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(54) **High pressure hose coupling and apparatus for installing same**

(57) A high pressure coupling for hose-like objects comprises nipple portion (10) having outwardly projecting, rounded-off ribs (18) which cooperate with rounded-off grooves (32) in a sleeve-like member (30) so that the hose (40) inserted between the nipple portion and the sleeve-like member is held securely in position after the nipple portion is internally expanded with subsequent reduction of the cylindrical surface of the sleeve-like member. Both the nipple structure as well as the sleeve-like member are made from appropriate stock machined accurately to the required dimensions. Sharp edges (22) provided in the nipple portion anchor themselves securely in the crimped or flanged over end (36) of the sleeve-like member to assure a secure fastening between these two parts. A ram-actuated machine for installing the coupling includes a frame structure which supports a die assembly as well as guide columns slidably supporting a ram cap assembly. A method for making a connection to a reinforced hose includes stripping the outer layer off the end portion, inserting the end portion into a coupling, expanding the nipple of the coupling into engagement with the hose and reducing the diameter of the sleeve of the coupling to compress the hose.

FIG.1

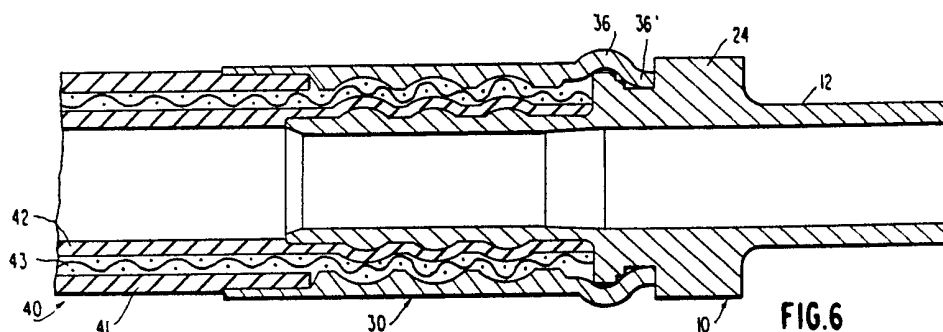
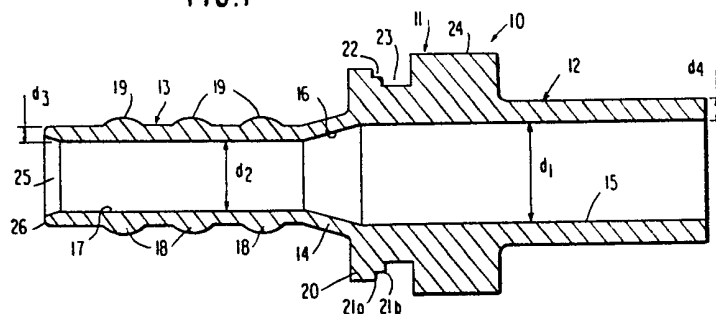


FIG.6

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FIG. 1

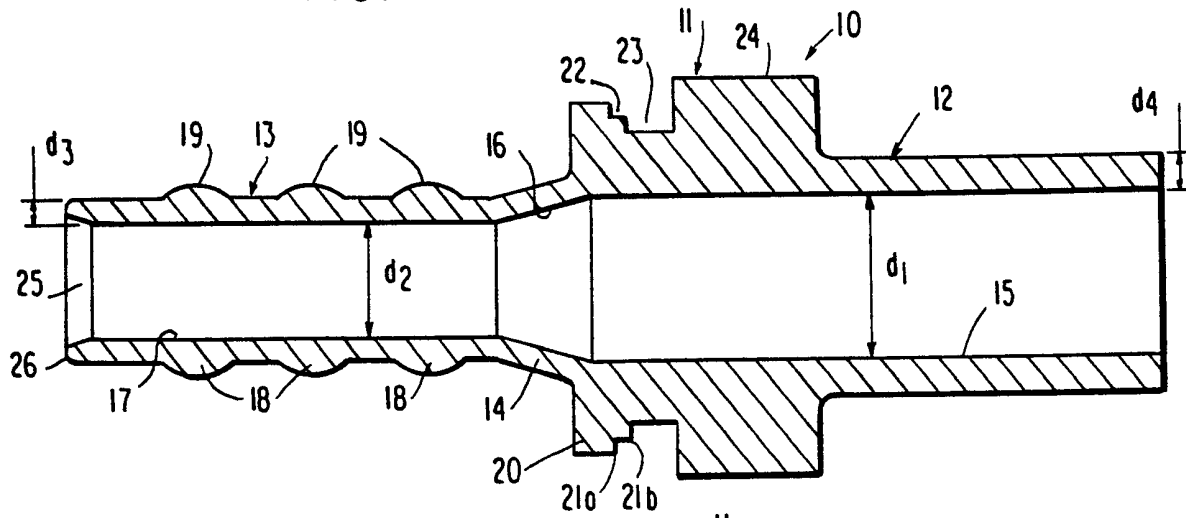


FIG. 2

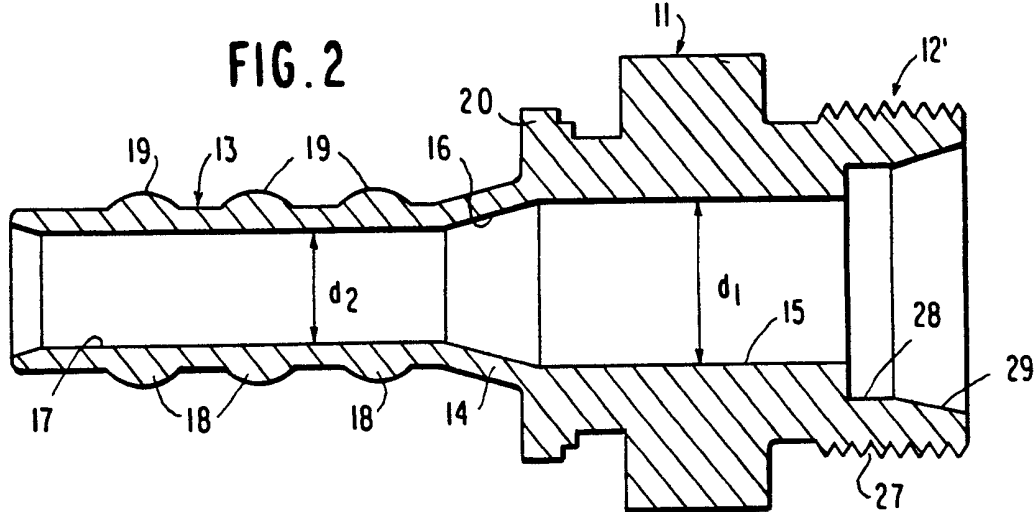
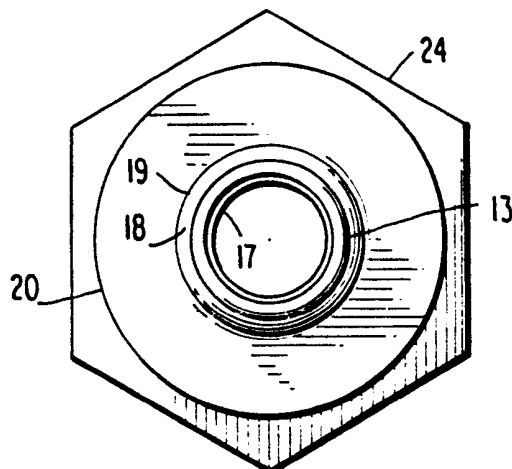


