

April 7, 1953

J. E. WOODS ET AL

2,633,630

METHOD OF MAKING PERFORATED PLATES

Filed July 6, 1945

2 SHEETS—SHEET 1

Fig. 1

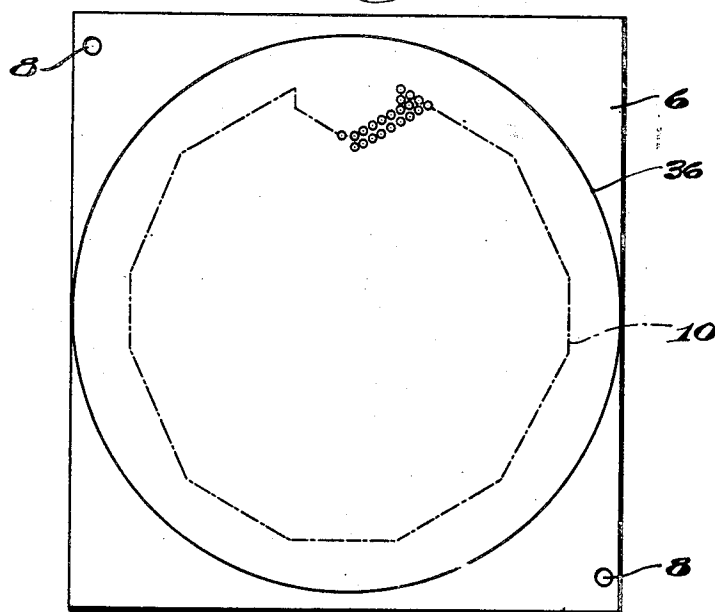


Fig. 2

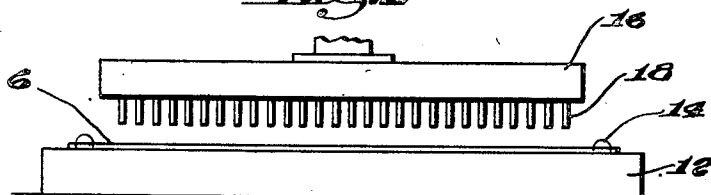


Fig. 3

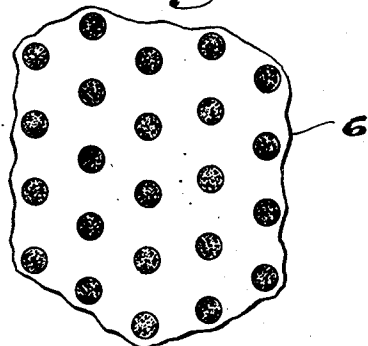
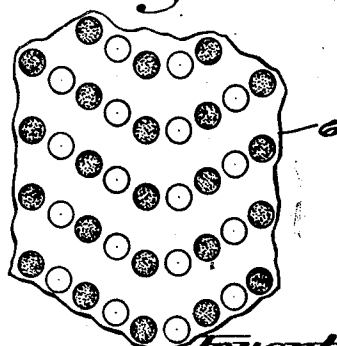


