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Maguire et al.

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[54] **MOLD FOR THE MANUFACTURE OF A PLASTIC ROPE CONNECTOR**

[75] Inventors: **John Maguire; Jonathan E. Sharp; Richard H. Frost,** all of Littleton, Colo.

[73] Assignee: **Rose Manufacturing Company,** Denver, Colo.

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[21] Appl. No.: **82,693**

Related U.S. Application Data

[63] Continuation of Ser. No. 847,884, Aug. 6, 1969, Pat. No. 3,591,215.

[52] **U.S. Cl.** **425/129,** 425/444, 249/95

[51] **Int. Cl.** **B29f 1/10,** B29f 1/14

[58] **Field of Search**...18/30 E, 30 UM, 30 WC, 30 WD, 18/30 WP, 30 NM, 2 RP, 42 D, 36, DIG. 59, DIG. 38; 264/263, 251; 249/67, 68, 91, 95; 425/129, DIG. 802, 111, 444

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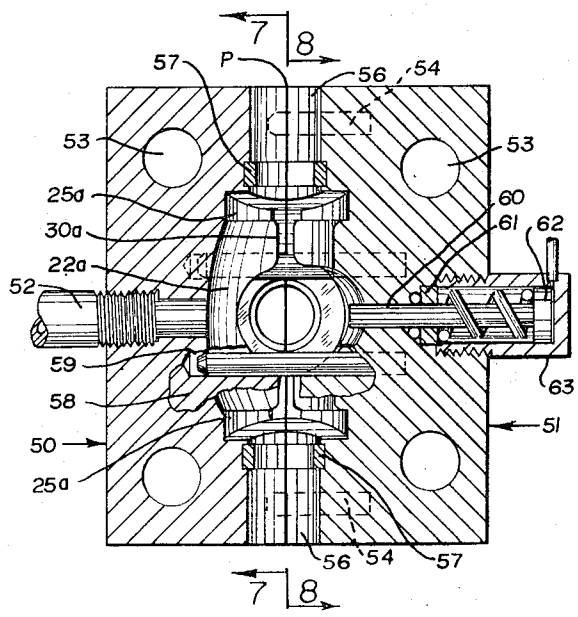
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Primary Examiner—J. Spencer Overholser
Assistant Examiner—David S. Safran
Attorney—Van Valkenburgh & Lowe

[57] **ABSTRACT**

This disclosure concerns a method for forming a plastic, button-like connector for securing a pair of crossed ropes together and also a mold for effecting the operation. The injection molding operation includes the step of holding the ropes in position in the mold cavity while the plastic is being injected therein-to and also a restricted opening where the ropes extend from the cavity to prevent loss of plastic during the injection operation.

