Dec. 4, 1956 J. R. SHARE 2,772,630

METHOD AND MEANS OF DECORATING METAL STRIP, BY OFFSET PRINTING

Filed Aug. 28, 1952 2 Sheets-Sheet 1

Fig. 1.

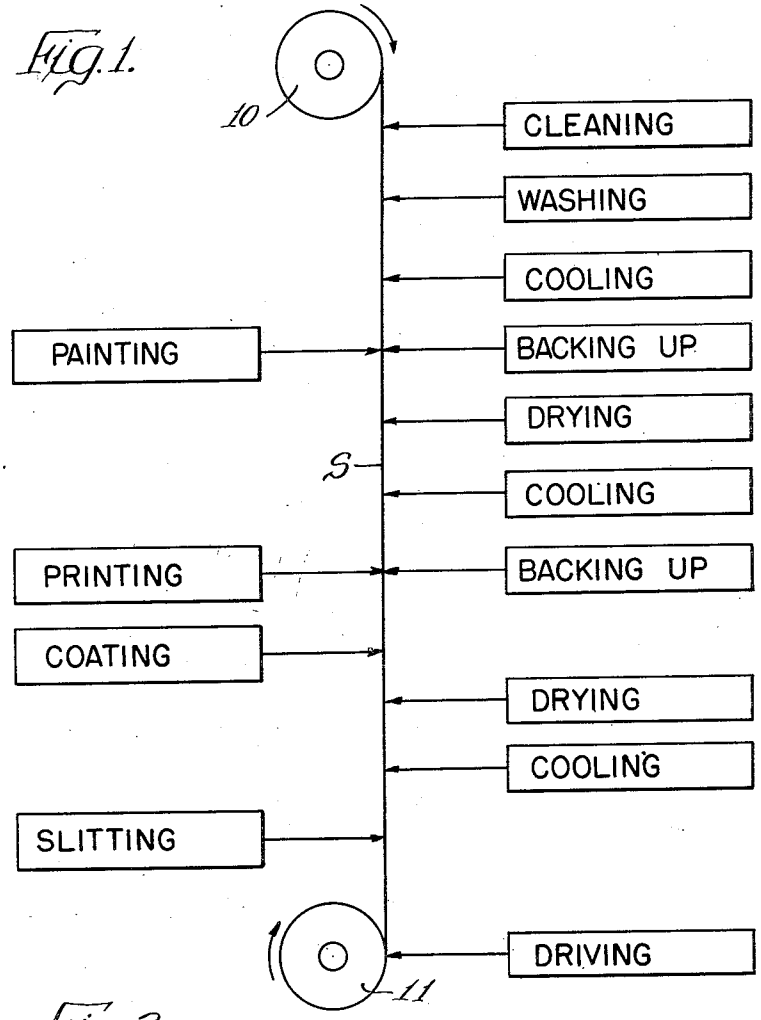
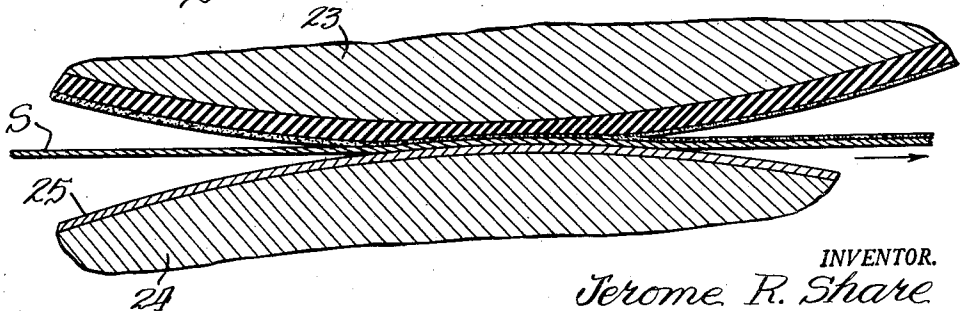


Fig. 3.



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Fig. 2A.