Fig. 4



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2 SHEETS—SHEET 2

Fig. 5

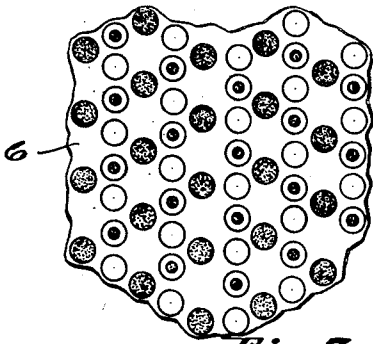


Fig. 6

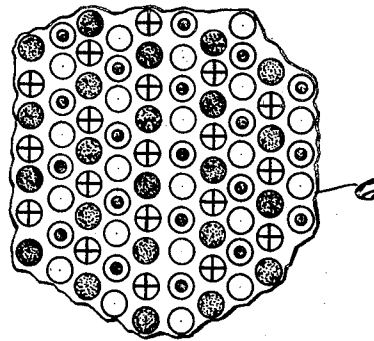


Fig. 7

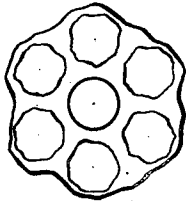


Fig. 8

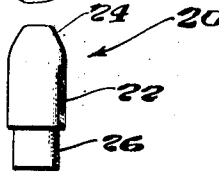


Fig. 9

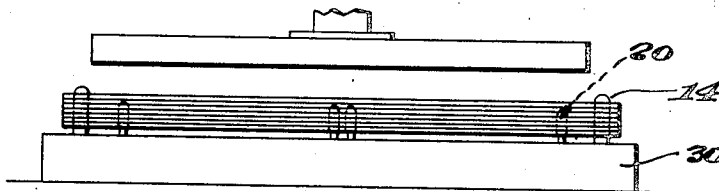


Fig. 10

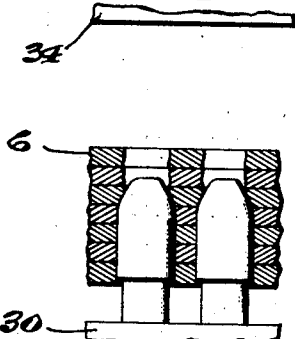


Fig. 11

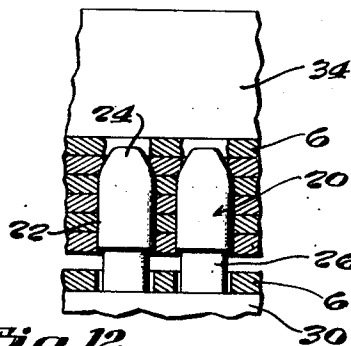
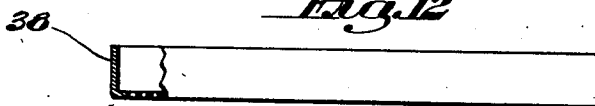


Fig. 12



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UNITED STATES PATENT OFFICE

2,633,630

METHOD OF MAKING PERFORATED PLATES

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Application July 6, 1945, Serial No. 603,492

4 Claims. (Cl. 29-163.5)

1

The present invention relates to methods of making perforated plates and more particularly plates having a large number of accurate closely spaced holes, such as the header plates used in radiators and oil coolers of the type described in the Woods Patent No. 2,298,996 dated October 13, 1942.

Fig. 1 is a plan view.

Fig. 2 is a side elevation.

Figs. 3, 4, 5, 6 are plan views showing the punched holes spacings.

Fig. 7 is a plan view of the holes before trueing.

Fig. 8 is an elevation of a trueing pin.

Fig. 9 is an elevation showing the trueing of the holes punched.

Figs. 10, 11 are elevations showing the trueing operation.

Fig. 12 is an elevation of the product.

Heat exchange apparatus of that type employs a very large number of closely spaced thin wall tubes. As an example, a typical oil cooler for aircraft may use about 2600 tubes, each of .210" outside diameter and spaced .250" on centers. In the header the web of metal between adjacent tubes is thus only .040". The manufacture of header plates of such type is extremely difficult since, if the holes are punched individually or in small groups, the metal creeps so that it is impossible to maintain accurate dimensions. On the other hand, punching of all of the holes at one time is difficult because the punches must be so close together that adequate support cannot be provided for them.

According to the present invention, the header plates are punched while flat with gang dies which substantially span the entire area. The holes are punched in several, preferably four, operations whereby in the first punching operation a series of regular but widely spaced holes is formed and in the subsequent operations the spaces between the original holes are punched in regular order.

It has been found that by this procedure, even though the holes are properly spaced on centers, the webs are distorted and the holes formed in the original punching operation are partially closed up. Efforts have been made to round and size the holes by reaming but this is slow and expensive. According to the present invention the plates are quickly and easily sized by stacking them in piles with loose pins extending through the holes. Starting with a single properly formed master sheet the successive sheets may be stacked with assurance that the pins will enter the holes and bring them to the proper size and spacing. Preferably a sheet to be used is removed from the

2

bottom of the stack, a new sheet to be sized is placed on top and the entire stack is put in a press whereby the pins are forced into the holes of the new sheet.

The invention will be described in connection with a method of making headers approximately 11" in diameter and having approximately 2600 holes each .210" in diameter and spaced .250" on centers. The plate 6 from which the headers is formed is as shown in Fig. 1 originally about 13" square and is provided at diagonally opposite corners with dowel holes 8 to line up the plate for the several operations. The area within which the holes are to be punched is indicated by the dot-and-dash line boundary 10 in Fig. 1.

