Nov. 5, 1968 H. P. SCHOFIELD 3,408,846

HYPODERMIC NEEDLES

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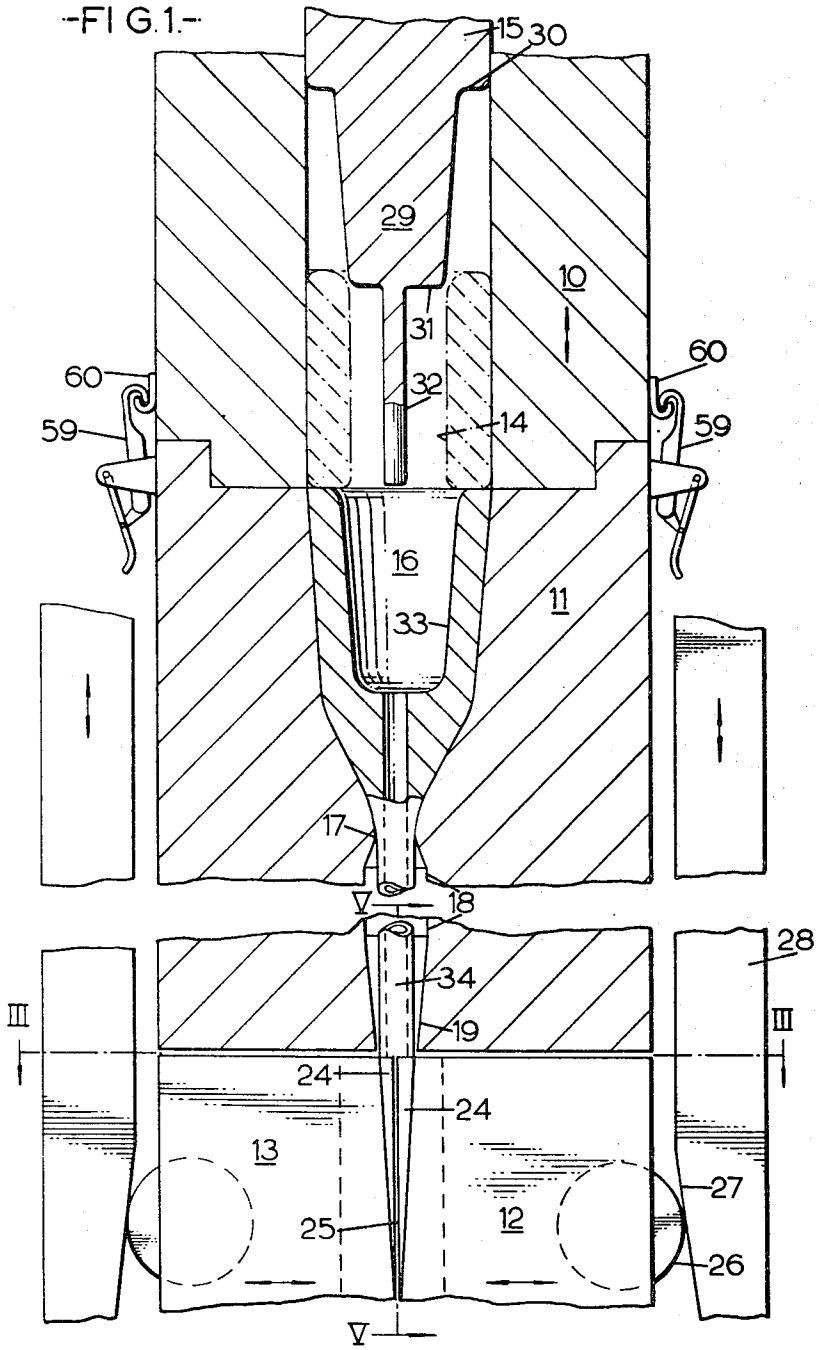
-FIG.1.-



