The invention is concerned with the working of a piece of strip by the simultaneous drawing of cups therefrom by means of punches disposed next to one another in a straight row. The fundamental problem in the working of strip is to have the least waste and at the same time to achieve a large depth of draw.

In stamping works millions of small round objects such as, for example:
(a) platedets, round blanks, washers, coins, metal stamps,
(b) cups, caps, buttons,
(c) rings, hollow rivets, shells, cartridge cases, and countless other articles are daily stamped out of metal, and recently out of plastic strip, whether they be flat forms such as are listed under (a), forms with a light to moderate drawing requirement listed under (b) or, finally, forms with a moderate to heavy drawing requirement listed under (c).

The exact nature of this invention as well as many of the attendant advantages thereof will be readily appreciated from consideration of the following detailed description taken with the accompanying drawings in which:

FIGURE 1 illustrates a layout for deep drawing involving a transverse set of dies in alternate offset relation to provide a triangular pattern of drawn articles;
FIGURE 2 illustrates a layout of the drawing dies in a transverse row providing a square pattern of drawn articles;
FIGURE 3 illustrates the flow of material as the dies are applied to the strip to produce the square pattern of FIGURE 2;
FIGURE 4 illustrates the flow of material in the strip when drawing according to the die pattern of FIGURE 1;
FIGURE 5 shows one layout of the dies in drawing following a triangular pattern according to the invention;
FIGURES 6 to 8 show other arrangements of the dies in drawing following the invention;
FIGURE 9 shows another arrangement of dies and the resulting drawing pattern practicing this invention; and
FIGURE 10 shows a further modification of the invention.

In stamping out all such objects an optimum use of the material is naturally striven for in the interests of industrial efficiency. This would result, if the centres of the blanks in the strip were arranged on a network of equilateral triangles, as is shown in FIGURE 1. The arrow marked with a V indicates the direction of feed. One might suppose that this layout of the blanks was used in normal stamping practice; this, however, is not the case. In general one can say that the objects listed above are stamped out according to the pattern shown in FIGURE 2, where the centres of the blanks coincide with the points of intersection of a network of squares. The square pattern is rarely used in the case of objects listed under (a); it is frequently used in the case of objects listed under (b); and it is nearly always used in the case of objects listed under (c) as the latter are produced by the most advantageous mass deep-drawing proc-

ess, the so-called Oeillet process. The layout shown in FIGURE 2 allows a better arrangement of tools, but uses up to 15% more material to produce the same number of blanks as the layout shown in FIGURE 1. In the unusual case in which one tries to produce the objects listed under (c) making use of the triangular pattern, one obtains against all expectation and intention, a higher consumption of material than with the square pattern.

This apparent contradiction is explained as follows. In the Oeillet process as usually practiced with the square pattern and the simultaneous action of all the punches in a row, the strip of material is pulled in towards the punches as shown by the arrows in FIGURE 3. This pulling-in of the strip takes place in the direction of feed on one side of the punches and in the opposite direction on the other side. The result is that the strip is shortened by the drawing process. This shortening or contraction is a characteristic feature of the Oeillet process and has the effect that the material can flow freely in and against the direction of feed in response to the deep drawing stress. The contraction can, with increasing stress, reach a high value and may amount to 60–70% of the feed of the strip. As the practice shows, a contraction of this order was hitherto achieved only with the square pattern and scarcely at all with the triangular pattern. The triangular pattern was usable, therefore, only in disadvantageous drawing conditions since, for the purposes of trouble-free working of the tools and of compensating for the deficient entry of the material into the die cavities, the individual punches have to be spaced farther apart, this expedient increasing substantially the amount of strip required to produce a given number of cups. The reason for this is that in the triangular pattern the staggered punches mutually hold fast the strip and prevent flow of the material, as is to be explained in connection with FIGURE 4.

Each individual punch has the tendency to pull in the material radially from all sides. Apart from the punches at the edge of the material, all other punches can pull in the material only in and against the direction of feed so that only the component in these directions comes into consideration. In the zone between the lines A-A and B-B this component has alternately opposite directions. Since, however, it is practically impossible for the sheet-like material to flow in opposite directions in its own plane, this pattern does not provide the necessary conditions for an adequate entry of the material into the die cavities.

These conditions exist only when the simultaneously-acting deep-drawing punches are disposed in a straight line as close together as possible. The fulfillment of this requirement, which is necessary for the economical use of the Oeillet process, appears to exclude the use of the triangular pattern where the drawing stress is high; since here no one saw the possibility of arranging the simultaneously-acting punches in a straight row.

Hitherto it was also known to stamp out the cups in a triangular pattern in which one side of the triangle lies in the direction of feed. It was also known to arrange the punches in a straight row. However, it is only in connection with the square pattern that a straight row of punches has been used, and now punch rows are always extended at right angles to the direction of feed.

The invention now reveals, for the first time, a way of combining the two hitherto mutually exclusive char-
acteristics, namely the triangular pattern or layout on the one hand and the straight-row arrangement of punches on the other.

According to the present invention the cups are drawn from the strip in a pattern of equilateral triangles with one side of each triangle in the direction of feed by means of punches disposed in a straight row making an angle of substantially 60° with the direction of feed. In comparison with the conventional Oeleit process this achieves the optimum use of the material and, by a favourable arrangement of tools avoids the existing excess consumption of material of up to about 15%. The layout according to the invention is illustrated in FIGURE 5. The Oeleit process so improved can be employed in combined sequence machines in which several drawing operations are performed one after the other in one and the same machine. Also, here, the above described pulling-in effect of the material, which is to be made possible, especially against the direction of feed, by suitable precautions, is likewise indispensable. Whereas in the conventional Oeleit process the pulling-in effect works exclusively in the direction and at the expense of the length of the material, in the process according to this invention the forces set up in the material by the punches reduce the width of the strip as well as its length, with the result that a lateral bend appears in the strip substantially as shown in FIGURE 5. The angle of this bend depends upon the ratio of the amount of contraction to the amount of the feed.

