Oct. 13, 1964 E. H. JOHNSON 3,152,393

PRINTING PLATES

Filed Aug. 1, 1961 2 Sheets-Sheet 1

FIG. 1

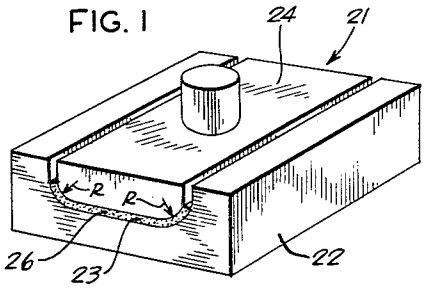
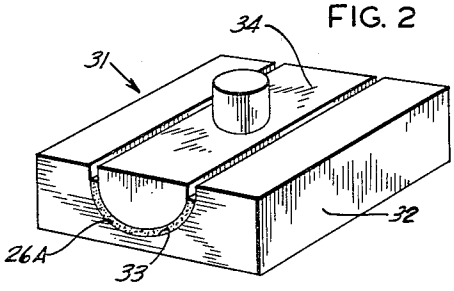


FIG. 2



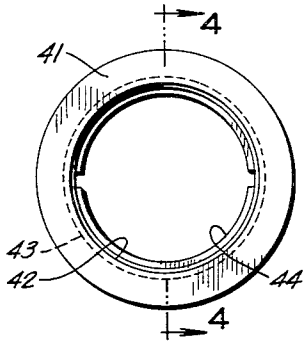


FIG. 3

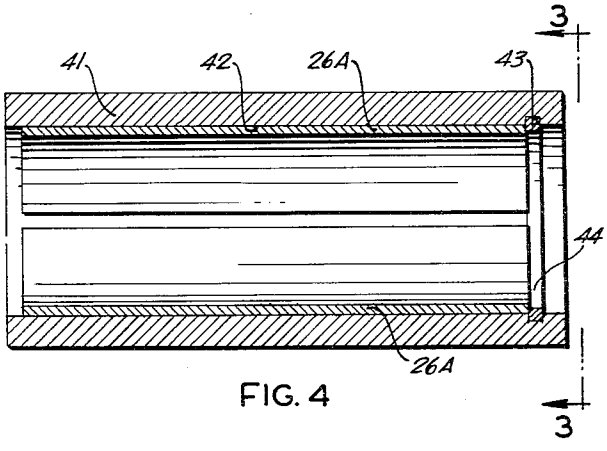


FIG. 4

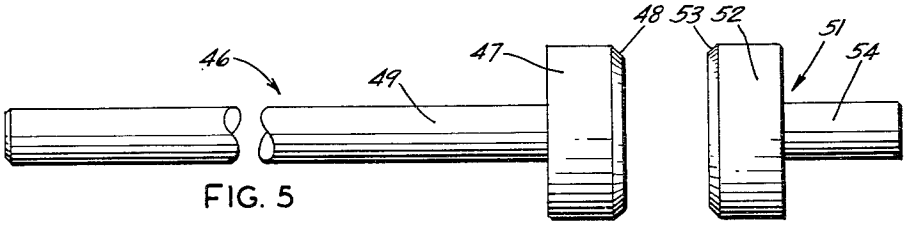


FIG. 5

FIG. 6

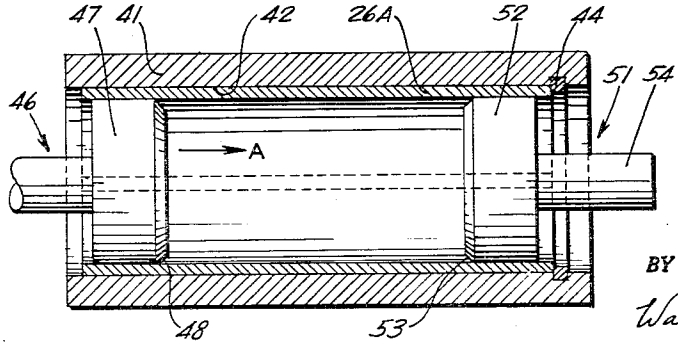


FIG. 7

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PRINTING PLATES

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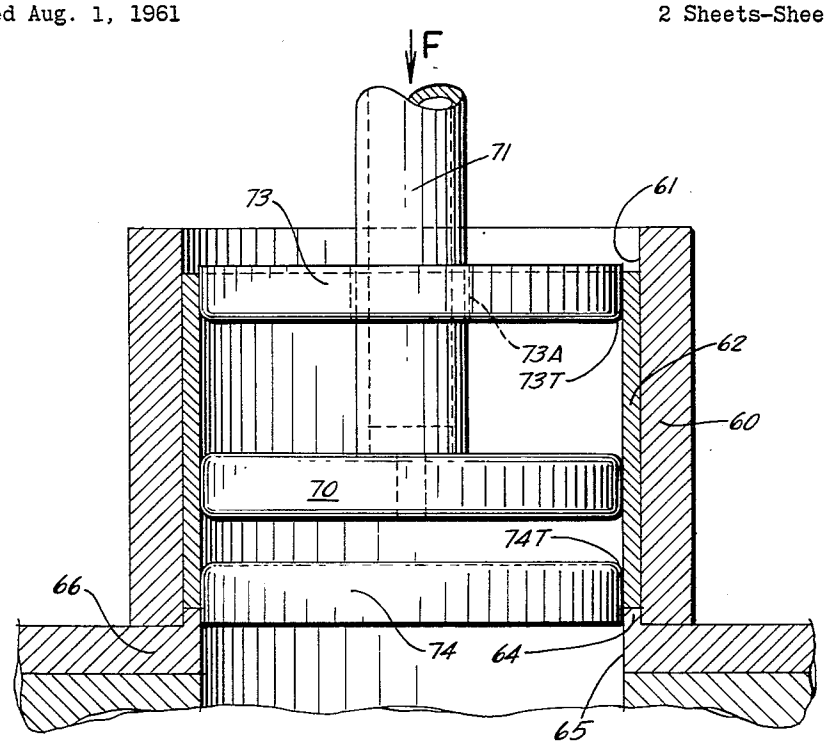


FIG. 8

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United States Patent Office 3,152,393 Patented Oct. 13, 1964

3,152,393

PRINTING PLATES

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Filed Aug. 1, 1961, Ser. No. 128,436
10 Claims. (Cl. 29—550)

This invention relates to a method and apparatus for making an accurately curved member from a flat plate, particularly an accurately curved printing plate from a flat plate of metal or similar hard material. This application is a continuation-in-part of application Serial No. 17,027 filed March 23, 1960, now abandoned.

At the present time high speed machines used to print such items as tabulator cards and numerous other similar items generally utilize rubber rollers having type molded integrally with the rubber roller. It is recognized that plates of metal or other hard material are much more desirable, but the difficulties of obtaining plates formed with sufficient accuracy to enable a sharp, clear impression to be obtained therefrom have heretofore prevented wide-spread adoption of metallic printing plates in such machines. Another factor mitigating against the general adoption of printing plates of metal or other hard material has been the cost of forming such plates. Thus, the methods of forming a flat plate into a partial cylindrical shape for use in such high speed machines has heretofore required the use of relatively expensive die structure leading to a high unit cost for the manufactured plates.