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HYPODERMIC NEEDLES

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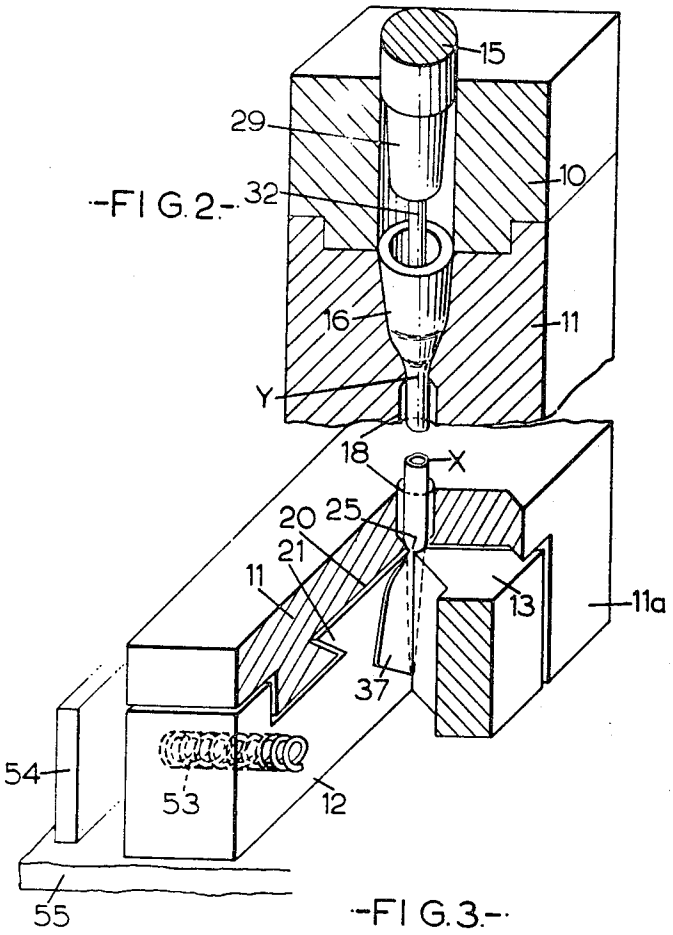
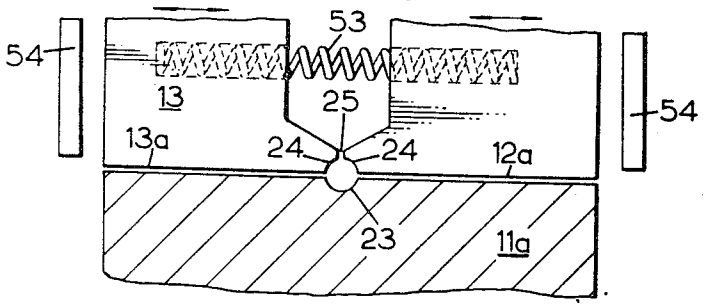
-FIG. 2-



