

The present invention relates to a method of producing at least two interconnected punched parts (claim 1) and an apparatus for practicing the method (claim 7).

5 A known kind of interconnecting two working materials within a punch press is the contact welding (e.g. system CONTRAP). Hereby, free punched contacts having portions severed from the profile wire are connected by means of resistance welding. This welding necessitates
10 relatively much energy. The stroke number is limited to about 400 strokes/minute.

A further method is known by the term FASTEC R which has been developed by the KURODA PRECISION INDUSTRIES LTD. By means of this method the individual punched parts can be connected to each other in the
15 punching tool. This connection is made thereby by means of recesses or similar, such that the stamped pieces are pressed into each other or engage each other. This method is applied specifically for the production of sheet metal
20 stacks, e.g. for rotors and stators. Such a method is disclosed in the DE-A 32 03 123.

In this method all working operations are made in a multiple press tool having a plurality of individual punches. The drawbacks of this method are that
25 - the average punching speeds of 3 - 400 strokes/minute are to be judged as too low,
- the tool needed for the production of such punched parts is of a complicated design and is expensive to produce, and
30 - the punched parts can deform due to the locally limited connection such that the punched parts do not smoothly lie on top of each other and accordingly cannot be united to a stack.

The DE-A-28 39 928 discloses to provide in a
35 multiple press tool besides the modules for the punching, perforating, bending, etc. a respective module for feed-

ing of parts and a module for interconnecting the punched parts by means of laser welding.

The drawback of this method consists in that the multiple press tool is loaded by production operations which are independent from the punching process.

In the JP-A 61-135 348 which describes the closest prior art a punching apparatus with a light beam-welding device is described in order to weld in a stamping course stamped rotor sheet metals during the last punching operation. The stamping apparatus is designed as multiple press tool. The last station of the multiple press tool is equipped with a braking device which allows a packaging of the rotor sheets. The packaging is made with the addition of a laser in order to weld the rotor sheets. The welding device comprises a laser source and a focussing device. The focussing device is mounted in such a manner to the tool upper part that the laser is directed perpendicularly to the surface of the rotor sheet onto a prepared welding location. The welding of the rotor sheet punched during the punching operation to the previously punched rotor sheet proceeds in the lower dead center when the rotor sheet is pressed onto the stack of sheets held in the braking device.

This apparatus has insofar drawbacks in that

- the preparing of the welding location poses high demands at the punching tool,

- a hollow area is generated by the flowing and partial evaporating of the melt at the surface of the upper rotor sheet metal which increases at an increasing height of the stack and leads therewith at an increasing height of the stack at least to unsafe connections,

- it is only possible to weld in the lower dead center of the tool upper part, whereby the rotor sheets to be welded together must be held stationary under pressure for the solidification of the melt which follows in a larger expenditure regarding tool design,

- more energy is needed for the welding operation,

- a welding of thinly coated or oil wetted, resp., sheets is not possible, and

5 - the focussing device is located at the tool upper part which renders the focussing of the laser more difficult.

Object of the invention is to avoid the mentioned drawbacks.

10 The invention is based on the object to provide a method for producing at least two punched parts connected to each other, by means of which the punched parts are nonreleasably connected, the holding force is substantially increased and the accuracy to size of the
15 interconnected punched parts is increased.

This object is solved in accordance with the invention by the features of claim 1.

The advantages gained thereby are to be seen substantially, in that the punching speed can be in-
20 creased and the influence of the connection onto the shape of the punched parts can be decreased to a minimum.

According to a preferred embodiment of the invention, in which the punched parts are combined to a stack, adjacent punched parts are welded together at the
25 area of the superposed edges.

The advantages stemming therefrom are to be seen, in that the quality of the connection is increased, that the stacking is made exactly one above each other in the punching tool, wherewith separate known stacking de-
30 vices are no longer needed, and that the sequence of the punching can be shortened.