FIG. 3



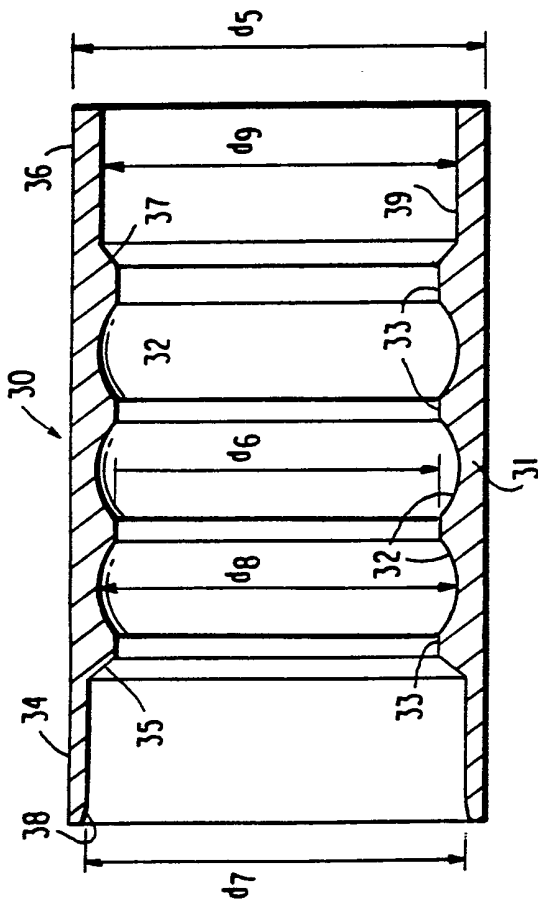


FIG. 5

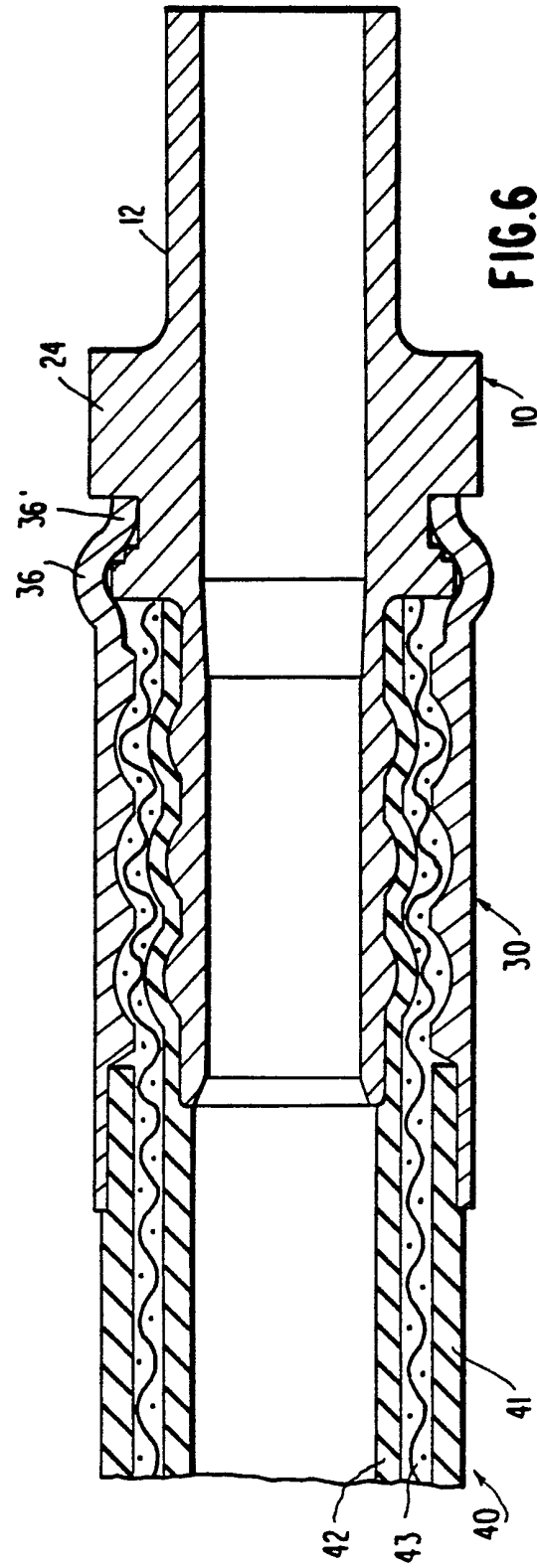
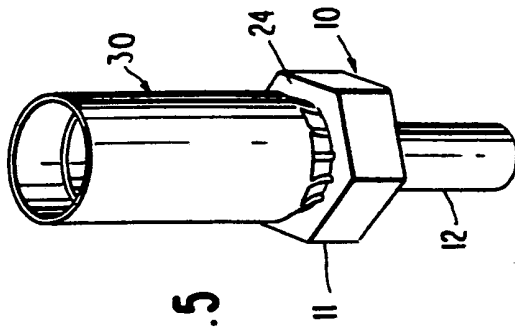
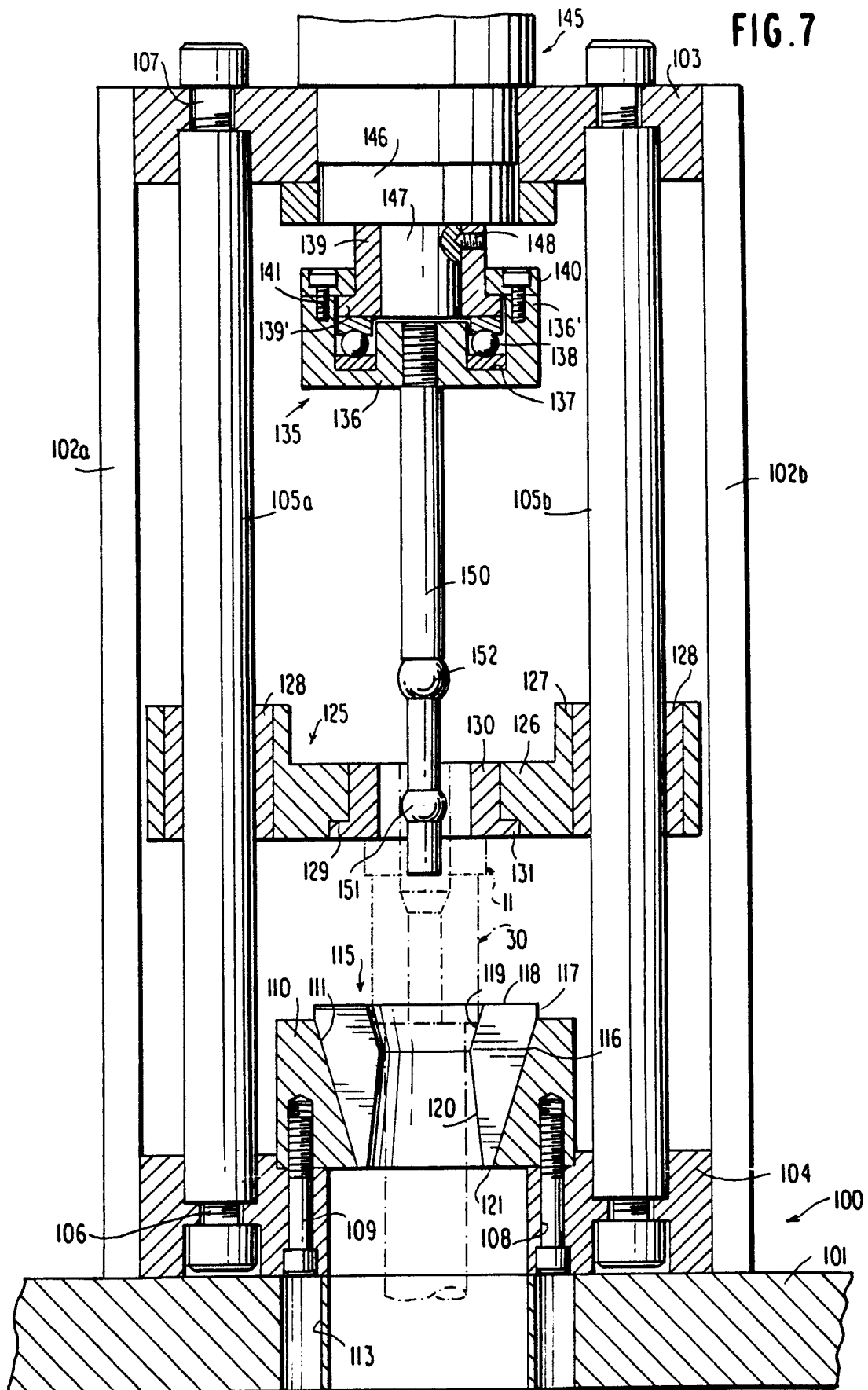


