The invention relates to hypodermic needle units of the type usable with hypodermic syringes and, more particularly, relates to a hub and a needle tubing assembly and a method of making the assembly.

It is an object of the present invention to provide a new and improved hypodermic needle unit wherein the forces acting to join together a hub and needle tubing are substantially uniform throughout all points of contact between the hub and needle tubing.

It is a further object of the present invention to provide a hypodermic needle unit wherein a hub and a needle tubing are maintained in assembled relation by frictional and interlocking engagement.

Another object of the present invention to provide a new and improved method of assembling a hub and a needle tubing to produce a hypodermic needle unit.

It is yet another object of the present invention to provide a method of assembling a hub of predetermined size with a needle tubing having one of a plurality of different diameters or having one of a plurality of different cross sections.

It is another object of the present invention to flow the material of a hub into engagement with a needle tubing in such a manner as to increase the tensile and compressive strength relative to the unwoked hub, whereby the resistance to deformation of the worked hub is appreciably increased due to the work hardening of the material attendant with the working of the hub.

It is a further object of the present invention to assemble a hub to a needle tubing by causing the material in an oversized collar of the hub to flow into engagement with substantially the entire portion of the tubing extending within the collar while at the same time increasing the thickness of the collar, thereby to provide a very strong joint.

It is yet another object of the present invention to assemble a hub and a needle tubing so that substantially uniform gripping forces act at all points of contact between the hub and the tubing with the result that no localized stress points are developed.

The above and other objects of the present invention are realized by the provision of a new and improved hypodermic needle unit and a method for making the unit.

Briefly, the hypodermic needle unit comprises a hub provided with a collar in engagement with an end of a needle tubing. Substantially the entire length of the needle tubing disposed within the hub is reduced in diameter so that interlocking and frictional engagement is effected with substantially the entire hub. By this construction, the needle unit has a high "pull strength" and "push strength," i.e., the unit is able to penetrate tough membranes or tissues and is able to be withdrawn from bone or muscle without becoming unjoined. Moreover, the forces acting to secure the hub and tubing together are uniformly distributed over the area of contact with the result that local stress concentrations are avoided.

In accordance with a method of assembling the needle tubing and the hub, the needle tubing having one of many different sized diameters is disposed within the oversized collar of the hub. The collar material is caused to flow into engagement with substantially the entire length of the hub extending into the collar; the thickness of the collar being increased and the material in the collar being work hardened so that the tensile and compressive strength of the worked collar are increased to provide a strong and rugged joint. The configuration of the collar is substantially changed while substantially the entire length of the tubing within the hub is reduced in diameter to provide an interlocking, as well as frictional, engagement with substantially all of the collar.

The invention both as to its organization and method of operation, together with further objects and advantages thereof, will best be understood by reference to the following description, and in connection with the accompanying drawing, in which:

FIG. 1 is a perspective view of a hypodermic needle unit comprising an assembled hub and needle tubing and characterized by the features of the present invention;

FIG. 2 is an enlarged sectional view, illustrating the hub before assembly;

FIG. 3 is a fragmentary sectional view, illustrating initial working of the hub caused by fixedly positioning the hub to a mandrel prior to assembly with the needle tubing;

FIG. 4 is a fragmentary sectional view, illustrating the position of the needle tubing within the hub prior to final working of the hub;

FIG. 5 is a fragmentary sectional view, illustrating the shape of the hub during final working;

FIG. 6 is a fragmentary sectional view, illustrating the hub and needle tubing after final working in their assembled position;

FIG. 7 is a sectional view taken along line 7-7 of FIG. 4;

FIG. 8 is a view similar to FIG. 7, illustrating a needle tubing having a square cross section; and

FIG. 9 is a fragmentary sectional view of the needle unit illustrating the relative position of the hub and needle tubing after the needle tubing is being inserted.

Referring now to the drawing, and particularly to FIG. 1, a hypodermic needle unit 10 characterized by the features of the present invention is illustrated therein and comprises a hub 11 connected at its upper end to the lower end of an elongated needle tubing 12. The needle unit 10 is usable with suitable hypodermic syringes (not shown) and may be of the disposable type. A single needle unit 10 and a single syringe are assembled together by manually inserting an end of the syringe into the open ended base 11a of the hub 11. The syringe and the unit 10 are maintained in assembled relation by the friction between the hub 11 and the end of the syringe or, alternatively, by staking portions of the hub to the syringe to provide interlocking engagement therebetween.