6 Claims, 11 Drawing Figures



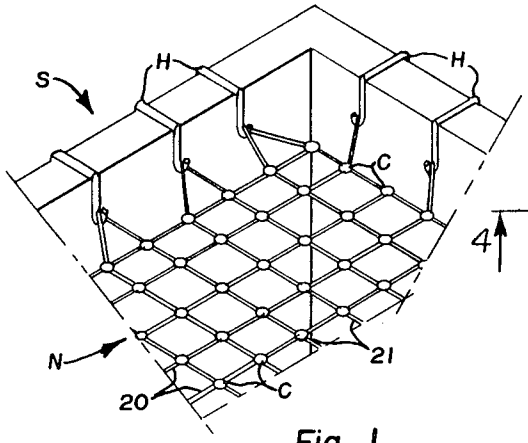


Fig. 1

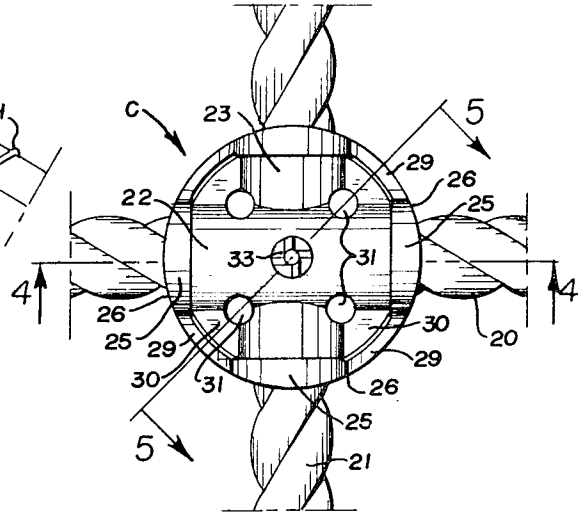


Fig. 2

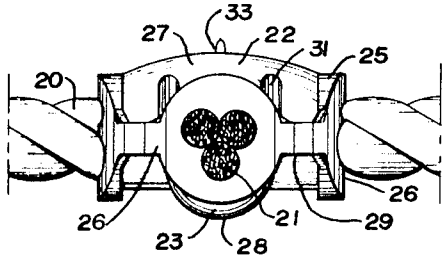


Fig. 3

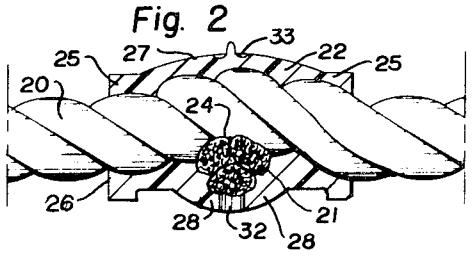


Fig. 4

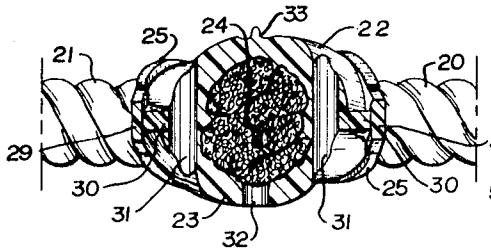


Fig. 5

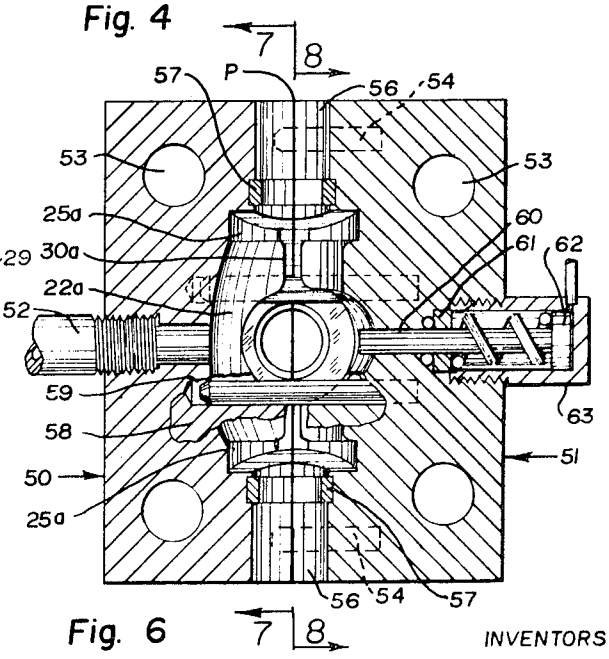


Fig. 6

INVENTORS
Jonathan E. Sharp
Richard H. Frost
John Maguire
By Van Valkenburgh & Howe
ATTORNEYS

