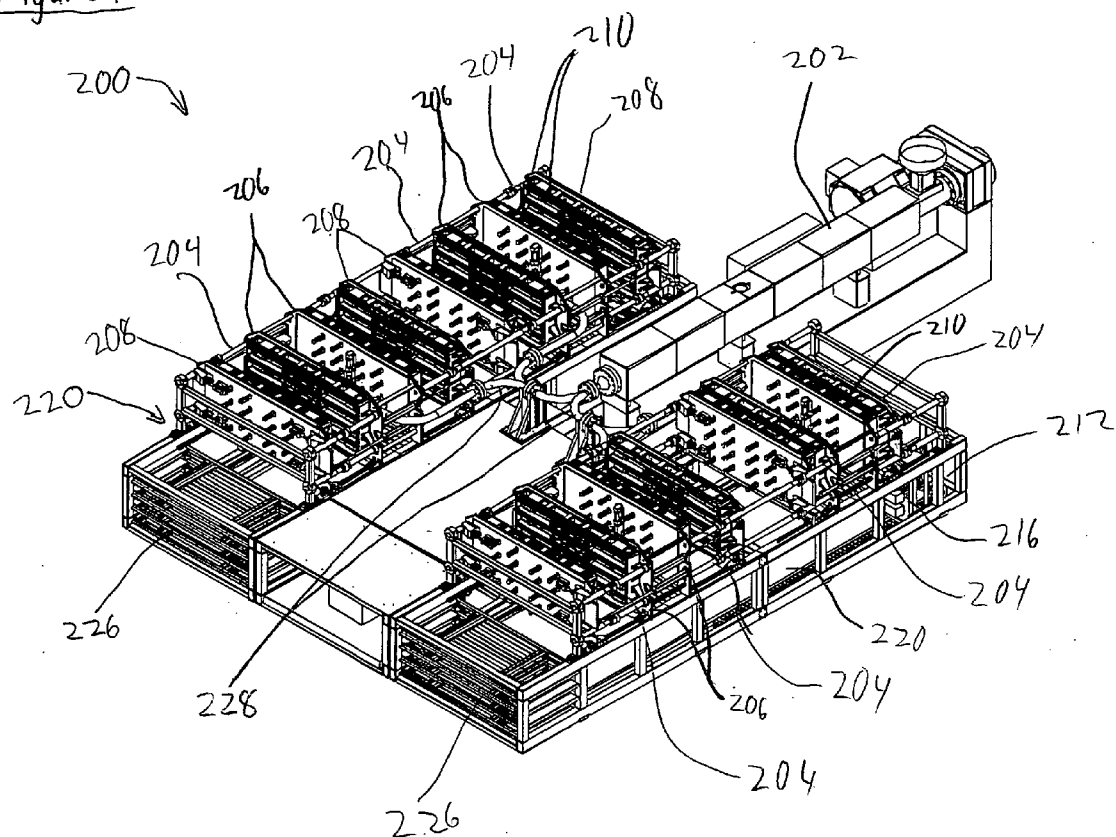


Figure 19

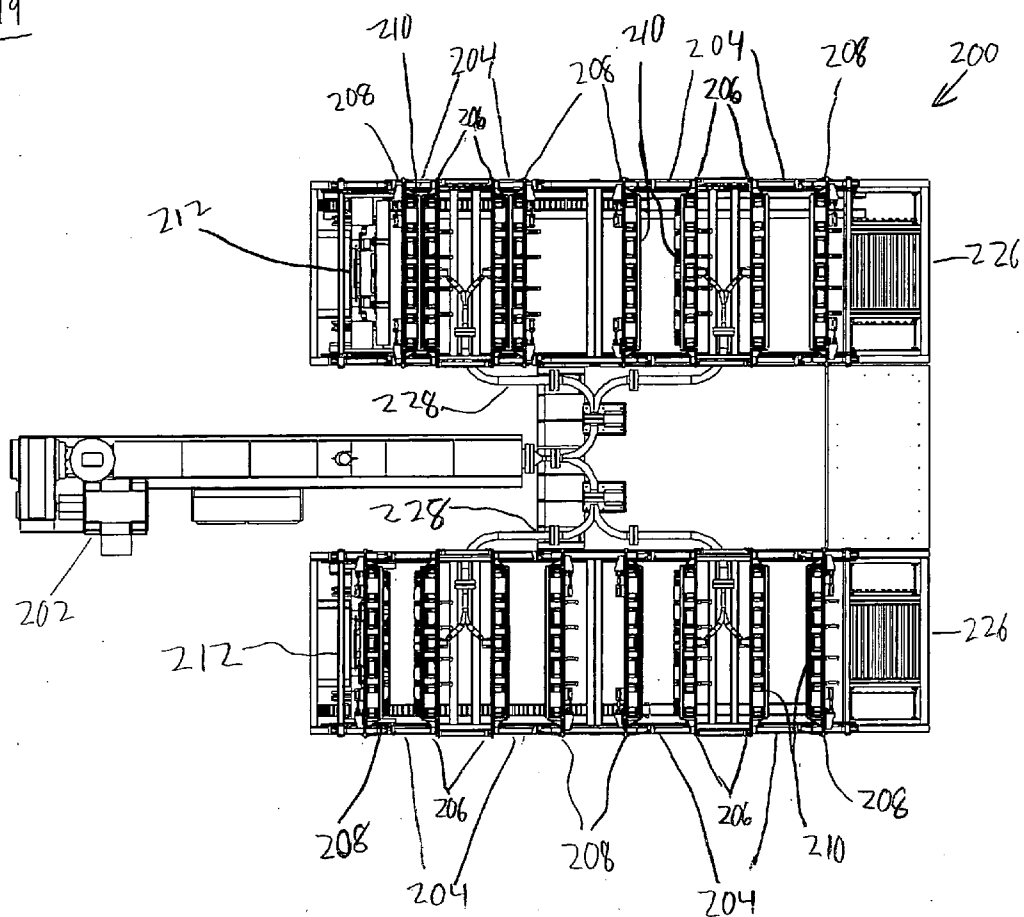


Figure 20

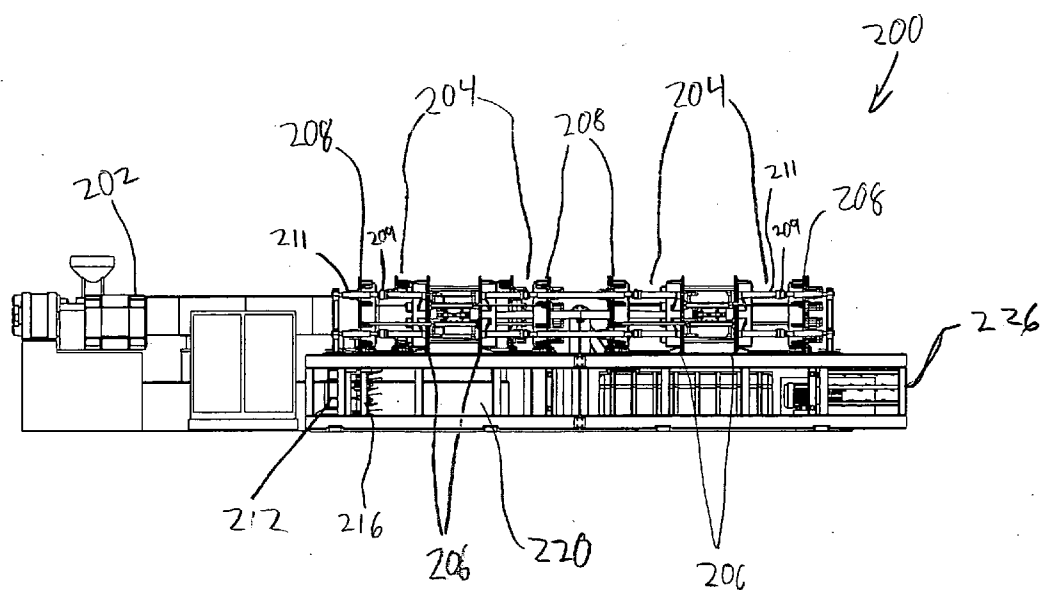
