April 6, 1965 S. S. MILLER 3,177,104

METHOD OF MAKING PRINTING CYLINDERS

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FIG. 1

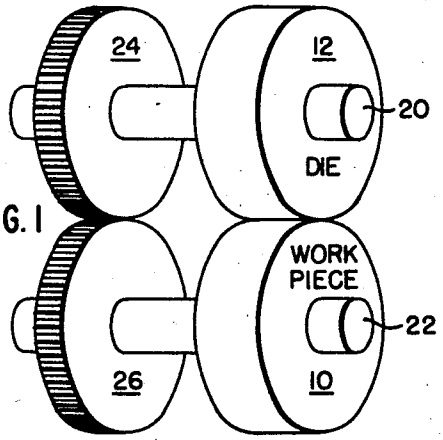



FIG. 2

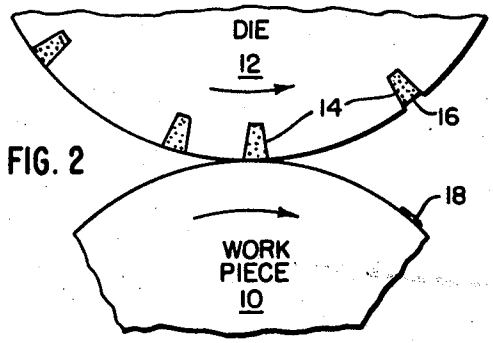



FIG. 3

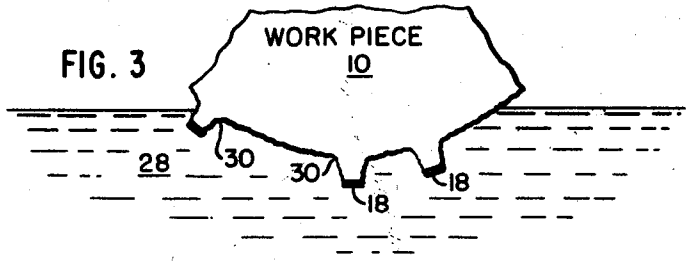
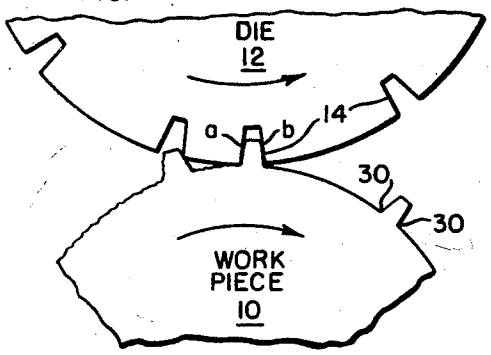



FIG. 4




INVENTOR.
SEWARD S. MILLER

BY Kenway, Jenney & Hildreth

ATTORNEYS

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FIG. 5

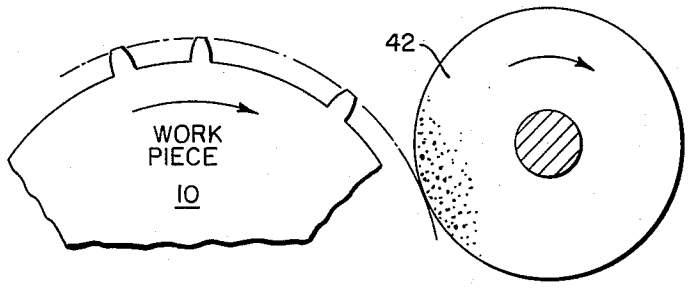
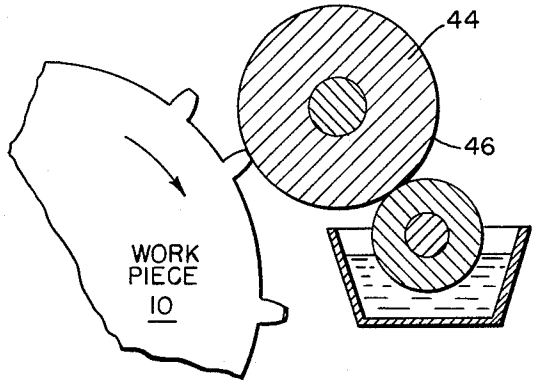