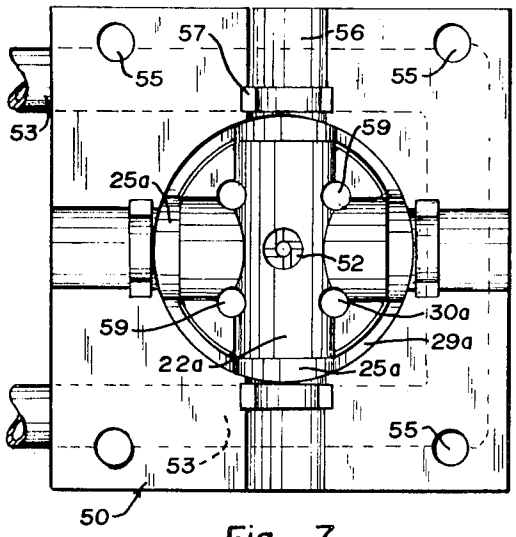


Fig. 7

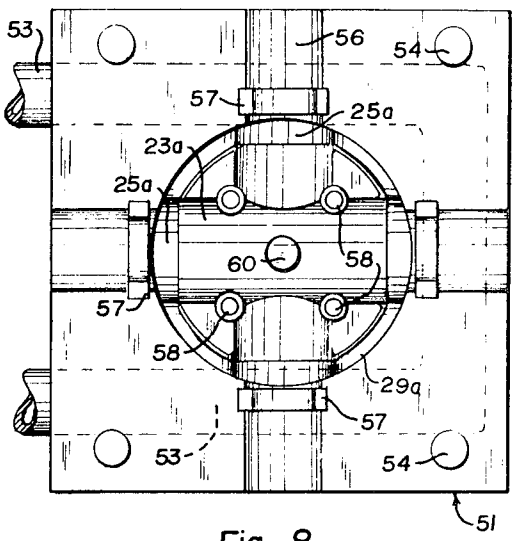


Fig. 8

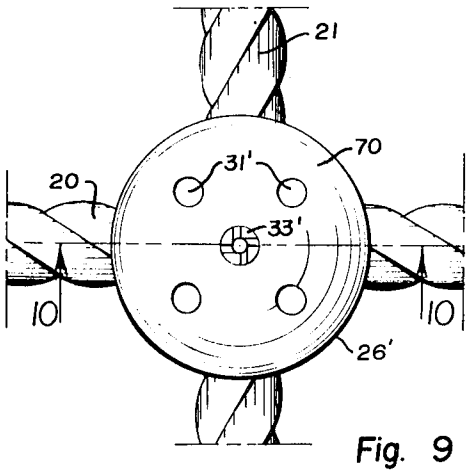


Fig. 9

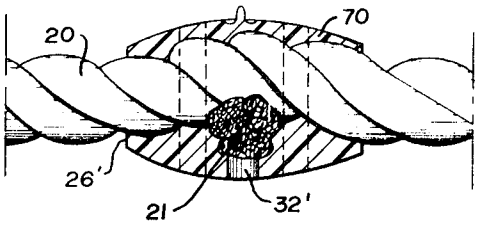


Fig. 10

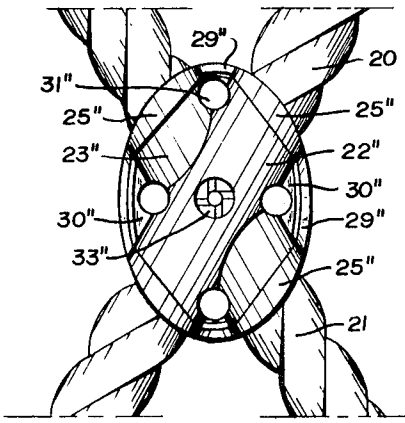


Fig. 11

INVENTORS
Jonathan E. Sharp
Richard H. Frost
John Maguire
BY Van Valkenburgh & Frost
ATTORNEYS

MOLD FOR THE MANUFACTURE OF A PLASTIC ROPE CONNECTOR

This application is a division of our copending application, Ser. No. 847,884 filed Aug. 6, 1969, now U.S. Pat. No. 3,591,215.

This invention relates to rope connectors and more particularly to connectors for securing crossed ropes. As such, the invention, an improved rope connector and hereinafter referred to as a rope connector or simply a connector, is useful in the manufacture of rope nets, rope ladders and the like.

There is a continual increasing demand for comparatively heavy rope nets, that is, for nets manufactured with ⅜ and ½ inch size ropes or larger, for safety nets for hauling cargo and for similar purposes. There is also a need to reduce the cost for these comparatively large rope nets. Initially, such nets have been manufactured by hand weaving, with heavy and cumbersome shuttles. It is simply not practical to weave a net with such large ropes, either manually or by machine. Accordingly, it has been proposed to manufacture rope nets by interlocking crossed ropes, spaced apart in an arrangement similar to a warp and a woof of a weave. Various clips and clamps prepared ahead of time have been proposed for this purpose, but have not proven to be especially successful. There is a need for an improved rope connector for the manufacture of rope nets which has a high holding strength, which is economical and which is easy to apply to crossed ropes.

The present invention was conceived and developed with the foregoing considerations in view, and comprises, in essence, a connector of a selected thermoplastic, synthetic resin formed by injection molding about a pair of crossed ropes. Preferably, the form of the connector is such as to attain a maximum degree of strength with the minimum amount of material.

An object of the invention is to provide a novel and improved rope connector of a selected thermoplastic synthetic resin for interconnecting crossed ropes, which has substantial strength and toughness, which grips the ropes tightly and which is especially suited for the manufacture of rope nets.

Another object of the invention is to provide a novel and improved rope connector which can be quickly and easily applied to crossed ropes to simplify the manufacture of heavy rope nets.

