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(54) METHOD FOR SEOUENTIALLY CONTINUOUS MACHINING OF SHEET PIECES FROM SHEET MATERIAL.

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(56) References cited:
DE-A- 2 802 972
DE-B- 2 539 157
US-A- 3 370 492
US-A- 3 431 806
US-A- 3 448 645
US-A- 3 449 991
US-A- 3 683 731
US-A- 4 241 632

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Description

The invention relates to a method for sequentially and continuously machining or shaping sheet parts from continuous strip-like sheet material, such as coiled sheet metal, or sheet material in sheets, by means of an electronically controlled machine tool.

Sheet parts can be machined from sheet material by numerous methods. If we consider the entire chain of work steps, for example, from coiled sheet material to a completed sheet product, which has been machined by applying several working methods, the combinations of methods can at the roughest level be divided into methods for short production runs and those for long production runs.

In short production runs the machining of sheet parts is usually done by first slitting the sheet into strips, whereafter the strips are cut into pieces of suitable length. Thereafter the machining of the pieces is continued, as required, by punching, drilling, notching, etc. When this method is used, the tool costs are moderately low and the delivery time is short. The manufacturing costs are high because the work stages are numerous and there are several transfers from one work station to another. The dimensional precision is poor.

The latest equipment for short production runs consists of so-called sheet-working centers, in which the machining is carried out by punching, nibbling, and laser cutting. The characteristics of sheet-working centers are in general as follows:

- dimensional precision is good,
- standard tools can be used,
- standard sheet sizes can be used,
- delivery time is short,
- equipment is very expensive,
- the share of capital outlays in manufacturing costs is large,
- arranging unmanned production is difficult and expensive,
- manufacture of small parts is not competitive.

One method of handling sheet material in these sheet-working centers is to cut the sheet material coming from a coil first into sheets, which are transferred automatically to the actual working center. At the working center the sheet is machined by one or several of the above-mentioned methods, the tools themselves being fixed and the point to be machined being directed into place by moving the sheet. Such equipment is large in size and also very expensive.

Strip-like sheet material has been handled in short production runs by hot-cutting methods and, fully analogously with this method, also by using a laser cutter. Here the small number of alternative machining methods, i.e. only one work method, restricts the uses, owing either to deficient dimensional precision or to low speed. If the piece requires substantial cutting in proportion to its size and the shapes to be cut are such that they can be done more easily by other machining methods, low speed becomes the problem.

Punching has also been applied to the machining of strip-like sheet material. In this method the sheet is fed forward at indexing intervals corresponding at least to the size of the final product, the cutting of the product and its detaching from the strip being synchronized with this indexing. In addition, the apparatus includes a beam which contains the punching tools and can be moved transversely in relation to the travel direction of the sheet. By means of these tools the punching takes place after the tool or the tools have been brought to the intended point by indexing the sheet forwards over a suitable step in the longitudinal direction and indexing the tool beam over a suitable distance in the transverse direction. In this method, also, there are the following problems: (1) the longitudinal movement is only forwards in steps and only by moving the sheet, and therefore imprecision and detrimental restrictions regarding the shape of the workpiece result; (2) the work method is limited to one type, i.e. punching; (3) all workpieces across the entire width of the sheet are cut out at the same time, in which case either a) only one piece is cut over the entire width, which limits the size of the piece or presupposes previous slitting of the sheet into the correct width, or b) if there are several workpieces in parallel, several similar cutting tools in parallel are needed, aligned both with one another and with the preceding punch, which results in complicated and expensive tools; (4) the interspacing of the patterns of the final product so that the sheet surface is used effectively is successful only in special cases.

A long production run takes place by means of presses and feeding devices from a coiled strip which has been previously slit to the correct width. The machining is by serial tools, the workpiece being completed in one pressing. The advantages of this method include high dimensional precision and low manufacturing costs, if the production run is long enough. The disadvantages include:

- long delivery time (preparation of the tool, and cutting of the coil of strip in advance),
- expensive tool (usually suitable for the manufacture of only one product),
- in the prior slitting of the coil of strip, a proportion of the raw material goes to waste,
- the prior slit strip must be ordered in the correct amount, otherwise either the number of products is too small or a quantity of the strip is left over,
- the production cannot be carried out in an unmanned system for longer than it takes to

come to the end of a coil of sheet strip,
- in short production runs the manufacturing costs are high.

The greatest disadvantages of the current machining methods are either that the manufacture of the end product must be divided into several partial work steps on different machines, or that it is necessary to invest in an unreasonably complicated and expensive machine. In both cases the costs are too high.

Furthermore, the difficulties are increased by the fact that, regardless of which alternative has been chosen, it must further be decided whether to choose a setup suitable for short production runs or for long production runs, in which case one of the alternatives suffers. A disadvantage common to all other methods and combinations of methods, with the exception of hot/laser cutting, is the considerable waste of material between the patterns cut or between the cut pattern and the edge of the strip. The disadvantage of hot/laser cutting, for its part, was the use of only one work method, which is not suitable for all pieces.

Let us now set the following requirements for the method for implementing the machining:

1) It must be possible to use as raw material a standard stored material, either in flat form or coiled, so that during the entire manufacturing procedure it does not need to be cut into sheets or slit into a strip corresponding to the width of the product. This must be done in order to reduce the number of work steps substantially, to reduce the number of alternative materials substantially, and to reduce material waste substantially.

2) The method must be such that, when it is used, it must be possible to apply at least nearly all known methods of machining, such as punching, nibbling, drilling, laser cutting, etc., in combinations chosen freely according to the situation.

3) The method must be such that, when it is used, the tool type can be selected individually to correspond to the size of each specific batch of workpieces. For example, a short production run is by laser cutting and drilling, a longer run by multi-step punching and cutting, and a very long run by using a conventional serial tool in a press.

4) It must be possible to change the product at any moment, without additional waste of material.

5) The method must be easy to automate so that continuous manning is not needed.

6) The dimensional precision achieved must be good.

All of the above objectives cannot be achieved by any of the known methods described previously.

US-A-4708042 discloses two cylinders having pistons for tool stamps, but there is no indication of the possibility of their being replaced by other kinds of driving mechanisms, or that they could be used separately from one another. There is furthermore no suggestion as to how this could be possible. In US-A-4708042 the tool stamps and slide pistons are stationary relative to one another and it is difficult to change their positions without reassembling the whole machine because they have been irremovably fixed to the punching carriage. Furthermore, US-A-4708042 does not mention the possibility of using several machining methods and does not indicate how this could be possible. The pre-characterising portion of claim 1 is based on US-A-4708042.