It is therefore a primary object of this invention to form a curved printing plate from a flat plate of metal or other hard material with a high degree of accuracy, after which engraving or a like operation is to be effected thereon to develop the printing characters. It is a related object of the present invention to form such an accurately curved printing plate at a relatively low cost.

In accordance with the present invention a flat plate of metal or other hard material is formed to an accurately controlled cylindrical configuration in three operations. In the first operation opposite edge portions of the flat plate are formed with curvatures, and the radius of each of the curvatures thus formed is the same as the radius of the finished curved plate. Next, and in the second operation the portion of the plate between the curved edge portions is formed in an arcuate shape to produce a preform member of a partial cylindrical configuration approximately that of the finished plate. In the third and final operation, one or more of the preforms are disposed side by side in an open-ended cylindrical bore formed in a finishing die apparatus. A plunger member, of lesser axial length than the preforms and having a diameter related to the diameter of the bore and thickness of the preforms, such that insertion of the plunger between the preforms in the bore is effective to form the portions of the preforms engaged by the plunger to the curvature of the bore, is moved progressively along the inner surfaces of the preforms between the open ends of the bore. Such movement of the plunger member is effective to cause the preforms to assume the shape and finish of the surface of the finishing die in a quite accurate manner. To accurately form a curved plate member by a novel method and a series of forming operations as aforesaid are specific objects of this invention. Advantageously, holder rings are arranged in the die apparatus to prevent skewing of the preform during the finishing operation being performed thereon.

