United States Patent [19]

Versteeg

[11] **3,748,720**

[45] **July 31, 1973**

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

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[73] Assignee: **Imex A.G.,** Zurich, Switzerland

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[52] **U.S. Cl.** **29/471.3,** 29/471.1, 29/482, 52/648, 52/650, 52/664

[51] **Int. Cl.** **B23k 31/02**

[58] **Field of Search** 29/471.1, 471.3, 29/482, 475; 52/648, 650, 664

[56] **References Cited**

UNITED STATES PATENTS

2,140,283	12/1938	Faber	52/648 X
3,407,560	10/1968	Baumann	52/648 X
3,672,022	6/1972	York	52/664 X
3,705,473	12/1972	Rueda	52/650

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Assistant Examiner—Richard Bernard Lazarus
Attorney—John P. Snyder et al.

[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 simulatenously 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.

4 Claims, 8 Drawing Figures

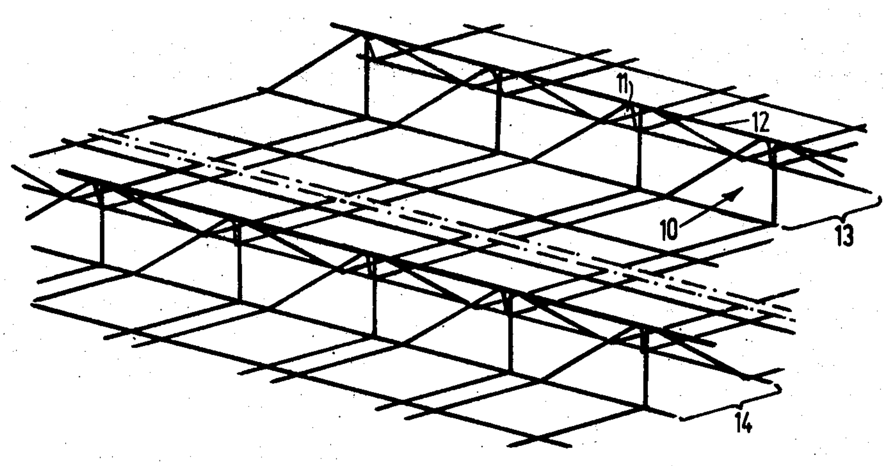
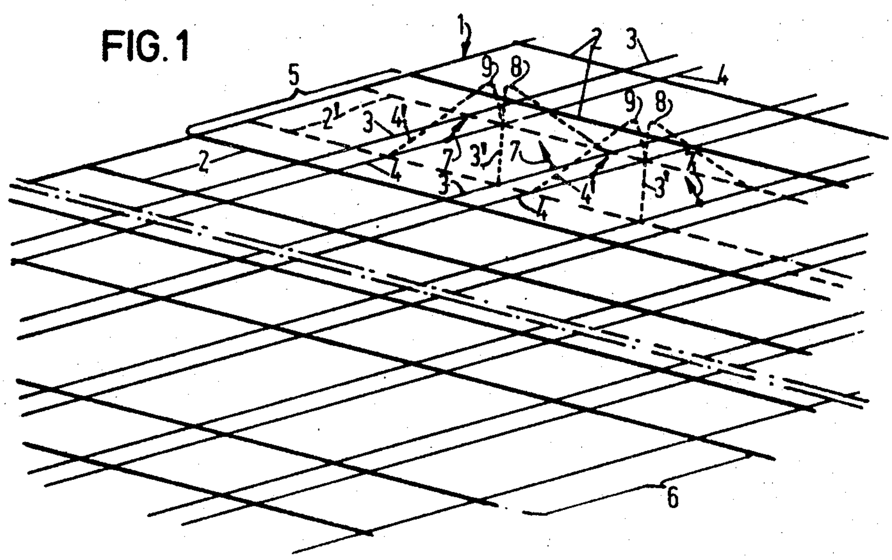