An apparatus for practicing the invention is characterized by claim 7.

The apparatus has the advantages, that the
35 punching tool is simplified and an increase of the frequency of the strokes of the punch press is made possible. Furthermore, it is of advantage that the focussing

device of the punching tool can be located independently at the machine, wherewith the possible applications are comparatively larger.

In the following the invention will be explained more in detail based on the appended drawings.

There is shown in:

Figures 1 to 4 schematically illustrated forms of applications of the inventive method,

Figure 5 a schematically illustrated embodiment of the inventive apparatus for the production of stacks of sheet metal made of sheets for electrical industry,

Figure 6 on an enlarged scale a detail of the apparatus illustrated in Figure 5, and

Figure 7 a schematic illustration of the time course during the production of sheet metal stacks.

In the method referred to herein the punched parts are welded together within the punching sequence by means of light beam-welding. The punching sequence depends on the part to be punched and can consist in the simplest case of one single punching operation. The course of the welding procedure is set by the punching apparatus, for instance by a coding disk coupled to the eccentric shaft of the punching apparatus. If two punched parts are to be welded together, the welding proceeds only at the second punching operation and the punched parts must be in a rest position.

In Figures 1 to 4 various forms of applications of the inventive method are illustrated, whereby the same reference numerals are used for the characterizing of same elements.

At the embodiment illustrated in Figure 1 the punched parts 1 and 2 comprise a recess 3 and can be welded together at the outer edge 4 and/or at the edges 5 formed by the recess 3 and by means of laser beams 6 from laser devices 7.

In contrast to the embodiment illustrated in Figure 1 the laser beam 6 is directed in accordance with Figure 2 via a reflection means 8, e.g. a mirror onto the location to be welded.

5 According to an embodiment as shown in Figure 4 two angled profiles 9 and 10 are welded together.

In this connection attention is drawn to the fact that the method is not confined to these embodiments.

10 According to Figure 5 an apparatus for practicing the above described method comprises a punch press having a punch 11 and a table 12, a punching tool 13 and a laser source 14 with a focussing device 15.

The punching tool 13 is mounted on the punching table 12 in accordance with known procedures. The punching tool 13 is designed in dependence on the part to be punched and includes as generally known a tool lower part 16, a tool upper part 17, guiding columns 18 for the tool upper part, which are mounted to the tool lower part, a holding plate 19 and a stripper 20 which are guided at the guiding columns, a pressure plate 21, a punch 22 and a punch supporting plate 23, which is mounted to the tool upper part 17, as well as guide plates 24, 25 for the strip of material (not illustrated) and a lower die 26, which is mounted in the tool lower part 16.

A device 31 for supporting and adjusting of the focussing device 15 of the laser-device is located at the lower tool 16. The focussing device 15 is connected via a light guiding cable 32 to the laser source 14. The laser source 14 is advantageously a pulsed laser, of which the beam source is a glass rod or a YAG-rod. In order to adjust the focussing device 15 the apparatus 31 is equipped with an adjusting member 33. At the above described example a laser having a beam divider for a welding at a plurality of locations is foreseen such as e.g. illustrated in Figure 2. It is, however, also pos-

sible to foresee two focussing devices 15, which are respectively held oppositely of each other at a device 31.

For the adjusting of the laser beam a viewing device may be foreseen, which is coupled to the focussing device. Besides the above described separated arrangement of laser source 14 and focussing device 15 it is also possible to apply a laser device with an integrated focussing and viewing device.

The welding devices 7 are controlled by a control device 34. The control device comprises a coding disk which is mechanically mounted to the eccentric shaft of the punch press, a scanning device which coacts with the coding disc and a control circuit which receives signals from the scanning device and provides signals for execution of the corresponding function within the operation.

A braking device 27 is mounted below the lower die 26, by means of which the individual punched parts can be discharged as stack.