Other and further objects of the present invention will be apparent from the following description and claims and are illustrated in the accompanying drawing which, by way of illustration, shows preferred embodiments of the present invention and the principles thereof and what

are now considered to be the best mode for applying these principles. Other embodiments of the invention embodying the same or equivalent principles may be used and structural changes may be made as desired by those skilled in the art without departing from the present invention and the purview of the appended claims.

In the drawings:

FIG. 1 is a perspective view of die apparatus used in a first forming operation in the method of the present invention;

FIG. 2 is a perspective view of another die apparatus utilized in a second forming operation in the method of the present invention;

FIG. 3 is an end elevation view of a sleeve member utilized in a third forming operation in the method of the present invention;

FIG. 4 is an elevation view, in section, of the sleeve member illustrated in FIG. 3;

FIG. 5 is an elevation view of a forming member adapted to be utilized with the sleeve member illustrated in FIGS. 3 and 4;

FIG. 6 is an elevation view of a positioning and retaining member adapted to be utilized with the sleeve illustrated in FIGS. 3 and 4;

FIG. 7 is a sectional view showing the parts illustrated separately in FIGS. 4–6 in their assembled die apparatus relation; and

FIG. 8 is a sectional view illustrating another form of die apparatus that can be used in practicing the present invention.

Under and in accordance with the present invention an accurately curved member is formed from a flat plate in three separate and distinct operations. In a first operation the flat plate is placed in suitable die structure and two opposite edge portions of the flat plate are formed with curvatures having predetermined and equal radii. Subsequently, and in a second forming operation the portion of the plate extending between the curved edge portions is formed in an arcuate shape to thereby produce a preform member of a partial cylindrical configuration having a convex outer surface and a concave inner surface. In the third and last forming operation a preform member is placed in a die member having an accurately curved and longitudinally extending inner bore, and a forming member is moved longitudinally along the inner surfaces of the preform member between the opposite ends thereof to progressively press the outer or convex surface of the preform member into engagement with the surface of the bore of the die member to thereby cause the outer surface of the preform member to assume the exact configuration and finish of the surface of the bore. One or more preforms can be finished in a single operation. After these forming operations are completed, the desired curvature has been obtained, and the plate is then to be engraved or otherwise processed to form the printing characters.

In FIG. 1 there is illustrated die apparatus, indicated generally by the reference numeral **21**, for accomplishing the first forming operation as described hereinabove. The die apparatus **21** comprises a lower block **22** formed with a generally U-shaped and longitudinally extending recess **23** affording a die surface in the upper face thereof. A punch **24** is movable vertically toward and away from the block **22** and includes a lower surface which is shaped complementary to the die surface **23**. Thus, the lower and opposite edge portions of the punch **24** are rounded complementary to the facing surfaces of the die surface **23**, and the radius of curvature R of such portions of the punch **24** is exactly the same as the desired radius of the finished plate formed under the method of the present invention.

In the operation of the die apparatus **21**, a flat plate,

ultimately to become the printing plate (that is, the plate to be engraved), is positioned on the upper surface of the block **22** and aligned above the recessed die surface **23** in any suitable manner. Thereafter, the punch **24** is moved downwardly into engagement with the flat plate, thus causing the plate to be formed to the configuration of the plate member **26** illustrated in FIG. 1.

The partially formed member **26** is then removed from the die apparatus **21**, and is in condition to be subjected to the second forming operation under the method of the present invention. In FIG. 2, a second die apparatus, indicated generally by the reference numeral **31**, comprises a lower stationary block **32** and a movable punch **34**. As in the die apparatus **21**, the lower block **32** is formed with a recess **33** affording a die surface in the upper face of the block. In this instance, however, the curvature of all portions of the die surface **33** is the same so that the die surface **33** is of a uniform arcuate configuration as viewed in end elevation. The punch **34** is formed with a lower rounded surface complementary to the die surface **33** so that movement of the punch **34** toward the block **32** is effective to form the central portion of a member **26** interposed between the block and the punch to an arcuate shape. Thus, at the conclusion of the second forming operation in the die apparatus **31** there is produced a preform member **26A** having a configuration very close to that desired in the finished curved plate.

The lower block **32** is preferably made of Bakelite resin die stock so as to prevent any marring of the outer convex surface of the preform member **26A**.