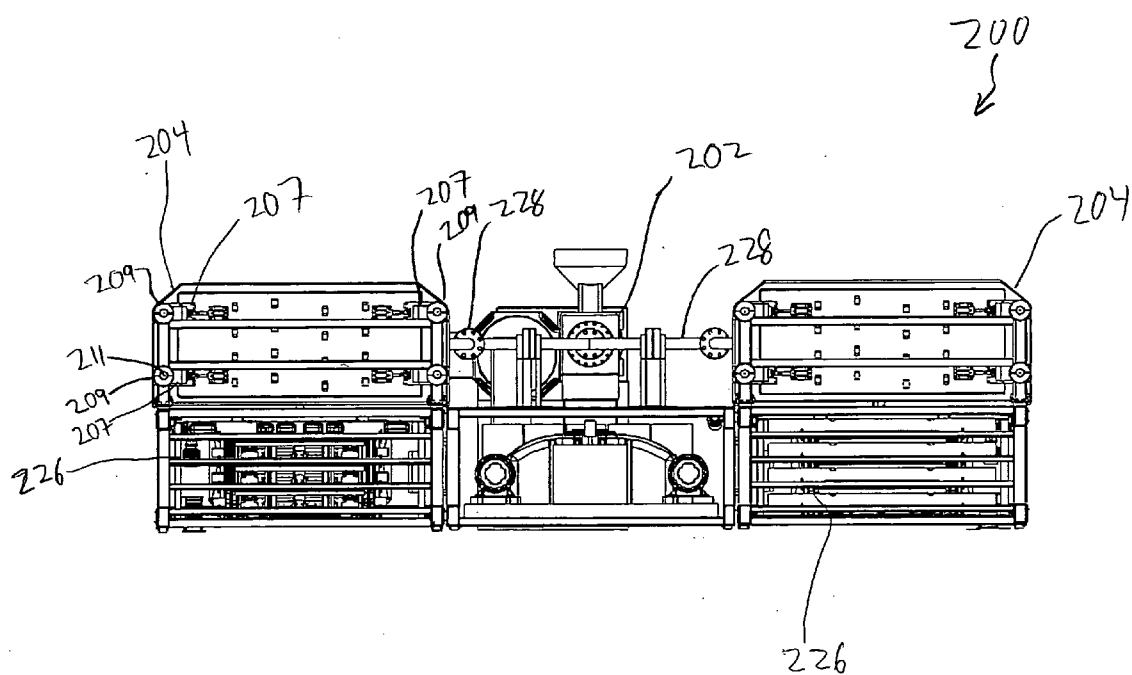
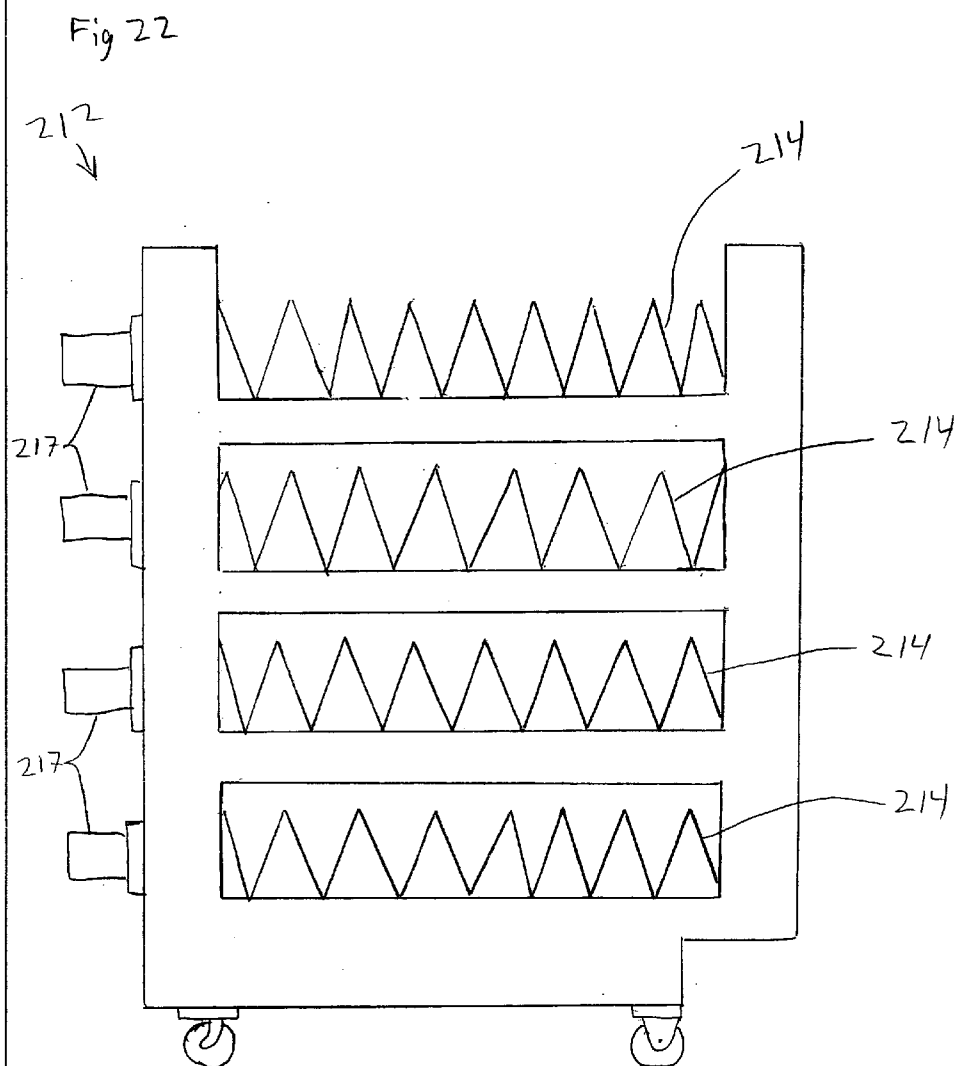
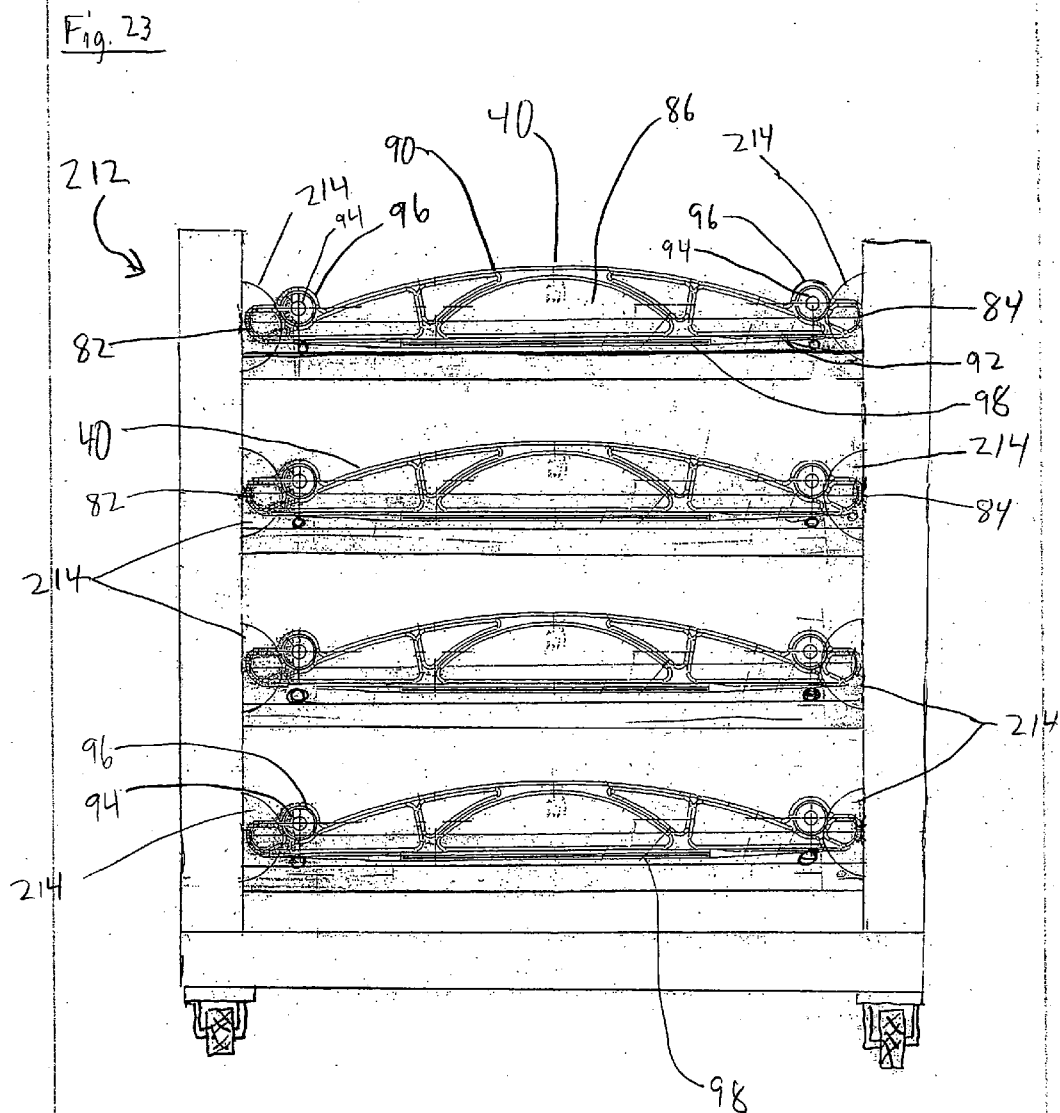