Another object of the invention is to provide a novel and improved rope connector which may be effectively used with various types of ropes, and manufactured from a variety of easily obtainable materials, as a low-cost, neat-appearing, compact, rugged and durable unit.

Another object of the invention is to provide a unique and simplified method for the injection molding of a connector about a pair of crossed ropes which insures the gripping and holding of the crossed ropes in position during the injection operation to properly fit the connector upon the ropes, in a symmetrical, uniform manner.

Other objects of the invention are to provide a novel and improved mold form for the injection molding of a thermoplastic resin connector about a pair of crossed ropes which permits the ropes to be quickly and easily aligned within the mold, which thereafter holds the ropes in position against the forces encountered during injection of hot plastic resin into the mold, and which provides for a subsequent, quick cooling of the resin to prevent possible damage to the rope by the hot resin.

With the foregoing and other objects in view, the present invention comprises certain constructions, combinations and arrangements of parts and elements and selected operations, sequences and steps as hereinafter described, defined in the appended claims and illustrated in the accompanying drawing in which:

FIG. 1 is a fragmentary perspective view of a net spanning an opening to illustrate one manner in which a net manufactured in accordance with the invention may be used.

FIG. 2 is a plan view of a preferred embodiment of an improved connector formed about a pair of crossed ropes.

FIG. 3 is a side elevation view of the connector and ropes shown at FIG. 2.

FIG. 4 is a sectional elevation view through the connector as taken from the indicated line 4—4 at FIG. 2.

FIG. 5 is a sectional auxiliary view through the connector as taken from the indicated line 5—5 at FIG. 2.

FIG. 6 is a sectional elevation view of a two-piece mold for the manufacture of the connector by injection molding, with the mold blocks being closed together, the sectional view being taken through a central transverse plane of the mold which is at the same location as the section shown at FIG. 4, but with some portions of the mold being shown in broken lines and with portions being broken away to show constructions otherwise hidden from view.

FIG. 7 is a plane view of one face of the mold as taken from the parting line of the mold in the direction of the indicated arrows 7—7 at FIG. 6.

FIG. 8 is a plan view of the opposite face of the mold as taken from the parting line of the mold in the direction of the indicated arrows 8—8 at FIG. 6.

FIG. 9 is a plan view of a connector similar to FIG. 2, but showing an alternate embodiment incorporating the principles of the invention.

FIG. 10 is a sectional elevation view through the connector illustrated at FIG. 9, as taken from the indicated line 10—10 at FIG. 9.

FIG. 11 is a plan view of a connector similar to FIG. 2, but showing another alternate embodiment of the invention wherein the ropes are crossed at an inclination as to provide for a diamond-shaped net arrangement.

The present invention concerns the joining of two crossed ropes by a connector of thermoplastic resin which is formed about the ropes by an injection molding operation. The invention permits rope nets to be manufactured in a simple manner, and is especially useful for the manufacture of comparatively heavy rope nets, formed by ⅜-inch, ½-inch and even larger ropes.

To exemplify the use of such a net, FIG. 1 illustrates, somewhat diagrammatically, a portion of the entrance of a vertical shaft S, having a safety net N secured thereover, as by anchor hooks H holding the edges of the net about the sides of the shaft. The net, when used to prevent a person from falling into the shaft, is made of at least ⅜-inch rope with the mesh spacing being 6-inches or less.

Consonant with the present invention, the net N is manufactured by crossing spaced longitudinal ropes 20 and spaced transverse ropes 21, so designated as a

matter of convenience, and with the ropes at each crossing being secured together by connectors C having the general form of a button as illustrated at FIG. 2.

The connector C is preferably formed of one of several types of thermoplastic, synthetic resins, hereinafter called "Plastics," which are capable of being melted and molded to shape under the influence of heat and pressure. For example, suitable thermoplastic plastics having various melting points include: polystyrene m.p. 250°–400° F.; polyethylene m.p. 300°–450° F.; polypropylene m.p. 340°–450° F.; nylon m.p. 440°–600° F. Also such plastics can be blended with various fillers and reinforcing materials such as fiberglass, to improve the resistance to ultra violet light and to increase the strength of the material. Another group of plastics which may also be used for the manufacture of a connector include thermosetting types of plastics, for example, various types of polyester and polysulphide epoxy compounds.