FIG. 6



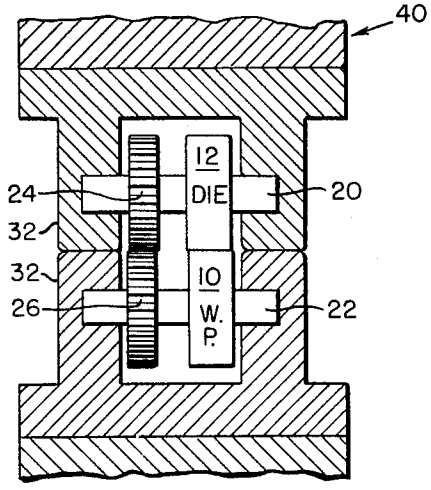




FIG. 7

*INVENTOR.*
SEWARD S. MILLER

*BY* Kenway Jenney & Hildreth

ATTORNEYS

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3,177,104

# METHOD OF MAKING PRINTING CYLINDERS

Seward S. Miller, Garden Grove, Calif., assignor to Mark Steel Stamp Corporation, Fullerton, Calif., a corporation of California

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7 Claims. (Cl. 156—14)

This invention relates to the manufacture of printing cylinders for high speed printers and the like, and more particularly to a method of making cylinders having raised characters.

Printing devices operable at high speeds frequently employ a rapidly rotating cylinder having rows of type characters projecting from its periphery. Printing is carried out by means of a row of hammers each of which may be selectively actuated to strike against the type characters with a sheet and an adjacent inked ribbon interposed between the type and hammer line by line as the sheet is advanced. A typical printer of this type is described in United States Patent No. 2,940,385.

The present invention provides a method of making raised character printing cylinders in an inexpensive, yet highly precise, manner. The process is characterized by a combination of etching and cold working operations which may be viewed in a very general way as utilizing relatively rapid etching operations to form a rough approximation of the characters, followed by cold working, with or without grinding, to bring the caps or faces of the characters to highly precise outlines. An important characteristic of the process is the complete lack of etching or deformation of the character faces prior to the final cold working and grinding operations.

Suggestions of somewhat similar processes are contained in the prior art with reference to the etching of figures on rollers generally, but none heretofore developed has been successfully applied to the manufacture of articles with the degree of precision required to provide raised characters on a printing cylinder. The processes of which we are aware have been more in the nature of successive, and more or less continuous, etching operations wherein resist is frequently or continuously applied to control the etching to maintain conformity with the die. In the end the entire surface is etched and partakes of the characteristic roughness of etching. The use of coining steps has been described in conjunction with such prior art processes as a means to remedy etching irregularities by smoothing over the surfaces formed by etching.

By way of contrast, in the process of the instant invention, the faces of the type characters are protected from etching by the etch-resist material, during the entire process so that when the final cold working operation is carried out these surfaces may be formed to a precise dimension.

The preferred embodiment of this invention is described in detail below with reference to the accompanying drawings, in which:

FIG. 1 is a schematic perspective view showing a die and a workpiece arranged for use in this invention;

FIG. 2 is a fragmentary cross section showing the application of etch resist material to the workpiece from the die;

FIG. 3 is a fragmentary cross section showing the effect of etching the workpiece following the operation shown in FIG. 2;

FIG. 4 is a fragmentary cross section showing a cold working operation wherein partly formed characters on the workpiece are subject to working by the die;

FIG. 5 is a fragmentary cross section showing a grinding operation in which the faces of the characters are accurately formed;

FIG. 6 is a fragmentary cross section showing the application of a second coating of etch resist to the faces of the characters from an inking roll; and



FIG. 7 is a cross sectional view showing a die and a workpiece mounted in a press for precision coining to predetermined dimensions.

In general, the process features the application of etch resist to a cylindrical metal workpiece in areas corresponding to, but larger than, the faces of the characters to be formed, followed by the etching away of the surrounding metal to form embryonic characters in the form of raised cores. The workpiece is then engaged with a cylindrical die having recesses into which the character cores mesh, and under pressure the die and workpiece are rotated and brought together as the side edges of the characters are cold formed to precise outline. The recesses of the die are formed with inwardly merging edges adapted to compress the sides of the etched, and somewhat undercut cores. As the workpiece and die are rotated, the character cores are molded to the recesses and the leading and following edges of the character cores are further worked and formed by the gearing action of the corresponding surfaces of the recesses. In this gearing action additional metal is displaced from the tops of the characters at their leading and following edges to produce a convex curvature in the manner of the teeth of a gear. The metal thus displaced produces a cold flow which may either fill in excessively etched portions elsewhere or cause the top faces of the characters to become raised. The action of the die and workpiece is thus partly a coining action by which the character cores are simply forced under pressure into conformity with the recesses, and partly a progressive forging action by which the leading and following edges are gradually curved from the sides of the recesses and caused to flow elsewhere. These combined actions result in the formation of highly precise character outlines.