Figure 21







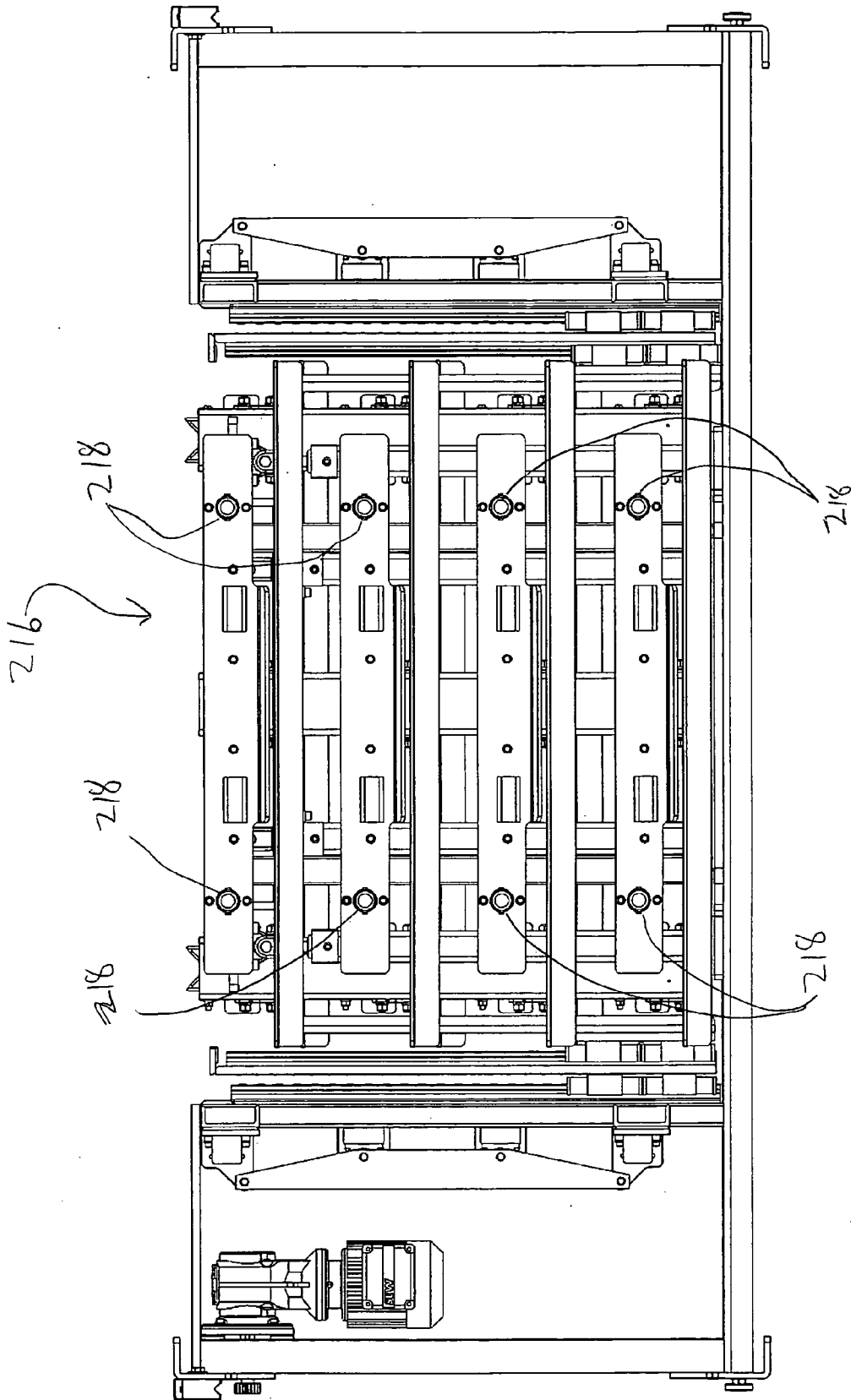
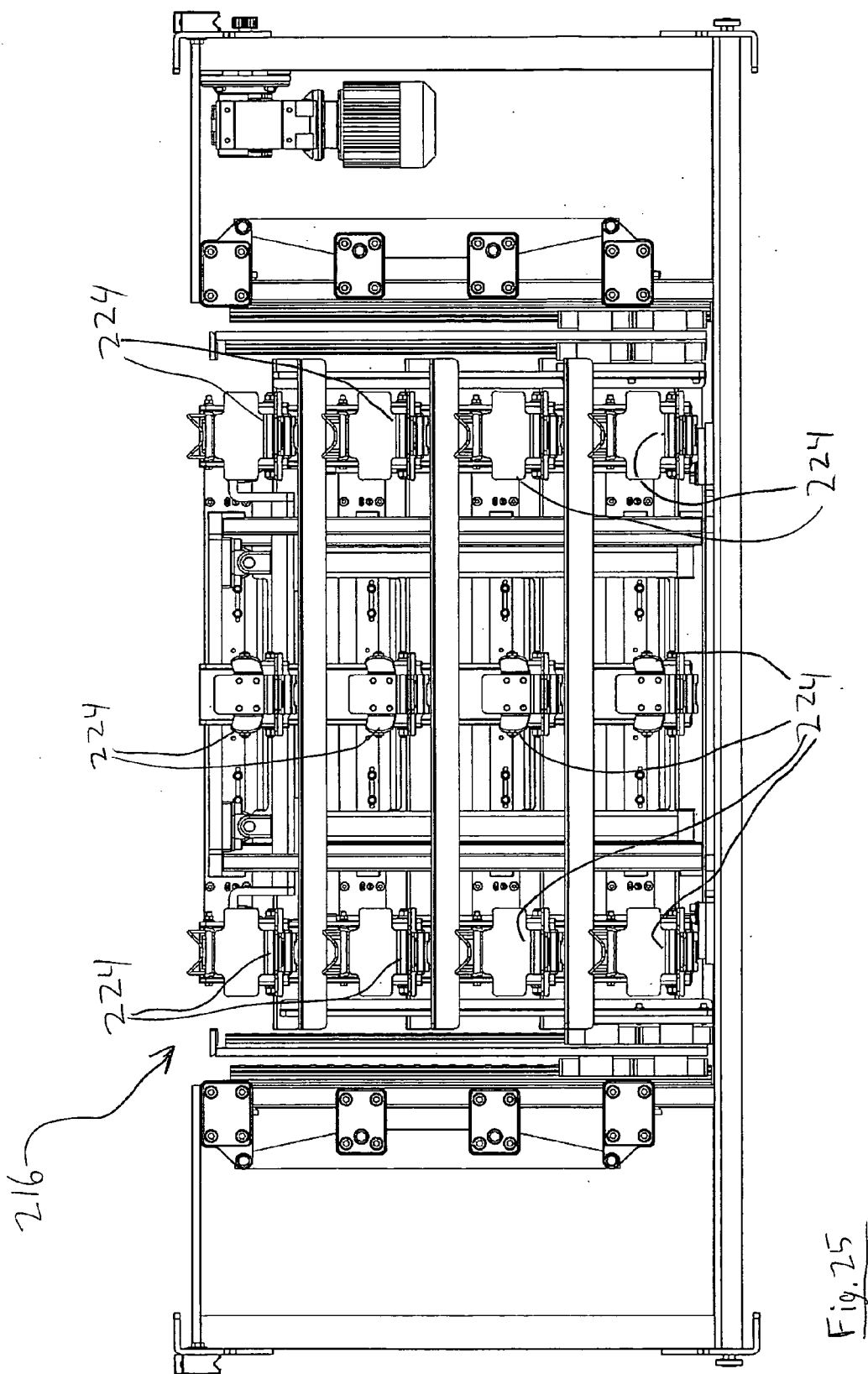


