

[54] **APPARATUS FOR THE PRODUCTION OF REINFORCEMENT**

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[51] Int. Cl..... **B23k 37/00**

[58] Field of Search 228/4, 5, 15; 29/34 D; 140/112

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[57] **ABSTRACT**

A reinforcement for concrete ceilings, concrete walls and the like is produced by providing first a reinforcing mat from longitudinal reinforcing bars and groupwise disposed transverse reinforcing bars. In one or more spaced rows of meshes of the mat which extend parallel to the longitudinal reinforcing bars, the transverse bars of each group in such mesh rows are bent apart in directions obliquely to the plane of the mat and simultaneously flexed V-wise in such a way that the bent and flexed transverse bars meet each other again groupwise at their flex apexes, so as to form a row of protruding pyramids instead of each of these mesh rows. Thereupon, the summits of the pyramids are interconnected by means of a straight individual bar to form a protruding lattice girder. The apparatus for producing such reinforcement comprises pairwise supporting means to receive and support the reinforcing mat, pairwise securing means cooperating with the supporting means for holding the mat, bending means for simultaneously bending apart and V-wise flexing the transverse bars of a row of meshes, transport means for handling a straight individual bar, and welding means for welding the individual bar to the row of pyramids formed by bending and flexing the transverse bars of a row of meshes.

10 Claims, 8 Drawing Figures

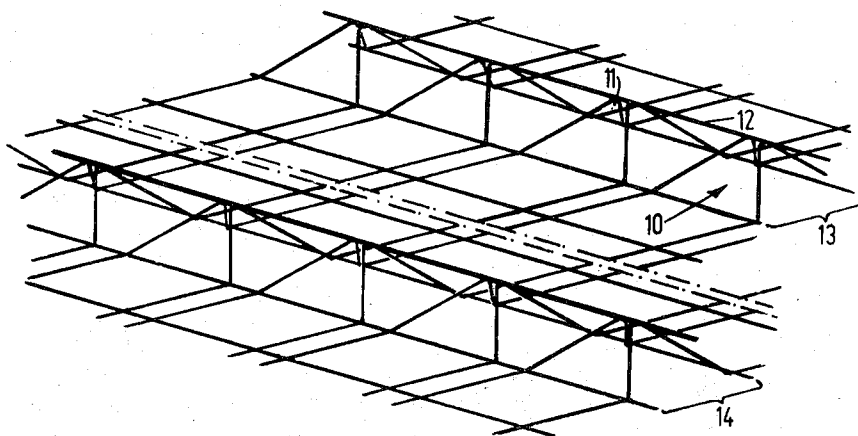


FIG. 1

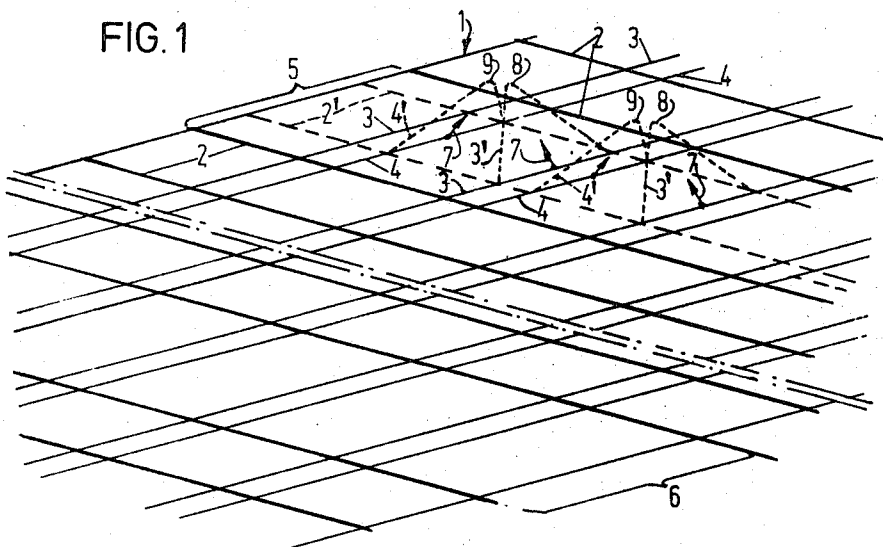
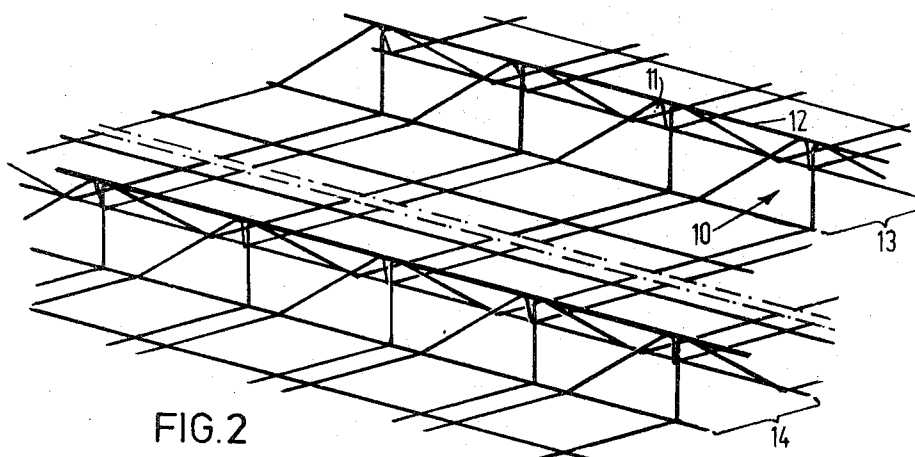