FIG. 6

FIG. 7



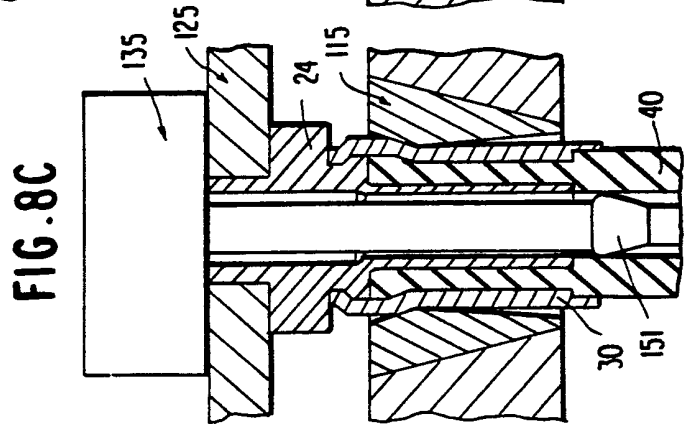
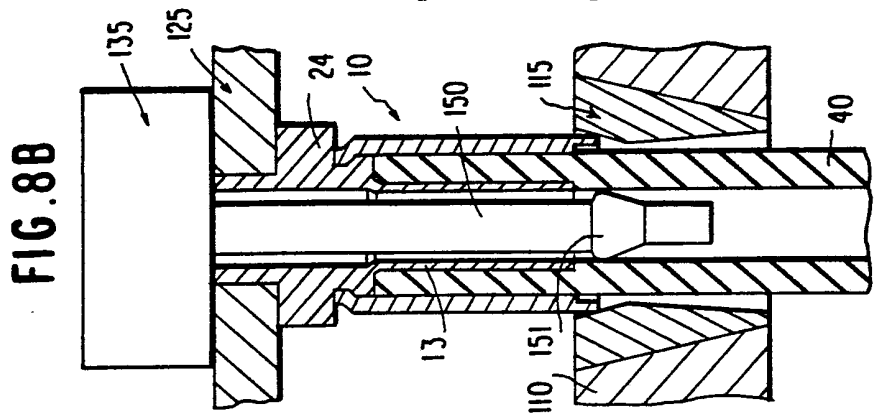
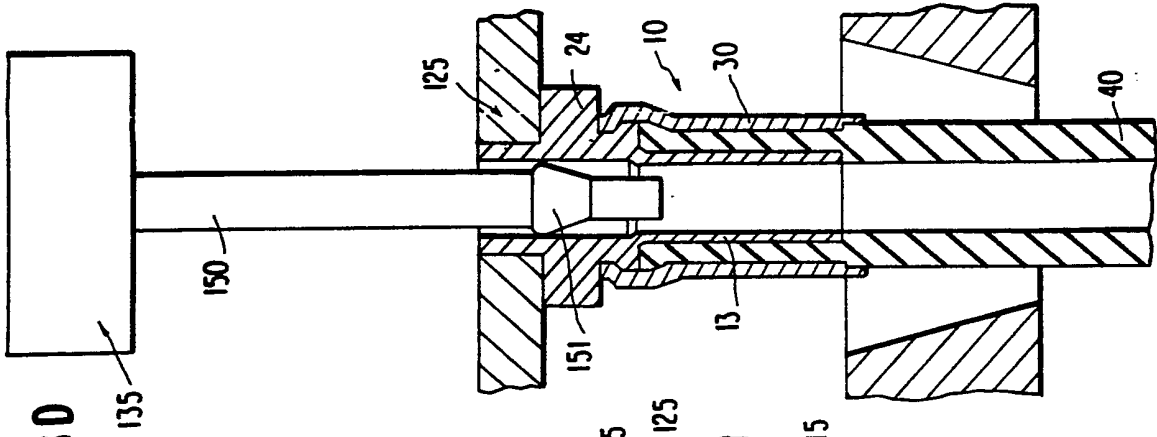


FIG. 8D

The present invention relates to a high pressure hose coupling and to an apparatus for installing the same.

BACKGROUND OF INVENTION

Hose couplings in which either the nipple is to be internally expanded or an external sleeve member is to be reduced in its external diametric dimension within the area of overlap with the hose are known as such. The U.S. Patent 1,786,489 to Hopkins, U.S. Patent 1,825,005 to Loughhead, U.S. Patent 2,216,839 to Hoffman, U.S. Patent 2,377,010 to Howard and U.S. Patent 2,595,900 to Soos are representative of such prior art. Additionally, couplings are known in the prior art which propose both internal expansion of the nipple and external compression of the sleeve member, as for example in U.S. Patent 2,399,790 to Conroy and U.S. Patent 2,865,094 to Press. However, all of these prior art couplings entail certain disadvantages which lessen their likelihood for successful use in high pressure applications. For example, sharp-edged teeth on the outside of the nipple or sharp-edged teeth on the inside of the sleeve member are likely to cause damage to the hose which seriously jeopardizes the holding ability. Additionally, in many instances the structural details of the couplings involve high manufacturing expenditures and complicated assembly and installation operations.

The aforementioned U.S. Patent 2,399,790 to Conroy describes a method for permanently attaching hose couplings in which internal expansion of the nipple is initially commenced followed by reduction of the diameter of the outer shell. However, in this patent the outer shell is integral with the head and with the externally threaded end so that the stem or insert has to be either threadably connected with the head or held in place by a flanged arrangement resting on the shoulder of the head of the coupling. This means that prior to attaching the hose coupling of Conroy, the latter must be preassembled. Additionally, the ram cap directly engages with the head integral

with the shell of the coupling so that the threaded, respectively, flanged connection between the insert and the coupling is likely to be subjected to large stresses.