If all the holes were to be punched in one operation, the punches could not be satisfactorily supported because the space between them would be only about .040". Furthermore, as previously stated, it is not satisfactory to punch the holes individually or in small groups because the creep of the metal would make it impossible to maintain dimensions. Accordingly, the plate is punched in four punching operations, each with a gang punch having approximately 650 individual punches. In each operation, therefore, the holes are spaced 1/2" on centers to afford sufficient space between adjacent punches for adequate support. In the first punching operation shown in Fig. 3 the holes are punched at the places indicated by the stippled circles; in the second operation (Fig. 4) another set of holes is punched as indicated by the plain circles; in the third operation (Fig. 5) the holes are punched as indicated by the circles with stippled centers; and in the fourth operation (Fig. 6) the holes are punched as indicated by crosses. An elevation of a punch for one of the operations is indicated diagrammatically in Fig. 2 wherein the plate is supported on a bed 12 and held in proper position by dowels 14. A gang punch 16 provided with individual punches 18 is used for the punching operation.

Four separate punching operations with separate punches are preferred. It is possible to use a single punch and move the plate with relation to it for the different operations, but some of the punches must be left off near the periphery, otherwise some holes would extend beyond the circular boundary 10. This method would necessitate punching a few of the holes by hand after completion of the gang punching operations. In any case, the actual arrangement of the punches will depend upon the lay-out which is readily determined in advance. The important feature is that each punching operation encompasses the

3

entire surface so that there is no tendency for metal creep which would distort the dimensions at the completion of the operation. The holes are spaced as indicated in the group shown in the upper part of Fig. 1 and in Fig. 6.

In all punching operations subsequent to the first, the holes and webs are necessarily distorted, even though the punched holes are properly located on centers. Thus, after the last operation, the holes which were punched in preceding operations may be partly closed as indicated in exaggerated way in Fig. 7. The hole formed in the last punching operation is shown in the center and the holes formed in preceding operations are shown around it. Since many of the holes are now out of round, the tubes could not be inserted into them. A reaming operation would be slow and expensive and would further remove some of the metal of the webs and thus reduce the strength of the plate. According to the invention, a hole trueing and sizing operation is now performed. Previous to the sizing operation, however, a sheet is first run through a straightening or flattening machine of conventional form to remove any waves or buckles that might have been occasioned by the punching operations.

The hole sizing operation is accomplished by stacking several plates over pins of special form, one pin being used for each hole. As shown in Fig. 8, each pin 20 comprises a central body portion 22 having an outside diameter corresponding to the proper hole size. Each pin has a tapered top end portion 24 of a length somewhat greater than the thickness of one sheet, and a shouldered bottom portion 26 of a length somewhat greater than the thickness of a sheet and of a diameter considerably smaller than the body portion 22. It is necessary to use one pin for each hole, that is 2600 pins are necessary for the header design described herein. In Fig. 10 there is shown a stack of seven plates. The body portions of the pins 20 extend through the holes of the four bottom plates while the fifth plate has been engaged by the tapered portions 24 of the pins. The sixth plate is shown with the pins entering the holes, and a seventh plate may be placed on top. The four bottom plates have had their holes aligned and sized by the pins, and the upper plates are ready for alignment by the pins. The stack is placed on the bed 30 of a press, the top plate being aligned with the stack by means of the dowels 14, as shown in Fig. 9. The entire stack is then subjected to pressure by a ram. In the process of moving all of the plates downwardly in relation to the pins, the tapered portion of the pins find their way into the holes of the upper plate or plates as shown in Fig. 11. The bottom plate is freed from the pins because of the provision of the shouldered portions 26. The bottom plate shown in Fig. 11 is now finished and may be removed after removing the stack from the dowels.

For each sizing operation, therefore, one plate is applied to the top of the stack, the stack is pressed, and the completely sized plate is thereafter removed from the bottom in a series of pressing operations, being advanced by an amount equal to its own thickness on each operation. Since the pins are the correct outside diameter for the formation of the holes, the holes are pressed out to proper shape and the webs are brought to uniform proper size. It will be understood that the portions 22 of the pins may be of any desired length and that the stack will be of a corresponding height. It has been found satis-

4

factory to use a pin length which will accommodate about four plates on the portion 22, as indicated in Figs. 10 and 11.