By the method according to the invention, which is defined by the combination of features of claim 1, a crucial improvement is achieved regarding all of the disadvantages described above.

The following factors can be considered to be the most essential advantages of the invention:

- Standard sheets and standard coils of strip can be used as raw material,
- by combining standard tools it is possible to manufacture many different types of workpieces,
- great dimensional precision,
- manufacturing costs are low also in short production runs,
- it is possible to use the cheapest possible raw material,
- the loss of raw material is smaller than in other methods,
- it is possible to use full coils of strip, for example 10,000 kg/coil, in which case the manufacture can continue unmanned throughout the length of the coil, for example for 400 hours,
- the operation can be computer-controlled; in this case all of the operations of the enterprise can be computerized,
- the subsequent refining of the workpiece can be carried out easily by using manipulators or robots,
- it is directly suitable as a part of an automatic production line,
- replacements and settings of the tool can be automated,
- changes of series can be carried out by using a computer program,
- it is possible to apply various manufacturing methods, drilling, punching, cutting, drawing, slotting, nibbling, plasma cutting, laser cutting,
- the entire quality control of the workpiece can be carried out immediately by a computer

- it is possible to machine most raw materials,
- it is possible to manufacture exactly the required number of products. The remaining material can be used for other production, since standard sizes are used.

The invention is described below in detail with reference to the accompanying Figures.

Figure 1 depicts schematically, as an axonometric representation, an application according to one embodiment of the invention,

Figure 2 depicts a schematic side view of an application according to the embodiment of Figure 1,

Figure 3 depicts schematically one method of interspacing the products on the sheet, made possible by the invention,

Figure 4 depicts a schematic representation, from below, of one tool/work method setup according to the invention,

Figure 5 depicts another method of interspacing the products on the sheet, made possible by the invention,

Figure 6 depicts one product form easily achieved by the method according to the invention.

Figure 1 shows an overall representation of an embodiment of the invention. In the embodiment concerned, the machining method is punching, but the use of some other machining method changes only one single tool, and not the way or method of the invention for using them together or separately.

In Figures 1 and 2 the sheet raw material 15 comes from a sheet coil 5, which is standard stored material. The feeding of the sheet forwards is here implemented by means of a drive means 13 and rolls 10, the sheet 15 pressed between them being indexed forwards over the distance necessary at each given time. Indexing devices of other types can also be used. In this case, to the frame 9 of the tool holder there have been attached three hydraulic presses 8 in which the tools are two punching dies 2 and one upper cutter blade 1. Opposite to these there are, attached to the same frame 9 which serves as a single working unit, bolsters 4 and a lower cutter blade 3. This is possible to accomplish for example by making the frame 9 in the shape of a U, and attaching the upper and lower tools to the branches of the U, at mutually corresponding points by means of, for example, mounting plates, not shown in this Figure. The tool-holder frame 9 is, for example, mounted on guides 11 which may be several in number and/or may be positioned in different ways. The frame 9 is indexed transversely in relation to the travel direction 16 of the sheet 15, in direction 17, by an indexing device 12, for example in the form of a screw and ball nut with the aid of a drive means 14.

The machining of the workpieces and their detaching from the sheet 15 is done here transversely relative to the travel direction 16 of the sheet, starting from the first edge 18 of the sheet 15. In the first machining step the foremost of the punching dies 2 makes the hole of the first workpiece in area a of this workpiece. The cutter and the later of the punching dies 2 are at this time outside the edge 18 of the sheet. In the following step the foremost of the punching dies 2 makes the first hole of the second workpiece in area b of this workpiece, and the later of the punching dies 2 at the same time makes the second hole in area a of the first workpiece, detaching both scrap pieces 7. In the third step the punching dies work in areas c and b, as above, while the cutter 3, 4 detaches the first completed workpiece 6 from area a. Thereafter the punching dies move to areas d and c and the cutter to area b, where the above-mentioned work steps are repeated. When the cutter 3, 4 has detached the last completed workpiece in this row, from area m, at which time the punching dies are outside the other edge 19 of the sheet, the entire frame 9 together with the tools returns to the first edge 18 and starts repeating the above-described chain of work steps towards the other edge 19 of the sheet. The procedure continues in this way until the sheet 15 has been used up, or until the required series of workpieces has been made, whereupon the tools are replaced with others and the machining of new workpieces is started, for example further from the same sheet if the material remains the same, or from a fresh material if the sheet coil is replaced with another.

When operating by the method described above, only one set of tools corresponding to the workpiece is needed, and the tools need to be aligned only in relation to one another, in which case the tooling costs remain low and high precision is achieved. The waste material is as small as it can in general theoretically be in the machining method in question, since pre-slitting into strips is not needed. the interval between replacements of material is long, since the coil contains considerably more material than, for example, slit coils corresponding to the width of one product. The savings of material are further increased by the fact that, as the procedure starts from sheet edge 18, machining all the way to edge 19, it is possible in different machining lanes I-II, etc. (Figure 3) to interspace the products 20 in the manner which is considered best, either in the travel direction 16 of the sheet 15 as in Figure 3, or in the travel direction 17 of the frame 9 of the tool holder, or in both directions simultaneously over the entire surface of the sheet 15. In Figure 3, in which the length of the workpiece is A, the saving thus achieved is of the magnitude B (this is only to illustrate the principle, there may be found an even more efficient layout for the pieces concerned). The workpiece 20 can be replaced, in the middle of the sheet, with workpiece 21, the only limiting condition being that the sheet material is the same. Such bi-directional interspacing and replacement is not possible in other combinations of machining methods.

The method described above is perhaps one of the most primitive embodiments according to the invention. However, the method is suitable for use with considerably more complicated equipment. There may be a considerably larger number of tools 2, 4 and 1, 3, they can be easily replaced by means of bolt attachment or automatically; and their positions can for this reason be easily changed. When control logic is added to the method, such as numeric control, a nibbling function may, for example be produced. In this case the punching die can be fitted to make, for example, 50 punchings while the frame 9 moves at an even, small-stepping speed, whereafter the other tools make one punching. This nibbling can be diversified by making in the tool holder frame 9 one or several tool holders 23 guidable in different directions.

Figure 4 depicts such an arrangement, in which the tool holder 23 has been arranged to be movable by means of an indexing device 37 in direction 22, which is transverse or perpendicular to the travel directions 17 of the frame. In this case the nibbling, slotting or laser cutting can be controlled simultaneously in two mutually perpendicular directions 17 and 22, which are at the same time independent of one another. By means of this arrangement, the indexing of the sheet 15 during the machining of one row of workpieces is also avoided; such moving would easily cause flaws in the piece. In terms of control the most advantageous manner of moving the tool holder frame 9 and for transferring the tool holders relative to the frame is to use a machine element producing a linear indexing; there exist several types of such machine elements.