The preferred embodiments of the present invention are concerned with the task to provide a hose coupling which is capable of withstanding extraordinarily high pressures and assures a long length of life, yet at the same time can be accurately manufactured from high quality material in a relatively economic manner by machining. Additionally, an embodiment of the present invention provides a machine which is simple in construction and yet which offers great versatility and substantially facilitates the installation of the hose coupling over the hose-like object to be held thereby.

A coupling which is relatively simple in construction, easy to manufacture and relatively easy to install yet is able to withstand high pressures is described in patent application 9002409.2 (GB2230313). While the couplings described in that application were able to withstand surprisingly high pressures, even higher pressures can be withstood with the use of the preferred couplings in accordance with this invention in conjunction with reinforced rubber hoses provided with several layers of metallic reinforcement. The preferred coupling in accordance with the present invention utilizes a sleeve-like member provided with internal rounded-off grooves machined into the same so that the external cylindrical surface of the sleeve-like member can be reduced in diametric dimension uniformly over its entire length in engagement with the hose-like object. This, in turn, permits the use of a machine allowing simplified installation of the coupling without increasing the cost of manufacture of the coupling in an excessive manner.

The underlying problems are solved according to the preferred embodiment of the present invention in that

the coupling consists of a nipple structure including a nipple portion provided with rounded-off external annular protuberances and a sleeve-like member provided with internal rounded-off circumferentially extending grooves whereby the sleeve-like member is adapted to be fixed onto the nipple structure by rolling, especially crimping the free end of the sleeve-like member facing the nipple structure into a groove between a collar and the head portion of the nipple structure, whereby sharp edges between the collar and the groove formed by a step, cut into the crimped free end of the sleeve-like member to assure a secure anchoring thereof onto the nipple structure.

Preferably the sleeve-like member is provided with a section of increased internal diametric dimension terminating in a flared, rounded-off end at its free end opposite the connection of the sleeve-like member to the nipple structure. This permits the hose-like object to bend as may be required in operation without experiencing damage due to the presence of the sleeve-like member.

The preferred machine in accordance with the present invention utilizes a die assembly having internal die surfaces tapering in mutually opposite directions for reducing the external diametric dimensions of the sleeve-like member after the internal dimensions of the nipple structure are expanded by insertion of a reciprocating mandrel provided with expanding members which preferably increase in size as the mandrel proceeds in its inserting direction. The ram cap assembly thereby engages with the head portion of the nipple structure which facilitates the assembly of the coupling over the hose-like object. Additionally, the preferred machine is so constructed and arranged that the various parts thereof are interchangeable for different size couplings without having to change or modify the basic structure of the machine.

The preferred embodiment of the present invention provides a high pressure hose coupling which is capable of withstanding extraordinarily high pressures and at the same time is easy to install and simple in construction as it consists only of two parts. In the preferred coupling the two parts of the coupling can be readily manufactured and assembled on a hose-like object to be held thereby. The preferred coupling can be readily machined and at the same time assures long life without danger of damage to the hose.

The preferred machine of the present invention is simple in construction, offers versatility in operation and permits ready interchange of the parts in case of change in the size of coupling.

The present invention will become more apparent from the following description when taken in connection with the accompanying drawing which shows, for purposes of illustration only, several embodiments in accordance with the present invention, and wherein:

Figure 1 is an axial longitudinal cross-sectional view through one embodiment of a nipple structure in accordance with the present invention;

Figure 2 is a longitudinal axial cross-sectional view through a modified embodiment of a nipple structure in accordance with the present invention;

Figure 3 is a left side end elevational view of the nipple structure of Figure 2;

Figure 4 is an axial longitudinal cross-sectional view through a sleeve-like member of a high-pressure coupling in accordance with the present invention;

Figure 5 is a perspective view of a preassembled high-pressure hose coupling consisting of the nipple structure of Figure 1 and the sleeve-like member of Figure 4;

Figure 6 is an axial longitudinal cross-sectional view through the hose coupling of Figure 5, installed over a reinforced hydraulic hose;

Figure 7 is a somewhat schematic view, partly in cross section, through a machine in accordance with the present invention for installing a high-pressure coupling over a hose-like object; and

Figures 8A through 8D are somewhat schematic cross-sectional views illustrating the sequence of operations of the machine illustrated in Figure 7.

DETAILED DESCRIPTION OF THE DRAWINGS

Referring now to the drawing wherein like reference numerals are used throughout the various views to designate like parts, and more particularly to Figure 1, reference numeral 10 generally designates therein a nipple structure in accordance with the present invention which consists of a main nipple portion generally designated by reference numeral 11, of a cylindrical connecting portion generally designated by reference numeral 12 for connection to some other part and extending from the main portion 11 toward the right as viewed in Figure 1, and of a nipple portion generally designated by reference numeral 13 which extends from the main portion 11 toward the left side, as viewed in Figure 1. The main portion 11 and the connecting portion 12 are provided with a bore 15 of substantially constant diametric dimension d_1 . The nipple portion is provided with an internal bore 17 of smaller diametric d_2 than the bore 15 and is connected with the latter by way of a tapering bore 16 provided in the tapering connecting portion 14 connecting the nipple portion 13 with the main portion 11. The nipple portion 13 which has a normal wall thickness d_3 is provided with several circumferentially extending protuberances 18 in the illustrated embodiment of Figure 1 with three annular beads or ribs 18 having

rounded-off outer surfaces 19 which may be formed by a part of a circle. The main portion 11 includes, starting from the tapering portion 14 and proceeding toward the right, a collar 20, two sharp edges 21a and 21b formed by a right angle step 22 leading to an annular groove 23 which in turn is adjoined by the head portion 24, preferably having a polygonal outer configuration, for example, a hexagonal configuration for engagement with a corresponding tool. The free left end of the nipple portion 13 terminates in a flared end 25 which is rounded off at 26 in order to minimize damage to the hose-like object. The tapering portion 14 has a wall thickness about the same as the normal thickness d_3 of the nipple portion 13 and extends at most only slightly underneath the collar 20 so as to minimize the work to be performed when the tapering portion 14 is expanded which depends on the overlying material thickness of the wall to be expanded. The wall thickness d_4 of the cylindrical connecting portion 12 can thereby be somewhat thicker than the normal wall thickness d_3 of the nipple portion as it is not subjected to any expansion as will be explained more fully hereinafter. The sharp edges 21a and 21b are important to assure a secure anchoring of the sleeve-like member as will be described more fully hereinafter.

The nipple structure of Figure 2 differs from the embodiment of Figure 1 only in that the connecting portion 12 of Figure 1 is replaced in Figure 2 by a shorter externally threaded connecting portion 12' and in that the internal bore 15 passes over on the right-hand side into a short cylindrical bore section 28 of larger diameter which leads to the outside by way of the tapered bore section 29. The external threads 27 on the connecting portion 12' are for connection with an internally threaded member (not shown) of any known construction. Figure 3 illustrates a left end view of the nipple structure of Figure 2 in which the external surfaces of the head portion 24 of the nipple main portion 11 are shown as hexagonal surfaces.