In FIGS. 3 and 4 there is illustrated a sleeve member **41** utilized in the third forming operation under the method of the present invention. The sleeve member **41** is made of hardened tool steel and is formed with a longitudinally extending inner bore **42** which is ground and lapped to the exact contour of the curved plate to be formed by the method of the present invention. Adjacent one end of the sleeve member **41** the bore **42** is formed with an annular recess **43** which affords a seat for a ring **44**. The ring **44** serves as stop structure for a pair of preforms **26A** which are positioned within the bore **42** in side-by-side relation, as illustrated in FIG. 4. The ring **44** functions to prevent axial movement of the preforms **26A** during the course of the third and last forming operation, as will become more apparent from the description to follow. It should be noted that the ring **44** projects inwardly from the sidewalls of the bore **42** to a lesser extent than the extending edges of the preforms **26A**.

In the third forming operation a forming member **46** (see FIG. 5) which includes a plunger or head member **47** is moved longitudinally through the bore **42**, in the direction of the arrow A in FIG. 7, between the inner concave surfaces of the preforms **26A**. The plunger **47** is preferably tapered at the leading end, as indicated by the reference numeral **48**, so as to facilitate entry between the preforms **26A**. As illustrated in FIG. 7, the plunger **47** is of considerably lesser axial extent than the preforms **26A**, but the diameter of the plunger **47** is accurately related to the diameter of the bore and the thickness of the preforms **26A** such that insertion of the plunger **47** between the preforms in the bore is effective to exert sufficient radial force on the portions of the preforms thus engaged by the plunger to cause the outer convex surfaces of the preforms to assume the exact curvature and finish of the die surface of the bore **42**. The forming member **46** also includes handle or rod means **49** for moving the plunger **47** longitudinally through the bore as aforesaid.

During movement of the forming member **46** through the bore there is a tendency for the ends of the preform members **26A** opposite those initially engaged by the plunger to move radially away from the surface of the bore **42**. Were such action permitted, the preform members **26A** would be bowed longitudinally and would be imperfect.

However, in accordance with one form of the present invention such bending and bowing of the preform members is effectively prevented by inserting a positioning or retaining member **51** between the preform members **26A** prior to moving the forming member **56** along the axial extent of the preform members as described hereinabove. As illustrated in FIG. 6 the positioning and retaining member **51** includes a cylindrical head portion **52** of slightly smaller diameter than the diameter of the head portion **47** of the forming member **46**. Thus, the diameter of the head portion **52** of the member **51** is approximately two thousandths of an inch (0.002 inch) smaller than that of the head portion **47** of the forming member **46**. Thus, the member **51** is a light tap fit between the preforms **26A**. One face of the head portion **46** is also preferably tapered, as indicated by the reference numeral **53**, to facilitate its insertion between the preform members **26A**. The positioning member **51** also includes a stub shaft **54** for facilitating manipulation of the positioning and retaining member.

In FIG. 7 the component parts of a die apparatus used in the third and finishing operation of the method of the present invention are illustrated in their assembled positions. Thus, the cylindrical head **52** of the positioning and retaining member is disposed in alignment with or closely adjacent the related end edges of the preforms **26A** so as to retain the end portions of the preform members **26A** in abutting engagement with the sidewalls of the bore **42** adjacent the stop ring **44** during the greater portion of the axial travel of the forming member **46** in the direction indicated by the arrow A. As illustrated in FIG. 7, the external diameter of the cylindrical head **52** is less than the internal diameter of the ring **44**. Therefore, at the conclusion of the forming and finishing stroke of the forming member **46**, the head end **47** of the forming member is engageable with the cylindrical head **52** of the positioning and retaining member **51**, and continued axial movement of the forming member is effective to eject the member **52** through the stop ring and from the bore **42** while the end portion of the preforms **26A** are at all times engaged with the sidewalls of the bore and thereby prevented from rising from the surface of the bore. The preforms **26A** have now become trued plates ready to be engraved, and are removed from the sleeve **41** to be turned over to the engravers.

The die apparatus illustrated in FIG. 8 of the drawings represents another mode of practicing the present invention, and in this instance the die apparatus includes a circular die member in the form of an elongated sleeve or tube **60** having an internal bore **61** dimensioned to represent the accurate curved shape to be imparted to the preform **62** that is to become the eventual printing plate. It may here be mentioned that the preform **62** may be a single member of something less than 360°, but again several segmental preforms can be arranged within the bore **61** in the manner described above, each having been subjected to the preliminary shaping operations described above.

