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S p e c i f i c a t i o n

The invention relates to an arrangement for connecting metal sheets by a rivet-like joint, having the features which are mentioned in the pre-characterising clause of Patent Claim 1.

5 Such an arrangement is known from German Offenlegungsschrift No. 3106313. In this arrangement, near the anvil of the female die two levers are arranged which have the complementary cutting edges. The levers are pivotable about axes running at right-angles to the press stroke direction, and a helical compression spring acts on the two
10 levers in such a way that they are biased into the cutting position in which they rest against the anvil. The linear distance between the two lever pivot axes is greater than the distance between the two die punch cutting edges.

 An arrangement of the same type is also known from U.S. Patent No.
15 2288308. In this case the female die comprises a plurality of components: from a base there extends an anvil which tapers towards the free end; on the base are supported the complementary cutting members which rest against the inclined lateral faces of the anvil and are in the form of steel plates which have been bored through. Through the borehole
20 there is passed a bolt on which sit spring discs also acting on the outside of these plates. The distance between the plate edges by means of which the latter are supported on the base and about which they tilt when deflecting laterally is therefore greater than the distance between the cutting edges and the complementary cutting edges in the cutting
25 position.

 The same applies to the embodiment according to U.S. Patent No. 2254558; in the embodiment illustrated therein, the cutting edge bodies and return leaf springs are angled or bent in one piece and the cutting edge bodies are supported by the anvil.

With the known constructions described, the result is that while the two metal sheets are being cut through, on the components provided with the complementary cutting edges, that is to say, the levers and/or plates, there occurs a force component directed inwards, onto the anvil, ensuring that the complementary cutting edges do not already deflect laterally during the cutting-through phase.

The result on the other hand, however, is that in the second phase of the extrusion process the complementary cutting edges not only deflect laterally but during their deflecting movement they also have a component directed towards the die punch which tends to allow the connection produced not to become as rigid as would actually be possible under otherwise similar conditions. In addition, shavings can penetrate between the cutting edge members and the parts of the anvil supporting them, thereby bringing the usefulness of the whole arrangement into question. It would instead be desirable if the elements provided with the complementary cutting edges were to be accurately moved away laterally.

This could, if required, be achieved constructionally by means of a corresponding sliding bearing for the components provided with the complementary cutting edges and springs acting in a direction perpendicular to the press stroke direction. But by this means not only an expensive and complicated construction would be obtained, but also a still greater lateral projection of the female die than already appears to be unavoidable with the most modern known construction according to the German Offenlegungsschrift mentioned initially.

The problem on which the invention is based is to provide an arrangement of the same type in which an optimum connection is produced, and also in which a simple construction allows inexpensive mass production, and which finally can have minimum dimensions in a direction at right-angles to the press stroke.

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This problem is solved according to the invention by the fact that the complementary cutting edges are formed by free end edges of leaf springs fixed at one side and extending parallel to the movement of the male die.

5 The following advantages are thereby offered:

The leaf springs are simple stamped parts, and since they extend parallel to the press stroke, the anvil may also be a simple stamped sheet metal part. The leaf springs simultaneously perform three functions: they represent the complementary cutting edges, they transmit
10 the cutting forces to a base, and they provide the return force after the lateral deflection.

This swinging out movement takes place about an axis which lies almost exactly beneath the complementary cutting edge in question, since the leaf springs used can be relatively thin. It has in fact proved
15 that the risk of lateral deflection of the complementary cutting edges during the cutting phase is quite small even with fairly thin leaf springs. The leaf springs penetrate not only with their complementary cutting edges but also, even if only to a very limited extent, with the whole of their surface which faces towards the die punch, into the metal
20 sheet facing towards them, and are therefore supported by the metal sheet itself against deflection.

However, since the leaf springs, as stated, can be relatively thin, there is also only a minimal projection in a direction at right-angles to the press stroke.