Figure 4 illustrates a sleeve-like member generally designated by reference numeral 30 for cooperation with a nipple

structure such as shown in Figure 1 or Figure 2. The sleeve-like member 30 which is made from cylindrical stock includes a main portion 31 provided with several rounded-off annular grooves 32, in the illustrated embodiment with three annular grooves 32 of part-circular shape. The sleeve-like member 30 has an external diametric dimension d_5 and a normal internal diametric dimension d_6 . The normal internal diametric dimension d_6 of the main portion 31 of the sleeve-like member 30 can be seen in the web portions 33 adjacent the annular grooves 32. The left end portion 34 of the sleeve-like member 30 has an internal diametric dimension d_7 which is larger than the diametric dimension d_6 and may even be slightly larger than the maximum depth of an annular groove represented by the dimension d_8 . The left most web section 33 passes over into the larger internal bore of the left end portion 34 by way of a bevelled tapering section 35. The right end portion 36 of the sleeve-like member 30 has an internal bore 39 with a diametric dimension d_9 which is smaller than the internal bore d_7 and may even be somewhat smaller than the maximum diameter d_8 of the annular grooves 32. The internal bore of diametric dimension d_6 of the right-most web section 33 is connected with the internal bore 39 of the right end portion by way of a bevelled tapering section 37. The free end of the left end portion 34 of the sleeve-like member 30 is formed by a rounded-off tapering portion 38.

The nipple structure of Figures 1 and 2 as well as the sleeve-like member of Figure 4 can be readily machined utilizing, for example, a programmed machine tool to assure economic operation. By utilizing machined parts, several advantages are obtainable. The dimensions can be carefully selected and made to accurate dimensions. It will also allow the use of a thicker material in the area of the annular ribs or beads 18 on the nipple portion 13 which in turn is more likely to maintain the given profile when the nipple portion is expanded. By being able to maintain accurate dimensions of the nipple structure and of the sleeve-like member, there is also greater assurance that the

non-expanded outer diameter of the nipple portion 13 will permit easy insertion into the hose-like object. Additionally, the larger dimensions d_7 of the left end portion 34 of the sleeve-like member 30 which is rounded-off at 38, permits the hose to bend in its installed condition without likelihood of hose damage. The inner diameter d_6 of the main portion 31 of the sleeve-like member 30 which can also be maintained quite accurately, will permit the free end of the hose to fit easily into the space between the nipple portion 13 and the sleeve-like member 30. In case a reinforced hose is to be connected to the coupling of this invention, its hose end, which is preferably turned down to approximately the outer surface of the metallic braiding, will fit easily into the space between the nipple portion and the sleeve-like member. Furthermore, machining the various parts from various stock sizes will permit the manufacture of parts accurately matched to given hose types and hose sizes.

In actual use, the sleeve-like member 30 is slipped over the free hose end whereupon the nipple portion 13 of the nipple structure 10 is inserted into the free end of the hose. The nipple portion 13 is thereupon expanded as will be described more fully hereinafter by reference to Figure 7 whereafter the external dimensions of the sleeve-like member 30 are reduced within the area of the nipple portion and the free end of the sleeve-like member facing the nipple structure is securely fixed to the nipple structure by rolling-in or crimping the free end portion 36 of the sleeve-like member 30 facing the nipple structure into the groove 23 in such a manner that the sharp edges 21a and 21b of the step 22 will cut into the inner surfaces of the thus-deformed free end portion of the sleeve-like member and thereby securely anchor the same onto the nipple structure, as indicated at 36' in Figure 6.

In the alternative, the nipple structure 10 and the sleeve-like member 30 may be preassembled by rolling-in or crimping the free end portion 36 of the sleeve-like member 30

facing the nipple structure 10 into the groove 23 in the manner described hereinabove to provide the preassembled coupling illustrated in Figure 5. As the various dimensions of the two machined parts constituting the thus-assembled nipple structure can be maintained accurately, assurance is given that the free end of the hose-like object will easily fit into the annular space between the nipple portion 13 and the sleeve-like member before the nipple portion is expanded and the sleeve-like member is thereafter reduced in its external diametric dimensions.

The assembly of the nipple structure 10 and of the sleeve-like member 30 thereby always takes place in such a manner that in the installed condition of the coupling, these two parts 10 and 30 are so axially aligned that the beads or ribs 18 of the nipple portion 13 coincide with the annular grooves 32 in the sleeve-like member 30.

It is thereby important to first expand the internal bore 17 of the nipple portion 13 before the external dimensions of the sleeve-like member 30 are reduced because this sequence of operation will assure that the internal dimensions of the expanded nipple portion, expanded to essentially the internal diametric dimension of the hose-like object, will remain substantially preserved notwithstanding the subsequent diametric reduction of the sleeve-like member.

In the event a reinforced hose is to be secured to the high-pressure coupling in accordance with the present invention, it is preferable to turn down the hose end to be inserted into the space between the sleeve-like member 30 and the nipple portion 13 so that the more or less exposed outer metallic surface of the reinforcement will increase the anchoring effects during the reduction of the diametric dimensions of the sleeve-like member as a result of metal-to-metal contact. Figure 6 illustrates somewhat schematically a hydraulic hose generally designated by reference numeral 40 having a metallic wire reinforcement 43 embedded between the outer and inner rubber layers 41 and 42. In the illustrated embodiment, the

reinforcement consists of four wire-spiral layers. As can be seen from Figure 6, the outer layer 41 of the hose 40 has been turned down within the area to be held between the expanded nipple portion 13 and reduced main portion 31 of the sleeve-like member 30. This permits metal-to-metal contact between the wire layers of the hose reinforcement 43 and the internal surfaces of the sleeve-like member 30. Of course, the dimensions to which the sleeve-like member 30 is machined will take into consideration the turned-down dimensions of the hose.

In a typical example for a high-pressure hose coupling consisting of the nipple structure of Figure 2 and of the sleeve-like member of Figure 4 for use with a reinforced hose having an inner diameter of about 12 mm. and an outer diameter of about 24.5 mm., the length of the nipple structure is 66 mm.; the length of the connecting portion 12' is 14 mm.; the length of the head portion is 10 mm. while the collar 20 is 2.5 mm. in length with the step about 1 mm. in axial length. The left-most annular rib 18 is spaced 9 mm. from the left end of the nipple portion 13 with the two further annular ribs 18 spaced each about 8 mm. from one another.

The internal diameter d_1 is 11.5 mm.; the internal diameter d_2 is 8 mm.; the outer diameter of the normal nipple portion is 11 mm., and the maximum thickness of the annular beads 18, i.e., the maximum radial dimension of the annular ribs 18 is 13 mm. The collar 20 has an outer diametric dimension of 24 mm. with the step 22 being spaced equidistantly between this outer dimension of 24 mm. and the outer diametric dimension of 20 mm. of the groove 23. The diametric dimension of the bore section 28 is 16 mm. whereby the transition from the tapering portion 14 into the collar 20 and the transition from the connecting portion 12' or 12 in Figure 1 are rounded off. The sleeve-like member 30, for use with the same hydraulic hose having its free end turned down to expose the outer surface of the metallic braid is as follows: the external diametric dimension of the non-deformed sleeve-like member d_5 is 28 mm.; the diametric dimension d_6 of

the internal bore 39 of the right end portion 36 is 24 mm., the internal diametric dimension d_7 of the left end portion 34 is 26 mm.; the normal internal dimension d_6 of the main portion 31 is 22 mm. with a maximum depth of the annular grooves 32 having a diametric dimension d_8 of 25 mm. The overall length of the sleeve-like member 39 is 49 mm. with the left end and right end portions 35 and 36 each about 10 mm. in axial length, with the annular grooves 32 equally spaced from one another at 8 mm. and with the maximum depth of the left-most annular groove 32 being at 16 mm. from the end of the left end portion 34 of the sleeve-like member 30.