The preform to be shaped is disposed within the cylindrical bore **61** so that one end each thereof is engaged with an annular stop ring or rib **64** that borders one end of a circular opening **65** formed in a boss **66** on which one end of the die sleeve **60** sets. Thus, the annular rib or flange **64** projects complementally into the die bore **61** and represents a fixed stop for preventing end-wise movement of the preform **62** out of the bore **61** during the course of finishing operations performed thereon.

As in the foregoing embodiment of the invention, the preform **62** is subjected to progressively advancing uniform radial forces by a circular plunger or sizing tool **70** moved axially of the preform **62**. Thus, the sizing tool as in the foregoing embodiment is in the form of a disc having a radius predetermined as being effective to force the preform **62** radially into firm contact with the

bore 61 so that the preform 62 will conform to the accurate contour of the bore 61. It will be recognized that the sizing disc 70 is moved along the interior of the preform 62 by virtue of a force F applied to a rod 71 which carries and which is affixed to the shaping disc 70.

In order to prevent either end portion of the preform 62 from pulling radially away from the inner surface of the die 60 during the course of the finishing operation, retainer rings 73 and 74 are respectively located at the upper and lower inner peripheries of the preform 62 as viewed in FIG. 8. Advantageously, the peripheral edge of each retainer 73 and 74 which is innermost of the preform 62 is tapered at 73T and 74T to facilitate insertion of the retainer ring into the corresponding inner end of the preform 62. The shaping tool 70 is likewise tapered.

It will be noted that the upper retainer ring 73 is provided with an aperture 73A in the medial portion thereof enabling the shaft 71 to project freely therethrough. It will be realized of course that the lower retaining ring is first inserted into the preform arranged within the bore of the die, whereafter the tool 70 can then be moved downward in an initial shaping operation to a point where the upper retainer ring can be slipped in place. Thereafter, the tool 70 is moved through the preform to effect the accurate curving thereof, until the lower retainer ring 74 is struck and ejected from the interior of the preform by the disc 70 moving out of the lower end of the preform.

Thus, in accordance with the present invention there is afforded a method and apparatus for making an accurately curved plate from a sheet of flat stock. By reason of the three-step method of formation utilized under the present invention, quite simple die structure can be utilized with resultant economies of manufacture. Nevertheless, the finished curved plate is precisely and accurately dimensioned.

Hence, while I have illustrated and described preferred embodiments of my invention, it is to be understood that these are capable of variation and modification, and I therefore do not wish to be limited to the precise details set forth, but desire to avail myself of such changes and alterations as fall within the purview of the following claims.

I claim:

1. The method of making an accurately curved member of less than 360° extent from a flat plate comprising the steps of forming opposite edge portions of the flat plate with curvatures having a predetermined radius, forming the portion of the plate between the curved edge portions in an arcuate shape to produce a preform member of a partial cylindrical configuration having a convex outer surface and a concave inner surface, placing the preform member entirely within a finishing die having a predetermined arcuately curved and longitudinally extending inner surface with the convex surface of the preform member facing the inner surface of the die, exerting a radial force progressively along the length of the inner surface of the preform member to form the convex outer surface to the predetermined configuration of the curved surface of the finishing die by moving a circular forming member longitudinally along the die from one end of the preform member to an opposite end of the preform member and in forced engagement therewith to exert said radial force, constraining said preform against endwise movement and constraining said preform against radial movement away from the inner surface of said die while the forming member is being moved as aforesaid by another circular member disposed within one end of the preform whereby said one end of the preform is confined between said die and the other circular member thereby confining said one end of the preform against radial distortion in the course of moving the first-named circular member progressively as aforesaid.

