METHOD AND APPARATUS FOR MAKING PERFORATING STRIP

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This invention relates to improvements in the manufacture, and a machine for carrying out the manufacture, of perforating strip which is adapted to be used on a cylindrical offset or lithographic press.

In an offset or lithographic press, inked images are transferred by a rubber blanket to paper stock. It is often desirable to perforate the paper so that portions of the paper can be removed after the printing is completed. It is, therefore, desirable to provide perforating strip which can be readily cut to desired lengths so that the lengths can be quickly and positively cemented on the impression cylinder of the offset press. As each job is set up on the press, a supply of strip is kept at hand so that the required lengths of strip can be cut and conform and cemented to the impression cylinder.

A basic requirement for the configuration of the perforating strip is that it have a flat base and perpendicularly disposed perforating teeth on the upper face of the base. Elongated stock has been worked in various ways to supply this basic structure.

Stock in ribbon form has been worked to turn up one of its edges perpendicular to the remainder of the body of the stock. This rib-edge, arranged perpendicular to its base, is notched. The result is continuously arranged teeth on the edge of the stock base. However, with pressure from the rubber blanket of the press on the teeth, this base is easily displaced from its impression roll. It is, therefore, preferable to arrange the teeth along the center line of the base to obviate this problem of displacement.

To form the teeth on the longitudinal center line of a stock base, stock has been milled in its longitudinal direction to cut material away from the center portion of the stock. If cavities are first spaced along the center line, this milling leaves teeth along the center line. If the stock is first milled, transverse notches must be subsequently made through the center portion to complete formation of the teeth. However, milling is too slow to produce strip in the quantities usually desired. It has become evident that a method and means is required to work longitudinal stock in a one-step, continuous, operation which does not require the time-consuming cutting away of material from the stock.

A principal object of the invention is to deform with one, continuous operation, firm and bendable material having a substantially circular cross-sectional shape, into perforating strip having a flat base on which teeth are perpendicularly disposed in alignment along its longitudinal center line.

Another object is to continuously, progressively, cold forge a wire of soft, annealed, low-carbon steel into a perforating strip with a flat base on which elongated perpendicular teeth are disposed in alignment along the longitudinal center line of the base.

Another object is to form a perforating strip with a flat base having elongated and aligned perpendicular teeth on one face of the base and deposited adhesive on the other face with removable tape.

The invention contemplates the process of cold working an elongated body of soft, annealed, low-carbon steel to reform its substantially circular cross-section into a shape having a flat base of two sides, perpendicular teeth being mounted on one side of the base and disposed in alignment along the center line of the base.

The invention further contemplates the wire being worked by cold forging with rolling dies, carried out progressively and continuously in one direction along the length of the wire.

The invention further contemplates a machine with a die comprised of an impression roll and a blank roll in contact at their peripheries so they will rotate together. Cavities formed in the outer diameter surfaces of the rolls receive soft, annealed, low-carbon, steel wire and continuously and progressively cold forge the wire into perforating strip of desired shape. The machine simultaneously provides means to sharpen the teeth in their longitudinal direction and apply removable adhesive transfer tape to the flat face of the strip.

Other objects, advantages and features of this invention will become apparent to one skilled in the art upon consideration of the written specification, appended claims, and attached drawings wherein:

FIG. 1 is a somewhat diagrammatic assembly of the essential elements of the machine carrying out the process in which the invention is embodied;

FIG. 2 is a side elevation of the die rolls of the FIG. 1 machine;

FIG. 3 is an end elevation of the die rolls of FIG. 2;

FIG. 4 is a sectioned elevation of a portion of the blank form roll of the dies;

FIG. 5 is a sectioned elevation of a portion of the impression roll of the dies;

FIG. 6 is a side elevation of the perforating strip formed with the process;

FIG. 6A is a view along lines 6A—6A of FIG. 6;

FIG. 7 is an isometric view of the steady rest of FIG. 1;

FIG. 8 is a side elevation of the steady rest of FIG. 7;

FIG. 9 is a sectioned side elevation of the tape and trim rolls of the machine of FIG. 1;

FIG. 10 is an end elevation of the tape and trim rolls of FIG. 9.

FIG. 1 has been established to illustrate the essential elements of a complete machine, embodying the present invention, for producing perforating strip ready for use. The various moving elements are shown in positional relation to each other as they work an elongated stock of material to produce the final form of the strip, complete with adhesive deposited on its surface which is to be fixed to the impression cylinder of an offset press. The supports and power sources for the moving elements of the machine are not shown, being capable of many specific forms which are not pertinent to the invention.