-FIG. 3-



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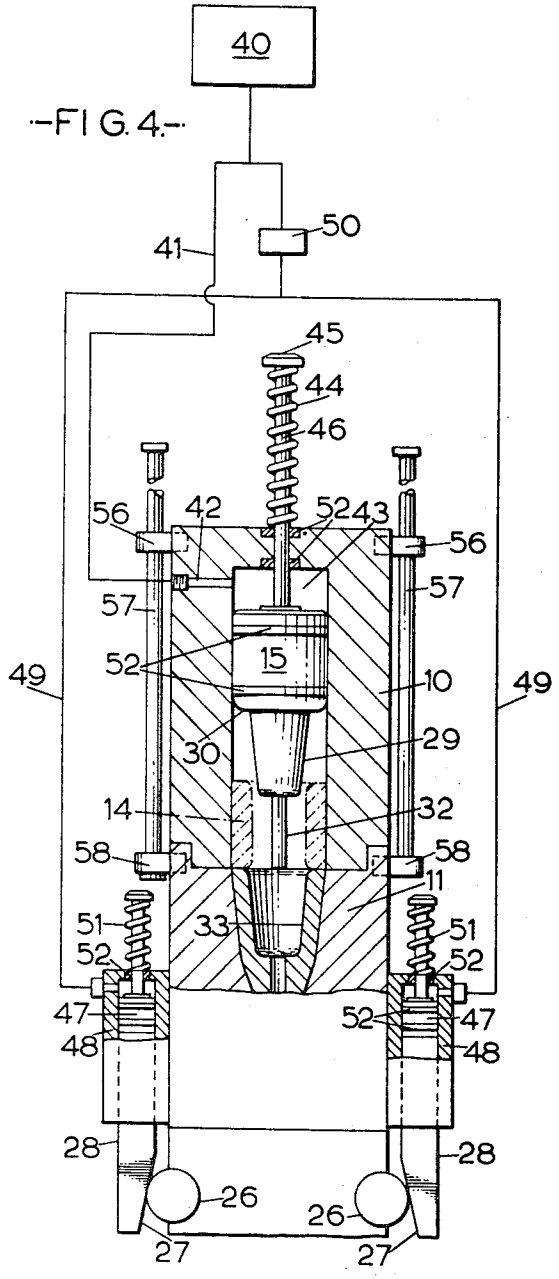
-FIG. 4-



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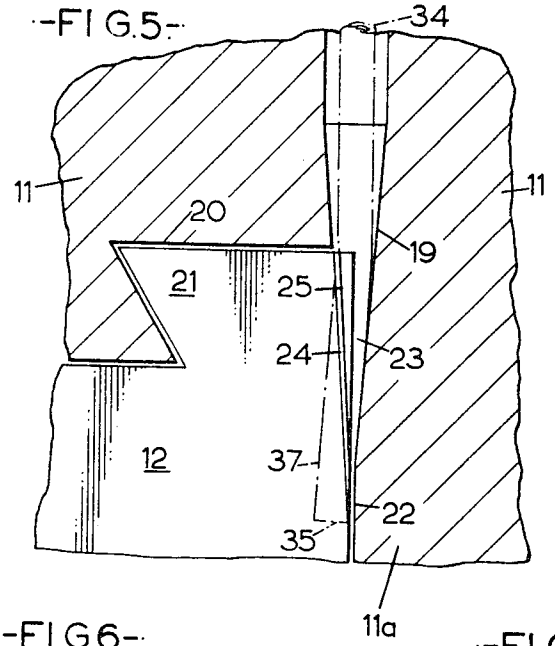
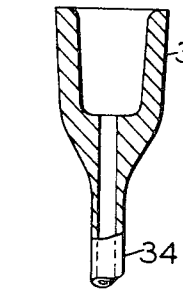
-FIG.5-



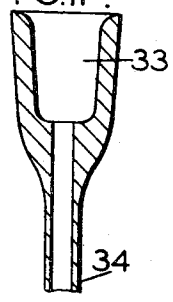
-FIG.6-

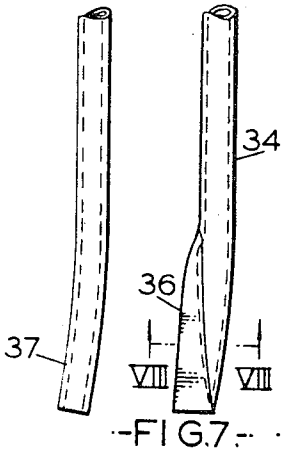


-FIG.8-

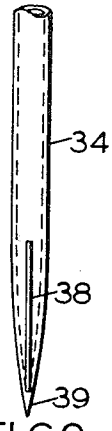
-FIG.10-

-FIG.11-





-FIG.7-



-FIG.9-

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HYPODERMIC NEEDLES

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Continuation-in-part of application Ser. No. 298,719, July 30, 1963. This application Oct. 31, 1966, Ser. No. 590,933