In the tool holder frame 9 there may be several tool holders 23, 25, and 27, of which all, some, or one, can be controllable during work, such as the holder 23, or adjustable only in connection with the replacement of the tools, and there may be attached to each of them several tool sets 24, 26, and 27. In an individual tool set there may be several tools, for example several punching dies in a hydraulic press. Each of these tool sets may be of any type of machining method with its control devices and power sources. When necessary, it is of course also possible to use a common power source. The tool holders, or some of them, may be positioned below the sheet 15, for example, in the lower branch of the frame 9, or there may be tool holders on both sides of the sheet 15 and simultaneously in use. In this case it is possible to take into account the asymmetry of the machining trace in the direction of sheet thickness and its effect on the completed workpiece. It is, for example, possible to punch or to cut the different holes of one and the same workpiece from different directions. The tools to be attached to the tool holders may carry out any machining methods allowed by the limiting conditions of an individual machine construction, such as drilling, punching, cutting, nibbling, plasma cutting, slotting, etc., and also shaping methods such as chamfering, for example from the side edge or front edge of the sheet, flanging, compression molding, etc. In the present patent application and its claims, the term machining is deemed to include also shaping.

(a) The tool holder frame 9 indexable and guidable transversely to the travel direction 16 of the sheet 15, or in general the entity made up of the tool holders; (b) the tool holders 23, 25, 27, etc., indexable and guidable in relation to this, which can be transferred by a linear movement or by means of eccentrics, etc. relative to the frame; and (c) the tools attached to each tool holder and usable independently of one another, constitute a hierarchical entity (cf. decision tree, etc.). Such an entity is suitable for control by using microprocessors or complete computers, and particularly microcomputers, in which case their programming can be carried out simply by following the machining-technique hierarchy with the main program-subprogram hierarchy. Although the frame, the tool holders, and the tools with their actuating devices are as such independent of one another, their operation in relation to one another must, of course, be sequenced correctly, i.e. they must be mutually synchronized.

When using tool holders 23, 25, 27, etc. adjustable or controllable in a sufficiently versatile manner, and when using a logic control device sufficiently versatile and flexible, for example a microcomputer, the workpieces can for example be positioned on the sheet 15 in a manner which greatly saves material. For example, in Figure 5, every other row of workpieces is a mirror image of the adjoining rows. In reality the workpieces can be positioned on the sheet arbitrarily, even every individual workpiece 29-36 in a different position, provided that the coverage of the sheet 15 surface is effective and the machining itself takes place in a direction transverse to the sheet 15.

Effective control and the versatile possibility to move the tools in accordance with the invention also allow standardization of the tools. This means that each opening, hole combination and piece outline does not require a separate tool made specifically for it. For example, the piece in Figure 6

a) if made by using a serial tool in a press, requires 32 punching dies and a cutting device in the tool, which is expensive;

b) if made by laser cutting, the machining is slow;

c) if made in several work steps using conventional workshop techniques, the machining is both slow and expensive. By using the method according to the invention it is possible to select the machining methods and tools suitable for the size of the series, for example, holes 41 by using punching die 1, holes 38 by using punching die 2, all small holes 39 (compared with the diameter, because of the great sheet thickness) by using drill 3, and openings 40 and the outline by laser cutting. In this case the drillings are controlled numerically, as is the laser cutting. As the series to be produced increases in size, a shift is made to punching and cutting to the extent appropriate.

As regards the details of the tool holder frame 9 and the machining technique, it must be taken into account that if the frame is of the shape U presented, in the machine the tool traveling last in the travel direction 17 on each row must carry out the cutting step, in order that the result should be a removed area of the sheet 15 corresponding to the removed workpiece, to provide room for the central part of the U-shape. If the upper tool holders are guided without a U-shaped frame, for example numerically, into alignment with the lower bolsters concerned, or if the machining methods are such that lower bolsters are not needed, the waste material can be left in strip form because, in this case, the route along which it is removed is always free. Usually it is, however, most advantageous to cut off the waste material, because then the front edge of the sheet 15 in its travel direction 16 remains neat, which makes it easy to continue the work. The transfer of the remaining coil of the sheet and its handling, if the work is discontinued at such a stage, is then also possible without additional work steps.

The invention is not limited to the examples described above; the method can be modified and various machining methods and machine elements not mentioned here, as well as computer technology, can be used in carrying out the method within the scope of the appended claims.

Claims

1. A method for sequentially and continuously machining or shaping workpieces at a machining area with tools mounted on working units (9), many different types of tools (1, 2; 3, 4; 24, 26, 28) being capable of being mounted on said working units (9), said workpieces (6; 20, 21; 29, 30, 36) being formed from sheet material (15) of selectable width, including the steps of:

(a) selecting a first plurality of tools (1, 2; 3, 4; 24; 26 and/or 28) from said tools (1, 2; 3, 4; 24, 26, 28) of different types, said selected tools being able to form a first type of workpiece (6, 20, 21, 29, 30, 36) from said sheet material (15);

(b) attaching each said selected tool to associated driving mechanism on a said working unit (9) and guiding it to operate on said sheet material (15) with a pre-planned sequencing with respect to others of said first plurality of selected tools (1, 2; 3, 4; 24; 26, 28) for at least one of first and second traverses of said working unit (9) between first and second longitudinal edges (18, 19) of said sheet material (15) in first and second opposite directions (17) which are perpendicular to said sheet feed direction (16);

(c) feeding the sheet material (15) along a sheet feed direction (16) to the machining area (A);

(d) positioning at least one said working unit (9) adjacent the surface of said sheet material (15) for movement in said first and second traverses;

(e) moving said working unit (9) in said first traverse along said first perpendicular direction (17) from said first longitudinal edge (18) toward said second longitudinal edge (19);

(f) returning said working unit (9) in said second traverse in said second perpendicular direction (17) from said other longitudinal edge (19) of said sheet (15) toward said one starting longitudinal edge (18) of said sheet (15), said working unit movement being capable of extending from one longitudinal edge (18) of said sheet (15) to the other longitudinal edge (19) of said sheet (15), said longitudinal edges (18, 19) being parallel to said sheet feed directions (16);

(g) advancing said sheet material (15) along said sheet feed direction (16) after each said first traverse and after each said second traverse of said working unit (9);

(h) repeating said first and second traverses of said working unit (9) after each advance of said sheet (15) until a desired number of said workpieces (6; 20, 21; 29, 30, 36) has been completed;