25 In the subsidiary Claims, suitable and advantageous developments of the subject of the invention are defined, the resulting advantage in each case being mentioned within the framework of the explanation of example embodiments which follows. Reference is thereby made to the accompanying drawings.

Fig. 1 shows in perspective, partly in section, a set of tools consisting of a male die punch and a female die which together with the press forms an arrangement according to the invention,

Fig. 2 shows a side view in each case of one half of the symmetrically constructed cutting edge members for a female die in embodiments a, b and c,

Fig. 3 shows in vertical section in each case half female dies in three embodiments, a, b and c, which are modified in relation to Fig. 1,

Fig. 4 shows special forms of female dies and male dies in embodiments a, b, c, d, e,

Fig. 5a shows in perspective, partly in section, a further embodiment of male die and female die,

Fig. 5b shows a female die similar to that in Figure 5a,

Fig. 6 serves to explain a preferred application of the arrangement, Fig. 7 shows a complete arrangement, including a possible embodiment of the press,

Fig. 8 shows a partial view of an arrangement in which the female dies and male dies are mounted on revolving discs,

Figs. 9a and 9b show in longitudinal and cross-section, respectively, connections of two metal sheets in which an insert is provided in the manner of a rivet, and

Fig. 10 shows in section, to a great extent schematically, an arrangement for producing the connection according to Figs. 9a, 9b.

In Figure 1 the male die 10 can be seen with its die punch 12, which in this case has a rectangular cross-section with cutting edges 11, and may have a flat or somewhat convex front face; its outline is preferably trapezoidal. The female die comprises the anvil 14 and two cutting edge members 16 which are the same as each other. Anvil and cutting

edge members are captively connected to one another, for example by means of a hollow rivet 18. In the region of this connection the three components lie flat against one another, and also in the end region facing towards the die punch 12. In between, the anvil is so cut away on the sides facing towards the cutting edge members that it has an approximately rhomboid cross-section; the free spaces thus created make it possible for any shavings falling in to be carried away to the outside without preventing the cutting edge members from springing back. In operation, the side of the cutting edge members facing towards the anvil surfaces is supported in the lower region, where the rivet 18 is also situated, for example by means of a screw (not shown) which extends through the rivet and attaches the female die to a retaining means, which also supports it on the side remote from the die punch 12. In the region of their free end, the cutting edge members can deflect.

Whilst the shape of the anvil and of the die punch in Fig. 1 is shown corresponding approximately to reality, the shape of the cutting edge members shown there is not the most favourable. Better shapes are shown in Figs. 2 and 3.

Tests have in fact shown that the stability of the arrangement is determined to a great extent by the alternating stress of the cutting edge members deflected during each operation. It is therefore preferred that the latter should be so shaped that the deformation is distributed as uniformly as possible over the free length - corresponding to the flexion of a beam constrained on one side, loaded at the end - approximately the profile shown in Fig. 2a being produced. In a simplified form according to Fig. 2b, the flanks of the cutting edge members are cut away in a semicircular shape or, as shown in Fig. 2c, slot-like recesses 20 on the edge or slot-like apertures 22 in the solid part of the cutting edge members can be provided. Such differing contours with

the same cutting edge member thickness produce differing spring characteristics, and this is necessary in order to adapt to different qualities of metal sheet; with the same thickness of metal sheet, the cutting edge members for stainless steel should be considerably more rigid than, for example, for aluminium.

It should be noted here that also for different thicknesses of the metal sheets to be joined, care should be taken in that the depth of the female die, that is to say, the measurement between the complementary cutting edges and the highest point of the anvil is around the sum of the thicknesses of both sheets, reduced by an amount between 10 and 60, and preferably of 30%. It can be seen that with the cutting edge members remaining the same, only the anvil parts have to be exchanged in order to obtain sets of tools for other metal sheet thicknesses. The most favourable depth in each case can be prescribed in a reproducible manner either by limiting the press stroke or, and this is often the simpler solution, by limiting the force exerted by the presses.