Claims priority, application Great Britain, Aug. 3, 1962, 29,833/62

6 Claims. (Cl. 72—254)

ABSTRACT OF THE DISCLOSURE

There is disclosed a method and apparatus by which a hypodermic needle having a hub and a cannula extending therefrom is produced, by impact extrusion, from an annular billet of nontoxic material. Such billet is disposed in the cavity of a female die and is extruded into a cup-shaped recess corresponding to the hub to be formed and into a bore extending from the recess to form the tubular cannula with the end portion of the latter remote from the hub being deflected so as to assume a longitudinal curvature, whereupon the end portion of the cannula, at the inside of its curve, is laterally compressed or pinched to define an ear which is severed from the cannula to define a longitudinal slit at a side of the tapered end terminating in a solid point. The apparatus for performing the foregoing operations has a die assembly made up of parts which are automatically displaced relative to each other in the necessary sequence.

This application is a continuation-in-part of application Ser. No. 298,719, now abandoned, filed July 30, 1963.

The present invention relates to hypodermic needles, and particularly to a method and apparatus for producing the same.

Usually hypodermic needles comprise a tubular element or cannula of regular cross section and a hub or appendage to which it is attached and by which the cannula is mounted on a syringe. The joint between the two is generally unsatisfactory for a number of reasons not the least important being that a tube of regular cross section projecting from a larger body, by virtue of its connection at one of its ends to said body, must be relatively weak at the joint.

The primary object of this invention is to make possible the manufacture of nontoxic hypodermic needles at such low cost that they may be disposable, that is, used for one injection only and then thrown away.

Another object is to provide hypodermic needles that are substantially stronger than those currently in use.

A further object is to perform the various stages of manufacture automatically.

According to the present invention a method of producing a hypodermic needle having a cannula extending from an integral hub comprises locating an annular billet of nontoxic material in a relatively wide cup-shaped cavity of a female die which corresponds substantially to the external configuration of the hub to be formed and has a bore extending from its base corresponding to the external diameter of the cannula to be formed, subjecting the billet to an impact extrusion operation so as to shape said billet into said hub with the cannula extending therefrom, deflecting the end portion of the cannula remote from the hub during the impact extrusion so that such end portion is curved slightly out of the common axis of the cannula and hub, laterally compressing or pinching the curved end portion at the inside of the curve to form a laterally projecting ear and substantially instantaneously severing said ear completely to leave a symmetrically

tapered end of the cannula having a solid point with a longitudinal slit in said end immediately in back of such point at the location where the ear has been severed.

Apparatus for performing the above method comprises power operated ram means for imparting impact extrusion pressure to an annular billet of nontoxic material, die means having recesses therein for shaping the billet on impact of the ram into the form of a hollow hub and an integral hollow cannula part, the end of which remote from the hub is curved longitudinally simultaneously with formation of said cannula part in said die means; means displaceable laterally of said die for compressing a portion of the periphery of the curved end of said cannula part at the inside of the curve to form an ear therefrom and means for severing said ear at the termination of said lateral compression simultaneously to form a tapered end on said cannula which is symmetrical about the axis thereof and has a solid point and a longitudinal slit communicating with the interior of said cannula and located immediately in back of said point where said ear has been severed.

Considered in greater detail the apparatus includes a multiple part die comprising a main part which has a first recess adapted to receive an annular billet of nontoxic material and having a shape consistent with the external periphery of the hub of a needle to be produced, a second recess disposed coaxially of, and in communication with the first recess to form a portion of an integral cannula part between the hub and the remote end of a needle to be produced and a third recess formed in a planar face of the main part which contains an extension of the common axis of both the first and second recesses and is of semicircular cross-section and tapering to a point, two other die parts in the form of jaws oppositely displaceable in directions laterally of said common axis and have recesses which, in cross-section, constitute opposite quadrants of a circle and are longitudinally tapered to a point, inclined shearing edges on the oppositely displaceable jaws, guide faces on said main part for sliding engagement by the jaws during displacement thereof and power operated ram means for imparting impact extrusion pressure on an annular billet when seated in the first mentioned recess.