(i) synchronizing the operation on said sheet material (15) of each individual tool (1, 2; 3, 4; 24; 26 and/or 28) of said selected first plurality with the operation of the other tools of said selected first plurality (1, 2; 3, 4; 24;

26 and/or 28) so that each tool may perform its functions without impediment from other tools;

(j) implementing electronically by programmed computer means said guiding, indexing and synchronizing so that each function of the machining is made to correspond hierarchically to a corresponding function carried out by a program;

characterized in that there is a single said working unit (9) (9) including a plurality of tool holders (8; 23, 25, 27); and in that the method includes the steps of:-

(k) connecting each of said tool holders (8; 23, 25, 27) with a specific type of driving mechanism and further with said selected tools (1, 2; 3, 4; 24; 26 and/or 28) of different types to said working unit (9) for indexing therewith in said first and second directions (17) substantially perpendicular to said sheet feed direction (16) of said sheet material (15); and

(l) inactivating electronically by programmed computer means said first plurality of selected tools (1, 2; 3, 4; 24; 26 and/or 28) and the associated tool holders (8; 23, 25, 27) with driving mechanisms and making operative a second plurality of tools and associated tool holders with driving mechanisms selected from said many different types of tools (1, 2; 3, 4; 24, 26, 28) said second plurality of selected tools being able to form a second type workpiece (6; 20, 21; 29, 30, 36) from said sheet material (15).

2. A method according to claim 1, characterized in that the method further comprises the steps of: positioning tools (1, 2 and 3, 4) on tool holders (8

both above and below the sheet material (15) to be machined; and

machining the workpiece (6; 20, 21; 29, 30, 36) from both sides, and aligning the upper tool (1; 2) required by the machining at each particular time with the correspondingly needed lower tool (3; 4) by forming between them a mechanical connection which is fixed during operation.

3. A method according to claim 1, characterized in that the method further comprises the steps of:

stopping the traverse of said working unit (9) during each tool operation, and moving said working unit (9) between said longitudinal edges (18, 19) in incremental steps on a predetermined basis; and

guiding and indexing at least one (23) of the tool holders (8; 23, 25, 27) within the working unit (9) in a direction (22) which is transverse to said direction (17) of the movement carried out by the working unit (9) between the longitudinal edges (18, 19) of the sheet materials (15).

4. A method according to claim 1, characterized in that the method further comprises the step of: cutting the sheet material (15) so that the next leading edge of the sheet material (15) in the sheet feed direction (16) perpendicular to said longitudinal edges (18, 19) forms a direct starting point for the next working indexing by said working unit (9) from said one longitudinal edge (18) of the sheet (15) to the other longitudinal edge (19).

5. A method according to claim 1, characterized in that a mechanism (12; 37) producing a linear indexing is used for moving the working unit (9) between said longitudinal edges (18, 19) and for moving the tool holders (8; 23, 25, 27) mounted on said working unit (9) in relation to the working unit (9), and in that tools (2, 24, 26, 28) requiring drive devices have said devices mounted on the associated tool holders (8; 23, 25, 27).

6. A method according to any one of claims 1 to 5, characterized in that each of said selected tools (1, 2; 3, 4; 24; 26 and/or 28) with their driving mechanisms perform one of any preplanned machining method.

Patentansprüche

1. Verfahren zum aufeinanderfolgenden und kontinuierlichen Bearbeiten oder Formen von Werkstücken in einem Bearbeitungsbereich mit Werkzeugen, die auf Arbeitseinheiten (9) montiert sind, wobei zahlreiche verschiedene Typen von Werkzeugen (1, 2; 3, 4; 24, 26, 28) an den Arbeitseinheiten (9) montierbar sind, wobei die Werkstücke (6; 20, 21; 29, 30, 36) aus bahnförmigem Material (15) wählbarer Breite gebildet werden, mit den folgenden Verfahrensschritten:

(a) Auswählen einer ersten Mehrzahl von Werkzeugen (1, 2; 3, 4; 24; 26 und/oder 28) aus den genannten Werkzeugen (1, 2; 3, 4; 24, 26, 28) verschiedener Typen, wobei die ausgewählten Werkzeuge dazu in der Lage sind, einen ersten Typus eines Werkstückes (6, 20, 21, 29, 30, 36) aus dem genannten bahnförmigen Material (15) zu bilden;

(b) Befestigen eines jeden der ausgewählten Werkzeuge an zugeordneten Antrieben an einer der genannten Arbeitseinheiten (9) und zu dessen Führen, um an dem genannten bahnförmigen Material (15) mit einer vorgegebenen Reihenfolge in Bezug auf andere der genannten ersten Mehrzahl ausgewählter Werkzeuge (1, 2; 3, 4; 24; 26, 28) zu arbeiten, zwecks wenigstens einer Traversierung einer ersten und zweiten Traversierung der genannten Arbeitseinheit (9) zwischen einer ersten und einer zweiten Längskante (18, 19) des bahnförmigen Materiales (15) in einer ersten und einer zweiten, einander gegengerichteten Richtung (17), senkrecht zur Bahnförderrichtung (16);

(c) Zuführen des bahnförmigen Materiales (15) in Bahnförderrichtung (16) zum Bearbeitungsbereich (A);

(d) Positionieren wenigstens einer der genannten Arbeitseinheiten (9) im Bereich der Fläche des bahnförmigen Materiales (15) zwecks Bewegung in der ersten und der zweiten Traversierung;

(e) Bewegen der ersten Arbeitseinheit (9) in der ersten Traversierung entlang der genannten ersten senkrechten Richtung (17) von der ersten Längskante (18) gegen die zweite Längskante (19);

(f) Rückführen der Arbeitseinheit (9) in der zweiten Traversierung und in der zweiten senkrechten Richtung (17) von der anderen Längskante (19) der Bahn (15) gegen die eine, ausgehende Längskante (18), wobei sich die Bewegung der Arbeitseinheit von einer Längskante (18) der Bahn zur anderen Längskante (19) der Bahn (15) erstrecken kann und die Längskanten (18, 19) parallel zur Bahnförderrichtung (16) verlaufen;

(g) Fördern der Bahn (15) in Bahnförderrichtung (16) nach jedem des genannten ersten Traversierens und nach jedem des genannten zweiten Traversierens der Arbeitseinheit (9);

(h) Wiederholen des ersten und des zweiten Traversierens der Arbeitseinheit (9) nach jedem Vorschub der Bahn (15) solange, bis eine gewünschte Anzahl von Werkstücken (6; 20, 21; 29, 30, 36) vervollständigt wurde;