The final operation to finish off the workpiece may include a grinding of the characters to bring their faces to proper cylindrical alignment at the print cylinder surface, and subsequent etching and cold working operations. Where the sequence of etching and cold working is carried out in steps, the subsequent application of resist may be made to the raised faces of the character cores from a rubber print roller, or it may be made by filling the die with resist and rotating the workpiece with it under slight pressure.

The various steps are shown schematically in the accompanying drawings, which should be taken as diagrammatic inaccurate representations aimed at facilitating an understanding of the operations.

In the illustrated preferred embodiment the process is carried out on a cylindrical workpiece **10** of mild steel, brass, or other suitable metal which is caused to correspond to a die or millpiece **12**, of the same diameter as the workpiece and having recesses **14** formed with steeply sloping sides and corresponding to the characters to be formed. Etch resist is applied to the surface of the workpiece in areas corresponding to but larger than the faces of the characters to be formed. The resist may be applied from the die itself as the recesses are appropriately wider at the surface of the die than inwardly where the faces of the characters will be formed, or it may be applied by other means. Most conveniently the recesses **14** of the die **12** are first filled with a conventional etch resist **16**, and the excess is removed so that only the recesses are filled. The die **12** and the workpiece **10** are then arranged to be rotated in rolling contact such that etch resist **16** is transferred from the die to the workpiece in the general outline of the base of the characters to be formed, as indicated at **18** in FIG. 2. For this purpose the die and the workpiece are mounted on shafts **20** and **22** which are driven to-

gether through gears 24 and 26 having pitch diameters corresponding to the diameters corresponding to the diameters of the die 12 and workpiece 10, so that an accurate application of etch resist 18 is made to the surface of the workpiece 10. The die 12 and workpiece are next separated and the workpiece 10 is rotated in an etching fluid 28 to remove material from the areas between the characters as shown in FIG. 3. Character cores 30 are thus formed, the faces of which constitute unaltered portions of the original surface of the workpiece. Etching is continued until a suitable amount of material has been removed, generally until the character cores are formed to about 75–95 percent of the height of the final characters. The outlines of the faces of the characters are then formed by cold working within the recesses 14 of the die 12, as shown in FIG. 4. In this coldworking operation, the workpiece 10 and die 12 are first thoroughly cleaned and again mounted together on the geared shafts 20 and 22. As shown schematically in FIG. 7, the die and workpiece are rotated while being pressed together to a predetermined separation which may be controlled by mounting the members for rotation in a hydraulic press 40 in which the separation of the pressure platens is determined by bringing bearing blocks 32 together during the cold working operation.

As shown in FIG. 4, the rotation of the die and workpiece causes the characters to partake at their leading and following edges of a convexedly curved outline by which metal is displaced away from the sides of the recesses, as at "*a*" and "*b*." This displacement is additional to that which results from a pure coining action and further assures that the side surfaces of the characters are formed by their contact with the sides of the recesses. In practice this displacement may also cause the unetched faces of the characters, which are portions of the original surface of the workpiece, to raise from the printing surface a slight amount of nonalignment of the tops of the character faces may result. However, the sides of the characters are thereby caused to be formed very accurately at the location of the printing surface, and when the characters are later ground to proper cylindrical alignment the outlines of the faces are accurately defined.

Following cold working of the characters, the workpiece is mounted on a shaft opposite a precision grinder 42 as shown in FIG. 5 and the faces of the characters are ground to proper diameters. This may be the final operation, but where highest precision is demanded, the characters at this stage are formed to slightly less than final height and a subsequent sequence of the same steps is followed to bring about character formation. A second application of etch resist is made, conveniently from an inking roller 44 to which a layer 46 of each resist has been applied, as suggested by FIG. 6, and a subsequent etching is utilized to bring the cores to full depth. This is then followed by a second cold working during which the sides and edges of the cores are further worked and brought to conformity with the die, and the surfaces between the characters may also be formed smoothly by the coining action of the face of the die. As this additional cold working of the characters will cause the faces of the characters again to displace from the flow of displaced metal, a second grinding of the faces is generally desirable, as described above with reference to FIG. 5.