In the installed condition illustrated in Figure 6, the internal diametric dimension of the nipple portion 13 is expanded to about 11 mm. in diameter while the external diametric dimension of the sleeve-like member 30 is reduced to about 26 mm. The foregoing are merely typical dimensions for a given hydraulic hose which can be varied as known to a person skilled in the art for different sizes and types of hoses.

A machine for assembling a high-pressure coupling onto the end of a hose-like object is illustrated in Figure 7. The machine of Figure 7 includes a frame generally designated by reference numeral 100 which includes a main base frame member 101 and two upright frame members 102a and 102b interconnected by a top frame member 103 and a bottom frame member 104. Guide columns 105a and 105b are threadably secured in the top and bottom frame members 103 and 104 by threaded connections 106 and 107. A die holder 110 is threadably secured to the bottom frame member 104 by means of bolts 109 extending through the bores 108 in the bottom frame member 104. The base frame member 101 is provided with bores 113 to permit access to the bolts 109. The die holder 110 is provided with inwardly downwardly tapering conical surfaces 111 for cooperation with complementary external tapering conical surfaces 116 of a die generally designated by reference numeral 115. The external tapering surfaces 116 of the die 115 are adjoined at the top by a short cylindrical surface

117. The die 115 is provided with a flat top surface 118 and a downwardly inwardly tapering first conical surface 119 adjoined by a downwardly outwardly tapering second conical surface 120. As the die holder 110 and the die 115 are circular in configuration, the surfaces 111, 116, 119 and 120 are conical surfaces. A flat bottom 121 of the die 115 is substantially flush with the bottom surface of the die holder 110.

A ram cap assembly generally designated by reference numeral 125 includes a ram cap member 126 of disk-like shape which includes a sleeve-like extension 127 slidably guided on guide columns 105a and 105b by way of slide bearings 128. An undercut 129 in the ram cap member 126 interchangeably accommodates a guide member 130 suitably secured to the ram cap member 126 in any known manner (not shown). The internal diametric dimension of the guide member 130 is thereby matched to the connecting portion 12 or 12' of the nipple structure 10 of Figures 1 and 2. The guide member 130 which is of approximately L-shape in cross section, includes radially outwardly extending leg portions 131 fitting into the undercut 129.

The ram head assembly generally designated by reference numeral 135 includes a main ram head member 136 provided with an axially extending rim portion 136'. The main ram head member 136 is provided with an annular recess 137 to accommodate a roller bearing 138. A connecting member 139 which is also of approximately L-shape in cross section, includes short leg portions 139' fitting into the space between the top of the bearing 138 and a top plate 140 threadably secured to the rim portion 136' of the main ram head member 136, the leg portions 139' being radially surrounded by the rim portions 136'. The top plate 140 is threadably secured to the main ram head member 136 by bolts 141.

The ram mechanism generally designated by reference numeral 145 may be of any known construction and is therefore not shown in detail herein. The ram mechanism includes a ram member 146 connected with a ram shaft 147 which in turn can be

adjustably secured to the connecting member 139 by one or more set screws 148. It is understood that the various parts so far described are of disk-like configuration.

A reciprocating spindle 150 which, threadably secured to the main ram head member 136, includes a first expanding member 151 followed by a second expanding member 152 of larger dimension than the expanding member 151 so that, as the spindle is moved downwardly into the bore of the nipple structure, the expanding member 151 will first expand the internal bore of the conical connecting portion and of the nipple portion whereby the second expanding member 152 will then further expand the internal dimensions thereof. Of course, any number of expanding members of any appropriate shape may be used. As the ram head assembly 135 moves downwardly together with the expanding mandrel 150, it will come into engagement with the ram cap assembly 125 while the tapering portion 14 and the nipple portion 13 are internally expanded to a diameter corresponding essentially to the internal diameter of the hose-like object. As can be seen from Figure 7, the disk-like recess, rectangular in cross section, formed in the top of the ram cap assembly 125 is large enough to accommodate the disk-like ram head assembly 125, also rectangular in cross section as seen in Figure 7. Continued downward movement of the ram head assembly 135 and ram cap assembly 125 will cause engagement of the latter with the head portion 24 of the nipple structure 10 and will cause the nipple structure 10 and therewith the sleeve-like member 30 to be forced into the tapering section 119 of the die 115 as the ram head and ram cap assemblies 135 and 125 continue their downward movement, actuated by the ram mechanism 145. This in turn will force the sleeve-like member 30 to undergo a reduction of its external diametric dimensions as it slides along the tapering surface 119 and passes through the area of greatest restriction formed by the intersection of die surfaces 119 and 120. Upon completion of the downward stroke of the ram head assembly 135, of the ram cap assembly 125 and of the mandrel 150, which completes the assembly operation, the spindle

150 is withdrawn from the now established high-pressure coupling which causes the latter to be frictionally taken along in the upward movement as will be explained by reference to Figures 8A through 8D, until the thus-assembled hose and high pressure coupling is removed by opening the split die 115.

O P E R A T I O N

The operation of the machine illustrated in Figure 7 will now be described by reference to Figures 8A through 8D, schematically illustrating the various positions of the parts of this machine in the course of the assembly operation.

Figure 8A illustrates the parts in their respective positions before the operation of the machine is commenced. The ram head assembly 135 together with the mandrel 150 carrying an expanding member(s) 151 are in their retracted position, i.e., in which the ram mechanism has returned these parts to their normal upper position. The high-pressure coupling 10 of this invention which in this case may be a preassembled coupling as shown in Figure 5, is mounted over the free end of the hose 40 which has been inserted from below through the die 115 until the hose end abuts at the main portion 24 with the open end of the sleeve-like member 30 now resting on the inwardly tapering surface of the die 115. The ram cap assembly 125 rests against the free shoulder of the main portion 24.

During downward movement of the ram head assembly 135 together with its mandrel 150, the expanding member 151 which is of smaller external dimension than the inner diameter d_1 of bore 15 (Figures 1 and 2) engages with the conical portion 14, and after internal expansion thereof, with the internal bore 17 of the nipple portion 13 to expand the same to an internal diameter corresponding approximately to the internal diameter of the hose. When the ram head assembly 135 comes into contact with the ram cap assembly 125, the expanding member 151 has completed its expanding operation. The set screw connection 148 (Figure 7) permits the necessary adjustment for different configurations of the nipple and in particular of the connecting portion 12 and 12'

thereof. The parts are now in the position illustrated in Figure 8B. As the hydraulic ram mechanism continues its downward movement, the sleeve-like member 30 is now forced into the die 115 and because of the conically tapering surface 119 thereof (Figure 7) is shrunk to the desired external dimension. Figure 8C illustrates the position of the parts in the lowermost position of the ram mechanism. As can be seen, the deforming pressure produced by the ram mechanism is transmitted from the ram head assembly 135 by way of the ram cap assembly 125 onto the nipple main portion 24 which in turn applies the necessary axial displacement force to the sleeve member 30 which had been previously secured to the nipple structure as described above.