Preferably the annular billet consists of a short length of aluminum tubing, with impact extrusion alone being utilized in the production of the needle and its integral hub. If desired, however, the needles may be of stainless steel, a light metal alloy, or of a plastic material.

The cross-section of the cannula or needle portion where it merges into the hub part may be varied as desired, and the external periphery of the needle need not be concentric with the axis of the bore. In cross-section, the needle may have a corrugated external periphery or one in which a bulge is formed at one peripheral part diametrically opposite a peripheral recess. Further, if desired, the needle may be substantially of triangular section with the apices thereof being rounded.

The hub may be of any desired shape, for example, circular or hexagonal, or it may have a flange, the shape of which is such that it has parallel opposite side faces terminating in semicircular curved portions, all of which may be of a nonslip nature.

Preferably, however, the material and the shape of the finished needle is such that heat treatment for hardening the same is not required.

The above, and other objects, features and advantages of this invention, will be apparent in the following detailed description of an illustrative embodiment to be read in conjunction with the accompanying drawings forming part of this specification and in which:

FIG. 1 is a sectional view of the die parts of an apparatus in accordance with one embodiment of this in-

vention, with a needle produced therein by an impact extrusion operation being shown in full lines and partly in section and with a billet for the production of a needle being shown in broken lines;

FIG. 2 is a perspective exploded view of a portion of the die parts;

FIG. 3 is a sectional view taken along the line III—III on FIG. 1;

FIG. 4 is an elevational view, partly in section, which schematically illustrates an apparatus incorporating the die parts of FIG. 1, but shown on a smaller scale;

FIG. 5 is a sectional view taken along the line V—V on FIG. 1;

FIG. 6 is an elevational view, partly in section, of the unitary hub and cannula of a needle at the first stage of production;

FIG. 7 is a view of a portion of the cannula at the second stage of production;

FIG. 8 is a sectional view taken along the line VIII—VIII on FIG. 7;

FIG. 9 is a view of the pointed end of the cannula at the termination of the final stage of production;

FIG. 10 is an end view of the cannula part of the needle of FIG. 9; and

FIG. 11 is an elevational view, partly in longitudinal section, of the finished needle.

In carrying out the invention, the multiple part female die may be formed in a number of ways, and the annular or short tube-shaped billet may be fed into one of the die parts either from that end thereof at which the impact extrusion ram enters the die part, or from the opposite end of said die part. When manually or otherwise fed into said die part the billet or workpiece remains stationary therein by virtue of a friction-fit with the inner peripheral wall of said part until engaged by the ram which may be operated hydraulically or mechanically through a spring loading.

In the embodiment illustrated in FIGS. 1–5 of the accompanying drawings, a die assembly is shown to comprise a female die formed of four parts **10**, **11**, **12** and **13**. The die parts **10** and **11** are relatively displaceable to enable an annular or short tube shaped metallic or plastic billet or workpiece **14** to be fed into the bore of the part **10** at the opposite end thereof to that at which a ram or male die **15** of the die assembly enters to perform the impact extrusion operation. For this purpose the interengaging ends of the die parts **10**, **11** are complementarily formed (FIGS. 1, 2 and 4) to facilitate accurate realignment following separation of die part **10** from part **11** and the insertion of a billet into the lower end of die part **10**. The billet is preferably of uniform wall thickness with its end edges appropriately tapered or rounded.

The part **11** has an internal cup-shaped compartment **16** which is coaxial with the bore of the part **10** and the shape of which resembles the external shape of the hubs of the needles to be formed. Thus, as shown, compartment **16** tapers gradually to a constriction or neck portion **17** (FIG. 1) of the die having a diameter equal to that of the cannula portions of the needles and opening into a bore **18** which is wider than said intended diameter of the cannula portions. In this respect it will be understood that the diameter of the cannula portion of each needle is determined by the cross-section of the constriction or neck portion **17** and that the diameter of the material passing through said constriction will not subsequently increase despite the larger diameter of the bore **18**.