Fig. 24



COMPOSITE RAILROAD TIE AND METHOD OF MANUFACTURE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation-in-part and claims the benefit of the filing of pending U.S. patent application Ser. No. 11/114,620 which in turn is a continuation-in-part of U.S. patent application Ser. No. 10/837,978 which in turn is a continuation-in-part and claims the benefit of the filing of U.S. Provisional Patent Application Ser. No. 60/516,697, entitled "Improved Composite Railroad Tie and Method of Manufacture", filed on Nov. 3, 2003, and the specifications of these prior applications are incorporated herein by reference.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention relates to an improved railroad tie and process of manufacture. More particularly, the improved railroad tie is fabricated out of various thermoplastic resins and fillers using an injection molding and cooling process. Part of the cooling is accomplished using a cooling cavity located in the mold. Further the present invention uses a unique automated system for molding the ties. Further, the improved railroad tie has one or more cavities on at least one side of the tie to provide a lighter and less expensive railroad tie and to provide more lateral stability for resistance to sliding around railroad curves. Even more particular the improved tie uses an improved insert designed to add strength while reducing the amount of required thermoplastics and resins for the tie. The insert also includes features which enable the use of an automated production line. The same improvements in the mold and automated system as well as the improved insert can be used to mold structural members other than railroad ties.

[0004] 2. Prior Art

[0005] Railroads are typically constructed out of two steel rails fastened to a plurality of wooden railroad ties using a bracket and/or railroad spikes. The railroad ties run perpendicular to the rails and are held in place by a rail bed of gravel. When the train rolls down the track, the wheels ride on the rail. The weight from the wheel is transferred through the rail onto the railroad tie and into the gravel rail bed. Most of the forces exerted on the railroad tie are in compression. The railroad tie is held in place by the gravel rail bed surrounding the bottom and sides of the railroad tie. This gravel helps resist the vibration and forces exerted on the railroad tie.

[0006] One of the primary concerns in the operation of a railroad is safety. A major safety problem is derailment. Derailments can cost millions of dollars in damage and loss of use of a railway. On average, there is one derailment in the U.S. every day. The leading cause of this problem is a lack of lateral stability. This is caused when the railroad ties allow the track to move from side to side. This happens when the gravel on either end of the tie, as well as the friction between the gravel and the sides and bottom of the tie, cannot restrain the forces exerted on the tie by the train rolling over the rails above it.

[0007] Historically, the railroad ties are constructed out of timber. A standard railroad tie is 7 inches tall by 9 inches

wide by 108 inches long. The surfaces of the tie are typically flat. The increased demand for wood in today's economy, coupled with the limited supply, has driven up the cost of wooden railroad ties.

[0008] When the railroad ties are in use they are subjected to conditions which greatly reduce the useful life of the railroad tie. These include exposure to moisture, wood destroying insects, and freezing and thawing. These, coupled with the forces and vibrations exerted on the ties by the trains, lead to a limited useful life for the railroad ties. Currently in the United States various railroad companies replace 10 to 15 million ties per year.

[0009] Due to the shortcomings and cost of the wooden railroad ties and recent advances in various composites, other materials have been used to fabricate railroad ties. U.S. Pat. No. 6,604,690 issued to Hartley Frank Young on Aug. 12, 2003 discloses a concrete railroad tie. While concrete provides a solid material for a tie, it can tend to be excessively heavy and hard to move.

[0010] U.S. Pat. No. 5,055,350 discloses a composite railroad tie made from sand and recycled thermoplastic containers. The sand is coated with an adhesive and then mixed with the thermoplastic. Using sand as the filler in this thermoplastic mix has the same drawback as concrete in that it is excessively heavy. The sand also increases the wear on the die used to extrude the tie.

[0011] U.S. Pat. No. 5,799,870 issued to John C. Bayer discloses a railroad tie made from a gypsum filler and a thermoplastic resin. Much of the material in a railroad tie is not necessary in order to support the load placed upon it. The railroad ties disclosed in the Bayer patent are formed using an extrusion process. Due to the way they are formed, they must have a solid cross-sectional shape. This means that the railroad tie is heavier than necessary. It is also more expensive than necessary because it contains more material than is needed for its application. The solid cross-sectional shape and excess material increase the cooling time by reducing the surface area and increasing the mass and heat density of the hot freshly extruded ties. This means that the production must either have a larger cooling bath or a slower production rate, either which adds to the cost of the ties.

[0012] Other features of prior art for molding large structural members similar to ties require cumbersome cooling processes. U.S. Pat. No. 5,766,711 issued to Andrew Barmakian on Jun. 16, 1998 discloses a Composite Camel Structure and Method for Manufacture. The method of molding requires a core be molded into the center of the structure. During the molding process cooling water is circulated through the core to remove heat from the injected plastic. After the molded object is cooled the core must then be drained and filled with buoyant material. This design adds to the material cost of the structure as well as the labor and manufacturing cost due to the additional necessary steps.

[0013] Other prior art on molding large structural members avoid the additional cost of using these cooling cores. U.S. Pat. No. 6,244,014 issued to Andrew Barmakian discloses a Steel Rod-Reinforced Plastic Piling. In manufacturing these pilings cooling of the part is achieved by submersing the part in a cooling bath while still in the mold. While this presents certain advantages over using a cooling

core, the process of submerging the entire mold presents its own set of problems such as having to maintain a cooling tank large enough to accommodate the molds, handling of the molds with the added weight of the piling inside and the cost of having multiple molds on hand to keep production going while the molds are cooling.