As shown in Figure 6, recesses 36 are provided in the lower die 26 and conclusively also in the tool lower part and holes 37 are provided in the punch 22 in order to direct the laser beam 6 onto the parts 1, 2 to be welded together.

A preferred embodiment of the method refers to the production of sheet metal stacks of sheets for electrical industry, such as for rotors, stators and transformers. Figure 7 illustrates the course at this method in dependence from the rotation of the eccentric shaft.

As illustrated in Figure 7, the cutting operation I is terminated upon reaching the lower dead center UT. Thereafter the exiting II of the punch proceeds. At the area of the lower dead center UT the laser beam 6 can be directed to the outer or inner, resp., edge 4 or 5, resp., if the punch 22 or lower die 26, resp.,

are provided with elongated through holes 37, 36. At a punch 22 without through holes the application of the laser beam 6 occurs at III. Thereafter the welding IV is carried out, of which the termination can occur prior to
5 or at the upper dead center OT. Immediately after this point the feeding of V of the strip occurs followed by a strip clamping procedure VI. During the feeding of V of the strip and the clamping VI of the strip the twisting VIII of the stack occurs. After the clamping VI of the
10 strip the cutting procedure I is prepared by a guiding VII of the guiding pegs of the tool, a new cycle begins.

The above description discloses that the inventive method provides the specific advantage that a welding procedure can be made at an arbitrary portion of
15 the movement between the lower and the upper dead center.

By this procedure stacks of sheet metal can be produced, of which the quality is vastly better than that arrived at in accordance with known methods regarding running properties and electrical properties as well
20 as connecting force, whereby it shall be especially noted that it is possible to operate at high punching speeds, e.g. 800 strokes/minute, and that the punching tools are subjected to a substantial simplification.

Patent Claims

- 5 1. Method of producing at least two interconnected punched parts (1, 2) which in the course of a punching operation are welded together by light beam welding at at least one location, characterized in that the punched parts (1, 2) are welded within the bottom die
10 (26) at superposed edges (4, 5), whereby the light beam is directed onto the edges (4, 5), and in that the light beam is directed onto the location (4) to be welded when the punch (22) attains a position between lower and upper dead center.
- 15 2. Method according to claim 1, characterized in that the punched parts (1, 2) are welded at one of the outer edges (4).
3. Method according to claim 1, characterized in that the punched parts (1, 2) are welded at edges
20 formed by a recess (3).
4. Method according to one of the claims 1 to 3, whereby the punched parts are combined into a stack, characterized in that adjacent punched parts in the stack are welded together at the location of the superposed
25 edges at at least two welding positions which are foreseen at opposite locations of the punched parts.
5. Method according to one of the claims 1 to 4, characterized in that the welding process at said locations is carried out simultaneously or staggered re-
30 garding time.
6. Method according to one of the claims 1 to 5, characterized in that punched parts of differing materials are welded together.
7. Apparatus for practicing the method ac-
35 cording to claim 1, having a punch press (11, 12) with a punching tool (13) and a welding device (7, 14) with a pulsed laser-device and a control device (34) which is



controlled in dependence from the course of the punching operation of the press, characterized in that the laser-device (7) comprises a focussing device (15) for adjusting the laser beam, and that the control device (34) includes a camshaft gear in order to control the laser source (14) in dependence from the punching stroke or punching operation, resp.

8. Apparatus according to claim 7, characterized in that the laser device (7) is mounted at the punch press (11, 12) or at the punching tool (13).

9. Apparatus according to claim 7 or 8, characterized in that the focussing device (15) is mounted at the tool lower part (16) and is connected to the laser source (14) via a light transmitting cable (32).

10. Apparatus according to claim 7, characterized in that a reflection device (8) is foreseen which is mounted at the punching tool (13) and can be supplied with a cooling agent.

11. Apparatus according to one of the claims 7 to 10, characterized in that means (31) for supporting the laser-device (7) and for adjusting of the course of the beam are foreseen.