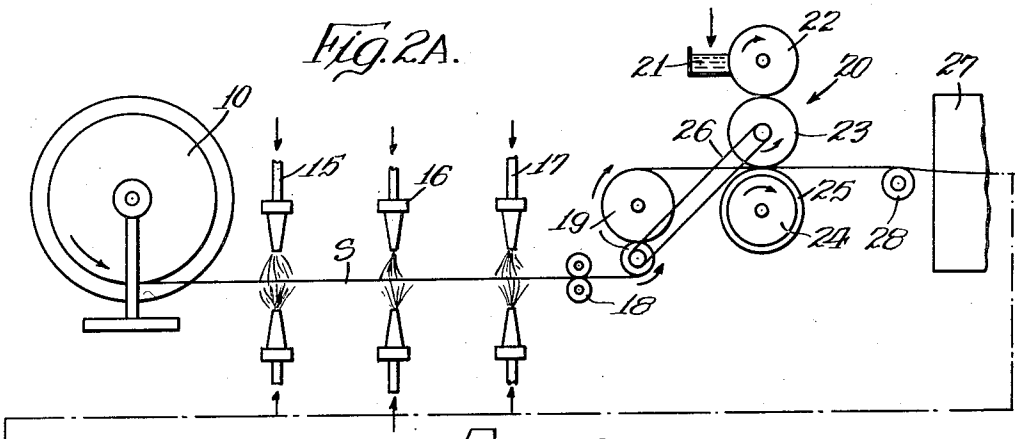


Fig. 2B.

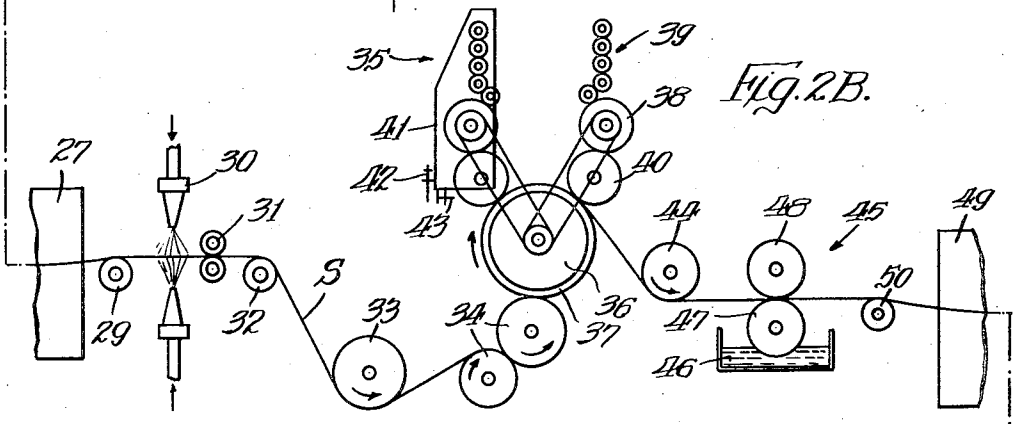
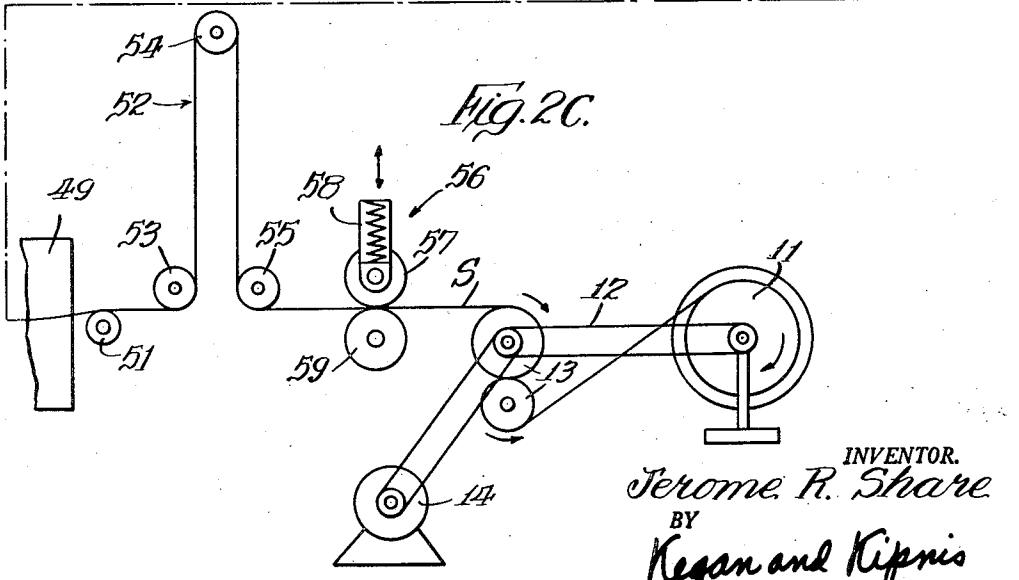


Fig. 2C.