FIG. 2



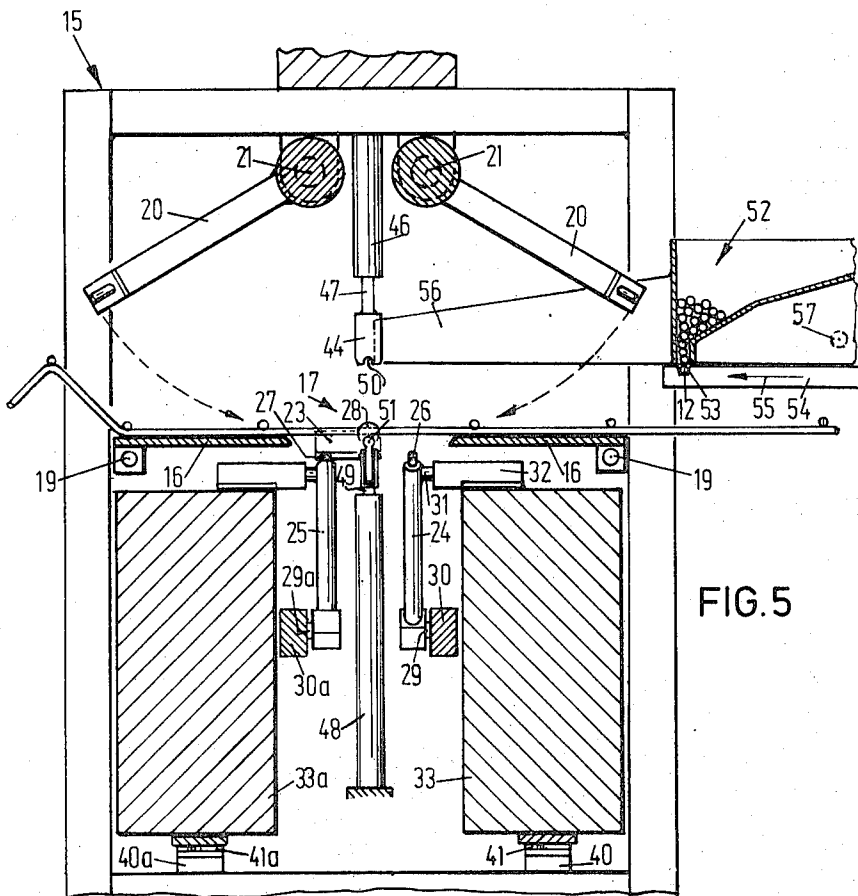


FIG. 5

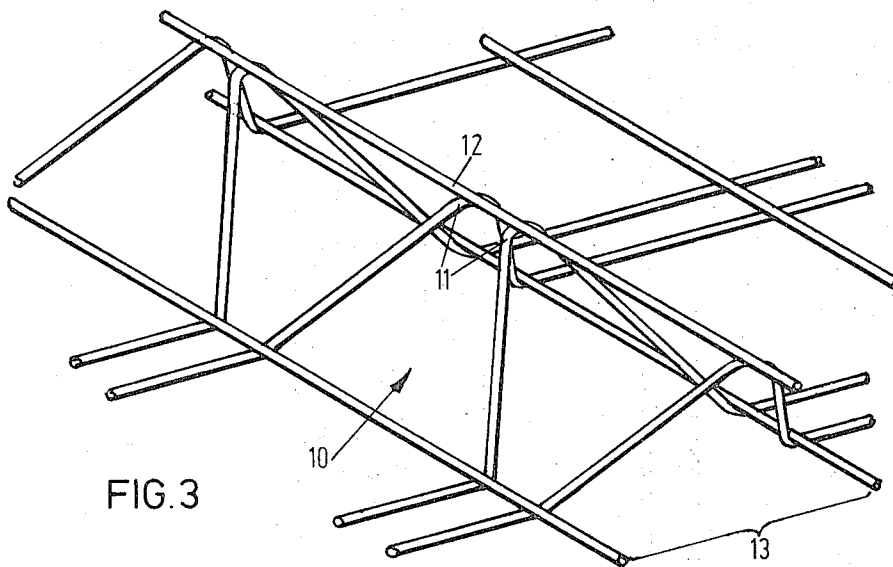