[0014] One of the problems that has plagued the injection molding industry is the inability to use a split mold on these extra large structures. Typically large molds that bolt together or have a tubular shape are used. This leads to problems in removing the completed part from the mold, which in turn leads to low production rates and higher production costs.

[0015] In the field of injection molding liquid cooled molds are known for use in making objects much smaller than a tie. However, they rely on one or more cylindrical holes drilled through the block of the mold. These cooling passages are operated completely filled with cooling fluid. The heat is therefore only removed via a conductive heat transfer. The cooling passages also provide little surface area for heat transfer. Thus further limiting the efficiency of this arrangement.

[0016] Other suppliers of plastic composite ties on the market today inject a plastic into a long rectangular tube. The tie must then cool completely in the rectangular tube mold to avoid having the tie swell. Finally, each tie is removed by production workers using a forklift and chain to pull attached to lag bolt inserted into the end of the tie. In other applications a pneumatic or hydraulic cylinder was used in lieu of a forklift. All in all this proves to be a very inefficient process.

SUMMARY OF THE INVENTION

[0017] Due to the shortcomings of the prior art, it is an objective of the present invention to provide a railroad tie which is formed using an injection molding and post cooling process using various thermoplastics and fillers.

[0018] Another objective of the present invention is to provide a railroad tie which has one or more cavities formed into at least one of the faces to provide a lighter railroad tie and one that can be better gripped by the material of the roadbed for improved lateral stability.

[0019] It is a further objective of the present invention to provide a thermoplastic railroad tie which can be cooled quicker than the prior art due to the increase of surface area and the decrease in mass and volume.

[0020] Yet another objective of the present invention is to provide an improved composite railroad tie with increased strength and reduced weight and cost through the use of reinforcing materials.

[0021] A further objective of the present invention is to provide an improved composite railroad tie with a structural insert molded into the web of the tie. The insert provides increased stiffness and quality, thus permitting the use of a wider range of polymers for a ductile skin or shell of the tie.

[0022] The present invention also includes an improved insert which provides additional strength to the improved composite tie while helping to minimize weight and maintain strength. This same insert has improved features which allow it to be used in an automated production line.

[0023] Another object of the present invention is an improved split mold and vault with each half having an interior cooling cavity in which cooling water is sprayed onto the back side of the mold cavity maximizing the cooling rate of the molded tie and in turn maximize the production rate. The improved split mold and vault allow for using it to mold extra large structural elements

[0024] It is another object of the invention to provide an automated system which can provide high production rates for large structural elements in a relatively small area. Thus reducing manufacturing costs, overhead and labor.

[0025] It is a further object of the present invention to provide an improved process and system for injection molding composite ties. The system being highly automated to help lower labor and production costs while producing high quality ties of the present design.

[0026] The objects of the present inventions can also be applied to large structural members other than ties.

[0027] Other objects, features, and advantages will be apparent to persons of ordinary skill in the art in view of the following detailed description of preferred embodiments and the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0028] For a more complete understanding of the present invention, the needs satisfied thereby, and the features and advantages thereof, reference now is made to the following descriptions taken in connection with the accompanying drawings in which:

[0029] FIG. 1 is a perspective view of one embodiment of the present invention.

[0030] FIG. 2 is a perspective view of another embodiment of the present invention with a tread pattern on one surface of the tie.

[0031] FIG. 3 is a side view of the preferred embodiment of the present invention showing the preferred dimensions in inches.

[0032] FIG. 4 is a cross-sectional view of the preferred embodiment of the present invention, taken along the line indicated in FIG. 3, showing the dimensions in inches.

[0033] FIG. 5 is a cross-sectional view of the preferred embodiment of the present invention, taken along the line indicated in FIG. 3 showing, the dimensions in inches.

[0034] FIG. 6 is a perspective view of one embodiment of the present invention with an I-beam cross-section imposed on it.

[0035] FIG. 7 is a perspective view of one embodiment of the present invention with an insert imposed to show the location of an insert.

[0036] FIG. 8 is a side view of the embodiment of the present invention shown in FIG. 7.

[0037] FIG. 9 is a cross-sectional view of the embodiment shown in FIG. 7 taken along line 9-9.

[0038] FIG. 10 is a cross-sectional view of the embodiment shown in FIG. 7 taken along line 10-10.

[0039] FIG. 11 is a side view of one embodiment of the insert.

[0040] FIG. 12 shows a side view of the preferred embodiment of the insert.

[0041] FIG. 13 shows an end view of the preferred embodiment of the insert.

[0042] FIG. 14 shows the cross section of a traditional shaped tie molded from a polymer just after being removed from the mold.

[0043] FIG. 15 shows a cross section of one of the improved ties shortly after being removed from the mold.

[0044] FIG. 16 shows a cross-sectional view of the preferred embodiment of an improved mold and vaults with the cooling cavities used to manufacture the improved composite tie.

[0045] FIG. 17 is a perspective view of the preferred embodiment of an improved mold.

[0046] FIG. 18 is a perspective view of the automated system designed to mold the composite railroad ties or other large structural members.

[0047] FIG. 19 is a top view of the system as shown in FIG. 18.

[0048] FIG. 20 is a side view of the system as shown in FIG. 18.

[0049] FIG. 21 is an end view of the system as shown in FIG. 18.

[0050] FIG. 22 is a side view of the preferred embodiment of the insert cart.

[0051] FIG. 23 is a front view of the preferred embodiment of the insert cart.

[0052] FIG. 24 is a view of the insert handling side of the robot.

[0053] FIG. 25 is a view of the tie handling side of the robot.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0054] FIG. 1 is a prospective view of the preferred embodiment of the improved composite tie 20. The improved composite tie 20 has a top 22, a bottom 24, two opposing ends 26, and two opposing sides 28. The improved composite tie shown in FIG. 1 has three cavities 30 located in the side 28 of the tie 20. The backside 28 (not shown) of the tie 20 also has three cavities 30 which correspond to those shown in the front side 28 shown in FIG. 1. When the tie 20 is installed, the rail is attached to the tie 20 generally in the area indicated 32. The rails are attached to the tie 20 using railroad spikes, screws, brackets and/or other fasteners typically well known in the industry.

[0055] When the tie 20 is in use, the weight and force from the train is transferred through the rails generally into the area indicated as 32, the majority of these forces are in compression. As such, the railroad tie 20 does not need to be a solid rectangular block in order to handle these loads. Therefore, the cavities 30 are located in those areas where the material would otherwise be underutilized.

[0056] The cavities 30 provide several benefits. When the tie 20 is installed, it is surrounded by gravel from the rail bed. This gravel helps hold the tie 20 in place. It also fills the cavities 30 providing a better grip on the tie 20 than would be provided with a traditional flat sided tie, thus increasing the lateral stability of the tie. The cavities 30 also remove material which is not needed when the tie 20 is in use. This provides a lighter tie 20 than one with continuous flat sides 28. It also reduces the amount of material needed and thus reduces the cost.

[0057] FIG. 2 shows a prospective view of the preferred embodiment of the present invention with the added feature of a tread 34 located on the bottom 24. The tread 34 provides additional grip for the tie 20 when it is installed. It should be noted that the tread 34 could also be placed on other surfaces of the tie 20 as may be deemed necessary. The design and size of the tread 34 could also be altered from that which is shown in FIG. 2.