The bore **18**, at its end remote from constriction **17**, tapers, as at **19**, to a diameter equal to that of the external diameter of the cannula (FIG. 1), and here the front of die part **11** is cut away to form a dovetailed recess **20** for the reception of the upper ends **21** of the die parts **12** and **13** (FIGS. 2 and 5). Die parts **12** nd **13**, in effect, constittue two laterally and oppositely displaceable jaws which are guided in their movement by dovetailed recess **20** of die part **11** and by a face **22** (FIG. 5) of said die part **11** where it is cut away to receive the jaws **12** and **13**. The taper **19** in die part **11** which commences slightly above the horizontal plane containing the upper faces of the jaws **12** and **13** is continued in the remaining rear portion **11***a* of the die part **11** as shown in FIGS. 1 and 5 so that a conical recess **23** of semicircular section is formed in the face **22** and tapers to a point at a position which is spaced from the neck **17** by a distance equal to the length of the needles to be formed.

The laterally displaceable jaws **12** and **13**, in the region where their respective faces **12***a*, **13***a* come together on displacement of the jaws toward each other, are recessed at **24** to collectively form a semicircular recess which is complementary, and tapered similarly, to the tapered recess **23** in the face **22**. Thus, when the jaws **12** and **13** come together in the position shown in FIG. 3, the recesses **24** of such jaws together with the recess **23** of face **22** of die part **11** define a tapered bore consistent with the desired shape of the pointed ends of the needles to be made. Further, each of jaws **12** and **13** has a shearing edge **25** adapted to sever any material in the path of the said edges **25** as the jaws **12** and **13** approach their extreme positions of displacement towards each other.

The jaws **12** and **13** are provided with rollers **26** (FIGS. 1 and 4) which are adapted for engagement by inclined surfaces **27** on cams **28** which may be displaced longitudinally of the die by the same power source provided for displacing the ram or male die member **15**. As shown on FIG. 1, die member **15** has a tapered forepart **29** extending from an annular shoulder **30** to a leading face **31** from the center of which there projects a protuberance **32**. When the billet has been engaged by the shoulder **30** and the tapered forepart **29** of the ram **15**, protuberance **32** initiates the formation of the bore in the cannula part of the needle in the region of the hub, which bore is then maintained automatically during the extrusion of the cannula part.

As shown in the diagrammatic representation of FIG. 4, oil or other fluid under pressure is supplied from a suitably valved or otherwise controlled source **40** through a duct **41** and bore **42** into a chamber **43** of the die part **10** housing the ram **15** in order to displace the ram downwardly relative to said die part **10** when it is desired to operate on a billet **14** to effect the production of a needle by impact extrusion. Reverse or return displacement of the ram, on the release of the hydraulic or other pressure is effected by a spring **44** located between the closed end of die part **10** and an enlarged head **45** on a rod **46** projecting from the ram **15** through said closed end. Similarly the cams **28** may be downwardly displaced to enable their inclined surfaces **27** to force the rollers **26** inwardly towards each other and thus inwardly displace the jaws **12** and **13**, by hydraulic means including rams **47** operating in cylinders **48** carried by the die part **11** and into which ducts **49** open to deliver oil under pressure when a predetermined pressure is attained in the duct **41** sufficient to open a pressure relief valve **50**, that is, at the termination of the downward stroke of the ram **15**. Here again return movement of the rams **47** is effected by springs **51** acting upwardly on rods extending from the rams or pistons **47**. The usual oil seals for the rams **15**, **47** and for the rods extending out of chamber **43** and cylinders **48** may be provided, as at **52**. The return or laterally outward displacement of the jaws **12** and **13** is effected by a spring **53** (FIGS. 2 and 3) which may be seated in opposed recesses of the jaws, and such return movement is limited by engagement of the jaws with fixed stops **54** on a support **55** (FIG. 2).