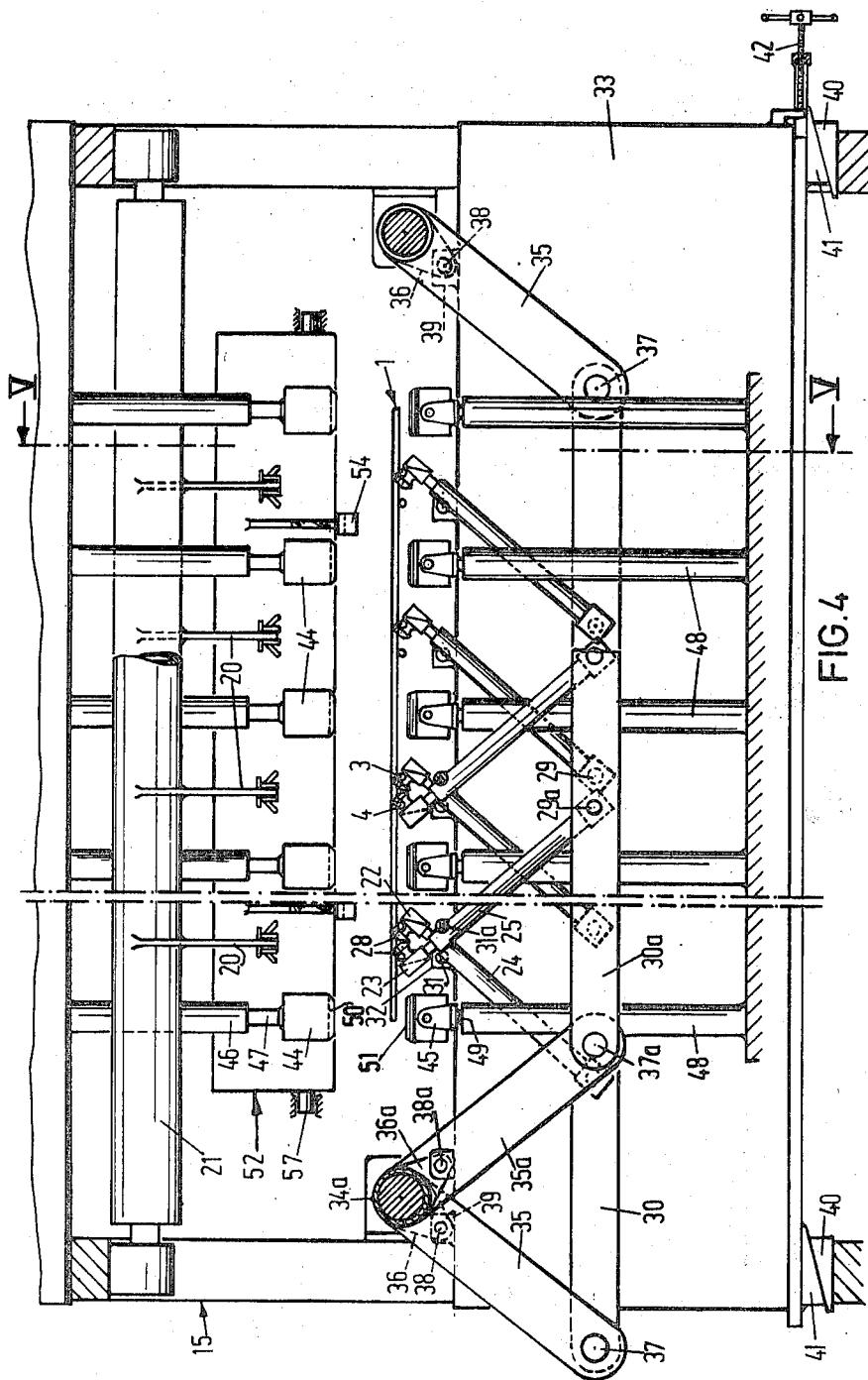
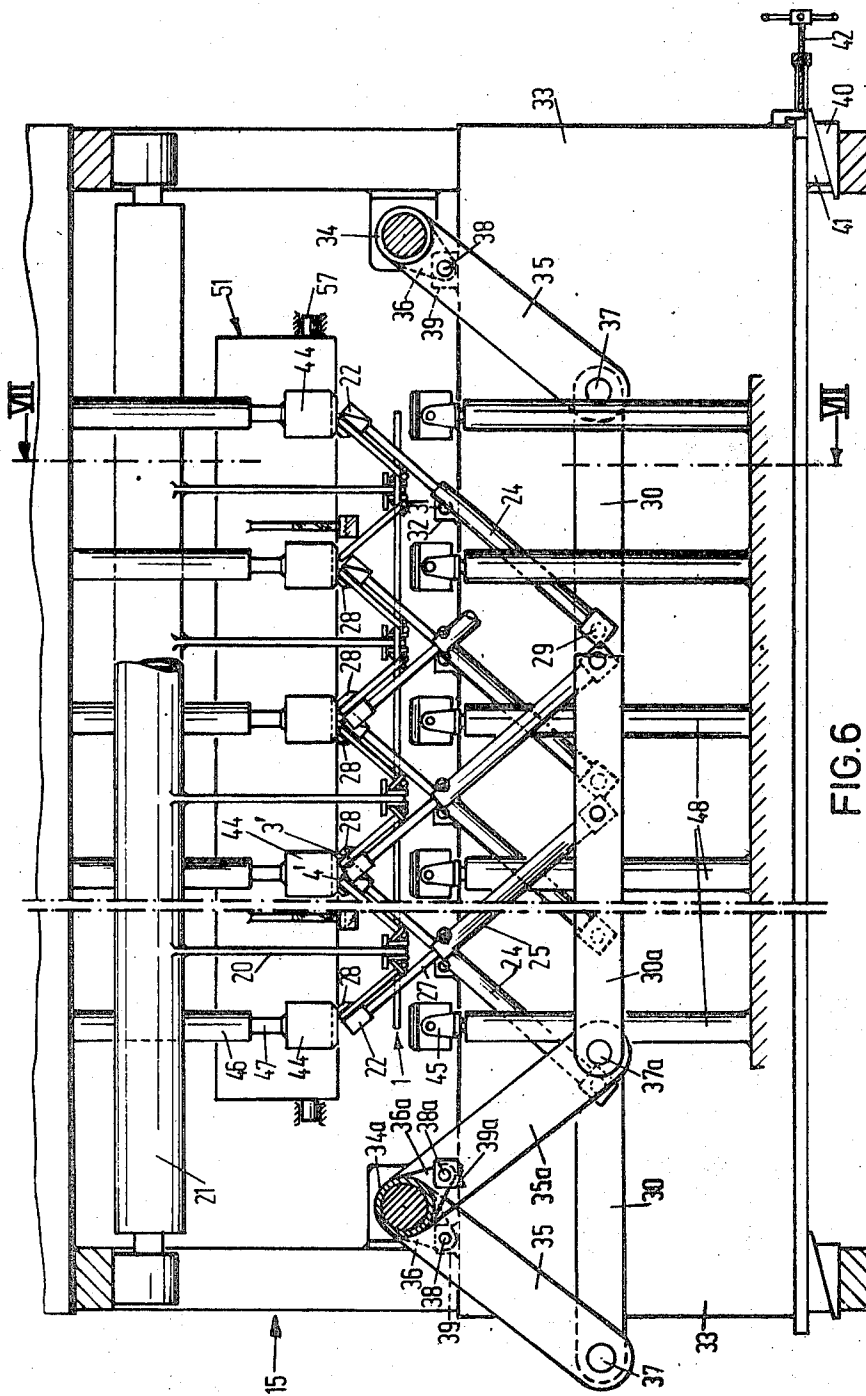