2. The method of making an accurately curved printing plate of less than 360° extent from a flat metal plate comprising the steps of forming opposite edge portions of the flat metal plate with curvatures having a predetermined radius, forming the portion of the metal plate between the curved edge portions in an arcuate shape to produce a preform member of a partial cylindrical configuration having a convex outer surface and a concave inner surface, placing the preform member entirely within a finishing die having a predetermined arcuately curved and longitudinally extending inner surface with the convex surface of the preform member facing the inner surface of the die, engaging stop structure with an end of the preform member, exerting a force on the inner surface of the preform member to form the convex outer surface to the configuration of the curved surface of the finishing die by moving a forming member, engaged with the entire circumferential extent of an axially extending portion of the inner surface of the preform member, in a single axial stroke and in a longitudinal direction only along the finishing die from one end of the preform member to the end engaged by the stop structure, and pressing an end portion of the preform member against the part of the finishing die adjacent said stop structure by means of a radial force exerted against the inner wall of the preform adjacent said end portion thereof while moving said forming member in said longitudinal manner to prevent longitudinal bowing of the preform member and radial bending of the end engaged with the stop structure.

3. The method of making an accurately curved printing plate of less than 360° extent from a flat metal plate comprising the steps of forming opposite edge portions of the flat metal plate with curvatures having a predetermined radius, forming the portion of the metal plate between the curved edge portions in an arcuate shape to produce a preform member of a partial cylindrical configuration having a convex outer surface and a concave inner surface, placing the preform member entirely within a finishing die having a cylindrical bore of predetermined radius extending longitudinally therethrough with the convex surfaces of the preform member facing the surface of the bore, exerting a constant radial force on the inner surface of the preform member progressively along the length thereof to form the convex outer surface of the preform to the configuration of the surface of the bore of the finishing die by inserting an unyielding forming member of predetermined radius into said preform in contact with the inner wall thereof and moving said forming member longitudinally through the bore, and constraining an end of the preform against movement radially away from said bore while the forming member is being moved as aforesaid, the last constraint being established by holding said end of the preform along the entire extent of the inner wall thereof against the opposed surface of the die by a radial force exerted along the entire extent of the inner wall of the preform adjacent said end thereof.

4. The method of making an accurately curved printing plate from a flat metal plate comprising the steps of forming opposite edge portions of the flat metal plate with curvatures having a predetermined radius, forming the portion of the metal plate between the curved end portions in an arcuate shape to produce a preform member of a partial cylindrical configuration having a convex outer surface and a concave inner surface, placing a pair of preform members side by side in a finishing die having a cylindrical bore extending longitudinally therethrough with the convex surfaces of the preform members facing the surface of the bore, engaging stop structure with an end of each of the preform members to limit axial movement of the preform members in an axial direction within the bore, exerting a force on the inner surface of the preform members to form the convex outer surfaces to the configuration of the curved surface of the finishing die

by inserting a forming member having a cylindrical shape between said pair of preforms to engage the forming member with the entire circumferential extent of an axially extending portion of the inner surface of each preform member and moving said forming member longitudinally only along the bore from one end of each of the preform members toward the opposite ends engaged by the stop structure, pressing end portions of the preform members against the part of the finishing die adjacent said stop structure by positioning a cylindrical member between said end portions while moving said forming member in said longitudinal manner to prevent bowing of the preform members at the ends engaged with the stop structure, and engaging said forming member with said cylindrical member to eject the cylindrical member from the bore at the conclusion of said longitudinal movement of said forming member.

5. The method of making an accurately curved printing plate of less than 360° extent from a flat metal plate comprising the steps of forming a preform member of a partial cylindrical configuration having a convex outer surface and a concave inner surface, placing the preform member in a finishing die having a predetermined arcuately curved and longitudinally extending inner surface with the convex surface of the preform member facing the inner surface of the finishing die, and moving a circular forming member longitudinally along the finishing die from one end of the preform member toward an opposite end of the preform member to shape the preform member to the configuration of the inner surface of the finishing die while constraining one end of the preform against movement radially away from the inner surface of the finishing die, said constraint being established by holding said one end of the preform along the entire extent of the inner wall thereof against the opposed surface of the die by a radial force exerted along the entire extent of the inner wall of the preform adjacent said one end thereof.

6. Die apparatus for forming partial cylindrical preform members each of less than 360° extent to an accurate cylindrical shape suitable for subsequent use as printing plates, said die apparatus comprising a die formed with a cylindrical bore extending longitudinally through the die and adapted to receive a pair of preform members therein, stop structure for engaging end edges of said pair of preform members adjacent one end of said bore, positioning means engageable with an inner surface of the preform members for maintaining the end portions of the pair of preform members which are abutted against said stop structure in engagement with the cylindrical bore, said positioning means including a cylindrical member movable axially past said stop structure and effective to press the end portions of the preform members against the end of the bore adjacent said stop structure forming means for forming the preform members to the curvature of said bore, said forming means including a plunger of less axial extent than said preform members and having a diameter related to the diameter of the bore and thickness and arcuate extent of the preforms such that insertion of the plunger between the preforms in the bore and a single movement of the plunger in an axial direction only through the bore is effective to form the preforms to the curvature of the bore, and means for moving said plunger longitudinally through the bore and into engagement with the positioning means to eject said positioning means past said stop structure at the completion of a forming operation on the preform members within the bore.