[0058] FIG. 3 is a side view of the preferred embodiment of the improved composite tie 20. FIGS. 4 and 5 are a cross-sectional view of the preferred embodiment of the improved composite tie 20 taken along the lines indicated in FIG. 3. The following table provides the dimensions of one of the preferred embodiments of the invention. The element numbers correspond to those indicated on FIGS. 3, 4, and 5.

Element Number	Dimension
50	3.5"
52	7.0"
54	15.0"
56	45.0"
58	R1.5"
60	5.0"
62	96.0"
64	9.0"
66	7.0"
68	R0.5"
70	5.0"
72	2.0"
74	5.0"
76	2.0"

[0059] It should be noted that any of the dimensions and/or the size, location and number of cavities 30 can be changed to meet varying needs while still falling within the scope of this invention.

[0060] The improved composite railroad tie 20 can be fabricated out of various thermo plastic resins and fillers commonly known in the field using an injection molding process. In the preferred embodiment, the material used would be comprised of recycled or wide-spec thermoplastic polymer, low cost fillers, and additives, such as foaming agents, black color, and extrusion aiding ingredients. In the preferred embodiment, the tie 20 is formed using a structural foam process.

[0061] The performance of the improved composite tie 20 can be compared to that of an I-beam. FIG. 6 shows the preferred embodiment of the improved composite tie 20 with the cross-section of an I-beam imposed upon it. The improved tie 20 has an area referred to as a web 36 which corresponds to the web of an I-beam. Likewise, it has four areas referred to as flanges 38 which correspond to the

flanges of an I-beam. The web 36 of the improved tie 20 is aligned with the area where the two halves of the mold meet when molding the improved tie 20. The performance of the improved tie 20 (although it may not be necessary) can be increased by molding stiffening material into one or more of the flanges 38 of the improved tie 20. The stiffening material could be any type of fiber, including but not limited to graphite, fiberglass, Kevlar or any other types of composite fibers known in the art. Likewise, stiffening material could be metal, including but not limited to rebar or any other type of metal. This would be accomplished by inserting the fiber, metal or other material into the mold prior to injecting resins or resins and fillers into the mold such that, when completed, the material would run lengthwise through the one or more of the flanges 38 of the improved tie 20.

[0062] Use of the reinforcing material will add strength and rigidity to the improved tie 20. This allows for the size of the cavities 30 to be increased while maintaining the same strength of the improved tie 20. This in turn means that the total weight of the improved tie 20 is decreased. This also means that the cost of materials in the improved tie 20 can be decreased. The increased size of the cavities 30, while using the reinforcing material 40, also provides more surface area and less volume for the improved tie 20, which in turn decreases the cooling time and in turn reduces the production costs. The increased stiffness and quality provided by the reinforcing material also permit using a wider range of soft polymers for a ductile skin or shell.

[0063] Reinforcing material can also be added to the web 36 to increase strength of the tie 20. FIGS. 7 through 10 illustrate a tie 20 which has an insert 40 in the web 36 of the tie 20. FIG. 11 shows an embodiment of the insert 40. The actual geometry of the insert 40 can be varied greatly to meet the demands of the expected load and the geometry of the tie 20.

[0064] FIG. 7 shows a perspective view of a tie 20 with the insert 40 imposed to indicate the preferred location and orientation. FIG. 8 is a side view of the tie 20 shown in FIG. 8 with rails 42 mounted on the tie 20. FIG. 9 is a cross-section of the tie 20 taken along line 9-9 in FIG. 7. The rails 42 shown in FIG. 8 have been included in FIG. 9 to illustrate the preferred location of the insert 40 relative to the rails 42. FIG. 10 is a cross-section of the tie 20 taken along line 10-10 in FIG. 7. The embodiment of the tie 20 shown in FIGS. 7 through 10 has two sections 44 of tie 20 with a solid cross-section. These solid cross-sections 44 are located in the area below where the rails 42 are attached. The solid cross-sections 44 provide an area where the spikes 46 or other fasteners can be driven into the tie 20 to secure the rail 42 to the tie 20. These solid cross-sections 44 prevent any portion of the spike 46 other than the head to be exposed to the elements and its resulting corrosion. These solid cross-sections 44 also handle the compressive force exerted on them from the load of a train running across the rails directly above them.

[0065] The tie 20 shown in FIGS. 7 through 10 has a plurality of cavities 30 located in the sides 28 of the tie 20. When installed the gravel of the railbed fills the cavities 30 providing additional lateral stability not available with the prior art. The tread 34 on the bottom of the tie 20 and grooves 48 on the side 28 of the tie 20 also add to the lateral stability. The cavities 30 also lower the weight of the

finished tie 20 by approximately 25% and increase its surface area by approximately 10% over a traditional tie with a constant cross section. The reduction in the weight and increase in surface area leads to a 50% reduction in the heat density (Btu/unit volume). The cavities 30 are separated by vertical walls with a thin cross-section. This specific pattern combined with increased surface area serves to provide a tie structure that solidifies faster and provides enough structural integrity to remove the molded part from the split mold earlier. This means faster cooling during production, lower production costs, lower material costs and easier handling during installation.

[0066] The insert 40 shown in the tie 20 of FIGS. 7 through 10 is located in the web 36 of the tie 20 between the two areas 32 where the rails 42 are attached. When the tie 20 is in use and a train is rolling over the rails 42 above the tie 20, area of the tie 20 between the rails 42 is subjected to a base load with an additional cycling the load as the wheels of the train are directly above the tie 20. This cyclical loading causes the tie 20 to flex in the area between the rails 42. The insert 40 is sized and located to help carry both of these loads. Because of the added strength of the insert 40 the size of the cavities 30 can be increased. This leads to additional cost savings in reduced material costs, decreased cooling time, increased production speeds and easier handling during installation. The increased stiffness and quality provided by an insert 40 molded into the web 36 of the tie 20 also permits the use of a wider range of soft polymers for a ductile skin or shell. The increased ductility of the material reduces the likelihood the tie 20 will crack during spiking. If the cracking is too severe it can render a tie 20 unusable for a rail bed.

[0067] The insert 40 shown in FIG. 11 is fabricated out of steel rebar. However the insert 40 can be fabricated out of any relatively strong and light weight material. Insert 40 fabrication methods include but are not limited to casting, forging, stamping, forming, welding and adhering. The possible materials used to make the inserts 40 include but are not limited to fibers, composites, metals and metal alloys. The fibers include but are not limited to carbon fiber, Kevlar and fiberglass.

[0068] FIG. 12 shows a side view of the preferred embodiment of the insert 81. FIG. 13 shows an end view of the preferred embodiment of the insert 81. The insert 81 has an elongated body with a first end 82, a second end 84, a first side 86 and a second side 88. A top edge 90 and a bottom edge 92. There is a flat planar landing 94 located near either end of the first and second sides of the insert 81. Each landing 94 has a shoulder 96 which extends perpendicular from the landing. There is a foot 98 which is located on the bottom edge 92 of the insert 81. The foot 98 has a planar surface 100 which faces away from the body of the insert 81. In the preferred embodiment of the insert 81 as shown in FIGS. 12 and 13, the insert 81 is a casting made from a ferrous material. It should be understood the insert could be made from various other materials as well as made in various fashions other than casting.

[0069] The insert 81 has a pair of nesting arches 83 and 85. The arches 83 and 85 are attached to the bottom edge 92 of the insert 81. The arches 83 and 85 are also secured to one another directly and by cross links 87. The arches 83 and 85 help concentrate the load on the tie 20 in the center of the tie

20 in the event the ballast washes out from under the ends **26** of the tie **20**. The connections between the nested arches **83** and **85** create openings **89** which pass through the insert **81**. In the completed tie **20** these openings are filled with the composite. These openings **89** help ensure a better interlocking between the composite and the insert **81** than an insert having a solid body.