One preferred plastic is polyethylene because it can be melted at a comparatively low temperature, has excellent molding qualities, and is very tough and somewhat elastic, being able to withstand considerable abuse, such as the stretching and pulling of the ropes without tearing or breaking. Moreover, polyethylene can be specified as a high density, medium density or low density material to obtain selected variations in its physical properties, a high density or medium density polyethylene being preferable for rope connectors disclosed herein.

The connector C is capable of being used with several different types of rope, such as ropes of manila, cotton and various types of plastics such as rayon, polypropylene and drawn nylon. However, in connection with the plastic ropes, it is to be noted that the connector is formed by a hot, melted plastic flowing about the rope in a mold and it may become important to select a connector material which will not melt or otherwise damage the strands of the ropes. On the other hand, the opposite result may be desired, that is to provide sufficient heat as to essentially weld the connector to the rope. Simple tests can determine whether or not a plastic of a selected type, suitable in other respects, can be used with a given rope.

The preferred type of connector C, illustrated at FIGS. 2 to 5, is in the form of a circular button holding a pair of crossed ropes **20** and **21**, having a diameter, preferably between three and four times the rope size, a maximum thickness of about twice the rope size and being generally symmetrical about a polar axis, normal to the plane of the ropes. As a matter of convenience, the following description will refer to the face of the connector shown at FIG. 2 as being the upper face, although it is recognized that in use, the connector may be oriented in any desired manner.

This connector is formed as a pair of tubular, crossed sheaths tightly embracing the ropes, an upper sheath **22** holding the longitudinal rope **20** and a lower sheath **23** holding the transverse rope **21**. These sheaths merge at the center of the connector with the crossed ropes within them being tightly squeezed together as at **24**, FIG. **4**, to minimize the thickness of the connector.

Each outward end of each sheath, **22** and **23**, terminates as a circular flange **25** having its outer wall **26** arcuate to form a portion of the circular, peripheral edge of the connector. These flanges are oriented to be centered at a common level, at a central plane through the connector normal to the polar axis thereof, with the ropes extending from each flange at a centered position so that the axes of all rope portions extending from the connector lie in the common central plane. Accordingly, the portion of each rope **20** and **21** within the connector, is arched as an offset to accommodate the other rope at the common crossing point, at the center of the connector, as in the manner illustrated at FIG. **4**. At the same time, the outward edge of each sheath **22** and **23** is arched, as at **27** and **28** respectively, to permit each sheath to better embrace the portions of the ropes **20** and **21** within the connector.

The crossed flanged sheaths **22** and **23**, in the shaped of a cruciform, are further reinforced and rigidified by arcuate rims **29** between the adjacent edges of adjacent flanges **25** to complete the circular, outer wall of the connector as illustrated. The pie-like spaces between the crotches of the crossed sheaths and these arcuate rims are enclosed by comparatively thin fillets **30**, at the central plane of the connector, to provide a continuity of structure.

This connector C includes four passageways **31**, one at each crotch of the cruciform shaped sheaths and these passageways are formed by retaining pins, hereinafter described. The connector also includes a shallow base socket **32** in the lower sheath **23** at the axis of the connector. To complete the unit thus described, a rosette mark **33** will appear at the top of the upper sheath **22**, opposite the socket **32**, which is a disruption resulting from the action of an injection nozzle at the wall of the mold wherein the connector is formed.

FIG. **6–8** illustrate a mold for forming the connector C upon a pair of crossed ropes. Injection molding apparatus capable of retaining the mold to move the mold section together and apart is conventional and need not be described. In the manufacture of a rope net, it is contemplated that the longitudinal and transverse ropes will be properly spaced apart on a suitable frame, and that the frame and the injection apparatus will be shiftable with respect to each other with suitable indexing controls to position the mold at each rope crossing point to form a connector, all in any suitable sequence of shifting operations.

The mold is formed as two half sections: a feed section **50** and a backing section **51**, so designated because of the location of an injection nozzle **52** in the feed section which enters the mold cavity at its center to form the rosette **33** heretofore described. This rosette is formed because a cross-like configuration of the nozzle exit is provided in lieu of a simple orifice to prevent a rope strand from accidentally blocking off the flow of plastic into the mold. These sections are separable at a suitable parting plane P, preferably at a central plane of the connector and move together and apart by conventional means, not shown. Also, other features of these mold sections are conventional. For example, each section may include cooling passageways **53** to carry a coolant liquid to reduce the setting time of a hot plastic material injected into the mold cavity. The backing section may include suitable guide pins **54** on the face plane of that section and the feed section may include mating sockets **55** on its face plane to assure proper re-

gistration of the mold sections when they come together.