The die part **10** may be manually raised from the die part **11** when it is desired to insert a billet into part **10** for a needle forming operation. To guide die part **10**

during such movement, die part **10** may be provided with lugs **56** adapted to slide longitudinally along pillars **57** mounted on the stationary die part **11** by way of lugs **58** (FIG. 4).

Any suitable reliable means may be employed for holding together die parts **10** and **11** during the pressure stroke in the impact extrusion operation, and to permit the described relative movement of such die parts at the end of the operation. Thus, for example, manually operable and well-known over-center latches **59** may be pivotally mounted at diametrically opposed positions on the wall of die part **11** for engagement with keepers **60** which are secured at similar diametrically opposed positions on the wall of die part **10** as is shown diagrammatically on FIG. 2.

The operation of the above described apparatus in producing a needle from an annular billet of non-toxic material is as follows:

When fluid under pressure is applied to the ram or male member **15** for effecting movement thereof into the bore in the die part **10**, with a billet **14** in position in said bore and with the parts **10**, **11** coaxial and held together by the latches **59**, **60**, the tapered part **29** of the ram enters the bore in the billet and momentarily tends to radially squeeze the latter to cause the length of the billet to increase while still retaining its tubular form. On further descent of the ram, the shoulder **30** comes into contact with the upper end of the billet **14** to force this into the part **11** of the die, thereby forming the tapered hub part **33** and a tubular part **34** below the latter. In this respect it will be appreciated that the protuberance **32** functions to maintain an axial bore in the tubular part **34** at the neck where the material leaves the hub **33** and commences to form what finally becomes the cannula portion of each needle.

At this instant the jaws **12**, **13** are spaced apart by a distance sufficient to allow the lower end of the tubular part to take the position shown in broken lines at **37** in FIG. 5, the bend in the lower end of the tube from the axis of symmetry of the remaining part of the tube being caused by the taper of the semi-circular recess **23** of the die part **11**. The billet **14** has thus been converted into the form shown in FIG. 6, that is, with an open end **35** in the bent portion of the tube **34** remote from the hub **33**.

At this stage of operation the fluid from the source **40** reaches a pressure sufficient to open the relief valve **50** with the result that the rams **47** are now displaced to effect similar displacement of the cams **28** connected thereto. As a result of such cam movement, the cam faces **27** act on rollers **26** to displace jaws **12** and **13** of the die relatively inward towards one another. When the edges **25** of the jaws and the bore faces **24** in the jaws approach the position shown in FIG. 3 they first compress the periphery of the curved or bent end portion **37** of the tube to form an ear **36** at the inside of the curve, so that the end of the workpiece remote from the hub **33** takes the shape illustrated in FIGS. 7 and 8. When, however, the jaws reach the position shown in FIG. 3 they operate to sever the ear **36** from the tube to produce a pointed end as shown in FIGS. 9 and 10, that is, with the end tapered symmetrically about the axis of the tube and with a longitudinal slit **38** immediately in back of a solid pointed end **39**. The finished product is shown in FIG. 11 and from this it will be appreciated that the cannula and hub of the needle are integrally formed and that penetration of the pointed end of the needle into the skin of a patient at the desired site of injection of the needle contents is effected by a piercing and spreading operation, as distinct from a cutting action.

All these operational stages are effected in such rapid succession that for all practical purposes they may be regarded as taking place substantially simultaneously, and when completed the pressure of fluid is released from chamber **43** and cylinders **48** to permit the springs **44** and **51** to urge their rams **15** and **47** towards their inoperative positions for the commencement of the next needle forming operation.