[0070] The process for making the improved composite tie **20** is comprised of injecting hot molten resin or resin and fillers into a mold, allowing the resins or resins and fillers sufficient time to cool so they will hold their shape when removed from the mold, then removing the improved composite tie **20** from the mold. FIG. **14** shows the cross section of a traditional shaped tie molded from a polymer just after being removed from the mold. The solid outer perimeter **102** of the tie has already formed. It must be thick enough to support and contain the molten center portion **104**. FIG. **15** shows a cross section of one of the improved ties shortly after being removed from the mold. The solidified outer perimeter **106** is indicated by the crosshatch. The molten center portion **108** is also shown.

[0071] The problem with the traditional shaped tie as shown in FIG. **14** is that once the outer perimeter **102** has solidified there is still a large volume of molten material **104** at the center (with a large heat density) that must be cooled through a relatively limited surface area in comparison to the improved tie shown in FIG. **15**.

[0072] The advantage of the improved tie **20** is further shown by the fact the composite used is a non-Newtonian fluid and is compressed during the injection process. If the traditionally shaped tie is removed from the mold before the majority of the center has solidified, the solidified perimeter **102** will not be thick and strong enough to contain the compressed molten center **104**. When this happens the tie swells, throwing the dimensions and planar surfaces out of tolerance. With the 10% increase in surface area and 50% reduction in heat density, the improved tie **20** has a much smaller molten center **108** and a much larger and stronger solidified outer perimeter **108** when it is removed from the mold. This allows the improved tie **20** to retain its shape after the same amount of in mold cooling time as a traditional shaped tie.

[0073] The tie **20** is then allowed to further cool either in the air or in a spray or liquid bath. The cooling time is a function of the temperature of the tie **20**, the heat density of the tie **20** and the surface area of the tie **20**. The improved tie **20** provides the advantage of increasing the surface area of the tie **20** while reducing the mass and heat density. This in turn leads to a shorter cooling time, which in turn leads to a faster production rate if the cooling step is the limiting factor in the production rate. As previously mentioned, the process can be modified to include inserting a stiffening material into the mold prior to injecting the hot molten resin or resins and fillers into the mold.

[0074] FIG. **16** shows a cross-sectional view of four improved molds **110** mounted in their opposing static vaults **206** and dynamic vaults **208** used to manufacture the improved composite tie **20**. Looking now at FIG. **17** the mold **110** is comprised of two halves **112** which are held together by a static vault **206** and an opposing dynamic vault **208**. Each vault **206** and **208** has a front side **199** and a backside **201**. There is an opening **203** and interior surface

205 in each vault **206** and **208**. Each mold half **112** has flange **129** which is used to secure the mold half **112** to a vault **206** or **208**. When the two halves **112** of the improved mold **110** are put together they form a mold cavity **116** where the improved tie **20** or other extra large structural object is molded. Each mold half **112** is comprised of a top **118**, a bottom **120**, a vault side **122**, a mold side **124**, a first end **126** and a second end **128**. As can be seen in FIG. **16**, a cooling cavity **130** is defined by the space between the vault side **122** of the mold half **112** and the interior surface **205** of its vault **114**. In the preferred embodiment the cooling cavity **130** capable of containing fluid. The cooling fluid header **132** extends down the back side **201** of the vault **114**. One or more nozzles **134** located in the cooling cavities **130**. The nozzles **134** are in fluid communication with the cooling fluid header **132**.

[0075] During the molding process once the mold cavity **116** has been filled with the composite material, the cooling cycle begins. Cooling is aided by a cooling fluid such as water being supplied under pressure to the cooling fluid header **132**. The cooling fluid then goes through the nozzles **134** and is sprayed into the cooling cavity **130** where it comes into contact with the interior surface of the cooling cavity **130** including the vault side **122** of the mold half **112**. This helps remove heat from the parts located in the cavities **116**, thus increasing run speed and decreasing manufacturing costs.

[0076] In the preferred embodiment the cooling fluid is sprayed across the entire surface and is evacuated from the cooling cavity **130** via a return or drain **138** so the cooling cavity **130** is at least partially empty. This optimizes conductive, convection and radiant heat transfer as the cooling fluid flows over the surface while containing the cooling fluid in the cooling cavity **130**. The known prior art only has channels drilled through the mold which are kept full of cooling fluid. As such the prior art only took advantage of conductive heat transfer for cooling. The mold halves **112** only provide thin shell of metal between the part being cooled and the cooling fluid versus the prior art with a large cross-section of metal between the part being cooled and the cooling fluid flowing through the gun drilled channels. The metal between the part being cooled and the cooling fluid acts like a resistor in an electrical circuit. Just as an electrical resistor reduces to the flow of electricity, so the metal between the part and the cooling fluid slows the transfer of heat out of the part. There is also more surface area to use for cooling with the cooling cavity **130** than was available with the prior art drilled channels. Heat transfer is further aided by using aluminum for the molds **110**. Aluminum conducts heat three times faster than the steel previously used for injection molds.

[0077] Once removed from the cooling cavity **130**, the cooling fluid can either be chilled by means typically known in the field such as a fin fan or other heat exchanger. Once the cooling fluid has been cooled or chilled it can then be reused. In the alternative, the cooling fluid can be discarded without removing additional heat from it.

[0078] FIG. **18** is a perspective view of the automated system **200** designed to mold the composite railroad ties or other large structural members. FIGS. **19**, **20** and **21** are top view, side view and end view respectively of the same system **200**. The automatic molding system **200** has an

extruder **202** which is used to melt the composite material and feed it under pressure to a plurality of presses **204**. Each press **204** has a static vault **206** and a dynamic vault **208**. Each static vault **206** and dynamic vault **208** have opposing sides of a mold **210** located on them. A traditional style mold can also be used. However, to obtain higher production rates an improved mold such as the one shown in FIGS. **16** and **17** can be used.

[0079] The inserts **40** for the ties are loaded onto carts **212** which can be rolled into position on a level just below the level of the presses **204**. FIGS. **22** and **23** provide a side view and front view respectively of the preferred embodiment of the cart **212**. The carts **212** have a helical member **214** located on either end of the insert **40**. The inserts **40** are dispensed from the carts **212** onto a robot **216** by the synchronized rotation of the helical members **214** by the motors **217**. The robot **216** has a set of electromagnets **218** that are oriented such that they come into contact with the landings **94** of the inserts **40**. Just prior to the insert being pushed off the cart by the helical members, the electromagnets **218** are activated to hold the insert in place. The shoulders **96** of each of the landings **94** also help maintain the correct orientation of inserts **40**.

[0080] Once the insert **40** has been loaded onto the robot **216**, the robot **216** moves away from the cart **212** and along a pathway **220** underneath the presses until it is located below the press **204** that it intends to load with the insert **40**. The robot then extends upward until the inserts **40** are at the proper height to be loaded into one half of the molds **210**. Each mold has a permanent magnet **222** which is located to correspond with the landings **94** of the inserts **40**. The robot extends the inserts **40** towards the molds **210** until the landings **94** of the inserts **40** become engaged with the permanent magnets **222** of the mold **210**. The electromagnets **218** of the robot **216** then turn off allowing the inserts **40** to be held in place in the mold by the magnetic force of the permanent magnets **222** and the shoulders **96** located on the landing **94**. The robot **216** then retracts away from the half of the mold **210** holding the insert **40** and moves towards the opposing half of the mold **210** located on the opposing vault **206** or **208** which will hold a tie **20** made on the previous cycle of the system **200**. The robot **216** has a plurality of extensions or receptors **224** which engage the tie **20** and remove it from the mold **110**. The robot **216** retracts from the second half of the mold **210** and lowers until it can proceed down the pathway **220** below the presses **204** to place the tie on a cooling rack **226** where it will remain until it is removed from the automated molding system **200**. The newly molded tie **20** can be further cooled by the ambient air or chilled air. Likewise, a cooling bath using a sprayed cooling fluid or immersion could be used to further cool the tie **20**.