The mold cavity is in the general form of the connector, having an upper sheath portion **22***a*, a lower sheath portion **23***a*, flange portions **25***a*, arcuate rim portions **29***a*, and spaces **30***a* to form the fillets **30**. A skilled die maker can form these features of the mold cavity, and will preferably form the cavity portions in each section **50** and **51** in a balance manner with the parting plane P at the center plane of the connector as illustrated.

A unique feature in high pressure injection molding resides in the passing of crossed ropes through the mold in order to inject the connect about them. Accordingly, passageways **56** extend from the mold cavity to each side of the mold, with each mold section **50** and **51** forming a half of the passageway. To prevent leakage of plastic from the mold cavity through these passageways, a gate ring **57** is located in each passageway adjacent to each flange portion **25***a* of the mold cavity which is sized to squeeze the rope extending through the passageway with sufficient tightness as to prevent flow therepast, but not so tight as to cut or otherwise damage the rope. Each gate ring **57** is formed as two half ring portions with a ring portion being at each mold section **50** and **51**.

To hold the crossed ropes **20** and **21** across the mold cavity and in position within the mold while the hot, viscous plastic is being injected into the mold cavity, four finger-like restraining pins **58** are mounted upon the backing section **51** to extend across the cavity parallel with the polar axis thereof. These restraining pins hold the crossed ropes at each crotch of the cross and prevent sidewise movement of the ropes. When the sections **50** and **51** are closed together, the pins **58** extend into sockets **59** in the feed section **50** of the mold. Accordingly, they form the passageways **31** through the connector C as heretofore described. As such, they may be tapered slightly to facilitate removing the connector from the mold after it is formed.

The force of viscous plastic injected from the nozzle **52** is substantial and is sufficient to push the ropes against the opposite wall of the mold cavity in the backing section **51**. Accordingly, a spacer pin **60** is provided at the center of the mold cavity opposite the nozzle **52** which protrudes a short distance into the sheath portion **23***a* of the mold cavity to contact and abut against the transverse rope section **21** when it is placed into the mold cavity. This forms the socket **32** in the finished connector.

The spacer pin **60** is also used to remove a finished connector from the mold after it has been formed upon a pair of crossed ropes and cooled and after the mold cavities **50** and **51** move apart. This pin **60** is ideally suited for an ejector since it is at the polar axis of the connector. To perform this ejection function, the connector pin is extended through an axially centered passageway **61** in the backing section **51** to function as a piston rod and terminate as a piston **62** in a hydraulic cylinder **63** carried upon the backing section **51**. The piston **62** actuates within the cylinder **63** to extend the spacer pin **60** outwardly and across the mold cavity as a single complete ejection movement, the length of the pin being sufficient to push the finished connector off the retaining pins **58** so that it may be easily removed from the mold. Suitable hydraulic lines extend from a regulator pressure source to the cylinder in any manner to extend and retract this spacer pin **60**, the lines not being shown in the drawing because the same may be an entirely conventional, well known arrangement for extending and retracting a rod such as the spacer pin **60**. It is apparent that the pin may also be arranged to eject with a suitable mechanical linkage instead of the hydraulic mechanism shown.

In operating the mold to manufacture a connector C upon a pair of crossed ropes, the mold sections **50** and **51** are initially separated and the crossed ropes **20** and **21** are located between the mold sections with the transverse rope **21** being at the side of the backing section **51**. First, the transverse rope **21** is placed in position against the backing section **51**, with the rope lying in the proper passageways **56** and placed between the two sets of pins **58**. Next, the longitudinal rope section **20** is placed in position against the backing section of the mold **51** and in its passageways and between the two sets of pins **58** crosswise from the rope **21**. Next, the mold cavity is closed and injection of hot fluid plastic commences. Restrained, as above described by the pins **58** and the spacer pin **60**, the plastic flows evenly about the ropes to form the connector.

After the connector is completed and cooled, the mold sections moved apart. The connector is secured to the restraining pins **58** and thus remains with the backing section **51**. Extension of the spacer pin **60** moves the connector off the pins, and the apparatus is ready for another cycle of operation.