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2,772,630

METHOD AND MEANS OF DECORATING METAL STRIP, BY OFFSET PRINTING

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Application August 28, 1952, Serial No. 306,815

5 Claims. (Cl. 101—228)

This invention relates to a method of offset printing on continuous metal strip.

Conventional offset printing on paper is done by the continuous strip method as a matter of course, while conventional offset printing on metal has been done by a discontinuous process confined entirely to operations on metal sheets.

Of course continuous operation is greatly preferred in practically all printing operations and the like because it generally can be made much faster than the intermittent operation on individual sheets and also because it can eliminate or greatly reduce a waste of material which is inherent in the sheet method and which occurs at each end of a pattern arrangement and sheet.

The problem of offset printing on metal strip, and the reasons which have delayed the advent of continuous operations in this field can be outlined, in part, as follows: Special problems of preliminary surface preparation prior to the offset printing are involved since the adhesion between metal and inks or coatings differs radically from the corresponding problem in ordinary printing practice. Next, the required co-relation between printing rollers and the strip to be printed upon involves further special problems, over and above the general well known problems of pattern length adjustment, provision for variable pattern lengths, etc.; the special problems being caused in part by the aforementioned special surface preparation and in other part by the inherent dimensional variations of metal strip. This phase of the matter is particularly difficult, it being necessary in the present field to drive printing rolls from the travelling strip rather than the reverse as usual. Still further problems are often involved by the necessity of final treatments for the surface printed upon or for the body of the strip, to produce a final surface preparation, slitting, punching and general treatment of the strip as may be required.

Both preliminary and final surface preparations require the use of a variety of coating materials and the like depending on the desired end use of the product. Such a product may be intended for instance for use as slats for Venetian blinds with patterns thereon as described for interior decorating purposes and with the high degree of colorfastness and resistance to daylight which is usually required for such application. Another example is, molding strips or panels for rooms, vehicles, furniture and the like, with high resistance to abrasive wear or other special forms of wear. Decorated metal cans, boxes, covers, etc., are other examples of final products which are often made from the usual printed metal sheets and which according to the present invention can be produced more rapidly and more economically from long strips of printed metal.

The general object of providing for continuous offset printing on metal strip has been achieved in accordance with this invention by a novel combination of operations which can generally be outlined as follows: To start the operation a leading end of the strip in question is unrolled from a supply roll, threaded through a series

of operating units to be mentioned presently, and fastened to a driving and receiving roll assembly at the far end of the production line. At the start of this line, adjacent the supply roll a preliminary surface preparation is effected to allow the subsequent position of a strongly adhesive paint or undercoating for the printing inks to be used. This paint or undercoating is then applied and properly distributed; for this purpose the metal strip runs over a hard-rimmed backup roll which also serves as a power take-off for auxiliary operations as will be described hereinafter. Next the paint or coating is dried by controlled heating and the strip is then cooled to controlled temperature allowing successful printing; and it should be noted that the selection and application of the paint or undercoat is such as to produce proper adhesion after the operations mentioned up to this point and those to be mentioned hereafter. In the printing operation again a hard back-up roll is used as power take-off, driving one or several special sets of offset printing devices which must be adjustable relative to the back-up roll to accommodate different gauge or thicknesses of the metal strip, and other special dimensional variations. This printing may be directly or indirectly followed by one or several further coating operations either on the same side or on the other side of the strip, and by a further sequence of drying and cooling operations. Suitably controlled slitting, punching or similar operations will usually follow. The motive power for all of the aforementioned operations is ultimately applied by the driving and receiving machinery.