[0081] Once the robot has lowered itself out from the space between the two halves of the mold **210**, the dynamic vault **208** moves toward the static vault **206** until the two halves of the mold **210** are closed. The two halves of the mold **210** are locked together by a plurality of wedges **207** on the back side of the dynamic vault **208** which slide to engage locking collars **209** located on the tie rods **211**. Once the mold **210** is closed and locked, the flow of the composite material from the extruder **202** is directed to the empty mold **210** through a series of piping and valves **228**. The com-

posite is then forced into the cavity of the mold **210** until the cavity is completely filled. The flow of composite material is then stopped.

[0082] Once the mold **210** has been filled with composite, the composite material is allowed to cool. The cooling can be aided by the use of a mold **110** as shown in FIGS. **16** and **17** wherein a supply of cooling fluid is pumped under pressure to a header **118** and through one or more nozzles **134**. From there the cooling fluid is sprayed onto the vault side **122** of the mold **210**. The cooling fluid removes heat from the mold **210** and the composite material being cooled. After the cooling fluid has been sprayed it is evacuated from the cooling cavity **130** through a return or drain **138** where it can be recycled by going through a fin fan or other heat exchanger to cool the cooling fluid wherein it can be reused.

[0083] Once the tie **20** has been cooled sufficiently for the external solidified perimeter **106** to support the molten center **108** of the tie **20**. The mold **210** is opened and the tie **20** is retained on one half of the mold **210** until it is removed from the mold **210** by the robot **216** and the process is then repeated.

[0084] The foregoing specifications and drawings are only illustrative of the preferred embodiments of the present invention. They should not be interpreted as limiting the scope of the attached claims. Those skilled in the arts will be able to come up with equivalent embodiments of the present invention without departing from the spirit and scope thereof.

Element number	Description of element
20	Improved composite tie
22	Top
24	Bottom
26	End
28	Sides
30	Cavity
32	Rail attachment area
34	Tread
36	Web (of the improved tie)
38	Flange (of the improved tie)
40	Insert
42	Rails
44	Solid section
46	Spikes
48	Grooves
50-76 (even only)	Dimension listing
81	Insert
82	First end
83	Nesting arch
84	Second end
85	Nesting arch
86	First side
87	Cross links
88	Second side
89	Openings
90	Top edge
92	Bottom edge
94	Landing
96	Shoulder
98	Foot
100	Planar surface
102	Solidified perimeter
104	Molten center
106	Solidified perimeter
108	Molten center
110	Mold
112	Mold half

-continued

Element number	Description of element
114	Vault
116	Mold cavity
118	Top (mold half)
120	Bottom (mold half)
122	Vault side (mold half)
124	Mold side (mold half)
126	First end (mold half)
128	Second end (mold half)
129	Flange (mold)
130	Cooling cavity
132	Cooling fluid header
134	Nozzle
136	Back side (of mold side)
138	Return
199	Front side (vault)
200	Automated molding system
201	Back side (vault)
202	Extruder
203	Opening
204	Presses
205	Interior surface (vault)
206	Static vault
207	Wedges
208	Dynamic vault
209	Locking collars
210	Molds
211	Tie Rods
212	Carts
214	Helical members
216	Robot
217	Motors
218	Electromagnets
220	Pathway
222	Permanent magnets
224	Receptors
226	Cooling rack
228	Piping and valves

What is claimed is:

1. An insert for a structural member comprising:
an elongated body with a first end, a second end, a first side, a second side, a top edge and a bottom edge; and
a foot located on the bottom edge, the foot comprising a planar surface facing away from the body.
2. The insert of claim 1 further comprising one or more landings located on the body; each landing having a flat area, a shoulder extending perpendicular from the flat area.
3. The insert of claim 1 further comprising two or more nested arches, the arches secured to one another.
4. The insert of claim 3 further comprising one or more cross links secured between the arches.
5. The insert as claimed in claim 1 wherein the insert is constructed from a ferrous material.
6. The insert as claimed in claim 1 wherein the insert is a casting.
7. The insert as claimed in claim 1 wherein each side comprises a first landing located near the first end and a second landing located near the second end.
8. An insert for a structural member comprising:
an elongated body with a first end, a second end, a first side, a second side, a top edge, a bottom edge and a plurality of nested arches.
9. The insert of claim 8, wherein the arches are attached to one another.

10. The insert of claim 8 further comprising a plurality of cross links between the arches.

11. An insert for a structural member comprising:

an elongated body with a first end, a second end, a first side, a second side, a top edge and a bottom edge; and
one or more landings located on the body; each landing having a flat area, a shoulder extending perpendicular from the flat area.

12. An injection molding machine comprising:

a mold with a first half and a second half, each half having a mold cavity located in a mold side of the half, a vault side located opposite the mold side, a top, a bottom, a first end, a second end, and a flange;

a pair of opposing vaults each having a front side, a backside, an opening in the front side, the opening having an interior surface and being sized to accommodate the vault side of the mold halves;

a pair of cooling cavities each defined by the vault side of one of the mold halves and the interior surface of the vault, each cooling cavity having a nozzle in fluid communication with a cooling fluid supply and a drain hole.

13. An injection molding machine as claimed in claim 12, wherein the cooling cavity is partially filled with cooling fluid.

14. An injection molding machine as claimed in claim 12, wherein the first half is a mirror image of second half.

15. A process for making structural member comprising:

closing a mold;

injecting a thermoplastic into the mold;

forming a structural member in the mold;

cooling the structural member in the mold;

removing the structural member from the mold while partially molten; and

further cooling the structural member.

16. The process of claim 15, further comprising placing an insert in the mold prior to closing it.

17. The process of claim 16 wherein the insert is comprised of:

an elongated body with a first end, a second end, a first side, a second side, a top edge and a bottom edge;

a foot located on the bottom edge, the foot comprising a planar surface facing away from the body; and

one or more landings located on the body; each landing comprising a flat area and a shoulder extending perpendicular from the flat area.

18. The process of claim 16 wherein the insert is constructed from a ferrous material.

19. The process of claim 16 wherein the insert is a casting.

20. The process of claim 17 wherein each side comprises a first landing located near the first end and a second landing located near the second end.

21. The process of claim 17, wherein the insert is placed by a robot which engages the one or more landings with an electro magnet.

22. The process of claim 15, wherein the mold is comprising:

a mold with a first half and a second half, each half having a mold cavity located in a mold side of the half, a vault side located opposite the mold side, a top, a bottom, a first end, a second end, and a flange; a pair of opposing vaults each having a front side, a backside, an opening in the front side, the opening having an interior surface and being sized to accommodate the vault side of the mold halves; and

a pair of cooling cavities each defined by the vault side of one of the mold halves and the interior surface of the vault, each cooling cavity having a nozzle in fluid communication with a cooling fluid supply and a drain hole.

23. The process of claim 22, wherein the cooling in the mold is accomplished in part by the steps comprising pumping a cooling fluid from the cooling fluid supply,

through the nozzle and into the cooling cavity and removing the cooling fluid from the cooling cavity through the drain hole.

24. The process of claim 23, wherein the cooling cavity is partially filled with cooling fluid.

25. The process of claim 22, wherein the first half is a mirror image of second half.

26. The process of claim 15, wherein the structural member is cooled in a liquid bath after being removed from the mold.

27. The process of claim 26, wherein the liquid bath is a spray bath.

28. The process of claim 15, wherein the structural member is cooled in air after being removed from the mold.

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