FIG. 1



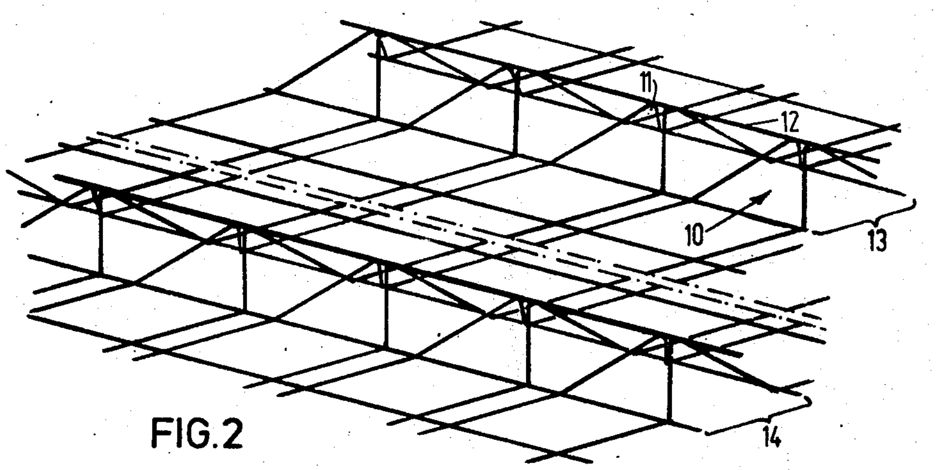
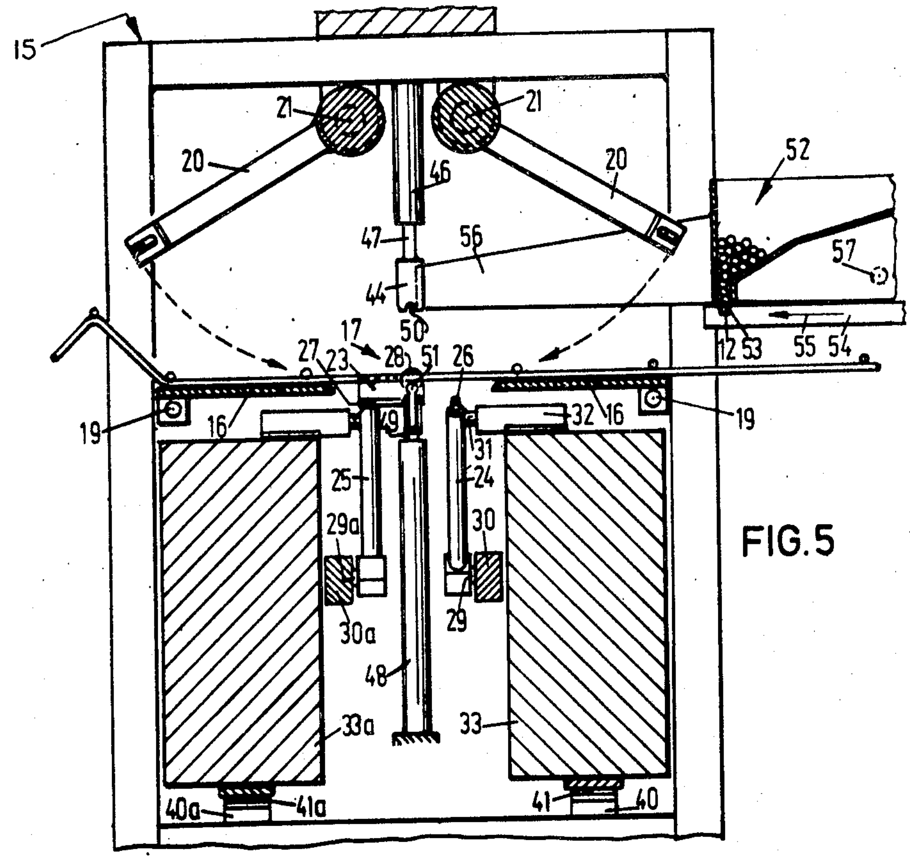


FIG. 2


15
21
21
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20
46
52
47
56
57
44
50
12 53
55 54
17
27 23
28 51 26
19
16
49
32 16
19
31
25
24
29a
30
30a
29
48
33a
33
40a
41a
41
40