The second coating operation mentioned may be omitted for certain purposes and a number of other modifications, omissions, additions, etc., can be applied. The important thing is the co-relation between the surface condition of the metal strip and the motion and adjustment of the printing and associated devices, as obtained by the power take-off and associated features generally mentioned above which will be explained in further detail hereinafter.

In this detailed description, special objects will also appear and certain features and advantages will be pointed out. In order that the invention may be fully understood particular reference will be made to a specific process, diagrammatically illustrated by the drawing appended hereto; but it is distinctly to be understood that such exposition is illustrative only and that the invention is not restricted to the particular details to be described or shown.

In the drawing:

Figure 1 is a purely diagrammatic representation of successive steps in the process hereof;

Figure 2 is a more detailed but still highly diagrammatic representation of such successive steps; this figure being broken into three parts 2A, 2B and 2C for greater convenience in noting the different successive function diagrams;

Figure 3 is a fragmentary sectional view of operating mechanism at one of the successive stages as will be explained in the following.

The production line starts with a supply roll **10** which may contain for instance a few thousand feet of the metal strip; and such strip may be for instance a few inches or up to a few feet wide and may consist of 18 gauge or 20 gauge of various different thicknesses of steel or aluminum or other metal. The strip is shown by letter S throughout the drawing. At the far end of the production line it is received and wound up on a receiver roll **11** which for this purpose is driven by suitable power take-off **12** shown as a chain drive mechanism. Power for this mechanism **12** and for the movement of the entire strip or web S and of the devices to be actuated thereby is produced by a set or pair of gripper rolls **13**

located in the production line adjacent to and slightly ahead of the receiver roll 11 and suitably driven by a motor unit 14.

Returning to the starting end of the line adjacent the supply roll 10 the strip is first cleaned by a spray unit 15, spraying a detergent cleaner and phosphoric acid solution against the strip; as shown against both sides thereof. This operation serves to free the strip from any oil and the like adhering thereto as a result of production, shipping or storage; and it deposits a coating of iron phosphate, well known by itself, upon the strip.

Next follows a washing unit 16 adapted to rinse the strip with hot water in order to remove excess acid and contamination, in a manner known by itself.

It is inherent in such hot water washing which is required for rapid and thorough removal of the acid, etc., that the temperature of the strip S itself is raised appreciably. This is undesirable for the next following major operation which as shown at the left side of Figure 1 consists in painting the strip or depositing thereon a suitable base coat for the subsequent printing. Therefore as shown at the right side of Figure 1 and at 17 in Figure 2, the strip next passes into and through a cooling stage where its temperature is lowered to approximately room temperature, for instance by a cold water jet as diagrammatically indicated.

In the painting or coating stage which follows next it is necessary to provide power for the application and distribution of the paint or coating material and to control such application at a speed proportional with that of the strip S. Therefore, pursuant to passage over a pair of guide and support rollers 18 to insure proper feeding of the strip to the painting unit, the strip next passes over a pair of power take-off rollers 19 for the operation of the coating unit 20.

This unit is shown as roller coater. The coating material is picked up from a pan 21 by a pick-up roller 22 which brings it to a coating roll 23 shown as being disposed above the strip S. A back-up roll 24 with a chrome plated rim 25 is disposed below the strip S, as shown in Figure 3, to provide a firm foundation for strips S of any desired thickness or gauge; this being important for efficient and uniform application of the paint or undercoat material on the top surface of the strip.

Some appreciable power is required for the operation of the pick-up roll 22 and other parts of the roller coater 20; therefore the power take-off 26, actuated by the power take-off rolls 19, is shown as rotating the coating roll 23. It will be noted that the surface of this roll travels in the same direction as does the strip S contacting the same, but at a higher velocity; the roll 23 being larger than the particular roll 19 connected thereto by the power take-off drive and the drive itself being shown, in this embodiment, as a chain drive having a 1 to 1 ratio. Thus the coating roll will not only transfer the material from the pan 21 to the strip S but will apply a wiping action to the transferred material.

While the drawing shows a roller coater 20 only for the top side of the strip S it will be appreciated by persons skilled in the art that both sides of the strip can be coated, in identical or different colors.