FIGS. **9** and **10** illustrate a connector of a more simplified form, that is, in the general form of a flat, oblate spheroid **70**. The longitudinal and transverse ropes **20** and **21** extend through the spheroid **70** as heretofore described.

Although the sheath forms about the ropes are eliminated by using the bulky spheroid shape, it is still necessary to retain the ropes in position and accordingly, the passageways **31'** and the socket **32'** at the pole of the spheroid, will be formed in the modified connector, using a mold similar to that heretofore described, the spheroid being bounded by a circular wall **26'** from whence the rope portions extend. Also, the rosette **33'** will appear on the pole opposite the socket **32'**.

FIG. **11** illustrates a connector which is modified by inclining the ropes at an angle to provide for a diamond-shaped net or the like. This unit provides for an elliptically shaped connector with the wall **26''** being rounded to an elliptical form, but is otherwise substantially the same as the connector shown at FIG. **2**, having an upper sheath **22''** and lower sheath **23''** terminated by flanges **25''**. The flanges are connected by arcuate rims **29''** with the gaps closed by fillets **30''** as aforedescribed. The structure includes passageways **31''**, a socket **32''** which is not shown, and a rosette mark **33'** on the upper face of the unit.

We have now described our invention in considerable detail. However, it is obvious that others skilled in the art can build and devise alternate and equivalent constructions which are nevertheless within the spirit and scope of our invention. Hence, we desire that our protection be limited not by the constructions illustrated and described, but only by the proper scope of the appended claims.

We claim:

1. An injection mold to form a connector of synthetic resin plastic about a pair of crossed ropes, said connector being characterized by having a sheath embracing each rope, with each sheath merging into the other at the center of the connector where the ropes cross, and including:

a. a pair of opposing surface members adapted to move together to a select registration with their contacting surfaces defining the parting of the mold and with a portion of the mold cavity being formed in each member;

b. channels in the surfaces of each member forming passageways when the members are moved together to receive the pair of crossed ropes and permit the ropes to extend into and cross within the mold cavity;

c. an injection nozzle means in one member at the center of the mold cavity where the ropes cross each other;

d. an abutment pin in the other member at the center of the mold cavity opposite the injection nozzle means, and extended into the mold cavity to hold a pair of crossed ropes therein in position against the pressure of plastic being injected into the cavity through the nozzle; and

e. a plurality of restraining pins disposed within the said mold cavity and arranged perpendicular to said contacting surfaces, said restraining pins being located at the intersection of lines extended along the sides of the channels and across the mold cavity, whereby said ropes are held in a center position in the mold cavity and against the abutment pin when plastic is injected into the mold cavity.

2. In the organization set forth in claim 1, wherein:

said restraining pins and the abutment pin are mounted in the same member;

said abutment pin is shiftably carried in said member; and

means adapted to extend the abutment pin from its normal position in the mold cavity to a position therebeyond to remove a completed connector from the mold cavity and from the aforesaid restraining pins when the members are separated.

3. In the organization set forth in claim 1, including pressure rings in each passageway adjacent to the mold cavity adapted to tightly grip a rope therein, to prevent loss of plastic through the passageway when plastic is being injected into the cavity.

4. In the organization set forth in claim 1, wherein the nozzle exit into the mold cavity is divided into sections to prevent a rope portion within the cavity from closing off the exit.

5. A mold having an internal cavity for forming a connector around a plurality of crossed, elongated members, the mold comprising:

a. at least two sections separable along connecting surfaces which define a parting plane and a portion of said cavity being formed in each of said sections;

b. means for injecting hardenable material into said cavity for molding said connector;

c. a plurality of crossing passageways formed in said contacting surfaces and extending diagonally across said mold cavity;

d. said passageways being arranged to correspond with the desired position of said elongated members and sized to fit said members;

e. a plurality of restraining pins disposed within said mold cavity and arranged perpendicular to said contacting surfaces; and

f. said restraining pins being located at the intersection of lines extended along the sides of adjacent passageways so as to retain said elongated members in a centered position in the cavity when the hardenable material is injected into the mold cavity.

6. In the organization set forth in claim 5, further including:

means for supporting said crossed elongated members in a direction perpendicular to said contacting surfaces;

said supporting means including an abutment pin extending from one of said sections, centrally located within said cavity and perpendicular to said contacting surfaces so as to prevent movement of said crossed members when the hardenable material is injected into the cavity.

* * * * *