FIG.5

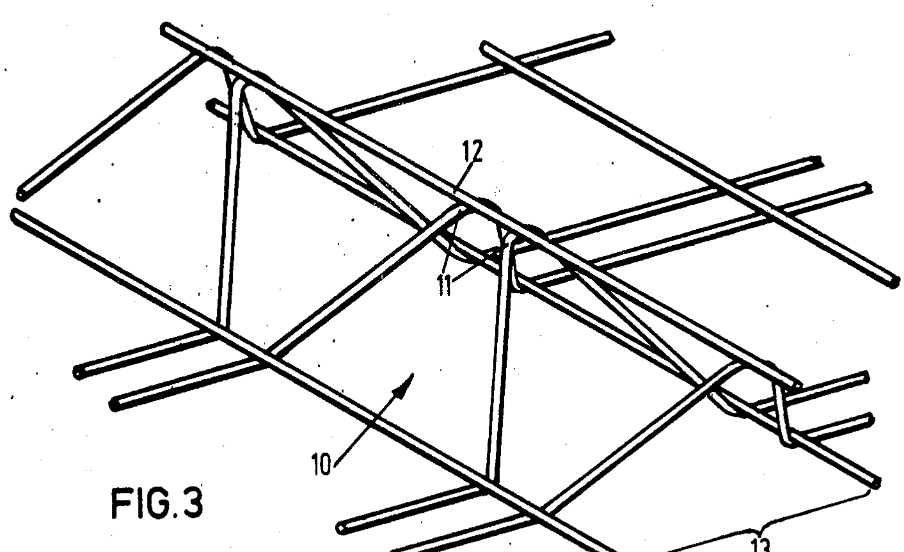
12
11
10
13

FIG.3

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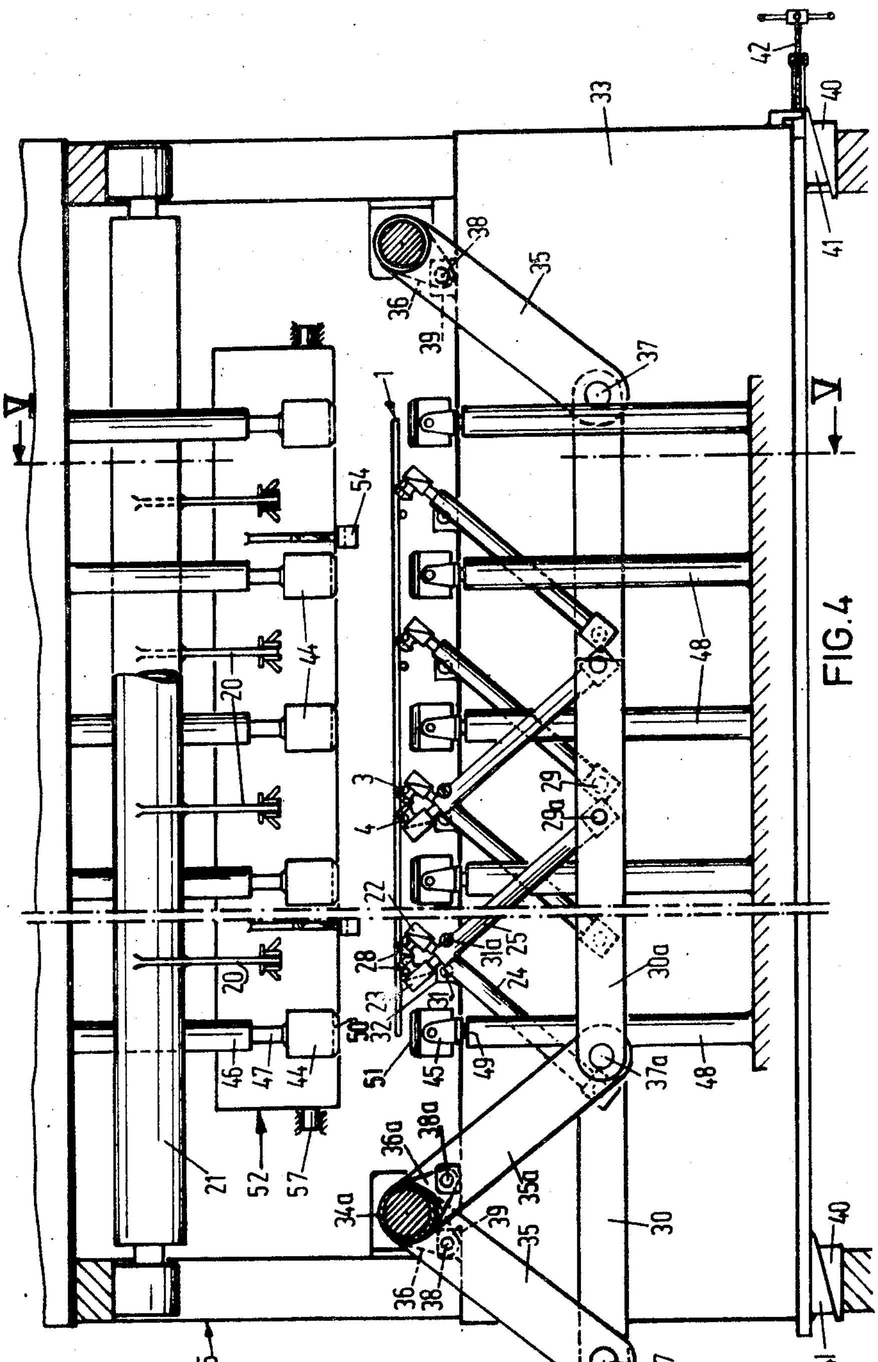