Instead of on the outline, the form of the longitudinal section of the spring can be varied. Thus, according to Fig. 3a, instead of a solid cutting edge member, packets of leaf springs can be used which may, for example, be exchangeable; as can be seen, only the innermost leaf springs 24 are rivetted to the anvil and form the actual cutting edge member, while the remainder are exchangeable and the whole packet is inserted in a retaining block 26.

As Figure 3b shows, the two cutting edge members can also be formed together with a base 28 as a one-piece component cut to length from a billet, with the anvil inserted into the U-shaped part of its profile.

According to Figs. 2a-2c, the adaptation of the cutting edge member cross-section to the most favourable deformation characteristic was effected by means of variable width of the cutting edge member. But the

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thickness of the cutting edge members can also be varied according to Fig. 3c, approximately the same characteristic being obtained as with the packets of springs according to Fig. 3a.

5 The anvil member 30 according to Fig. 4a does not have the rhomboid cross-section as indicated in Fig. 1, but has a simple rectangular cross-section in the central region. Instead, at the foot a roof-like inclined surface 32 is provided along which shavings can be carried away to the outside.

10 As indicated in Fig. 4b, the two cutting edge members need not be parallel; they may also lie at an angle and form the female die with a corner anvil 36; the die punch cross-section 38 is then in the shape of an equal-sided right-angled triangle.

15 Another alternative form, not shown, for the female die does in fact have parallel cutting edges, but these are not on the edge opposite the fixing or supporting point, but on a side edge running in a direction perpendicular thereto. This means that the fixing point of the springs is not situated, as in all other embodiments, substantially beneath the male die, but sideways therefrom, and that the space beneath the male die may accordingly be fairly restricted. The fact that conditions
20 in the longitudinal direction of the cut alter, since the female die deflects to a different degree at both ends, has not proved troublesome.

According to Fig. 4c, it is also possible for two die punches 12' with a common female die 40 to work together in one press; two points
25 of connection are thereby obtained simultaneously at each stroke, the resistance to torsion of the connection being greater than with a single connection of correspondingly increased cross-section.

It is even possible, as indicated in Fig. 4d, for both a male die strip 42 and anvil and cutting edge member strips 44 of any required

length to be cut to length from initial material with corresponding profile and then inserted into corresponding retaining members with which conventional presses, for example bending presses, can be equipped.

Fig. 4e shows in perspective a section from a complete tool, 5 equipped with male dies P and female dies M. It can be seen that the upper tool 46 and the lower tool 48 have both female dies and male dies; in order that the metal sheets to be joined are not, however, distorted or even bent, when the tool is closed - therefore in the end deformation position - the distance between the complementary cutting 10 edges of upper tool and lower tool is equal to the thickness of the two metal sheets to be joined.

Fig. 5a shows an embodiment in which the anvil 50 is constructed as a regular cylinder, the height of which in relation to a base 52 can be variably adjusted in the direction of the arrow, for example by means of 15 adjusting screws. The cutting edge members 54 have the shape of sectors of hollow cylinders or of barrel staves which - except for the separating slots between them - completely enclose the anvil. The separating slots can differ in number and be of differing slot width. At the base end, the cutting edge members 54 can be inserted or fixed in correspon- 20 ding recesses in the base 52. The cutting edge members can be produced by slotting a sleeve or may consist of individual segments.

For the die punch 56 in the shape of a simple regular cylinder there are two possibilities. In the first case the cross-sections of anvil 50 and die punch 56 are substantially congruent. In this case - as also in 25 the embodiments described previously - both metal sheets are cut through, and only in the region of the slots between the cutting edge members do the slugs of material pressed through still hang on the surrounding metal sheet. The die punches can have recesses in the region of the female die slots in order not to constrict the remaining connecting webs.