(i) Synchronisieren des Arbeitens eines jeden einzelnen Werkzeuges (1, 2; 3, 4; 24; 26 und/oder 28) eines jeden einzelnen Werkzeuges der genannten ausgewählten ersten Mehrzahl an der Bahn (15) mit dem Arbeiten der anderen Werkzeuge der genannten ausgewählten ersten Mehrzahl (1, 2; 3, 4; 24; 26 und/oder 28), so daß jedes Werkzeug seine Funktionen ohne Behinderung durch die anderen Werkzeuge ausführen kann;

(j) elektronisches Durchführen des genannten Führens, Indexierens und Synchronisierens durch programmierte Computer, so daß jede Funktion des Bearbeitens derart gestaltet wird, daß sie hierarchisch einer entsprechenden, vom Programm ausgeführten Funktion entspricht;

dadurch gekennzeichnet, daß eine einzige Arbeitseinheit (9) vorgesehen ist, mit einer Mehrzahl von Werkzeughaltern (8; 23, 25, 27), und daß das Verfahren die folgenden Verfahrensschritte aufweist:

(k) Anschließen eines jeden der genannten Werkzeughalter (8; 23, 25, 27) mit einem speziellen Antriebsmechanismus und weiterhin mit den genannten ausgewählten Werkzeugen (1, 2; 3, 4; 24; 26 und/oder 28) verschiedener Typen an die Arbeitseinheit (9), um hierdurch in der ersten und der zweiten Richtung (17) zu indexieren, im wesentlichen senkrecht zur Bahnförderrichtung (16) der Bahn (15); und

(l) elektronisches Inaktivieren der ersten Mehrzahl ausgewählter Werkzeuge (1, 2; 3, 4; 24; 26 und/oder 28) sowie der zugehörenden Werkzeughalter (8; 23, 25, 27) mit Antriebsmechanismen mittels programmierter Computer und durch Wirksammachen einer zweiten Mehrzahl von Werkzeugen und zugeordneten Werkzeughaltern mit Antriebsmechanismen, ausgewählt aus den genannten zahlreichen verschiedenen Bauarten von Werkzeugen (1, 2; 3, 4; 24, 26, 28), wobei die zweite Mehrzahl ausgewählter Werkzeuge dazu in der Lage ist, eine zweite Art von Werkstück (6; 20, 21; 29, 30, 36) aus dem Bahnmaterial (15) zu bilden.

2. Verfahren nach Anspruch 1, dadurch gekennzeichnet, daß das Verfahren weiterhin die folgenden Schritte aufweist:
Positionieren von Werkzeugen (1, 2 und 3, 4) an Werkzeughaltern (8) oberhalb und unterhalb des bahnbearbeitenden Bahnmateriales (15), und
des Bearbeitens des Werkstückes (6; 20, 21; 29, 30, 36) von beiden Seiten und Ausrichten des oberen Werkzeuges (1; 2), das zum Bearbeiten zu jedem bestimmten Zeitpunkt benötigt wird, mit dem entsprechend benötigten unteren Werkzeug (3; 4) durch Bilden eines mechanischen Anschlusses zwischen diesen, der während des Arbeitsvorganges fest ist.

3. Verfahren nach Anspruch 1, dadurch gekennzeichnet, daß das Verfahren weiterhin die folgenden Verfahrensschritte enthält:
Anhalten des Traversierens der genannten Ar-

beitseinheit (9) während einer jeden Werkzeugoperation und Bewegen der Arbeitseinheit (9) zwischen den Längskanten (18, 19) in inkrementalen Schritten auf einer vorbestimmten Basis; und
Führen und Indexieren wenigstens eines (23) der Werkzeughalter (8; 23, 25, 27) innerhalb der Arbeitseinheit (9) in einer Richtung (22), die quer zu der von der Arbeitseinheit (9) zwischen den Längskanten (18, 19) des Bahnmateriales (15) ausgeführten Bewegungsrichtung (17) verläuft.

4. Verfahren nach Anspruch 1, dadurch gekennzeichnet, daß das Verfahren weiterhin die folgenden Verfahrensschritte aufweist:
Schneiden des bahnförmigen Materiales (15), so daß die nächstführende Kante des Bahnmateriales (15) in Bahnförderrrichtung (16) senkrecht zur Längsrichtung der Kanten (18, 19) einen direkten Startpunkt für das nächste Arbeiten bildet, unter Indexieren der Arbeitseinheit (9) von der genannten einen Längskante (18) der Bahn (15) zur anderen Längskante (19).

5. Verfahren nach Anspruch 1, dadurch gekennzeichnet, daß ein Mechanismus (12; 37), der ein lineares Indexieren erzeugt, dazu verwandt wird, um die Arbeitseinheit (9) zwischen den Längskanten (18, 19) zu bewegen und zum Bewegen der Werkzeughalter (8; 23, 25, 27), die an der Arbeitseinheit (9) montiert sind, relativ zur Arbeitseinheit (9), und daß Antriebe, die von den Werkzeugen (2, 24, 26, 28) benötigt werden, an den zugehörenden Werkzeughaltern (8; 23, 25, 27) montiert sind.

6. Verfahren nach einem der Ansprüche 1 bis 5, dadurch gekennzeichnet, daß jedes der ausgewählten Werkzeuge (1, 2; 3,4; 24; 26 und/oder 28) mit ihren zugehörenden Antriebsmechanismen einen von jeglichen vorgeplanten Bearbeitungsschritten ausführt.

Revendications

1. Un procédé pour usiner ou mettre en forme séquentiellement en continu des pièces dans une zone d'usinage avec des outils montés sur des unités d'usinage (9), de nombreux types différents d'outils (1, 2; 3, 4; 24, 26, 28) étant susceptibles d'être montés sur lesdites unités de travail 9, lesdites pièces à travailler (6; 20; 21; 29, 30, 36) étant formées en matériau en feuille, notamment en feuille de tôle (15) présentant une largeur susceptible d'être sélectionnée et comprenant les étapes consistant:

a) à sélectionner une première pluralité d'outils (1, 2; 3, 4; 24, 26 et/ou 28) à partir desdits outils (1, 2; 3, 4; 24, 26, 28) de différents types, lesdits outils sélectionnés étant susceptibles de former un premier type de pièce à travailler (6, 20, 21, 29, 30, 36) à partir dudit matériau en feuille de tôle (15);
b) à fixer chacun desdits outils sélectionné à un mécanisme d'entraînement associé sur ladite unité de travail (9) et à le guider pour qu'il fonctionne sur ledit matériau en feuille (15) selon une séquence préplanifiée par rapport aux autres outils de ladite première pluralité d'outils sélectionnés (1, 2, 3, 4; 24; 26, 28) pour au moins l'une des première et seconde parties transversales de ladite unité de travail (9) entre les premier et second bords longitudinaux (18, 19) dudit matériau en feuille de tôle (15) dans lesdites première et seconde directions opposées (17) qui sont perpendiculaires à ladite direction d'alimentation de feuille de tôle (16);
c) à amener le matériau en feuille de tôle (15) le long d'une direction d'alimentation en feuille de tôle (16) vers la zone d'usinage (A);
d) à positionner au moins ladite unité de travail (9) adjacente à la surface de ladite feuille de matériau (15) pour se déplacer dans lesdites première et seconde traverses;
e) à déplacer ladite unité de travail (11) dans ladite première traverse le long de ladite première direction (17) à partir dudit bord longitudinal (18) vers ledit second bord longitudinal (19);
f) à faire revenir ladite unité de travail (19) dans ladite seconde traverse dans ladite seconde direction perpendiculaire (17) à partir dudit bord longitudinal (19) de ladite feuille (15), vers ledit bord longitudinal de départ (18) de ladite tôle (15), ladite unité de travail étant capable de s'étendre depuis un bord longitudinal (18) de ladite feuille (15) jusqu'à l'autre bord longitudinal (19) de ladite tôle (15), lesdits bords longitudinaux étant parallèles à ladite direction d'alimentation de tôle (16);
g) à faire avancer ledit matériau en feuille de tôle (15) le long de ladite direction (16) d'alimentation de feuille de tôle après chacun desdits premiers déplacements transversaux et après chacun de ladite seconde partie en traverse de ladite unité de travail (9);
h) à répéter lesdits premier et second déplacements transversaux dans ladite unité

de travail (9) après chaque avance de ladite feuille de tôle (15) jusqu'à ce qu'un nombre souhaité desdites pièces (16; 20; 21; 29; 30, 36) ait été réalisé;

i) à synchroniser le travail effectué sur ledit matériau en tôle (15) de chaque outil individuel (1, 2; 3, 4; 24; 26 et/ou 28) de ladite première pluralité sélectionnée avec le fonctionnement des autres outils de ladite pluralité sélectionnée (1, 2; 3, 4; 24; 26 et/ou 28); de telle façon que chaque outil puisse réaliser ses fonctions sans gêner les autres outils;

j) à mettre en place par voie électronique à l'aide de moyens d'ordinateur programmés, ledit guidage, ladite indexation et ladite synchronisation de sorte que chaque fonction de l'usinage soit réalisée pour correspondre, pour la priorité, à la hiérarchie de la fonction correspondante réalisée par un programme;

caractérisé en ce que ladite unité de travail (9) est unique et comprend une pluralité de porte-outils (8; 23, 25, 27) et en ce que le procédé comporte les étapes consistant:

k) à relier chacun desdits porte-outils (8; 23, 25, 27) à un type spécifique de mécanisme d'entraînement et, en outre, avec lesdits outils sélectionnés (1, 2; 3, 4; 24; 26 et/ou 28) de différents types de ladite unité de travail (9) pour les indexer avec eux dans lesdites première et seconde directions (17) de façon sensiblement perpendiculaire à ladite direction d'alimentation en feuille de tôle (16) dudit matériau en feuille de tôle (15); et

l) à mettre au repos par voie électronique, avec des moyens d'ordinateur programmés, ladite première pluralité d'outils sélectionnés (1, 2; 3, 4; 24; 26 et/ou 28) et les porte-outils associés (8; 24, 25, 27) avec leur mécanisme d'entraînement et à rendre opérante une seconde pluralité d'outils et de porte-outils associés avec des mécanismes d'entraînement sélectionnés à partir desdits différents types d'outils (1, 2; 3, 4; 24, 26, 28); ladite seconde pluralité d'outils sélectionnés étant susceptible de former une pièce à travailler d'un second type (6; 20; 21; 29; 36) à partir dudit matériau en feuille de tôle (15).

2. Un procédé selon la revendication 1, caractérisé en ce que le procédé comporte en outre les étapes consistant:
- à positionner les outils (1, 2 et 3, 4) sur des porte-outils (8) au-dessus et au-dessous du matériau en feuille (15) à usiner; et
- à usiner la pièce à travailler (6; 20, 21; 29, 30, 36) des deux côtés et à aligner l'outil supérieur (1; 2) requis pour l'usinage à chaque instant particulier, avec l'outil inférieur correspondant (3, 4) en formant entre eux une connexion mécanique qui est fixée au cours du fonctionnement.

3. Un procédé selon la revendication 1, caractérisé en ce que le procédé comporte en outre l'étape consistant:
- arrêter le déplacement transversal de ladite unité de fonctionnement (9) au cours de chaque fonctionnement d'outil, et à déplacer ladite unité de travail (9) entre lesdits bords longitudinaux (18, 19) selon des étapes incrémentielles sur une base prédéterminée; et
- guider et à indexer au moins l'un (23) des porte-outils (8; 23, 25, 27) à l'intérieur de l'unité de travail (9) dans une direction (22) qui est transversale à ladite direction (17) de déplacement réalisée par l'unité de travail (9) entre les bords longitudinaux (18, 19) du matériau en feuille de tôle (15).

4. Un procédé selon la revendication 1, caractérisé en ce que le procédé comporte en outre l'étape consistant à: couper le matériau en feuille de tôle (15) de telle façon que le bord menant suivant du matériau en feuille de tôle (15) dans la direction d'alimentation de tôle (16) perpendiculaire auxdits bords longitudinaux (18, 19) forme un point de départ direct pour l'indexation de travail suivante par ladite unité de travail (9) à partir dudit bord longitudinal (18) de la feuille de tôle (15) vers l'autre bord longitudinal (19).

5. Un procédé selon la revendication (1), caractérisé en ce qu'un mécanisme (12; 37) produisant une indexation linéaire est utilisé pour déplacer une unité de travail (9) entre lesdits bords longitudinaux (18, 19) et pour déplacer les porte-outils (8; 23, 25, 27) montés sur ladite unité de travail (9) par rapport à l'unité de travail (19) et en ce que des outils (2, 24, 26, 28) nécessitant des dispositifs d'entraînement ont lesdits dispositifs montés sur le porte-outils (8; 23, 35, 27).