Considering now the hypodermic needle unit 10 in greater detail, and referring specifically to FIGS. 1 and 6, the hub 11 is stamped from a workable metallic material, for example, aluminum, and includes a generally frusto-conical wall 14 terminating at its bottom end in the open ended base 11a which comprises an outwardly flared annular rim 13. The upper portion of the wall 14 is connected to an inwardly extending annular shoulder 15 which interconnects the wall 14 with an upstanding collar 16 of generally cylindrical configuration, the outer wall 16a of the collar 16 and the upper surface 15a of...
the shoulder 15 being right angularly related. As best shown in FIG. 6, the collar 16 is concentric with the longitudinal axis of the hub 11 and extends downwardly a slight distance beneath the shoulder 15 and upwardly a substantial distance above the shoulder 15, the upper end 16a of the collar 16 being inclined downwardly and outwardly at approximately a 30 degree angle with the vertical. The collar 16 defines along the axis of the hub a vertical bore 17 which extends throughout the entire height of the collar 16 and accommodates the lower end 12a of the needle tubing 12. The needle tubing 12 is manufactured from a metal tubing, for example, stainless steel, and includes a longitudinal passageway 12b for transporting fluid from the hub 11 along the tubing 12 to the membrane or tissue in which the tubing is disposed. The upper end 12c of the tubing 12 is tapered and/or beveled, as is well-known, to provide a sharp cutting edge or point to facilitate insertion of the tubing 12 into the membrane or tissue. The lower end 12a of the needle tubing 12 is supported from the collar 16 so that the body of the needle tubing 12 extends upwardly from the hub 11 along its longitudinal axis.

The needle tubing 12 and the hub 11 are so secured together that the needle unit 10 has what may be characterized as high "push strength," i.e., the tubing is able to penetrate even the toughest membrane or tissue without separating from the hub 11 and, more importantly, has what is characterized as high "pull strength," i.e., the tubing may be withdrawn from the tissue by applying a force to the hub without causing the hub to be separated from the tubing. In this connection, substantially the entire lower end 12a of the needle tubing 12 is narrowed or slightly reduced in diameter by the worked collar 16 so that both interlocking and frictional engagement between the tubing 12 and the collar 16 is obtainable. The reduction in the diameter of the tubing 12 only slightly reduces the width of the longitudinal passageway 12b and, accordingly, the flow of fluid through the needle tubing 12 is not obstructed or restricted.

In accordance with an aspect of the present invention, the hub 11 is so constructed that when the needle tubing 12 is inadvertently bent, the tubing 12 does not rupture or fracture but instead is gradually bent over the upper end of the hub 11 which is deformed by the wall of the needle tubing as it is bent. As described above, the upper end 16a of the collar 16 is inclined relative to the cylindrical surface of the tubing at an approximate angle of 30 degrees so that only a small annular wedge shaped portion 16b at the upper end of the collar 16 acts to support the needle tubing 12. Thus, as the needle tubing 12 is bent, as shown in FIG. 5, part of the wedge shaped portion 16b is gradually deformed to provide a rounded or curved surface, instead of a knife-like edge, about which the needle tubing 12 is permitted to bend.

Considering now the method of assembling a hub and needle tubing in accordance with the present invention, a selected one of a plurality of different sized needle tubings is secured to the above described hub having a predetermined oversized collar for accommodating the selected tubing. Briefly, the collar 16 of the hub 11 is caused to flow into interlocking and frictional engagement with the lower end of the tubing, so that the thickness of the collar is increased and the tensile and compressive strength of the collar material is increased thereby by increasing the resistance of the worked collar to subsequent deformation. As a result of the assembly operation, a uniform gripping force is developed at the area of contact between the hub and the needle without creating localized stress concentration points.

The hub 11, as indicated above, is stamped from aluminum which is readily workable without fracture when subjected to a working pressure or force. When the aluminum is stressed above its elastic limit it becomes fluid or pliable but when the force is removed the aluminum is stable in the sense that it assumes and maintains its deformed shape. As best shown in FIG. 2, the unworked hub 11 has a collar 16 provided with an oversized bore 19, which collar 16 is connected to the shoulder 15 by a rounded portion, identified by reference numeral 18. The upper end of the collar 16 is inclined downwardly and outwardly to facilitate its working as described below. It will generally be understood that 16 is not necessary that the upper end of the collar be inclined but that it may be rounded or flat.

In accordance with an important aspect of the invention, the collar 16 is oversized to accommodate any one of a number of different sized needle tubings which may be assembled to the hub by the same hereinafter described assembly operation. By using the oversized collar, the problem of tolerances and the problem of aligning a needle and a same size collar is eliminated. In practice, it has been found that a needle tubing having an outside diameter from .021 to .036 inch may be provided having a collar with a .062 inch inner diameter, the collar having sufficient material to be worked about the end of the tubing to provide a strong joint.