In a further development of the invention the strip is cut in the direction of feed and the branches of the strip thus divided are worked by separate rows of punches. The permissible arrangements of the punches are shown in FIGURES 6 to 8. In consequence of the previously mentioned lateral bend of the strip, the latter must be cut at the point X. The two branches of the strip are worked in the same machine. In comparison with the first-mentioned example of the process according to the invention, this development is not so advantageous since four edges now result from each feed and this, owing to lateral contraction of the strip, not only increases the amount of waste but creates difficulties where work of superior quality is required on account of the unavoidable formation of a bend. The arrangement shown in FIGURE 6 is not really practicable because the two parts of the strip overlap in the machine.

In a further example of the inventive process the draw punches are arranged unsymmetrically as shown in FIGURE 8. The invention is also concerned with a modification of the process just described which is characterised in that the cups are drawn from the strip on a network of equilateral triangles with one side of each triangle at right angles to the direction of feed by means of simultaneously acting punches disposed in a straight row at right angles to the direction of feed; the feed is reduced to 86.6% of the feed in the conventional Oeleit process depicted in FIGURE 2, that is, the strip is advanced between successive operation of the drawing punches an amount equal to the height of the equilateral triangles in the said network, expressed mathematically as √3/2 where b is the distance between the axes of two adjacent punches or dies in the row, and each row of cups drawn from the strip is laterally displaced with respect to the preceding and succeeding rows. In one example of this modified process the strip is shifted laterally during each feed by a distance equal to half the distance between the axes of the punches, the lateral shifting of the strip taking place alternately in opposite directions. Another possibility is to use two laterally staggered rows of simultaneously acting punches. And finally the modified process may be effected by passing the strip twice through a machine with a single row of punches. During the first pass, the feed and the operation of the punches are such that untouched zones of material are left between successive rows of holes. During the second pass the strip is laterally displaced and the cups are drawn from the untouched material. The modified process is not so advantageous as the first described version of the invention but it yields not insignificant economies in material in comparison with the conventional Oeleit process.

An embodiment of the modified process is exemplified in FIGURE 9. It is provided with a special feed mechanism, which at each feed effects a cross movement of the strip. As is to be seen from FIGURE 9 such cross movements take place alternately in opposite directions. In the other embodiment of the modified process, shown in FIGURE 10, the machine has two laterally staggered rows of simultaneously-acting punches. While the embodiment of FIGURE 9 involves increased expense in the construction of the feed mechanism, the embodiment of FIGURE 10 the second calls for skill and knowledge and increased expense in tool construction in order to ensure adequate entry of the material into the die cavities. In the embodiment of the modified process, it is to be observed that the feed is not simply double that of the first example; the contraction of the strip during the second pass has to be taken into account. This does not involve increased waste of material, but the different feeds for the first and second passes leads to higher tooling costs. In the arrangement of the laterally displaced arrangement, the loss of a drawn part for every two rows is a certain disadvantage of the modified process according to the invention. However, a minimum of five punches in each row secures economies in comparison with the known Oeleit process.

What I claim is:

1. A method for deep drawing cups from a noninterrupted, solid strip of material in a network of equilateral triangles, comprising stepwise feeding said strip to a plurality of drawing dies the main axes of which are arranged in parallel relationship to each other and in one straight row, said row extending transversely over the entire width of said strip as covered by said network, said row including an angle of about 60° with the direction in which said strip is fed, applying simultaneously said drawing dies arranged in one straight row to said strip intermediate said feeding steps and deep drawing said cups by said dies directly from said uninterrupted, solid strip.

2. A method for deep drawing cups from a noninterrupted, solid strip of material in a network of equilateral triangles, comprising feeding said strip to a plurality of drawing dies the main axes of which are arranged in parallel relationship to each other and in one straight row, and simultaneously deep drawing cups in one first straight row by said row of dies directly from said uninterrupted solid strip, thereupon moving said strip in a direction normal to said straight row of dies for a distance equal to √3 times half the distance between the main axes of two adjacent dies and parallel to said straight row of dies for a distance equal to half the distance between the main axes of two adjacent dies, and subsequently simultaneously deep drawing cups in a second straight row parallel to said first straight row by said row of dies directly from said noninterrupted, solid strip.

3. The process according to claim 2 in which the row of dies is perpendicular to the feeding direction of said strip, and said strip is displaced in a lateral direction with each feeding step.

4. A method for deep drawing cups from a noninterrupted, solid strip of material in a network of equilateral triangles, comprising the steps of feeding said strip to a plurality of drawing dies the main axes of which are arranged in parallel relationship to each other and in one straight row, and simultaneously deep drawing cups in one first straight row by said row of dies directly from said noninterrupted, solid strip and deep drawing cups in a second straight row parallel to said first row with the po-
position of said row of dies relative to said strip being moved a distance equal to $\sqrt{3}$ times half the distance between the main axes of two adjacent dies in a direction normal to said straight row of dies and half the distance between the main axes of two adjacent dies in a direction parallel to said straight row of dies from the position of said row of dies when deep drawing said preceding row of cups.

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