Next a drying action is applied in an oven 27 wherein the strip S hangs in suspension, being supported by rollers 28 and 29 at the two ends of the oven and wherein heat is applied by heating elements (not shown) to bake and dry the coating material onto the strip to the proper extent for the subsequent printing operation. Inasmuch as the rapid continuous operation employed requires a second drying step after printing, and since a certain degree of shrinkage and other physical and chemical conversions take place upon each baking operation I have found it most desirable to conduct the first baking operation in the oven 27 at temperatures in a rather specific range. With resinous base materials such as the material or paint known as "devran," manufactured by the Jones

Dabney Company of Louisville, Kentucky, I have found temperatures in the range of 375 to 575 degrees Fahrenheit as preferable, in this oven 27.

These temperatures, and indeed any temperatures elevated to a generally similar degree, raise the temperature of the metal strip S entirely too much for successful printing in the next following major stage; they create a number of dangers. For instance they would tend to lead to shrinkage of the metal strip S, between successive and longitudinally spaced printing rolls, and the unavoidable irregularity of such shrinkage would tend to destroy the desirable pattern alignment. Likewise, the high temperatures of the strip would unavoidably be imparted to the printing mechanism itself and would interfere with mechanical as well as chemical actions therein. Therefore I apply a second cooling operation to the strip emerging from the oven 27, as shown by a further cold water spray unit 30, lowering the temperature of the steel to a controlled degree which preferably is that of the room temperature prevailing in the printing unit.

In order to remove objectionable humidity and dampness from the strip I provide a pair of rubber squeegee rolls 31.

The strip S now enters, over a number of guiding and direction reversing rolls 32, 33 and 34, into the printing unit 35. This unit may be of the dry offset process type mainly when speed and capacity are the main considerations, or of the wet offset type when fine detail is required for the pattern to be printed upon the strip. These processes, at least as applied to paper and the like, are well known and need not be described in detail; I will substantially limit the description to the specific features required by the physical and chemical features and properties of the strip S and of the base coating thereon. Assuming that the dry offset process is to be used and that the base coated top side of the strip S is to be imprinted with two colors, the arrangement is as follows:

The strip S is guided tangentially to the back-up roll 36 by the last reversing roller 34, which roller also presses the strip firmly to the adjacent area of the back-up roll. From this area the strip S extends over the top of the back-up roll, in contact therewith and immovably relative thereto. The back-up roll has a chromium plated rim 37 to provide a firm and even support for metal strips of any gauge, with dried base coating of any thickness. Two longitudinally spaced blanket rolls 40, forming parts of offset printing units 41, are disposed adjacent the top of the back-up roll 36 and longitudinally spaced along the strip S. Suitable printing ink is supplied to these blanket rolls by the well known etched transfer rolls 38 which in turn are in contact with ink distributing rollers 39. Each printing unit 41 comprises such a set of distributing rollers, transfer roll, blanket roll and in addition, adjustment means 42 to raise and lower the unit 41 relative to the back-up roll 36 and additional adjustment means 43 to control the longitudinal spacing of the printing unit along the strip S running over the back-up roll 36. These adjustment means are provided in order to maintain the required accurate spacing between successive printing units 41, regardless of variable overall thicknesses of a metal strip S and a coating thereon.

In the example as described it will be assumed that each transfer roll 38 has the entire circumference thereof covered by the pattern to be printed, by means of the usual zinc sheet wrapped around the roll and etched with the pattern, the pattern design being dovetailed in the area where the ends of the zinc sheet are joined. Of course it will be understood by persons skilled in the art that different types of transfer mechanisms can be used mainly in the event that patterns of varying lengths must be contemplated.

The printing unit 41, like the coating unit 20, requires some appreciable power for its operation and mainly for the purpose of overcoming the friction between the dis-

tributing rollers. In conventional printing presses such power is provided by motor means directly coupled with one of the rolls; the blanket roll being employed to move the paper or other web which is being printed upon. In the present application, the press must be actuated by the web rather than the opposite. To this extent the situation is similar with that in the coating unit **20**; however the blanket roll of the printing unit of course must move at exactly the same speed with the web, not at a more rapid speed as does the coating roll of the roller coater. Therefore I show a power take-off chain connecting the shaft of the back-up roll **36** with that of the transfer roll **38** in each printing unit **41** and thereby actuating the transfer and ink distributing rolls **38, 39**. The blanket rolls **40** are in contact with the transfer rolls **38** and also with the web S running over the back-up roll **36**; the adjustment by means of adjustment means **42** and **43** can be and preferably will be such that the speed of the blanket roll at every instance is exactly that of the web itself and of course substantially that of the transfer roll **38**. This arrangement is important inasmuch as it is often unavoidable and may even be desired for special surface effects, that the overall thickness of the strip S and base coating thereon is subject to at least some little longitudinal variation, thereby causing some little longitudinal change of traction between the strip and the blanket roll.