FIG. 3





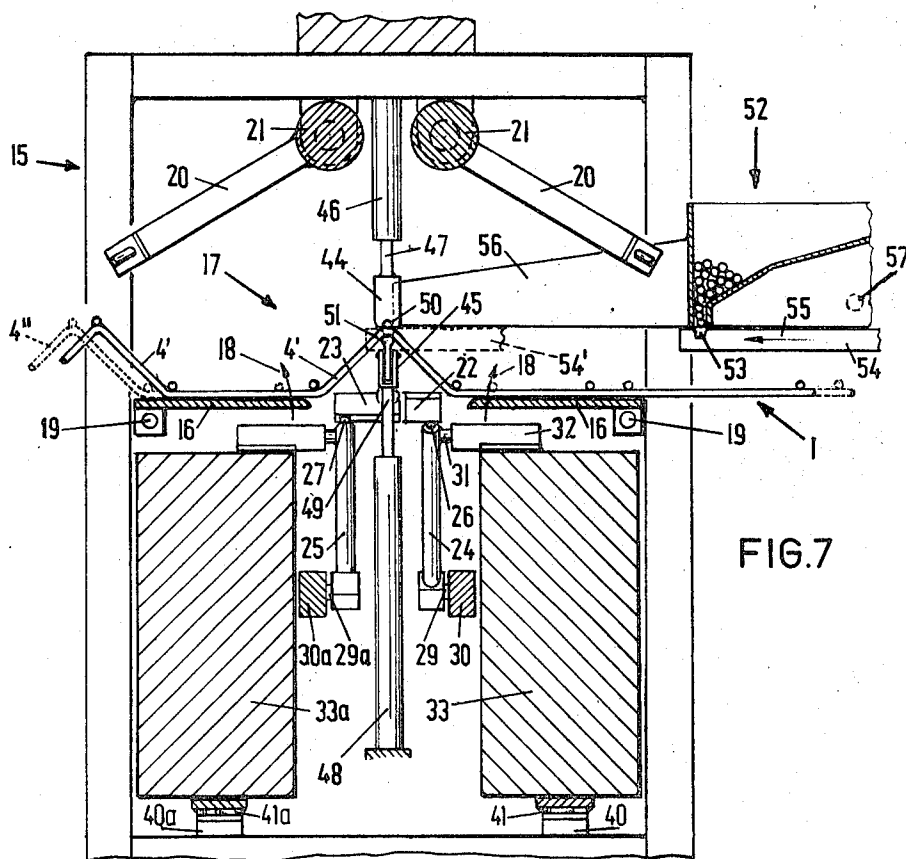


FIG. 7

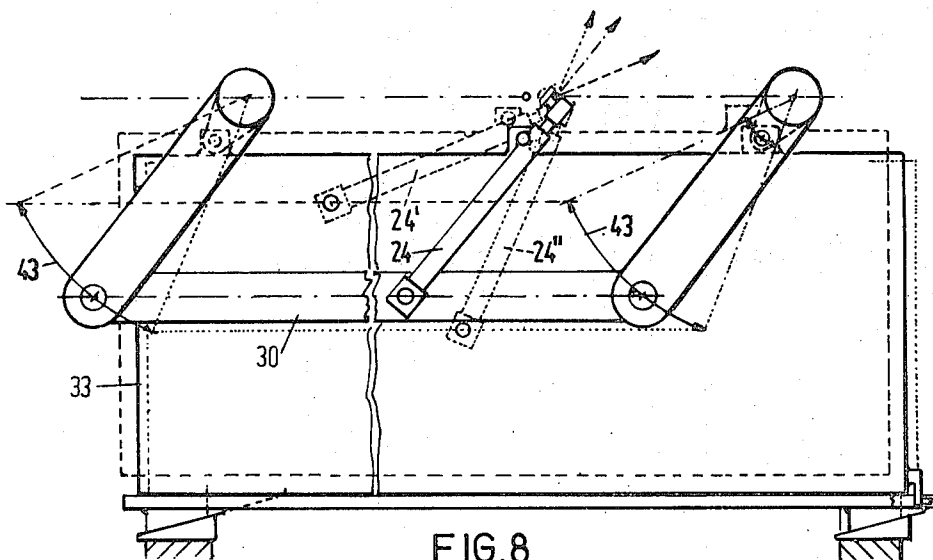


FIG. 8

APPARATUS FOR THE PRODUCTION OF REINFORCEMENT

This application for patent is a divisional from U.S. Pat. Ser. No. 226,175 filed Feb. 14, 1972 now U.S. Pat. No. 3,748,720.