6. Un procédé selon l'une quelconque des revendications 1 à 5, caractérisé en ce que chacun desdits outils sélectionnés (1, 2; 3, 4; 24; 26 et/ou 28) avec leurs mécanismes d'entraînement, réalise l'un de n'importe lequel des procédés d'usinage que l'on planifie préalablement.

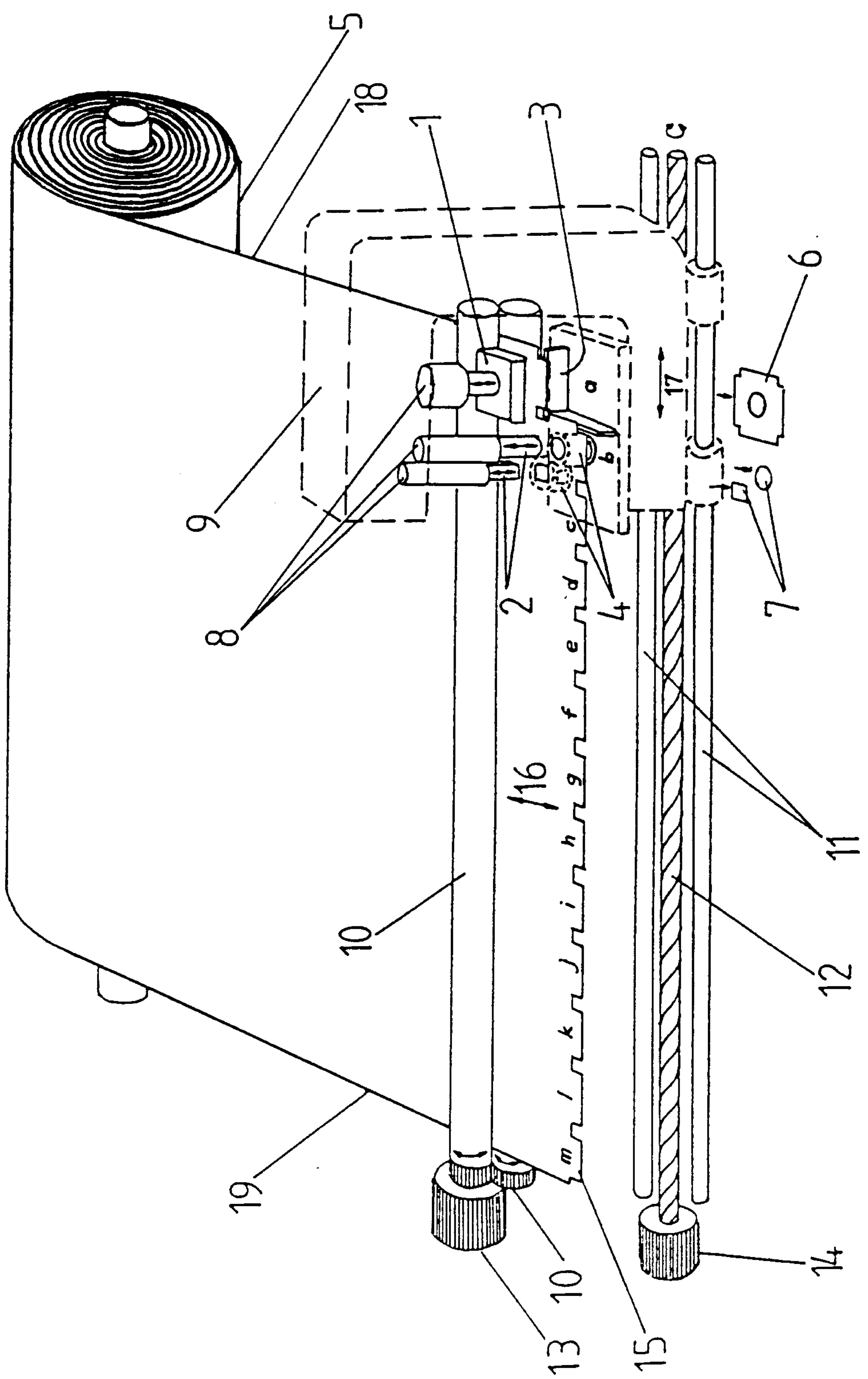

FIG.1

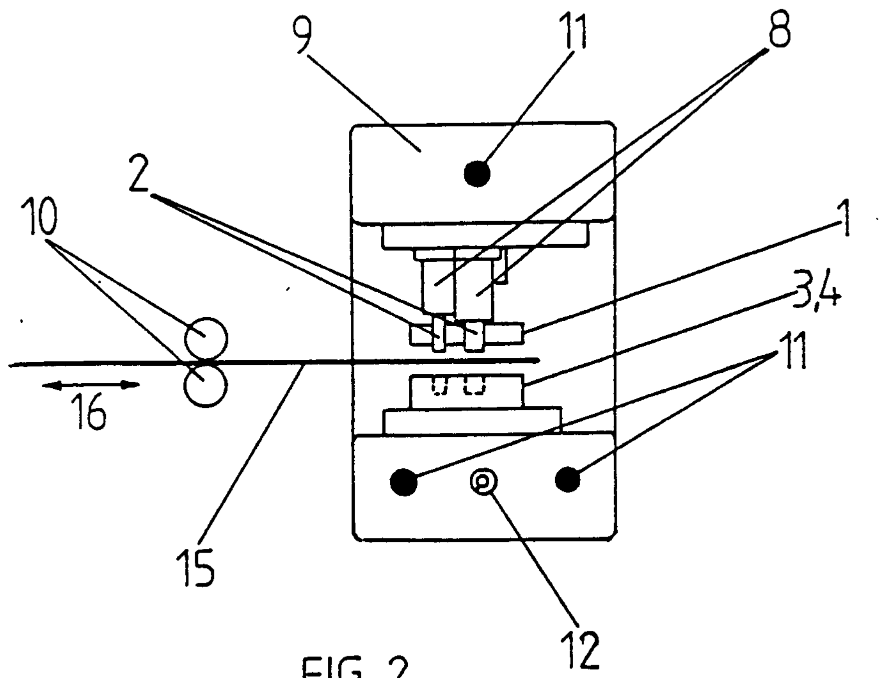

FIG. 2

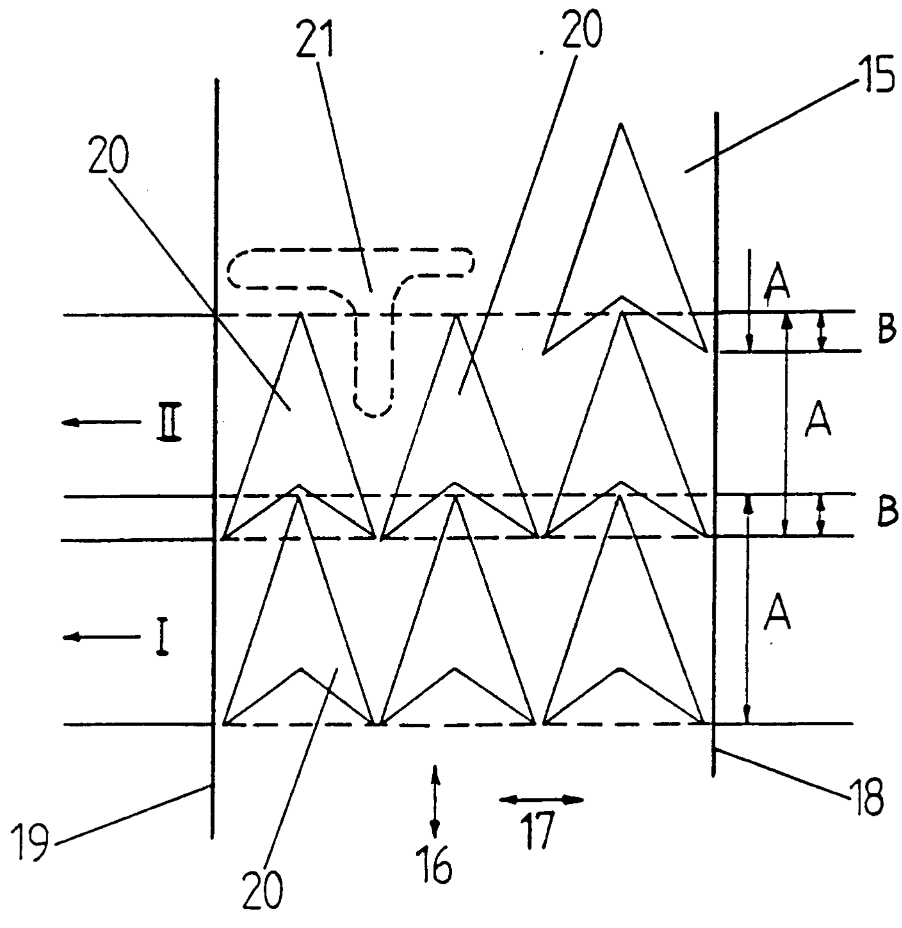

FIG. 3

FIG. 4

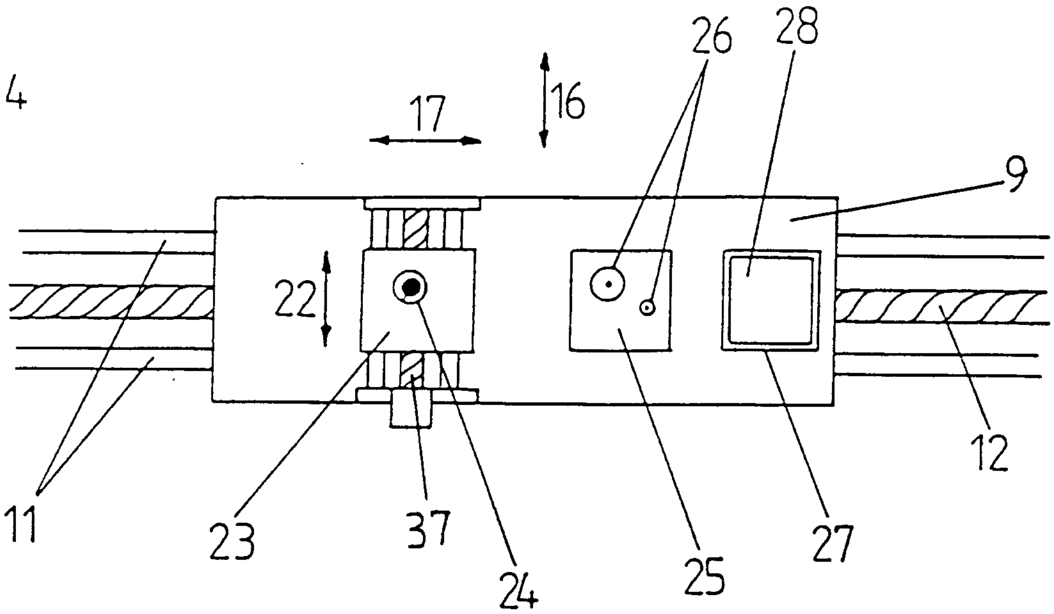

FIG. 5

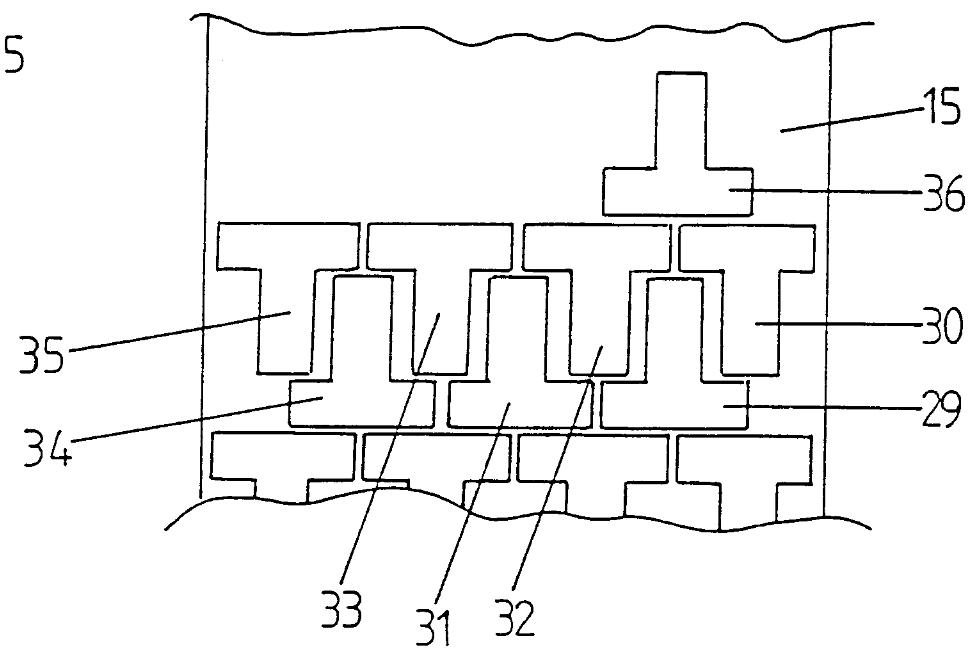

FIG. 6