Pursuant to printing in the unit **35** the strip S passes under a roll **44** into a coating unit **45** to apply a clear coating or the like to the under side of the strip by means of a pickup mechanism comprising a pan **46** and a pick-up roller **47** operating against the back-up roller **48**. This clear coating unit **45** of course is provided only in the event that original base coating, by means of a unit **20**, is limited to one side of the strip. However somewhat similar clear coating units may also be provided for the application of a resinous or other similar coating over and above the imprinted pattern, for the protection thereof; and various other modifications can obviously be made in this respect.

The second drying operation is performed in an oven **49** generally similar to that shown at **27**; with support rollers **50** and **51** at both ends for the suspended strip S. As mentioned before, the baking cycle for the strip is completed in this second drying operation. It may be noted at this point that in most applications as contemplated herein the strip S is propelled by the drive unit **13, 14** at a speed such as fifty or sixty feet per minute and that each oven **27, 49** provides approximately a one minute drying time or fifty to sixty feet length. I have found that the base coat material described above will bake out within the first baking cycle of approximately sixty seconds to an extent such that the surface thereof is compatible with most of the colored printing inks to be used for printing thereon, that the second and similar baking cycle produces a suitable adhesion between the print and the base coat and that the overall effect of the coating and baking operations produces sufficient adhesion between the base coat and the metal to allow the severe handling required for subsequent punching, slitting, gripping and other operations.

In order to allow rewinding of the strip S coated and printed upon and baked out in the last oven, and to avoid damage to the imprinted surface due to creeping incident to cooling and shrinkage, I provide a last cooling step, for instance by means of a tower **52** which may be provided by a sequence of direction changing rollers **53, 54** and **55**.

As a last step in the production of the decorated sheet metal products contemplated herein I provide a slitting and punching stage **56** comprising a slitting or punching roll or tool **57**, actuated by a suitable mechanism **58** against a back-up roll **59**, to form the desired slits, notches, indentations, separations or other bodily deformations or modifications in the strip S. It will be understood by persons skilled in the art that the mechanism **58** can be controlled from the strip itself, electro-optically or in some other well known manner.

The operation of the machinery, or performance of the process, can be visualized most clearly when full consideration is given to the fact that the motive power for all stages of operation of the strip S is and must be derived from the driving and gripping unit **13** at the end of the production line. Any attempt to interpose intermediate driving or speed controlling motors on any one of several of the back-up rolls in contact with the continuous strip, between the rolls **10** and **11**, leads to periodic stretching or gathering up or even kinking of the strip and would therefore be ineffectual. On the other hand, breaking the continuity of the strip between the points **10** and **11** and using a plurality of drives after any one or more of the different process stages would obviously add to the cost of the machinery and also to the cost of the process performed thereby.

When using, accordingly, a single drive **14, 13** I avoid the defects mentioned. I found it necessary however to compensate for certain side effects or incidents of this single drive. For instance, inasmuch as the power of the unit **14, 13** is applied to the printing unit **35** through the long secondary oven **49** wherein the strip hangs freely suspended while progressing at a substantial speed, it is unavoidable that a certain amount of vibration of the strip takes place in the oven **49** resulting in turn in the arrival of definite waves of longitudinal pull or stress in the preceding units. Likewise such vibrations or waves can be transmitted even by the preceding oven **27**; the frequency of said vibrations is rather unpredictable and frequently includes wave actions traveling forward or backward much faster than the overall bodily travel of the strip itself.

For these reasons considerable importance attaches to the direction reversing rollers of the offset printing unit which are shown at **32, 33, 34** and **44** and whereby the mutually contacting system of back-up and printing rollers **36, 40** is protected from adverse influences due to such vibrations. If the direction reversing and vibration damping rollers **34** and **44** were eliminated or removed from the immediate vicinity of the printing back-up roll **36**, the accuracy of pattern alignment in the printing unit **35** would be greatly impaired at least at times when prevailing vibrations cooperate or interfere in adverse manner.