This invention relates to a process and apparatus for the production of reinforcement for concrete ceilings, concrete walls and the like.

Prefabricated concrete slabs, having a reinforcement which is partially embedded in the slabs and partially protruding from one flat side of the slabs in the form of lattice girders, are frequently employed in the production of concrete ceilings. When such concrete slabs, correctly supported, have been placed in adjacent relationship, and, if desired, have been provided with interlinking reinforcement, a stratum of fresh concrete is disposed on top of the slabs, to embed the extending lattice girders of the reinforcement and to complete the slabs to form finished concrete ceilings. The slabs and concrete stratum are thus interconnected by the embedded lattice girders to form an integral body.

It is an object of the invention to provide a process and apparatus for the production of finished reinforcement for such concrete ceilings or slabs or for other concrete elements such as concrete walls and the like. Another object is to produce such finished reinforcement economically with inexpensive means and without any torsion of the component parts.

In an embodiment, the invented process of producing reinforcement for concrete ceilings, concrete walls and the like, comprises providing a reinforcing mat comprising longitudinal reinforcing bars and groupwise disposed transverse reinforcing bars; then, in one or more spaced rows of meshes of the mat which extend parallel to the longitudinal reinforcing bars, bending the transverse bars of each group of such mesh rows apart in directions obliquely to the plane of the mat but towards the same side of that plane, and simultaneously flexing the bent transverse bars V-wise in such a way that the bent and flexed transverse bars meet each other again groupwise at their flex apexes, so as to form a row of protruding pyramids instead of each of these mesh rows; and thereupon interconnecting the summits of the pyramids by means of a straight individual bar to form a protruding lattice girder.

In this way, starting from a flat reinforcing mat, it is easily possible to obtain a reinforcement system having flat parts and protruding parts (lattice girders), which reinforcement is particularly suited for use in slabs for concrete ceilings, as already stated, and also suited for use in slabs for concrete walls and other concrete structures and parts thereof.

The invention further provides an apparatus to be used in performing the process according to the invention, said apparatus in an embodiment comprising pairwise supporting means to receive the reinforcing mat, pairwise securing means cooperating with the supporting means for holding the mat, bending means disposed between each pair of supporting means and engageable and disengageable in directions inclined to the bearing surface thereof for simultaneously bending apart and V-wise flexing the transverse bars of a row of meshes, transport means for handling a straight individual bar, and welding means disposed between each pair of supporting means and engageable and disengageable perpendicularly to the bearing surface thereof for welding

the individual bar to the row of pyramids formed by bending apart and flexing the transverse bars of a row of meshes.

By means of this apparatus, which may be so contrived as to deal with one row of meshes or with several rows of meshes simultaneously, the process according to the invention can be performed in a simple manner.

The invention will be explained with reference to the accompanying drawings which are given by way of example and in which:

FIGS. 1 and 2 show an embodiment of the various stages of manufacture in the process according to the invention,

FIG. 3 shows the finished product (in isometric projection),

FIGS. 4 and 6 show an embodiment of the apparatus according to the invention in two different working positions (in front elevation and in partial cross-section).

FIGS. 5 and 7 are sections made along the lines V—V and VII—VII in FIGS. 4 and 6 respectively,

FIG. 8 schematically shows the various possible settings of the apparatus.

In the embodiment of the invented process illustrated in FIGS. 1 and 2, the starting material is a flat reinforcing mat (FIG. 1) comprising longitudinal reinforcing bars 2 and double transverse reinforcing bars 3,4. This reinforcing mat may be manufactured in any desired manner, e.g., by spot-welding or by plaiting. The longitudinal bars 2 are of limited length, but the length of the transverse bars 3,4 is not limited, so that continuous manufacture and processing is possible. Most of the meshes of the reinforcing mat are of normal length and width, but in some mesh rows 5,6 spaced apart from each other for some distance and extending parallel to the longitudinal bars 2, the meshes are formed with a larger width as viewed in the direction of the transverse bars 3,4.

To explain the process, only the mesh row 5 will at first be considered in the following description. In the first stage of the process, all the double transverse bars of the mesh row 5 are bent apart in the direction of the arrows 7, which are inclined in relation to the plane of the mat but all pointing to the same side thereof, and are also flexed V-wise. This bending and flexing step is continued until the bent and flexed transverse bars 3,4 have reached the positions 3',4' shown in dotted lines (FIG. 1), in which they meet one another again in groups of two at their flexed apexes 8,9, but in a different combination. In other words: the flexed apex 8 of the transverse bar 3' meets the flexed apex 9 of the transverse bar 4' of an adjacent mesh on one side, and the flexed apex 9 of the transverse bar 4' (initially close beside said bar 3') meets the flexed apex 8 of the transverse bar 3' of an adjacent mesh on the other side. As a result of this bending and flexing step the boundary bars 2 of the mesh row 5 come closer together until they are in the dotted position 2' and thus form a mesh row having the same width as the other rows of meshes.