7. Die apparatus for forming partial cylindrical preform members to an accurate cylindrical shape suitable for subsequent use as printing plates, said die apparatus comprising a die formed with a cylindrical bore extending longitudinally through the die and adapted to receive a pair of preform members therein, said die including stop structure for engaging end edges of said pair of preform members adjacent one end of said bore, said stop structure projecting inwardly of the bore by an amount less than the thickness of a preform member, positioning means for maintaining the end portions of the pair of preform members which are abutted against said stop structure in engagement with the cylindrical bore, said positioning means including a cylindrical member movable axially past said stop structure and effective to press the end portions of the preform members against the end of the bore adjacent said stop structure, forming means for forming the preform members to the curvature of said bore, said forming means including a plunger of lesser axial extent than said preform members and having a diameter related to the diameter of the bore and thickness and arcuate extent of the preforms such that insertion of the plunger between the preforms in the bore and a single movement of the plunger in an axial direction only through the bore is effective to form the preforms to the curvature of the bore, and means for moving said plunger longitudinally through the bore and into engagement with the cylindrical member to eject the cylindrical member past said stop structure at the completion of a forming operation on the preform members within the bore.

8. Die apparatus for forming partial cylindrical preform members to an accurate cylindrical shape suitable for subsequent use as printing plates, said die apparatus comprising a die formed with a cylindrical bore extending longitudinally through the die and adapted to receive a pair of preform members therein, a stop ring seated within an annular recess adjacent one end of the bore for engaging end edges of said pair of preform members adjacent one end of said bore to thereby limit axial movement of said preform members, said stop ring having an inner diameter greater than the distance between facing surfaces of said preform members disposed in said bore, positioning means for maintaining the end portions of the pair of preform members which are abutted against said stop ring in engagement with the cylindrical bore, said positioning means including a cylindrical member movable axially through the stop ring and effective to press the end portions of the preform members against the end of the bore adjacent said stop ring, and forming means for forming the preform members to the curvature of said bore, said forming means including a plunger of lesser axial extent than said preform members and having a diameter related to the diameter of the bore and thickness and arcuate extent of the preforms such that insertion of the plunger between the preforms in the bore and a single movement of the plunger in an axial direction only through the bore is effective to form the preforms to the curvature of the bore, and means for moving said plunger longitudinally through the bore and into engagement with the cylindrical member to eject the cylindrical member through said stop ring at the completion of a forming operation on the preform members within the bore.

9. In die apparatus of the kind including a die member having an open-ended inner bore affording a die surface of a predetermined configuration and wherein a preform of less than 360° extent shaped generally complementary to the radius of the die surface of the bore is to be disposed therein prior to being formed to the exact radial contour of said die surface, forming means including a rigid circular member of predetermined radius movable axially between the open ends of said bore for progressively forming axial portions of the preform to the radial contour of the die surface, stop means for engaging an end of the preform to limit axial movement of the preform within the bore, and a cylindrical member engageable complementally with the inside surface at one end of the preform for maintaining the end portion of the preform in engagement with the die surface to prevent said end portion from being bent radially inwardly during said axial movement of said forming means.

10. Die apparatus for forming a partial cylindrical preform member into an accurate cylindrical shape suitable

for subsequent use as a printing plate, said die apparatus comprising a die formed with a cylindrical bore extending longitudinally through the die and adapted to receive a preform member therein, stop means for engaging an end of said preform member adjacent one end of said bore, a ring for complementally engaging the inside surface at an end of said preform to thereby maintain the exterior end portion of the preform member in engagement with the cylindrical bore, forming means for forming the preform member to the curvature of said bore, said forming means including a plunger of less axial extent than said preform member and having a diameter related to the diameter of the bore and thickness of the preform such that insertion of the plunger into a preform in the bore is effective to form the portions of the preform engaged by

the plunger to the curvature of the bore, and means for moving said plunger longitudinally through the bore.

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