FIG. 4

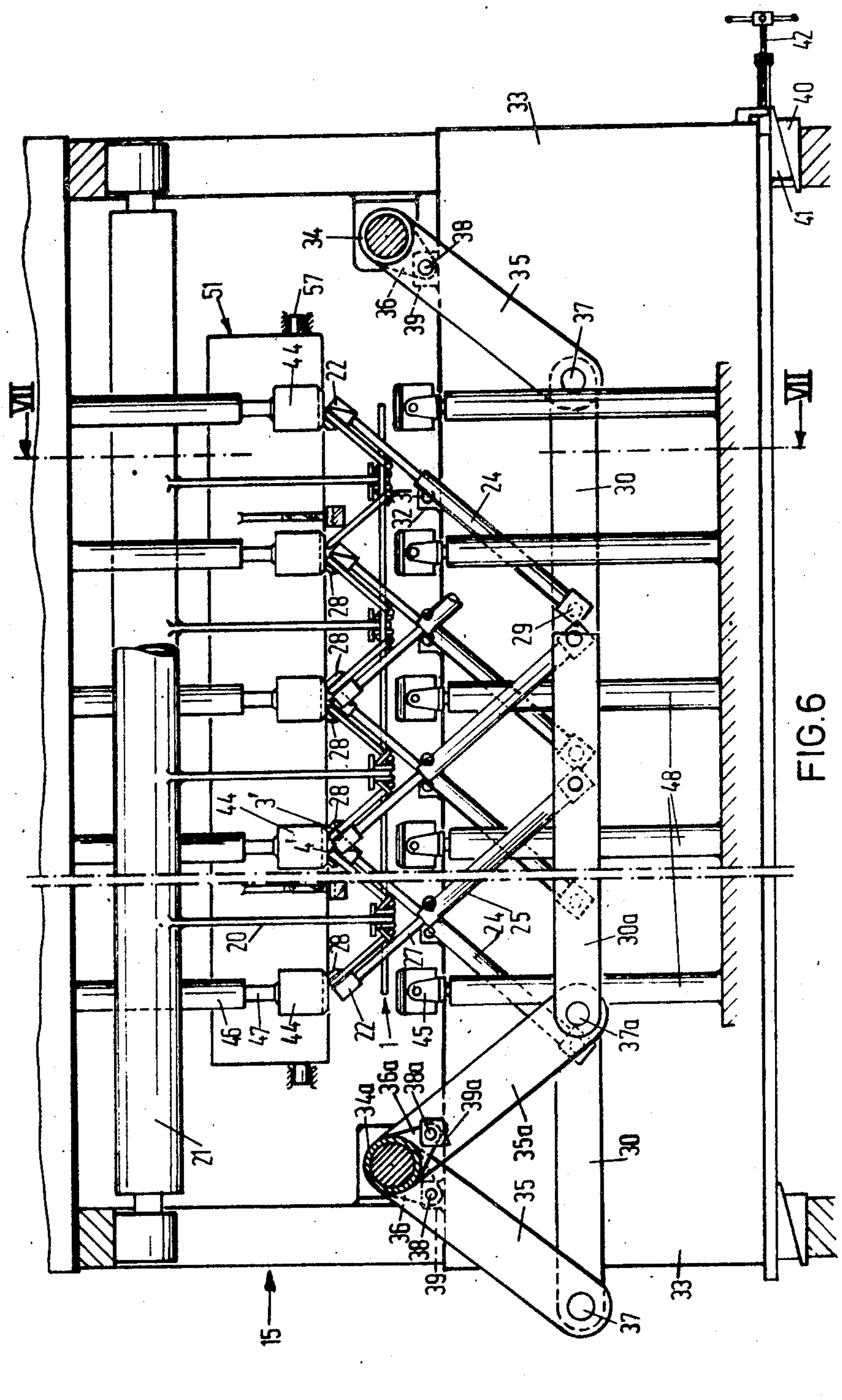
42
40
41
33
34
38
35
36
39
37
51
57
44
22
VII
30
24
32
29
28
3'
4'
4
25
30a
27
20
45
1
46
47
21
48
37a
34a
36a
38a
39a
35a
15