After this bending and flexing step, the transverse bars 3',4' from a row of protruding pyramids 10 (FIG. 2). The reinforcement is then completed by interconnection of the summits 11 of these pyramids 10 by means of an individual straight bar 12 to form a pro-

truding lattice girder 13. The individual bar can, for example, have a round or a profiled cross-section.

Simultaneously with the mesh row 5 the mesh row 6 has, as shown in FIG. 2, undergone the same stages of processing, so that there, too, a protruding lattice girder 14 has been formed.

In FIG. 3 the lattice girder 13 with some adjacent parts is shown again, in isometric projection. As appears from this figure, the individual bar 12 is disposed over the summits 11 of the pyramids 10 and is there connected to the pyramids, e.g., by spot-welding.

Obviously, many variants of the process described are possible within the scope of the invention. Thus the transverse bars in the reinforcing mat need not necessarily be present in a double arrangement, but may instead also be disposed in groups of three or more. Instead of performing the process on the mesh rows 5 and 6 simultaneously, these mesh rows can be dealt with consecutively. The bending and flexing operation need not always be obliquely upward, as illustrated, but may also just as successfully be obliquely downward. The individual bar 12 may be disposed under, instead of upon, the summit 11 and be welded there.

For most purposes the resulting final product has adequate strength in the direction of the transverse bars. If additional bracing is desired, however, then additional transverse bars may be disposed at the base of the lattice girders and may, if necessary, be connected to the longitudinal bars, or else a complete second reinforcing mat can be added.

The process according to the invention may be performed by various means. An apparatus whereby the whole process can be performed in a two-step operation is illustrated in FIGS. 4 to 7, while the possible settings of the apparatus are further explained with reference to FIG. 8.

The apparatus shown comprises bending means and also welding means disposed in a common frame 15. Two bearing plates 16,16 (FIG. 5) for the reinforcing mat are pivotably attached to the frame 15 at about mid-height thereof and have between them a working gap 17 (FIG. 5) of sufficient width to enable the various bending and welding means (to be described) to engage and disengage with a reinforcing mat supported by plates 16,16.

The plates are pivotably attached in such a manner that they may be swung upward from their normal horizontal position by a small angular distance in the direction of the arrows 18,18 (FIG. 7), the pivot shafts 19,19 being the centres of rotation.

Above the bearing plates 16,16 are two groups of securing devices 20,20 disposed pairwise opposite one another and each attached to a shaft 21,21 connected rotatably to the frame 15. As a result of rotation of the shafts 21,21 by means of a common drive (not shown) these securing devices 20,20 can all be swivelled simultaneously into and out of contact with the bearing plates 16,16 under them, so as to grip or release the reinforcing mat laid on the plates and to leave the region of the working gap 17 always unobstructed. The active end of each securing device 20,20 is so formed that it can engage simultaneously with two (or more) transverse bars disposed side by side in the reinforcing mat (FIG. 6).

Under the bearing plates 16,16 are two groups of bending punches 22,23 which can each be moved up and down obliquely in relation to the horizontal plane

of the bearing plates 16,16 by means of a group of parallel hydraulic cylinders 24,25 and parallel piston rods 26,27, this movement being performed by the bending punches all simultaneously, but in two intersecting directions. The movement of the bending punches 22,23 is so controlled that they are completely engageable, through the working gap 17, into the vicinity of a reinforcing mat disposed on the bearing plates 16,16 and are also completely disengageable therefrom. Moreover, the movement is so controlled that the bending punches of the one and of the other group (22 and 23) meet each other in pairs in the engaged position (FIG. 6) and also in pairs in the disengaged position (FIG. 4), but in a different combination. Each bending punch is provided with two studs 28 for engaging with a transverse bar of the reinforcing mat, and all the studs 28 are so disposed that, as seen in section in FIGS. 5 and 7, they are always one behind the other in a straight line about mid-way between the two groups of hydraulic cylinders 24,25.

In order to make the apparatus according to the invention suitable for dealing with many different kinds of reinforcing mat, the angle of inclination of the two hydraulic cylinder groups 24 and 25 is adjustable. To explain this adjustability the hydraulic group 24 will first be considered. The cylinders in this group are all pivotably attached at the bottom (at 29) to a connecting rod 30 and are all pivotably attached at the top (at 31) to projections 32 on a counterweight beam 33.

Further, there are two paired lever systems, each comprising a shaft bushing 34,34 and two levers 35,35 and 36,36 rigidly connected to the bushing. The levers are each pivotably connected (at 37,37) to one end of the connecting rod 30 and are also pivotably connected (at 38,38) to other projections 39,39 at each end of the counterweight beam 33.

The counterweight beam is supported at each end on the ground through a set of folding wedges 40,40 and 41,41 which are simultaneously movable by means of a screw spindle 42.