GENERAL STRUCTURE AND OPERATION

A supply of stock to be worked is illustrated at 1, in the form of a spool of wire. The wire is substantially round in cross-section, of soft, annealed, low-carbon steel and is shown in FIG. 1 as unwinding from spool 1 and feeding into rolling dies. The rolling dies are comprised of a blank form roll 2 and an impression roll 3, maintained in contact at their peripheries so their outer diameter surfaces will rotate together.

Roll 2 rotates clockwise and roll 3 rotates counterclockwise, their outer diameter surfaces in rolling contact. Cavities in these outer diameter surfaces receive wire 4 from reel 1 and continuously and progressively cold forge the wire stock into a perforating strip having a first flat face as a base and a second flat face with elongated teeth arranged in alignment along the center line of the second flat face. The teeth are then sharpened and adhesive deposited on the first base face.

The rolling dies may, or may not, be formed to produce teeth on the strip sharp enough to perforate paper
stock satisfactorily. However, the cold forged teeth can always be made sufficiently sharp by grinding the teeth in their longitudinal direction while the tooth of the strip is disclosed as a powered grinding wheel 5, positioned with respect to a steady-rest structure 6. The strip from rolls 2, 3 is passed over the steady-rest 6 and its teeth ground to an edge at a desired angle. Details of the steady-rest 6 are disclosed infra.

As the perforating strip, newly introduced by the rolling dies, passes to the steady-rest, it is guided with precision by guide roll 7. Roll 7 has a simple form, being a roll with a peripheral groove in its outer diameter surface in which the teeth of the strip are carried. The strip is, therefore, fed beneath the roll 7 through a point slightly below the level of the steady-rest surface over which the strip passes to be worked by the grinding wheel 5. With this arrangement, the strip base is carried firmly over the steady-rest surface and the teeth maintained in a path which precisely directs the strip onto the steady-rest structure 6 in order for contact with the grinding wheel 5 to sharpen the teeth to the desired degree.

The tooth-forming impression roll 3 of the strip dies does not readily release the teeth if it forms. The deformation of the wire body in forming the teeth of the perforating strip is a major change in the grain structure of soft, annealed, low-carbon steel. The cold working hardens the structure materially. The teeth formed by the tooth cavities of the impression roll 3 have a high degree of friction with their cavity walls. The teeth must be pulled from their cavities as the strip emerges from the dies or the strip will follow the impression roll and not feed itself and immediately into the guide roll 7. A means for maintaining tension on the strip coming out of the dies is desired. Rolls 8 and 9 embody the means with which to maintain the desired tension.

The diameter plane of tension rolls 8 and 9 is aligned with the strip path of steady-rest 6, the diameter plane of guide roll 7 and the diameter plane of roll 11. Roll 8 is mounted at a height that will carry the perforating strip, with its sharpened teeth, through a point below the level of the strip path on steady-rest 6. A peripheral groove is formed in the outer diameter surface of roll 8 to accommodate the teeth of the strip. Roll 9 is located so its outer diameter surface is spaced from the outer diameter surface of roll 8, the two sides of the flat base engaged between them with sufficient force to pull the teeth from their forming cavities on impression roll 3.

Arrows are used on the drawing to indicate that tension roll 8 rotates counterclockwise while tension roll 9 rotates clockwise. Holding the perforating strip between their outer diameter surfaces, these rolls pull the teeth from the dies which form them and pass it firmly over a path on the surface of the steady-rest 6. The die rolls are powered to pull the wire 4 from roll 1 into the tooth-forming cavities. The rolls 8 and 9 are powered and geared by a mechanism not shown to maintain the desired tension on the strip between the die rolls and the tension rolls.

As the formed perforating strip, with its sharpened teeth, emerge from tension rolls 8 and 9, the final step of the process is taken to deposit adhesive on the face of the strip to be fixed to the surface of the impression cylin-

### WIRE AND DIES

For a detailed disclosure of the process, and the machine carrying out the process, the elongated stock and the dies forming the stock into the perforating strip are considered in FIGS. 2–6. The wire 4 of spool 1 is preferably a soft, annealed, low-carbon steel. The actual reduction to practice of the invention successfully utilized steel having less than 0.18% of 1% carbon. The exact hardness resulting from the cold working of the dies has not been directly measured. However, the strip produced was sufficiently hard to function in perforation of paper stock over 30,000 times without material wear of the teeth. The particular dimensions of the perforating strip required a wire having a diameter of about 0.034 inch.