The finished needle may be removed from die part **11** in any desired manner, for example, upwardly from the end at which the ram **15** operates upon separation of die part **10** from part **11**, or sideways by dividing the upper portion of the die part **11** longitudinally through the axis of symmetry of the cup-shaped recess **16** and by enabling one of said divided parts to be displaced relatively to the other.

Although the above description and the drawings refer to a single die assembly, an apparatus in accordance with the invention may have a number of such die assemblies provided therein for simultaneous operation from a common source of fluid under pressure, whereby a corresponding number of needles are produced simultaneously.

In the foregoing, the invention has been described with reference to a specific illustrative embodiment, but it is to be understood that the invention is not limited to that precise embodiment, and that various changes and modifications may be effected therein by one skilled in the art without departing from the scope or spirit of the invention as defined in the appended claims.

What is claimed is:

1. A method of producing a hypodermic needle having a cannula extending from an integral hub, comprising extruding an annular billet of nontoxic material into a relatively wide cupshaped recess of a female die which corresponds substantially to the external configuration of the hub to be formed and has a bore extending from its base and diametrically dimensioned so that the material of said billet extruded through said bore defines the cannula to be formed, deflecting the formed cannula toward one side at the end thereof remote from the hub so that such end portion of the cannula is curved slightly out of the common axis of the cannula and hub, laterally compressing said curved end portion at the inside of the curve to impart to said end portion a symmetrically taped configuration with an ear projecting from one side thereof, and substantially instantaneously serving said ear completely to leave a longitudinal slit in said tapered end portion immediately in back of a solid point.

2. Apparatus for producing hypodermic needles comprising power operated ram means for imparting impart extrusion pressure to an annular billet of nontoxic material, die mans having recesses therein for shaping the billet on impact of said ram into the form of a hollow hub and an integral hollow cannula projecting longitudinally therefrom, means in said die means to deflect to one side the end portion of said cannula part remote from the hub during formation of said cannula part so that said end portion is longitudinally curved toward said one side, means displaceable laterally of said die means for compressing a portion of the periphery at the inside of the curved end portion of said cannula part to form an ear projecting therefrom and means for severing said ear at the termination of the compression at said end portion thereby to form a tapered end on said cannula which is symmetrical about the axis thereof and has a longitudinal slit which communicates with the interior of said cannula immediately in back of a solid point.

3. Apparatus for producing hypodermic needles comprising a multiple part die including a main part which has a first recess adapted to receive an annular billet of nontoxic material and having a shape consistent with the external periphery of the hub of a needle to be produced, a second recess disposed coaxially of, and in communication with said first recess to form a portion of an integral cannula part between the hub and the remote end of a needle to be produced and a third recess formed in a planar face of said main part and containing an extension of the common axis of said first and second recesses,

said third recess being of semi-circular cross-section and tapering to a point, two other die parts which constitute jaws oppositely displaceable in directions laterally of said common axis and have recesses which in cross-section constitute opposite quadrants of a circle and are each longitudinally tapered to a point, shearing edges on said oppositely displaceable jaws along said recesses thereof, guide means on said main part for guiding engagement with said oppositely disposed jaws during displacement thereof, a ram movable into said first recess, power operated means operative to displace said ram into said first recess for applying impact extrusion pressure to an annular billet seated in said first recess, and means operative after said displacement of the ram to effect displacement of said jaws toward each other.

4. Apparatus as claimed in claim 3; wherein said main die part comprises two relatively displaceable portions having coaxial cavities defining said first recess and one of which receives the billet and the ram at opposite ends thereof prior to the application of impact extrustion pressure.

5. Apparatus as claimed in claim 2; wherein said means operative to displace said jaws includes cam means displaceable by the power operated means for the ram and cam follower means on said laterally displaceable jaws engageable by said cam means to displace said jaws toward each other upon displacement of said cam means.

6. Apparatus as claimed in claim 3; wherein said means for guiding engagement with the jaws includes a dovetailed recess in said main die part in which complementary upper ends of said jaws are slidably engaged.

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