Upon completion of the internal expansion and external compression operations, the ram mechanism withdraws the ram head assembly 135 together with the mandrel 150 by lifting the same. As the external compression may have slightly reduced the internal diameter of the previously expanded nipple portion 13, the frictional forces between the expanding member 151 and the nipple portion 13 will also cause the coupling 10 together with the hose 40 to be lifted, taking along also the ram cap assembly 125 guided on the guide columns 105a and 105b (Figure 7). Furthermore, frictional engagement between the external surface of the sleeve-like member 30 and the die 115 is likely to lift the die 115 out of the die holder 110. When upward movement of the ram cap assembly 125 on the guide columns 105a and 105b is limited by a stop member (not shown) of any conventional construction, the ram cap assembly 125 together with the coupling 10 assembled over the hose 40 will come to a stop so that continued upward movement of the ram head assembly 135 together with the mandrel 150 overcome any friction between the expanding member 151 and the previously expanded bore 17 and will cause thereby the expanding member 151 to re-expand the nipple portion 13 to its predetermined internal diametric dimension. After complete retraction of the ram head assembly 135 and mandrel 150, the split die 115 can now be opened so that the

parts now find themselves in the position illustrated in Figure 8D.

In case the connecting part of the nipple structure is provided with an external thread, it may be appropriate to provide the ram cap assembly 125 with a complementary internal thread so that the assembled coupling can be securely screwed into the same. As the ram forces are transmitted from the ram head assembly 135 to the main portion 24 of the nipple structure by way of the ram cap assembly 125, such threaded connection would not be subjected to any undue stresses.

The machine according to the present invention illustrated in Figure 7 offers a number of advantages. It is simple in construction and involves relatively few parts. It can be easily manipulated and additionally offers the significant advantage that the parts thereof can be readily exchanged to conform to the changed dimensions of different sizes of the coupling whose dimensions are, in turn, selected in accordance with the size of a given hose.

While I have shown and described several embodiments in accordance with the present invention, it is understood that the same is not limited thereto but is susceptible of numerous changes and modifications as known to those skilled in the art. For example, the coupling in accordance with the present invention may also be installed by other methods, as, for example, disclosed in my copending application Serial No. 07/409,721. Additionally, the various parts may also be modified to meet particular requirements by changing the dimensions and/or structural details thereof. Thus, I do not wish to be limited to the details shown and described herein but intend to cover all such changes and modifications as are encompassed by the scope of the appended claims.

CLAIMS

1. A high-pressure coupling with a nipple structure (10) and a sleeve-like member (30) for a hose-like object to be securely fastened thereby, characterized in that the nipple structure (10) includes a main portion (11), a connecting nipple portion (12, 12') extending from the main portion (11) in one axial direction of the nipple structure, a nipple portion (13) extending from the main portion (11) in the other axial direction of the nipple structure, whereby the nipple portion (13) has spaced, circumferentially extending protuberances (18) whose external surfaces (19) are rounded-off, in that the main portion (11) includes a collar portion (20) with at least one sharp-edged step (22) formed between the collar portion (20) and a circumferential groove (23) which is adjoined by a head portion (24), as viewed in the direction from the nipple portion in the one axial direction, in that the nipple portion (13) is connected with the collar portion (20) by way of a tapering portion (14), in that the main portion (11) and at least a part of the connecting portion (12, 12') are provided with an axial bore (15) of a substantially constant first diameter (d_1), in that the nipple portion (13) is provided with an axial bore (17) of a substantially constant second diameter (d_2) smaller than the first diameter (d_1) which passes over into the axial bore of the first diameter by way of a tapering bore (16) in the tapering portion (14) whereby the tapering portion (14) has a thickness approximately the same as the normal thickness of the nipple portion (13) within the area between circumferentially extending protuberances and the tapering bore (16) of the nipple portion extends at most only a slight distance underneath the collar portion (20), and in that the collar portion (20) has an external dimension smaller than the external dimension of the head portion (24),

and in that the sleeve-like member (30) cooperates with the nipple structure (10) to define a space accommodating the hose-like object (40) when assembled over the nipple structure, in that the sleeve-like member (30) has a substantially

cylindrical external surface (d_5) and includes a main portion (31) provided with rounded-off internal circumferential grooves (32) and having a normal internal diametric dimension (d_6) smaller than the external dimensions of the collar portion (20), in that the main portion (31) of the sleeve-like member (30) is adjoined in the one axial direction by a connecting portion (36) and in the other axial direction by an end portion (34), whereby the connecting portion (36) of the sleeve-like member (30) has an internal diametric dimension (d_7) larger than the normal internal diametric dimension (d_6) of the main portion (31) and at least slightly larger than the external dimensions of the collar portion (20) so as to slidably fit over the same, and in that the free end portion (34) of the sleeve-like member (30) has an internal diametric dimension (d_8) at least as large as the internal diametric dimensions (d_7) of the connecting portion (36) of the sleeve-like member (30).

2. A high-pressure coupling according to claim 1, characterized in that the sleeve-like member (30) is preassembled onto the nipple structure (10) by crimping the free end of the connecting portion (36) into the circumferential groove (23) of the main portion (11) of the nipple structure (10) in such a manner that the sharp-edged step (22) cuts into the crimped free end of the connecting portion (36) of the sleeve-like member (30) to securely anchor and fix the sleeve-like member (30) on the nipple structure (10).

3. A high-pressure coupling according to claim 2, characterized in that the axial length of the collar portion (20) as well as its external dimensions are so chosen in relation to the internal dimension (d_7) of the connecting portion (36) of the sleeve-like member that the collar portion (20) can serve to center the sleeve-like member (30).

4. A high-pressure coupling according to any one of claims 1-3, characterized in that the nipple structure (10) and the sleeve-like member (30) are provided as separate parts to be securely connected with each other by crimping the free end of the connecting portion (36) of the sleeve-like member (30) into the circumferential groove (23) of the main portion (11) of the nipple structure (10) in securely anchoring relationship with the sharp-edged step (22), after the sleeve-like member (30) and the nipple structure (10) are assembled over, respectively, into the hose-like object (40).

5. A high-pressure coupling according to any one of claims 1-4, characterized in that the nipple structure (10) is made from a single piece of material.

6. A high-pressure coupling according to any one of claims 1-5, characterized in that the sleeve-like member (30) is made from a single piece of material.

7. A high-pressure coupling according to any one of claims 1-6, characterized in that the free end of the nipple portion (13) has an outwardly flared end portion (25) terminating in a rounded-off end (26).

8. A high-pressure coupling according to any one of claims 1-6, characterized in that the connecting portion (12) of the nipple structure is a substantially cylindrical part of substantially constant internal and external dimensions (Figure 1).

9. A high-pressure coupling according to any one of claims 1-7, characterized in that the connecting portion (12') of the nipple structure is provided with an external threaded portion (27) for connection with complementary internal threads of a part to which the coupling is to be connected (Figure 2).

10. A high-pressure coupling according to any one of claims 1-7 and 9, characterized in that the connecting portion (12') of the nipple structure (10) is provided with an internal bore section (28) of larger internal dimensions than the axial bore of the first diameter (d_1) and terminates in a tapered bore section (29) leading to the outside.

11. A high-pressure coupling according to any one of claims 1-10, characterized in that the transition from the tapering portion (14) into the collar portion (20) is rounded-off.

12. A high-pressure coupling according to any one of claims 1-11, characterized in that the normal external dimensions of the connecting portion (12, 12') of the nipple structure (10) are smaller than the external dimensions of the collar portion (20).