The process partakes of several more or less optional variations, the uses of which depend on the particular nature and characteristics of the material and characters to be formed. After an initial mild etching operation, the die 12 with etch resist still in the recesses 14 and workpiece 10 may be reassembled to apply etch resist material to those places of relatively deep etching, thereby equalizing the removal of metal during subsequent etching operations. At the same time the die and workpiece may be brought together under pressure, as shown in FIG. 7, to an intermediate predetermined separation which will correspond to the amount of etching that has taken place, to bring about some degree of cold working of the side walls of the characters.



In the final cold working operation, the workpiece 10 may be sufficiently etched that the faces of the characters 30 are brought substantially into conformity with the inner faces of the recesses 14. This will occur where the material removed from the workpiece exceeds the depth of the recesses so that the faces of the character cores 30 will be brought forcibly against the innermost surface of the recesses 14.

Coning of the faces of the characters will also occur where the displacement of metal outwardly from the character cores brings the tops of the cores into contact with the inner surfaces of the recesses in the die. Under such conditions, coined character faces may be formed even though the workpiece is not etched away by an amount exceeding the height of the characters.

Whether the coining is applied only to the edges of the characters, or to the faces and edges, it will be noted that the faces of the characters are formed without any etching and thus retain a relatively smooth unpitted condition which is needed for raised type characters of high quality.

The die or millpiece 12 is made conveniently by conventional pantographic engraving techniques, with the recesses formed with steeply sloping sides. It will be noted that the faces of the characters in the circumferential direction are smaller than the recesses; the recesses must accordingly be cut longer in the circumferential direction to compensate. The slope of the walls should be designed to assure proper contact with the etched cores. It should not be so close to perpendicular that the cores may enter the recesses without pressing against the side walls of the recesses sufficiently to be forced into conformity thereto, nor should it be so shallow a slope that proper gearing action at the leading and following edges of the tops of the cores does not result. In preferred embodiments the walls will slope about 22° from the radius but somewhat lesser or greater amounts, e.g. 15°–30° are entirely suitable.

Having thus disclosed my invention and described in detail the preferred embodiment thereof, I claim and desire to secure by Letters Patent:

1. The method of forming a printing cylinder having raised printing characters, comprising filling recesses in a cylindrical die with etch resist, said recesses being bounded by steeply inwardly converging sides substantially inclined from the radial direction; rotating said die in registration with the surface of a cylindrical workpiece to apply etch resist thereto in the areas of and surrounding the faces of the characters to be formed; etching away the surface material of said workpiece only outside the areas of the applied resist to form character cores having greater transverse dimensions than the full characters to be formed; cleaning the resist from the recesses of said die cylinder; rotating said workpiece in registration with said die cylinder, with the cores received in said recesses and interfering with the sides thereof, while relatively displacing said die and said workpiece to apply pressure therebetween, thus producing cold flow of the walls of said cores; and terminating the relative displacement of said workpiece and said die cylinder at a fixed relative axial displacement sufficient to maintain clearance between the remaining surface areas of said faces and the roots of said recesses, to provide precise predetermined conformity of character face outlines; and removing the applied resist from the surface areas of said faces.

2. The method recited in claim 1, which includes the further step of grinding the faces of said character cores to cylindrical alignment.

3. The method recited in claim 1, in which the sides of said recesses are inclined from the radial direction at an angle in the range of between about 15° and 30°.

4. The method recited in claim 1, in which the steps of applying etch resist to the character faces, etching away the surface material outside the areas of applied resist, and rotating the workpiece in contact with the die cylinder are sequentially repeated.

5. The method recited in claim 4, in which the initial etching is continued to form the character cores until the height of the character cores is between about 75% and 90% of full character height.

6. The method recited in claim 5, in which the sides



of said recesses are inclined from the radial direction at an angle in the range of between about 15° and 30°.

7. The method recited in claim 4, in which the printing cylinder is completed by the additional step of grinding the tops of the character cores to cylindrical alignment.

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EARL M. BERGERT, *Primary Examiner.*