Satisfactory dimensions for a strip having general use begin with a width of 0.100 inch. This 0.100 inch width base preferably has a thickness, or height, of about 0.006 inch. Mounted on the upper face of this 0.006 inch base are the perpendicular, elongated, aligned teeth. These teeth should be roughly triangular in cross-section and arranged along the center line of their strip face. The base of the triangular teeth should be about 0.008 inch and the teeth should extend about 0.020 inch above their strip face. These dimensions are not a limitation to the invention concept but are offered as a teaching of how to produce a satisfactory form of a strip with wire stock having a diameter of about 0.034 inch.

The dies for converting the steel wire into perforating strip are comprised of rolls 2 and 3. Roll 2 is made of solid stock. Roll 3 is made in two halves, bolted together to provide forming cavities at their parting line. FIG. 2 shows the strip to be used on the dies is manually removed from the strip, leaving the adhesive on the base face. The strip is then pressed onto a predetermined location on its impression roll.

The strip from rolls 8 and 9 is guided between two rolls which apply the adhesive-depositing tape. Guide roll 10 is a simple wide roll 7. Guide roll 10 receives the teeth of the strip in its peripheral groove and directs the strip between trim roll 11 and tape roll 12. In general, these rolls hold, grip and pass the strip between them while continuously applying the adhesive tape to the base face of the strip to provide the means for sharpening the teeth.

More specifically, a supply reel 13 of adhesive tape is mounted near tape roll 12 and fed onto tape roll 12 through a guide 14. As with the other rolls and structures which guide, work and move the strip, the conventional machine parts powering, supporting and coordinating rolls 10, 11 and 12 are not illustrated. However, the carrying out the inventive process are the more clearly shown and readily understood in their form and function.

Further details of rolls 11 and 12 will be disclosed infra.

At this time it need only be generally understood that tape trim roll 11 has a peripheral groove in its outer diameter surface which is wide enough to accommodate the complete strip as the strip is guided to by roll 10. At the bottom of this initial groove is a second groove, wide enough to accommodate the strip teeth. The edges of the large groove are sharp enough to cut the adhesive tape. The tape-bearing roll 12 is wide enough to fit into, and ride down into, the large groove of tape trim roll 11. The adhesive-depositing tape 13 is given a width slightly larger than the width of the strip and the large groove in roll 11. As the rolls apply the tape to the strip, and roll 11 forces strip and tape down into the large groove of roll 11, the excess tape, in its width, is scissored between the edges of roll 12 and the edges of the large groove in roll 11. The finished product of perforating strip and adhesive tape emerges from the rolls 11 and 12, ready for use. The adhesive is deposited on the base face of the strip and exposed when the tape is removed. However, until the strip is required on a press, it may be handled and packaged in coils, the adhesive covered by the tape which deposited it.
strip is formed. The depth of this base groove cavity is the 0.006 inch thickness preferred for the strip. The soft, annealed, low-carbon steel wire is deformed into the rectangular cross-sectional shape of the groove-cavity 17 while leaving the teeth upstanding on the upper face of the base.

Impression roll 3 has tooth cavities 18 spaced evenly along the parting line of the two halves of the roll. As these tooth cavities roll over the base-cavity 17, the wire material is not only pressed down into groove-cavity 17 but is left protruding into the tooth cavities. In this one, continuous, cold forging operation the round wire is given the final shape desired for the strip without cutting away material or auxiliary operations.

FIG. 4 is a greatly enlarged portion of a section taken through blank form roll 2. The groove-cavity 17 is shown to advantage. The height of this groove, or its depth, is that of the strip base thickness. In FIG. 5 the relief cut 19 is shown as made on the surfaces of the roll halves facing each other. This relief cut 19 is made through the holes for bolts 16 to maintain a relatively high unit area loading at the parting line between the halves. The high loading force impresses die roll halves from parting at the vital point where the forming cavities are applied to the wire in the cold forging operation.

FIG. 5 also shows the tooth cavities in one half of roll 3. These cavities are formed with an indexing grinder. Precisely ground, drawn together with high unit area loading at their peripheries, these roll halves form the rolling die which leaves wire material upstanding in tooth form on the strip base.

The teeth 20 are themselves illustrated in FIG. 6 and FIG. 7. The base 21 is also shown supporting the teeth in operative position, ready to function by perforating paper stock. The finished product, with its teeth 20 mounted along the center line of the base 21, will not cant, tip or buckle. The teeth are given a firm foundation and the entire structure balanced on the face carrying it to perform its perforating function.