13. A high-pressure coupling according to any one of claims 1-12, characterized in that the collar portion (20) has a cylindrical external surface, while the head portion has a polygonal external surface (24) for engagement with a tool.

14. A high-pressure coupling according to any one of claims 1-13, characterized in that the free end of the end portion (34) of the sleeve-like member (30) terminates in a rounded-off configuration (38).

15. A high-pressure coupling according to claim 14, characterized in that the rounded-off configuration of the free end of the end portion (34) of the sleeve-like member (30), in effect, also provides a slight taper (38).

16. A high-pressure coupling according to any one of claims 1-15, characterized in that the inner diameter (d_7) of the end portion (34) of the sleeve-like member (30) is larger than

the inner diameter (d_7) of the connecting portion (36) of the sleeve-like member (30).

17. A high-pressure coupling according to any one of claims 1-16, characterized in that the circumferential grooves (32) in the main portion (31) of the sleeve-like member (30) are part-circular in shape in an axial cross section, and in that the maximum diametric dimension (d_8) of a circumferential groove is within the range between the inner diametric dimension (d_7) of the end portion (34) of the sleeve-like member (30) and the inner diametric dimension (d_9) of the connecting portion (36) of the sleeve-like member (30).

18. A high-pressure coupling according to any one of claims 1-17, characterized in that the normal inner diametric dimension (d_6) of the main portion (31) of the sleeve-like member (30) is connected with the inner diametric dimensions (d_9 , d_7) of the connecting portion (36) and of the end portion (34) of the sleeve-like member by way of tapering portions (37, 35).

19. A high-pressure coupling according to any one of claims 1-18, characterized in that the nipple structure (10) and the sleeve-like member (30) are so dimensioned that in the assembled position thereof the peaks of the circumferentially extending protuberances (18) of the nipple portion (13) coincide at least approximately with the troughs of the circumferentially extending grooves (32) in the main portion (31) of the sleeve-like member (30) while the parts of the nipple portion (13) between adjacent circumferentially extending protuberances (18) which have the normal nipple portion thickness (d_3), correspond at least approximately with the parts of the main portion (31) of the sleeve-like member (30) which have the normal internal diametric dimension (d_6).

20. A high-pressure coupling according to any one of claims 1-19, characterized in that the nipple structure (10) and the sleeve-like member (30) are machined from cylindrical stock.

21. A method of making a high-pressure connection between a reinforced hose (40, 41, 42, 43) having at least one reinforcing layer (43) embedded in the hose (41, 42), on the one hand, and a coupling assembly which includes a nipple structure (10) with a nipple portion (13) and a sleeve-like member (30), on the other, characterized in that the external hose material (41) is removed at least close up to the outer surface of the reinforcing layer (43) over a predetermined axial distance from the free hose end to be connected to the coupling, in that the thus-removed free end is placed within the space defined between the inner and outer surfaces of the axially assembled sleeve-like member (30) and nipple portion (13) having rounded-off annular protuberances (18) whereby the predetermined axial distance corresponds approximately to a main portion (31) of the sleeve-like member (30) provided with internal circumferential grooves (32), in that the nipple portion (13) of the nipple structure (10) is then expanded from its original diametric dimension (d_2), which was smaller than the internal diametric dimension of the hose, to at least close to the internal diametric dimension of the hose (40), and in that the cylindrical outer surface (d_5) of the sleeve-like member (30) is thereafter uniformly reduced so as to firmly hold the hose compressed thereby by the cooperation of the circumferentially extending grooves (32) in the main portion (31) of the sleeve-like member (30) and the annular protuberances (18) of the nipple portion (13).

22. A method according to claim 21, characterized in that the nipple structure (10) and sleeve-like member (30) are so assembled that peaks and troughs formed by the annular protuberances (18) of the nipple portion (13) coincide essentially with troughs and peaks of the circumferentially

extending grooves (32) in the main portion (31) of the sleeve-like member (30).

23. A method according to claim 21 or 22, characterized in that the sleeve-like member (30) is securely anchored on the nipple structure (10) by crimping the end (36) of the sleeve-like member (30) facing the nipple structure into a groove (23) provided in the main portion (11) of the nipple structure (10) which includes exposed sharp-edged steps (22).

24. A method according to any one of claims 21-23, characterized in that the crimping step takes place before the hose (40) is located in the space between the nipple portion (13) and the sleeve-like member (30).

25. A method according to any one of claims 21-23, characterized in that the crimping step is carried out only after the sleeve-like member (30) has been mounted over the hose (40) and the nipple portion (13) has been inserted into the hose (40).

26. A machine for assembling a high-pressure coupling onto a hose-like object (40), in which the high-pressure coupling includes a nipple structure (10) with a main portion (11) and a nipple portion (13) having an original internal diameter (d_2) smaller than that of the hose-like object into which it is to be inserted, and a cylindrical sleeve-like member (30) which is to be arranged on the outside of the hose-like object, characterized in that the machine includes a relatively fixed frame (100, 101, 102a, 102b, 103, 104) including at least one upright guide member (105a, 105b), a die assembly including a die holder (110) secured to the frame (104) and a deforming die (115) held in the die holder (110), whereby the deforming die (115) has internal first and second surfaces (119, 120) tapering in opposite directions, a ram cap assembly (125) slidably mounted on the guide members (105a, 105b) and operable to engage with the main portion (11) of the nipple structure (10), a ram mechanism (146) operable to

produce a ram pressure, a ram head assembly (135) operable to be selectively lowered and raised by the ram mechanism (146) and operable to take along the ram cap (125) in its downward movement, a reciprocating spindle (150) operatively connected with said ram head assembly (135) and including at least one expanding device (151, 152), so that the spindle (150) is operable to expand the internal diametric dimensions of the nipple portion (13) during forcible downward movement of the ram mechanism (146) by way of the ram head assembly (135) with the sleeve-like member (30) initially resting on the inwardly tapering first surface (119) of the deforming die (115), whereby the external diametric dimensions of the sleeve-like member (30) are reduced, after expansion of the internal dimensions of the nipple portion (13) has been substantially completed, by forcing the sleeve-like member (30) through the inwardly tapering first surface (119) of the deforming die (115) by continuing application of force onto the sleeve-like member (30) by the ram mechanism (146) by way of the ram head assembly (135) in engagement with the ram cap assembly (125) which, in turn, applies pressure to the sleeve-like member (30) by way of the main portion (11) of the nipple structure (10).

27. A machine according to claim 26, characterized in that means (148) are provided for adjusting the axial position of the spindle (150) relative to the ram mechanism (146).

28. A machine according to claim 26 or 27, characterized in that the expanding device includes several expanding members (151, 152) which increase in size on the spindle (150) opposite the direction of expanding movement of the spindle.

29. A machine according to any one of claims 26-28, characterized in that a stop is provided to limit movement of the ram cap assembly (125) on the guide members (105a, 105b) in a direction opposite the expanding direction.

30. A machine according to any one of claims 26-29, characterized in that the die (115) is a split die operable to be opened upon completion of the coupling assembly operation.

31. A high-pressure coupling, substantially as hereinbefore described with reference to the accompanying drawing.

32. A method of making a high-pressure coupling, substantially as hereinbefore described with reference to the accompanying drawing.

33. A machine for assembling a high-pressure coupling, substantially as hereinbefore described with reference to the accompanying drawing.