The first step in assembling the hub 11 and the tubing 12 is to place the hub 11 manually or automatically over a mandrel 20 having a generally circular upper wall 20a and a generally conical wall 20b. The hub 11 centers itself automatically on the mandrel 20 by the coaction of the lower end of the hub wall 14 with the frustroconical wall 20b of the mandrel 20 and by the coaction of the shoulder 15 with the upper surface 20a of the mandrel 20. With the hub centered on the mandrel, the upwardly extending collar 16 is aligned with the axis of the mandrel 20 so that it is disposed immediately above a depression 22 defined in the center of the upper surface 20a of the mandrel 20. As shown, the bottom 22a of the depression 22 is several times less wide than the width of the collar 16 so that the depression 22 converges downwardly and inwardly, which wall 22a serves to support the tubing 12 within the collar 16 as described below. Although it is preferable that a depression 22 be provided in the mandrel so that the tubing extends beneath the shoulder, it is not necessary that a depression be provided in the mandrel or that the tubing extend below the shoulder. Accordingly, a mandrel having a flat upper surface could alternatively be used and would be satisfactory.

In order to prevent movement of the hub 11 during the assembly operation, the hub 11 is fixedly seated on the mandrel 20. In this connection, a retainer 24 having a bore 26 for receiving the collar 16 is lowered into engagement with the shoulder 15 of the hub 11, thereby to hold the shoulder 15 between the mandrel 20 and the retainer 24. In the process of lowering the retainer 24 onto the upper surface of the shoulder 15, the hub is initially worked and specifically the interconnecting portion 18 of the hub is worked, as shown in FIG. 3, to provide a sharp annular edge 28 defined between the right angularly related outer surfaces of the shoulder 15 and collar 16. The sharp annular edge 28 restricts the collar material from flowing horizontally along the shoulder 15. Accordingly, during the working step described below the collar material is constrained to flow inwardly toward the longitudinal axis of the hub instead of outwardly away from the axis of the hub.

The next step comprises disposing the tubing 12 and the hub 11 in pre-assembled alignment. This is effected by seating the lower end 12a of the needle tubing 12 against the inclined wall 22b of the depression 22 in the mandrel 20, the extreme lower end of the tubing 12 being at a particular height above the bottom 22a corresponding to the tubing diameter. For example, the greater the tube diameter, the higher the end of the tube is located above the bottom 22a of the depression and vice versa. In any event, the tubing 12 is maintained along the axis of the hub 11 and thus is centered relative to the hub by a hydraulic pressure ram 30 which is sidly posi-
tioned, as shown in FIG. 4, in the bore 26 defined in the retainer 24. Other apparatus could alternatively be used to maintain the tubing along the axis of the hub 12. In any event, the ram 30 is in slidable engagement with the bore 26 and includes a longitudinal bore 32 for slidably accommodating the body of the needle tubing 12, thereby to permit the ram 30 to be moved downwardly relative to the tubing 12. A particular ram with a particularly sized bore is used for each different sized tubing so that irrespective of the tubing diameter, the tubing is maintained along the axis of the hub prior to and during working of the collar 16 by the ram. With the hub 11 and needle tubing 12 in their pre-assembled position, the collar 16 is entirely confined within a chamber 23 defined by the mandrel 20, the retainer 24, and the ram 30 with the result that the collar material is unable to pass between the mandrel 20 and the retainer 24 but only is able to be worked toward the tubing.

The collar 16 is caused to flow into engagement with the lower end 12a of the needle tubing 12 by actuating the hydraulic pressure ram 30 so that the ram 30 moves downwardly in the bore 26 in intimate engagement with the collar 16. As the lower surface 30a of the ram 30 engages the upper surface of the collar 16, a working force is applied to the collar, which working force causes the yield point or elastic limit of the material to be exceeded so that a plastic flow of the material results. Because the collar 16 is confined within the chamber 23 and the lower surface 30a of the ram diverges downwardly, the material is caused to flow inwardly and downwardly toward the end 12a of the tubing 12.

As the ram 30 continues to move downwardly, more of the collar material flows into engagement with a greater portion of the wall of the tubing 12. At the same time, the size of the chamber 23 decreases to further confine the movement of the collar material. Actually, the collar material initially flows into engagement with the entire wall of the needle tubing and in this connection flows into the depression 22 in the mandrel 20— with only an insignificant narrowing of the needle tubing, as shown in FIG. 5. This result obtains because the yield point or elastic limit of the collar material is generally lower than the yield point or elastic limit of the needle tubing so that the needle tubing 12 does not change its shape until the material in the collar is in engagement with substantially the entire length of the needle tubing. As the ram 30 continues to move downwardly from the position shown in FIG. 5, the collar material transmits the force of the ram inwardly against the needle tubing since the collar material is unable to move further downwardly. This force acting against the walls of the needle tubing causes the tubing material to exceed its elastic limit or yield point with the result that the lower end of the needle tubing 12 is narrowed or reduced in diameter, as shown in FIG. 5 in somewhat exaggerated scale. The hydraulic pressure ram is set to develop such a pressure or force for each different sized tubing 12 that only a limited narrowing of the tubing 12 occurs. It will be appreciated that the worked collar 16 and the narrowed tubing 12 sufficiently offer an opposing force to the force of the ram 30 and when these forces are equal no further flow of the collar material or narrowing of the tubing takes place. Hence, although the tubing passageway 12b is slightly narrowed, it nonetheless readily transports fluid from the hypodermic syringe along the tubing to the mandrel 20. It is thus important that the amount of working of the collar 16 be controlled so that flow of fluid through the needle tubing is not obstructed and, as mentioned above, the hydraulic pressure ram is set accordingly.