The material of the dies is hard enough to deform the soft wire, and cold work it, without wear over long periods of time. A satisfactory hardness for this die material is in the order of Rockwell 64-65 on the C scale. Material presently available to meet these specifications is Star Zephyr, medium steel, such as commonly used for milling cutters.

STEADY-REST 6

The steady-rest structure of FIG. 1 is disclosed in more detail with FIGS. 7 and 8. In FIG. 7 the steady-rest 6 is disclosed without the grinding wheel 5 in position. The strip formed of wire 4 is shown passing over a fixed path of surface 25 of solid block structure 26. Wear of surface 25 is obviated by the surface being hard chrome plated. Block 26 is bolted to a base 27. Tooth-glide plate 28 is bolted to base 27 to present an arcuate edge against the newly-formed teeth of the perforating strip. The working surfaces of the plate are also chrome plated. A guide arm 29 is bolted to base 27 to hook over the perforating strip and capture and maintain it in its path across surface 25.

In FIG. 8, shown is a guide and base structure to better advantage in combination with grinding wheel 5. Strip 4 is shown in cross-section, its teeth sliding over surface 25 and the forward arcuate edge 30 positioned against the root of teeth 20. With teeth 20 backed solidly by edge 30, grinding wheel 5 is positioned at the angle desired to sharpen the teeth as they pass by.

TAPE AND TRIM ROLLS

FIGS. 9 and 10 are established to illustrate, in detail, how tape 13 is used to deposit adhesive on strip 4 and complete the combination of the finished product. It has already been generally illustrated that the strip is guided into rolls 11 and 12 by guide roll 10. Further, reference has been made to the peripheral grooves of rolls 11 and 12 which hold the strip 4 and apply the adhesive tape to the strip base. FIG. 9 shows these rolls positioned in an elevation view to bring out the precise relation of the grooves to the strip and tape. FIG. 10 shows the trimming function of the groove edges on the tape.

In FIG. 9, the teeth-receiving groove 40 of roll 10 is shown, receiving teeth 20 and cut deep enough to ride the upper surface of the strip base in. In FIG. 10, the teeth 20 are passed into a groove 41 of roll 11. The groove 41 is cut from a surface 42 of roll 11 which is itself a groove with reference to the outer diameter surface of roll 11. Groove-surface 42 is wide enough to accommodate the width of base 21, therefore, strip 4 is carried a finite distance below the outer diameter surface of roll 11.

Roll 12 is simply a disc having a width which enables it to slide into the outer groove of roll 11 to carry tape 13 against the lower base surface of the perforating strip. The sides of roll 12 are cut with sides of the outer groove of roll 11.

The result is demonstrated in FIG. 10. The excess width of strip 13 is continually cut to remove remnants 13A and leave the center portion of the tape in lamination with the base 21 of the strip. The finished product of strip and tape emerges from rolls 11 and 12, ready for use on a press.

From the foregoing it will be seen that this invention is one which is adapted to retain all of the ends and objects hereinbefore set forth, together with other advantages which are obvious and which are inherent to the method and apparatus.

It will be understood that certain features and sub-combinations are of utility and may be employed without reference to other features and sub-combinations. This is contemplated by and is within the scope of the claims. As many possible embodiments may be made of the invention without departing from the scope thereof, it is to be understood that all matter herein set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

1. Apparatus for making perforating strip, including, a circular blank roll die with a continuous groove cavity in the center of its outer diameter surface, a circular impression roll die with tooth cavities spaced in alignment along the center line of the outer diameter surface of the roll die and having uniform depth toward the center of the roll die from the surface, means for maintaining the rolls in contact at their peripheries with the aligned tooth cavities extending along the center of the groove cavity while the roll dies are rotated together, a supply of soft annealed low-carbon steel wire arranged at the entry to the roll dies and fed into the teeth and groove cavities of the rolls so as to be continuously and progressively cold forged by the die rolls into a perforating strip having a flat face as a base and a second flat face with elongated teeth arranged in alignment along the center line of the second flat face, a steady rest mounted at the exit from the roll dies and providing a flat surface over which the cold forged perforating strip is passed, and a grinder element mounted over the surface of the steady rest to sharpen the teeth of the strip as they are passed from the dies over the surface of the steady rest.