FIG.6

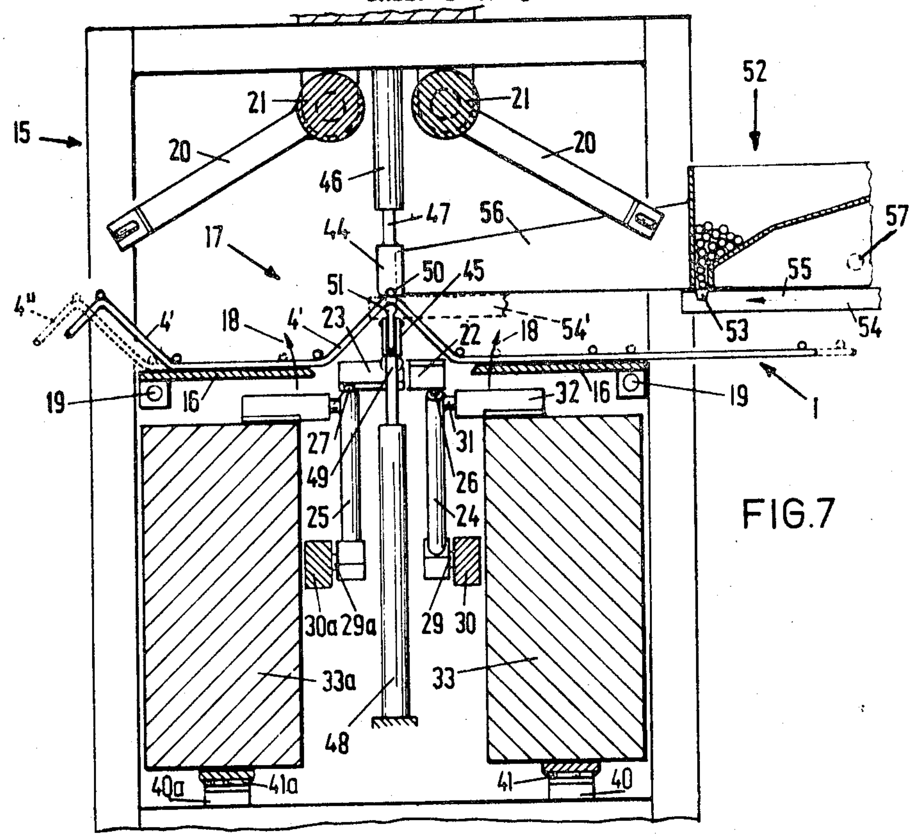
15
21
21
20
20
46
47
56
52
57
44
17
50
45
51
55
4"
4'
18
4'
23
22
18
54'
53
54
19
16
32
16
19
1
27
31
49
26
25
24
30a
29a
29
30
33a
33
48
40a
41a
41
40