So far, only another form of outline of the connection is produced in relation to Fig. 1 to 4a or 4b. But if the die punch is selected with cross-section dimensions 58 which are reduced by approximately double the thickness of the metal plate pressed through in relation to the corresponding dimensions of the anvil, the metal sheet is in fact pressed through but not cut into, so that in the finished connection it sits like a press-stud in the other metal sheet. Such a formation makes it possible for the point of connection to remain impermeable to fluids.

The regular cylindrical shape is, of course, in no way obligatory, and other polygonal outlines are also conceivable, for example square or hexagonal (cf. Fig. 5b for the female die for a square connection point).

The production of complete tools according to Fig. 4e can be rationalised if a construction corresponding to Fig. 6 is selected.

In each case a female die with ejectors 60 - for example in the shape of pins loaded by springs - and an associated male die with ejectors 60 are mounted on circular bases 62 of equal diameter. The ejectors may, of course, also be arranged independently of the female or male dies in the surrounding area. A male die plate 64 and a female die plate 66 are provided with column guides and thus reproducibly positioned with respect to each other. Both plates are then bored together at the corresponding points and into the boreholes 70 thus of necessity aligned, the bases 62 are inserted, the latter being rotated into a desired angular position and fixed therein. Damaged male or female dies are then able to be exchanged with few manipulations.

Fig. 7 shows as an example a hand-guided arrangement, equipped with a male die 80 and a female die 82. The male die jaw 86 is linked to the female die jaw 84 by means of bearing bolts 88, and into a recess in the female die jaw there is inserted the cylinder body 90 of a high pressure hydraulic cylinder, the plunger 92 of which actuates the male

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die jaw to produce a press stroke. The return is effected by means of the traction spring 94.

Occasionally it may be desired to close up the depressions produced by the joining process on the male die side of the joined metal sheets. This can take place during the course of connection, and Figs. 9a and 9b show in two sections perpendicular to each other through a connection of this type a rivet-like insert N. This represents to a certain extent the point of the male die which has remained in the join.

Fig. 10 shows in section, to a great extent schematically, an arrangement with which such a connection can be produced.

The female die M is arranged in the usual manner in a lower tool 100. Above it is formed a slot 102 into which the metal sheets 104, 106 to be connected fit with some play. Above the female die the lower tool has a guide channel 110 for the upper tool 108. Into this channel 110 there opens a recess 112 running at right-angles thereto, which serves as a magazine for the rivet N. The means by which the stack of rivets is conveyed in the recess 112 are familiar to a person skilled in the art and not therefore shown here.

Alternatively, there can also be inserted into the recess an extruded profile which has been cut to length and from which the upper tool cuts off a rivet at each press stroke.

Such a pincer-like construction of the arrangement has the great advantage that little space is required above and below the point of connection, and the connection can also be undertaken at points which are not readily accessible. The fact that the relative movement of male die and female die no longer follows a straight line, but an arc - if necessary, even one of relatively small radius - surprisingly does not affect the usefulness of the arrangement. Furthermore, the drive by means of a hydraulic cylinder is in no way obligatory; since even

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the straight-line motion is not unalterable, a power-transmitting lever mechanism can be provided which even allows arrangements that can be operated manually.

Fig. 8 shows an embodiment in which the male dies P and the female dies M are provided in each case on the periphery of a disc 70 and 72, respectively, the discs being rotatable in the direction of the arrows. There is therefore no press in the usual sense of the word, but the two tool components are brought into effective connection with each other and with the metal sheets 74, 76 by the rotary drive. In the left-hand portion of Fig. 8 the connection just produced can be seen at 78.

The discs sit in each case on the end of a cantilevered shaft, the shafts being driven synchronously by a motor. Between the male/female die combinations which come into engagement in each case, the discs can have a coating of a friction-promoting material, for example a layer of soft rubber, or can also be provided with a ribbed surface.