For this operation, it is necessary to start with a sheet in which the holes have been properly formed by reaming or any other suitable operation. After the process is once started, however, the stack forms its own pin-locating means. It has been found that the dimensions are maintained true even after thousands of sizing operations. In other words, the positioning of the pins by previously formed plates and without any other centering or aligning means has been found adequate to continue the sizing and aligning operation indefinitely.

Each plate, after having its holes thus sized, is cut on the line indicated at 36 in Fig. 1 and is formed with a flange 38 to form the completed header shown in Fig. 12. The tubes may then be inserted as described in the above mentioned Woods patent with assurance of proper tube spacing. It will be understood that a burr necessarily appears around each hole as a consequence of the punching operation. In the hole-sizing operation a burr is pushed upwardly by the passage of each plate over the pins. In the flanging operation for manufacture of the completed header, the flange is turned in such a direction that the burrs are on the opposite side of the plate therefrom. That is to say, the burrs are on the inside of each header plate. Owing to proper sizing of the holes, the burrs do not interfere with the insertion of the tubes. It is preferable to have the burrs on the inside surface of the header plates since if they were on the outside surface, they would interfere with the flow of brazing material by which the tubes are later secured to the headers as described in the Woods Patent No. 2,389,175, dated November 20, 1945.

It will be seen that the present invention comprises two main features: first, the method of punching in several operations, with each operation encompassing substantially the entire area of the perforated sheet, and second, the sizing and trueing operation with individual pins. Although the punching method, as herein described, utilizes four operations, it may be carried out in any number of operations, depending on the number of holes; thus for a 24" header having about 10,000 holes, it has been found satisfactory to perform twelve operations, forming about 750 holes in each operation. In any case, it is important that the holes formed in any operation, be not localized in a part of the sheet, but that they be spaced to span or encompass the entire perforated area. In this way the dimensions of the sheet are preserved and the proper hole spacing is maintained. The fact that the hole spacing is maintained, even though some holes may be distorted in shape, makes it possible for the individual pins to enter the sheet for the hole sizing operation of Figs. 9 to 11.

Having thus described the invention, we claim:

1. A method of making perforated plates having a large number of closely spaced holes separated by narrow webs, which consists in forming the holes by punching, forming a stack of plates in which a sizing pin is inserted into each hole of each plate of the stack, each pin having a tapered portion at one end and a portion of reduced size at the other end, and compressing the stack to apply a new plate to the tapered portions of the pins and to free a trued plate at the reduced portions of the pins.

2. A method of trueing holes in perforated

5

plates having a large number of close, regularly spaced punched holes separated by narrow webs, which consists in forming a stack of plates with the holes in register, each hole of each plate having inserted therein a sizing pin having a central portion of correct diameter for hole sizing, each pin having a tapered portion at one end and a reduced portion at the other end, applying a new plate over the tapered portions of the pins, and compressing the stack to cause the pins to enter the new plate and to free a trued plate from the pins at the reduced portions thereof.

3. A method of making perforated plates having a large number of closely spaced holes which consists in punching the holes in a series of operations in which the holes formed in each operation encompass substantially the entire area of the sheet, the holes for any single punching operation being spaced at distances greater than the ultimate hole spacing, the punching operations subsequent to the first forming holes in areas between the holes formed in preceding operations, whereby the sheet dimensions and the hole spacings are maintained, and trueing the holes by placing said sheet on a stack of similar previously formed sheets in which a sizing pin is received in each hole, each pin having a tapered portion for entry into a registering hole of the new sheet, each pin having a reduced portion at the end opposite the tapered portion, and compressing the stack to apply the new plate to the

6

stack and to free a trued plate from the reduced portions of the pins.

4. A method of trueing holes in perforated plates having a large number of close, regularly spaced punched holes separated by narrow webs, which consists in forming a stack of plates with the holes in register, each hole of each plate having inserted therein a sizing pin having a central portion of correct diameter for hole sizing, each pin having reduced end portions, applying a new plate to the stack with its holes in register with the pins, and compressing the stack to cause the pins to enter the new plate and to free a trued plate from the reduced portions at one end of the pins.

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