Since both the collar and hub materials assume stable shapes after their working, interlocking engagement, as well as frictional engagement, is effected between the hub and the needle tubing to prevent the needle unit from becoming unjoined, the amount of the interlocking being relatively slight but occurring over a substantial distance, i.e., substantially the entire length of contact of the hub and needle tubing. Thus, a needle unit made in accordance with the present method is characterized by having an extremely high "pull strength" while at the same time having a low passageway obstruction. The needle unit is further characterized by the fact that the wall of the collar 16 has increased appreciably in thickness and in strength and further as a result of the flow of the collar material the worked collar has increased resistance to subsequent deformation, i.e., increased tensile and compressive strength, due to the work hardening of the collar material resulting from its plastic flow. Moreover, it should be noted that substantially every portion of the lower end 12a of the needle tubing coasts with the collar 16 to maintain the needle unit 10 in assembled relationship, with the result that a uniform gripping or clamping force is developed between the hub 11 and the tubing 12 at all points of contact. In addition, there are produced no localized stress concentration points which tend to weaken the joint and increase the likelihood of the hub and tubing being unjoined during usage.

In accordance with an important aspect of the present invention, the above-described hub may be assembled to a tubing having a cross section other than the circular cross section described above, for example, the tubing may have a polygonal cross section. A tubing 112 having a square cross section is illustrated in FIG. 9. Although a tubing having a non-circular section is to be assembled to the hub 11, the same steps are employed to join the hub and the tubing and, furthermore, the above-described mandrel and retainer are used with the exception that a ram having a bore conformable to the section of the tubing is used.

While there has been described a particular embodiment of the present invention, it will readily be understood that numerous changes and modifications may be made which will readily occur to those skilled in the art. It is aimed in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the present invention.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. In a method for joining a needle tube and a hub, said hub having an enlarged body portion, a reduced collar portion and a shoulder portion extending therebetween, said collar portion having an axial opening therethrough of substantially greater diameter than the outer diameter of said tube, the steps of thrusting a mandrel into the body portion of said hub until the mandrel's end engages the inside of said shoulder, inserting the tube into the opening of said collar portion until the end of the tube abuts the end of said mandrel, temporarily confining said collar portion against lateral expansion, axially compressing said collar portion to force the material thereof inwardly into tight contact with said tube and to increase the wall thickness of said collar portion, and thereafter continuing the axial compression of said collar portion until the outer diameter of the portion of said tube in tight contact with said collar portion is reduced to a limited extent.

2. In a method for joining a tube and a hub, said hub having an enlarged body portion, a reduced collar co-axial therewith and a shoulder portion extending therebetween, said collar providing an axial opening therethrough of substantially greater diameter than the outer diameter of said tube, the steps of positioning the end portion of a mandrel in said body and against the inside surface of said shoulder, working said hub to provide a sharp angular junction between said shoulder and said collar, inserting the end portion of said tube into the opening of said collar, temporarily confining said collar against lateral expansion, and thereafter applying axial compressive force to the deformable collar while the same is confined to increase
the wall thickness thereof and simultaneously clamp the end portion of said tube securely therein.

3. In a method for joining a tube and a hub, the hub having an enlarged body portion, a reduced collar portion and a shoulder portion extending therebetween, said collar portion having an axial opening therethrough of substantially greater diameter than the outer diameter of said tube, the steps of thrusting a mandrel into the body portion of said hub until the mandrel's end engages the inside of said shoulder, inserting the tube into the opening of said collar portion until the end of the tube abuts the end of said mandrel, temporarily confining said collar portion against lateral expansion, and axially compressing said collar portion to force the material thereof inwardly into tight contact with said tube and to increase the wall thickness of said collar portion.

4. In a method for joining a tube and a hub, said hub having an enlarged body portion, a reduced collar portion and a shoulder portion extending therebetween, said collar portion having an axial opening therethrough of substantially greater diameter than the outer diameter of said tube, the steps of inserting the end portion of said tube into the opening of said collar portion and supporting the same in concentric position therein, temporarily confining said collar portion against lateral expansion, temporarily supporting said collar and shoulder portions against axial movement in the direction of said body portion, and thereafter axially compressing said collar portion in the direction of said body portion to force the material thereof inwardly into tight contact with said tube and to increase the wall thickness of said collar portion.

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