By actuation of the screw spindle 42 the wedges 40,40 and 41,41 can be moved inwards or outwards in relation to each other, so that the counterweight beam 33 can, as shown in FIG. 8 be moved from the position shown in full lines to a position shown in dotted or dashed lines while always remaining horizontal. Since the connecting rod 30 is connected rigidly to the counterweight beam 33 by the two lever systems, this connecting rod, too, is then shifted to a position as shown in dotted or dashed lines, while remaining horizontal, and in consequence thereof each hydraulic cylinder 24 is swivelled to the position 24' or to the position 24''. In this way the hydraulic cylinder 24 can be set to almost any desired position. The range of adjustment is indicated by arrows 43,43 in FIG. 8.

Just like the hydraulic cylinder group 24 the hydraulic cylinder group 25 is also adjustable in a similar manner, by means of a connecting rod 30a, a counterweight beam 33a, two paired lever systems 34a, 35a, 36a, two sets of folding wedges 40a, 41a, etc. Corresponding parts have been given corresponding reference numbers.

Finally, the stroke of the piston rods 26,27 is adjustable since the bending punches 22,23 must meet each other in pairs in the engaged position.

The apparatus described comprises two groups of welding heads 44,45, disposed pairwise and co-

operating with one another, for connecting a straight individual bar by spot-welding to the parts of the reinforcing mat which have been bent by the bending punches 22,23. The top welding heads 44 are above the bearing plates 16,16 and each about mid-way between two pairs of securing devices (FIGS. 4 and 3). They are all so adjustable simultaneously in the vertical direction by means of hydraulic cylinders 46 and piston rods 47 that they can meet the bending punches 22 and 23 in the engaged position thereof when the apparatus is in operation (FIG. 6). The bottom welding heads 45 are below the bearing plates 16,16 and vertically below the top welding heads 44 and can all be moved vertically up and down simultaneously by means of hydraulic cylinders 48 and piston rods 49. The movement of the bottom welding heads 45 is so controlled that they are completely engageable, through the working gap 17, into the vicinity of the top welding heads 44 and are also completely disengageable therefrom. In this way, the top and bottom welding heads 44 and 45 meet one another in pairs in the engaged position and can act upon the intermediately disposed parts of a reinforcement to be processed (individual bar and bent parts of the reinforcing mat). The stroke of the piston rods 49 is adjustable to suit different heights of the top welding heads 44.

The top welding heads 44 and the bottom welding heads 45 are of rather wide construction (FIG. 4) in order to ensure that they can always act on the parts of the mat which have been bent by the bending punches 22,23 whatever the angle of inclination of the hydraulic cylinder groups 24,25 may be.

For adaptation to the shape of the parts to be connected each top welding head 44 is formed at its active end with a groove 50 and each bottom welding head 45 is formed at its active end with a roll-like enlargement 51. Furthermore the welding heads 44,45 have electrical connections (not shown) whereby they can all be heated simultaneously.

A container 52 for the individual bars to be welded is disposed on the feed side of the apparatus (FIGS. 5 and 7) and is so formed that the individual bars 12 can be dispensed only one at a time. Under the container 52 are disposed some slides 54, each comprising a groove 53 for receiving the individual bar thus dispensed. These slides can be moved forward in the arrowed direction 55 by means of a drive (not shown) until they reach the position 54' (shown dotted in FIG. 7) in the vicinity of the top welding heads 44 and can then, after delivering the individual bar, be moved back to the original position. Also, the container 52 is provided with supports 56 which extend into the vicinity of the top welding heads 44 and prevent the individual bar from falling when the slides 54 are moved back. For adjustment to suit different heights of the top welding heads 44 the container 52, together with the slides 54 and the supports 56, are adjustable to various angular positions about a shaft 57.

The apparatus described functions as follows:

Before starting operations, the angle of inclination of the hydraulic cylinder groups 24,25, the stroke of the piston rods 26,27, the height of the top welding heads 44, the stroke of the piston rods 49 and the angular position of the container 52 are set to the desired values.

The securing devices 20,20 are in their top and swung-apart position (FIG. 5), the bending punches

22,23 in their disengaged position (FIG. 4), and the bottom welding heads 45 also in their disengaged position (FIG. 4).

A reinforcing mat, e.g. as shown in FIG. 1, is disposed in the apparatus and is, for example, pulled from right to left (in FIG. 5) over the bearing plates 16,16 until a row of meshes of greater width than normal, e.g. the row 5, is accurately over the working gap 17. Accurate positioning at this point can be ensured by means of stops (not shown). Next, the securing devices 20,20 are swung down (FIG. 5) until they touch the reinforcing mat on the bearing plates 16,16 and grip this mat by each engaging with a double transverse bar 4.

The first step of the production process starts when the two groups of bending punches 22 and 23 are engaged, through the working gap 17, into the vicinity of the reinforcing mat. The studs 28 on the bending punches 22,23 engage with the double transverse bar 3,4 of the mesh row 5 and these punches then move upward in two intersecting directions, inclined in relation to the plane of the mat, so that they bend these transverse bars 3,4 apart and also flex them V-wise. When the bending punches 22,23 have reached their fully engaged position, they meet each other in pairs, and the bent transverse bars 3',4' also again meet each other in pairs, but in a combination different from before. Furthermore these bent transverse bars 3',4' meet the top welding heads 44 adjusted to the appropriate height.

In consequence of the engaging movement of the bending punches 22,23 the width of the mesh row 5 decreases and the securing devices 20,20 are pulled closer together. Also, the leading part of the reinforcing mat is pulled back for some distance so that, for example, a previously bent part 4' of the bar 4 is shifted from the position 4'' drawn in dotted lines to the position 4' drawn in full lines (FIG. 7).