2. Apparatus for making perforating strip, including, a circular blank roll die with a continuous groove cavity in the center of its outer diameter surface, a circular impression roll die with tooth cavities spaced...
in alignment along the center line of the outer diameter surface of the roll die and having uniform depth toward the center of the roll die from the surface,

means for maintaining the rolls in contact at their peripheries with the aligned tooth cavities extending along the center of the groove cavity while the roll dies are rotated together,

a supply of soft annealed low-carbon steel wire arranged at the entry to the roll dies and fed into the tooth and groove cavities of the rolls so as to be continuously and progressively cold forged by the die rolls into a perforating strip having a flat face as a base and a second flat face with elongated teeth arranged in alignment along the center line of the second flat face,

a steady rest mounted at the exit from the roll dies and providing a flat surface over which the cold forged perforating strip is passed,

a grinder element mounted over the surface of the steady rest to sharpen the teeth of the strip as they are passed from the dies over the surface of the steady rest,

and means mounted at the exit from the steady rest and grinder to maintain tension on the strip as it leaves the rolling dies and passes over the flat surface of the steady rest to pull the cold forged teeth of the strip from the tooth cavities after the teeth are formed and maintained a positional relation between the grinder element and the strip teeth.

3. Apparatus for making perforating strip, including:

a circular blank roll die with a continuous groove cavity in the center of its outer diameter surface,

a circular impression roll die with tooth cavities spaced in alignment along the center line of the outer diameter surface of the roll die and having uniform depth toward the center of the roll die from the surface,

means for maintaining the rolls in contact at their peripheries with the aligned tooth cavities extending along the center of the groove cavity while the roll dies are rotated together,

a supply of soft annealed low-carbon steel wire arranged at the entry to the roll dies and fed into the tooth and groove cavities of the rolls so as to be continuously and progressively cold forged by the die rolls into a perforating strip having a flat face as a base and a second flat face with elongated teeth arranged in alignment along the center line of the second flat face,

a steady rest mounted at the exit from the roll dies and providing a flat surface over which the cold forged perforating strip is passed,

a grinder element mounted over the surface of the steady rest to sharpen the teeth of the strip as they are passed from the dies over the surface of the steady rest,

means mounted at the exit from the steady rest and grinder to maintain tension on the strip as it leaves the rolling dies and passes over the flat surface of the steady rest to pull the cold forged teeth of the strip from the tooth cavities after the teeth are formed and maintain a constant positional relation between the grinder element and the strip teeth,

and means mounted in fixed relation to the means for maintaining tension for applying an adhesive-depositing removable strip to the base face of the cold forged and tooth-sharpened strip.

4. Apparatus for making perforating strip, including:

a supply of soft annealed low-carbon steel wire being in the order of 0.18 to 1% carbon content;

rolling dies receiving the wire and continuously and progressively cold forging the wire into a perforating strip having a flat face as a base and a second flat face with elongated teeth arranged in alignment along the center line of the second flat face comprising,

a circular blank roll die with a continuous groove cavity in the center of its outer diameter surface,

circular impression roll die formed of two halves with tooth cavities spaced in alignment along the centrally located parting line of the outer diameter surface of the roll die and having uniform depth toward the center of the roll die from the surface,

and means for maintaining the rolls in contact at their peripheries with the aligned tooth cavities extending along the center of the groove cavity while the roll dies are rotated together to cause the rolls to forge the wire;

a supply of adhesive-depositing tape mounted in the line of strip forged by the rolls;

and a pair of rolls mounted in the line of strip from the rolls to receive the perforating strip from the rolling dies and the tape from the supply of tape to laminate the strip and tape into a unitary article of manufacture.

5. Apparatus for making perforating strip, including:

a supply of soft annealed low-carbon steel wire being in the order of 0.18 to 1% carbon content;

and rolling dies receiving the wire and continuously and progressively cold forging the wire into a perforating strip having a flat face as a base and a second flat face with elongated teeth arranged in alignment along the center line of the second flat face comprising,

a circular blank roll die with a continuous groove cavity in the center of its outer diameter surface,

circular impression roll die formed of two halves to be bolted together at points in a circle about their center and a relief cut in their adjacent facing surfaces and through the bolt hole circle to produce a predetermined area loading at the abutting surfaces in which tooth cavities are spaced in alignment along the centrally located parting line of the outer diameter surface of the roll die and having uniform depth toward the center of the roll die from the surface, and bolts and nuts through the two halves of the impression roll die at and along the bolt hole circle for maintaining the rolls in contact at their peripheries with the aligned tooth cavities extending along the center of the groove cavity while the roll dies are rotated together to cause the rolls to forge the wire.

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