For these reasons I believe the success of the present metal strip printing process is particularly dependent on the combination of the printing unit with the preceding and subsequent direction reversing rollers for the strip, together with the application of the driving effort at the end of the process or production line.

It will be understood by persons skilled in the art that a number of further modifications can be applied to the process and mechanism described and illustrated all within the scope of my invention as claimed herein.

I claim:

1. In apparatus to print repetitive patterns on metal strip, the improvement wherein the moving strip drives the printing mechanism in synchronism therewith and wherein vibrations in the strip are damped out in the printing zone, comprising: power driven take-up means for pulling the strip through the apparatus; a rigid rotatable back-up roll at the printing zone; first roller means positioned on one side of the back-up roll, bearing against the strip, and causing a pronounced change in the direction of strip travel; second roller means positioned on the other side of said back-up roll, bearing against the strip, and causing another pronounced change in the direction of strip travel, said first and second roller means pressing said strip against said back-up roll so that the movement of said strip drives said back-up roll in synchronism therewith; printing rollers positioned to print on said strip while the same is in contact with said

back-up roll; means whereby said back-up roll drives said printing rollers; and means whereby the unprinted strip is supplied to the apparatus.

2. Apparatus for continuously and accurately offset printing repetitive patterns on metal strip, characterized by the fact that the strip is pulled through the apparatus and drives the same so that each part in contact with said strip is synchronized therewith, and further characterized by substantial elimination of strip vibrations in the printing zone, comprising: means for holding a storage reel from which the unprinted strip is pulled; first strip vibration damping means including a set of spaced rollers positioned to bear against the strip and cause a pronounced change in direction of strip travel; a rigid rotatable back-up roll pressed against an end roller in said set of spaced rollers so as to grip the strip between said back-up roll and said end roller; second strip vibration damping means including a roller spaced from said back-up roll and bearing against the strip to cause another pronounced change in direction of strip travel, said end roller and the last-mentioned roller pressing said strip against the back-up roll over a portion of the surface thereof sufficient to cause said back-up roll to move synchronously with the strip in contact therewith; offset printing rollers positioned to print on said strip while the same is in contact with said back-up roll; means whereby said back-up roll drives said printing rollers; and a power-driven take-up for pulling the strip through the aforementioned apparatus and for winding the strip into a coil.

3. Apparatus for printing repetitive patterns on metal strip including, in combination: take-up means for pulling the strip through the apparatus, a back-up roller means over which said strip passes; first roller means positioned on one side of the back-up roll causing a change in the direction of strip travel; a second roller means positioned on the other side of said back-up roll, bearing against the strip, and causing another change in the direction of strip travel; said first and second roller means cooperating with said back-up roller means to maintain the strip under tension as it passes thereover, whereby vibrations in the strip are damped out at this zone; printing rollers positioned to print on said strip while the same is in contact with said back-up roller means; and means whereby the unprinted strip is supplied to the apparatus.

4. A method of effecting accurate printing of repetitive patterns on a moving strip of metal subject to vibrational interferences, comprising pulling one end of said strip through the following operations: paying out the strip in one direction; sharply altering the direction of strip travel by passing it between a back-up roll of a printing couple and a second roll; offset printing on said strip immediately after the sharp alteration; applying tension to said strip as it undergoes offset printing; again sharply altering the direction of strip travel as it passes through the printing operation by passing it over a third roll; whereby vibrations are prevented from entering the strip during the offset printing operation.

5. A method of effecting accurate printing of repetitive patterns on a moving strip of metal subject to vibrational interferences, comprising pulling one end of said strip through the following operations: paying out the strip; offset printing on said strip; applying tension to said strip on the back-up roll while printing; sharply altering the direction of strip travel while said strip is being subjected to said force but prior to imprinting thereon by passing it between a back-up roll of a printing couple and a second roll, sharply altering the direction of strip travel while said strip is being subjected to said force but after imprinting thereon by passing it over a third roll, whereby the strip in said printing zone is isolated from vibrations in said strip outside of said zone.

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