When the transverse bars 3,4 of the mesh row 5 have been sufficiently bent apart and flexed, the bending punches 22,23 are retracted from the vicinity of the reinforcing mat through the working gap 17 and are moved back to their completely disengaged position. Also, the securing devices 20,20 are swung away upwards and outwards. Then the slides 54 come into action and move an individual bar 12 forward until they reach the position 54', where the bar 12 is exactly under the welding heads 44 and over the summits 11 of the row of pyramids formed from the mesh row 5.

The second step of the production process starts when the bottom welding heads 45 are moved from their disengaged position through the working gap 17 of their engaged position in the vicinity of the top welding heads 44. The bottom welding heads 45 act upon the underside of the pyramid summits 11 which have been formed and lift these summits (with the individual bar 12 on them) until the individual bar has thus been lifted off its slides 54 and pressed into the grooves 50 in the top welding heads 44. In this operation the supports 56 prevent the individual bar 12 from falling. The slides 54 are moved back to their initial position.

Then the welding heads 44,45 are electrically heated, so that the individual bar is thereby welded to the row of pyramids and fixed to them.

After the welding of the individual bar, the bottom welding heads 45 are retracted through the working gap 17 to their fully disengaged position, while the welded product also subsides a little and is released by the top welding heads 45. The two bearing plates 16,16

are swung upwards by a small angular distance, so that the flexural stresses which have been formed in the reinforcing mat and could cause undesirable lifting of the flat parts thereof are compensated (FIG. 7). The mat can then be moved forward by such a distance that another row of meshes of more than normal width — e.g. row 6 — is disposed over the working gap 17, whereupon the various operating stages can be repeated. In this way, the protruding lattice girders of the final product (FIG. 2) can consecutively be formed.

After leaving the apparatus according to the invention the resulting product can be supplied commercially in sections of desired length or else in rolled form.

Although in FIGS. 4 to 7 only one pair of bearing plates 16,16 with associated securing devices 20,20 bending punches 22,23, welding heads 44,45 and one container 52 have been shown, a number of such units can of course be disposed side by side in the apparatus according to the invention, so that a number of mesh rows of one and the same reinforcing mat can be dealt with simultaneously. Also, the shape of the securing devices, bending punches, etc. need not necessarily be as illustrated. Other variants will be obvious to an expert in the art.

What I claim is:

1. In an apparatus for the production of reinforcement for concrete ceilings, concrete walls and the like, a combination of: pairs of supporting means defining a bearing surface for receiving and supporting a reinforcing mat which comprises longitudinal reinforcing bars and transverse reinforcing bars crossing each other in a single plane to define meshes of said mat; pairs of securing means cooperating with said supporting means for holding said mat on the bearing surface of said supporting means; bending means disposed between each pair of supporting means and engageable and disengageable in directions inclined to said bearing surface for simultaneously bending apart and V-wise flexing said transverse bars of a row of meshes of said reinforcing mat; transport means for handling a straight individual bar; and welding means disposed between each pair of supporting means and engageable and disengageable perpendicularly to said bearing surface of said supporting means for welding said individual bar to a row of pyramids formed by bending and flexing said transverse bars of a row of meshes of said reinforcing mat.

2. The apparatus as claimed in claim 1, in which said supporting means comprise bearing plates (16,16) which can be swung upward by a small angular distance.

3. The apparatus as claimed in claim 1, in which said

securing means are formed as two paired groups of securing devices (20,20) which cooperate with said supporting means and can be swivelled in relation thereto.

4. The apparatus as claimed in claim 1, in which said bending means comprise two groups of bending punches (22,23) which can each be engaged and disengaged obliquely in relation to the plane of said supporting means (16,16) by means of a group of parallel hydraulic cylinders (24,25) and parallel piston rods (26,27), but in two intersecting directions.

5. The apparatus as claimed in claim 1, in which said bending punches of one group (22) and those of the other group (23) meet each other in pairs in their fully disengaged position, and also again in pairs in their fully engaged position, but in a different combination.

6. The apparatus as claimed in claim 1, wherein said hydraulic cylinder groups (24 and 25) are, on the one hand, pivotably attached to a common connecting rod (30 and 30a) and are, on the other hand, pivotably attached to a counterweight beam (33 and 33a), and that said connecting rod (30 and 30a) and counterweight beam (33,33a) are rigidly interconnected by paired unequal-armed lever systems (34,35,36 and 34a,35a,36a), the position of said counterweight beam (33 and 33a) being movable by means of folding wedges.

7. The apparatus as claimed in claim 1, in which said transport means for delivering an individual bar comprise a container (52) and slides (54).

8. The apparatus as claimed in claim 1, in which said container (52) is angularly adjustable about a shaft (57).

9. The apparatus as claimed in claim 1, in which said welding means comprise two paired cooperating groups of welding heads (44,45), one group thereof being top welding heads (44) and being all adjustable simultaneously in vertical direction by means of parallel hydraulic cylinders (46) and parallel piston rods (47) and another group thereof being bottom welding heads (45) and being all engageable and disengageable simultaneously in the direction of said top welding heads (44) by means of parallel hydraulic cylinders (48) and parallel piston rods (49).

10. The apparatus as claimed in claim 1, in which each top welding head (44) is formed at its active end with a groove (50) and each bottom welding head (45) is formed at its active end with a roll-like enlargement (51).

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