It should be pointed out that the expression "metal sheet" used above embraces not only thin sheets (less than 2 mm thick) or medium sheets (less than 4 mm thick) but also thick sheets, for example 5 mm thick aluminium. It should also be noted that parts of extruded or other profiles are to be understood as metal sheets within the meaning of the invention. Thus, for example, by means of the subject of the invention a framework of channel profiles can be connected with a sheet-metal cladding. It should finally be noted that the two metal sheets (in the above sense) to be joined in no way need to have the same thickness or may consist of different materials; thus, for example, a sheet of aluminium 3 mm thick can be joined to a sheet of refined steel 1 mm thick without any difficulty.

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P a t e n t C l a i m s

1. An arrangement for connecting metal sheets by a rivet-like joint, having a female die and a male die which can be moved by means of a press towards the female die, between which dies the metal sheets to
5 be joined lie with their surfaces flat over one another, the male die comprising a die punch provided with cutting edges and the female die having complementary cutting edges and an anvil set back behind the complementary cutting edges, on which anvil the material pressed through between the complementary cutting edges is extruded behind the edges of
10 the indentation by the die punch, while the complementary cutting edges deflect laterally and are returned to their cutting position again by means of spring bias after the connection has been removed from the female die, characterised in that the complementary cutting edges are formed by free end edges of leaf springs which are fixed at one side
15 and extend parallel to the movement of the male die.
2. An arrangement according to Claim 1, characterised in that the leaf springs have a rectangular cross-section and are rigidly connected in their fixing region to the anvil which also has a rectangular cross-section.
- 20 3. An arrangement according to Claim 1, characterised in that the leaf springs have a cross-section in the form of a sector of an annulus and are rigidly connected in their fixing region to the anvil which has a round cross-section.
4. An arrangement according to Claim 1, characterised in that the
25 leaf springs have a cross-section that tapers from their fixing region towards the complementary cutting edges.
5. An arrangement according to Claim 4, characterised in that the

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tapering of the cross-section is so determined that the bending stress is distributed at least approximately uniformly over the length of the leaf springs.

6. An arrangement according to Claim 4, characterised in that the
5 leaf springs are formed by a stacked packet of individual lamellae.

7. An arrangement according to Claim 4, characterised in that the leaf springs have lateral recesses.

8. An arrangement according to Claim 4, characterised in that the leaf springs have apertures.

10 9. An arrangement according to Claim 2, characterised in that a space for collecting and carrying away shavings is formed between the anvil and the leaf springs.

10. An arrangement according to Claim 9, characterised in that the space for collecting and carrying away shavings is formed by undercuts
15 of the anvil.

11. An arrangement according to Claim 1, characterised in that the cutting edges co-operating with the leaf spring complementary cutting edges are formed on a packing part remaining between the edges of the indentation.

20 12. An arrangement according to Claim 11, characterised in that the packing part can be sheared off from a billet of material by means of an auxiliary cutting edge formed on the male die.

13. An arrangement according to Claim 1, characterised in that it has a plurality of male die and female die combinations in an upper tool
25 and a lower tool, respectively.

14. An arrangement according to Claim 13, characterised in that the upper tool and the lower tool have both male dies and female dies.

15. An arrangement according to Claim 14, characterised in that when the two tools are as close as possible, the complementary cutting edges of the female dies of the two tools are at a distance from one another which is at least approximately equal to the thickness of the metal sheets to be joined.

16. An arrangement according to Claim 1, characterised in that it has resilient ejectors for releasing the metal sheets from the male die and female die.

17. An arrangement according to Claim 16, characterised in that in each case one female die or one male die arranged together with an ejector on a base forms an assembly module.

18. An arrangement according to Claims 13 and 17, characterised in that the bases are cylindrical and are inserted in boreholes of an upper tool and a lower tool.

19. An arrangement according to Claim 1, characterised in that the die punch and the female die are each secured to the free end of a lever arm, the two lever arms being pivotable about a common pivot in order to press the die punch and female die together.

20. An arrangement according to Claim 19, characterised in that a hydraulic working cylinder is provided for the pivot drive of the two lever arms relative to each other.