FIG.7

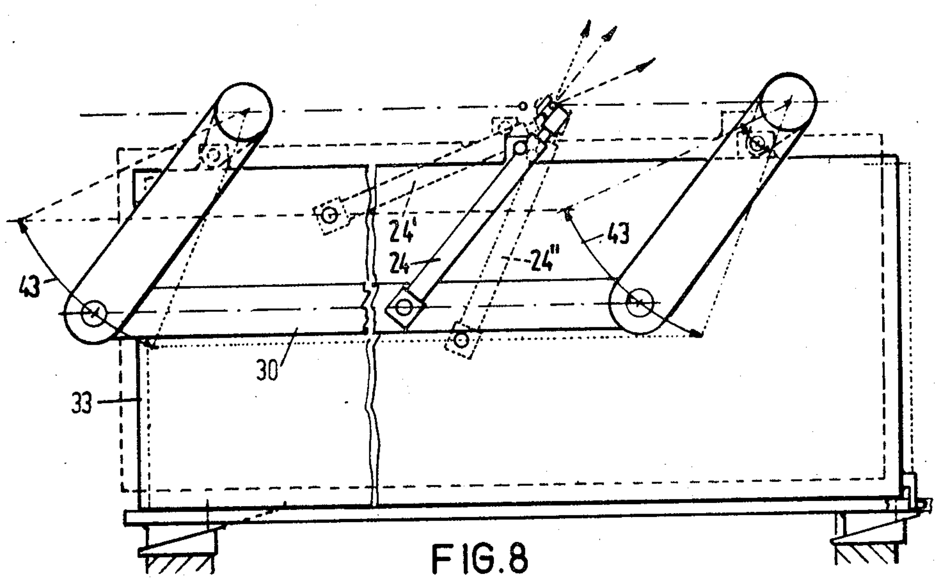
24'
43
24
24"
43
30
33

FIG.8

PROCESS FOR THE PRODUCTION OF REINFORCEMENT

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' form 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 protruding 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. pyramids, e.g., 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 cylinder group **24** will first be considered. The cylinders in the 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 counter-weight 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 **30*a*,** a counterweight beam **33*a*,** two paired lever systems **34*a*, 35*a*, 36*a*,** two sets of folding wedges **40*a*, 41*a*,** 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 cooperating 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** to 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. A process of producing reinforcement for concrete ceilings, concrete walls and the like, which comprises the following steps:

a. providing a reinforcing mat comprising adjacent pairs of parallel longitudinal reinforcing bars and groupwise disposed transverse reinforcing bars, said longitudinal and transverse bars being disposed in a single plane to define meshes of said mat with some of said pairs of said longitudinal bars being disposed at a selected normal spacing and other of said pairs of longitudinal bars being spaced further apart than said normal spacing;

b. bending the section of those transverse bars extending between said other pairs of longitudinal bars apart in directions obliquely to the plane of said mat but towards the same side of that plane and simultaneously flexing said sections of the transverse bars V-wise in such a way that apices of the bent and flexed transverse bar sections are grouped in closely spaced relation with the spacing between the bars of said other pairs of longitudinal bars being reduced substantially to said normal spacing, so as to form a row of protruding pyramids instead of each of said other pairs of longitudinal bars; and

c. interconnecting said pyramids at their summits by means of a straight individual bar to form a protruding lattice girder; the resulting product being a substantially flat reinforcing mat having protruding lattice girders.

2. The process as claimed in claim **1**, in which said individual bars have a round cross-section.

3. The process as claimed in claim **1**, in which said individual bars have a profiled cross-section.

4. The process as claimed in claim **1**, in which the various parts are joined by welding.

* * * * *