United States Patent [19]

Oroschakoff

[11] **3,744,207**

[45] **July 10, 1973**

[54] **REINFORCEMENT FOR REINFORCED CONCRETE STRUCTURES**

[76] Inventor: **Georgi Oroschakoff,** Simon-Denk-Gasse 7/7, Vienna, Austria

[22] Filed: **May 10, 1971**

[21] Appl. No.: **141,614**

[52] **U.S. Cl.** **52/664,** 52/650

[51] **Int. Cl.** **E04c 2/42,** E04c 5/00

[58] **Field of Search** 52/664–668, 646–653, 690, 691, 723

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Primary Examiner—Frank L. Abbott
Assistant Examiner—James L. Ridgill, Jr.
Attorney—Karl F. Ross

[57] **ABSTRACT**

Reinforcing sections which are two-dimensional or angled and/or C-shaped can be non-positively connected at least in pairs to form self-supporting reinforcements which have any desired shape and are rigid and resist tension and compression. The sections are connected by causing them to extend one into the other, hooking one onto the other and snapping one onto the other.

12 Claims, 88 Drawing Figures

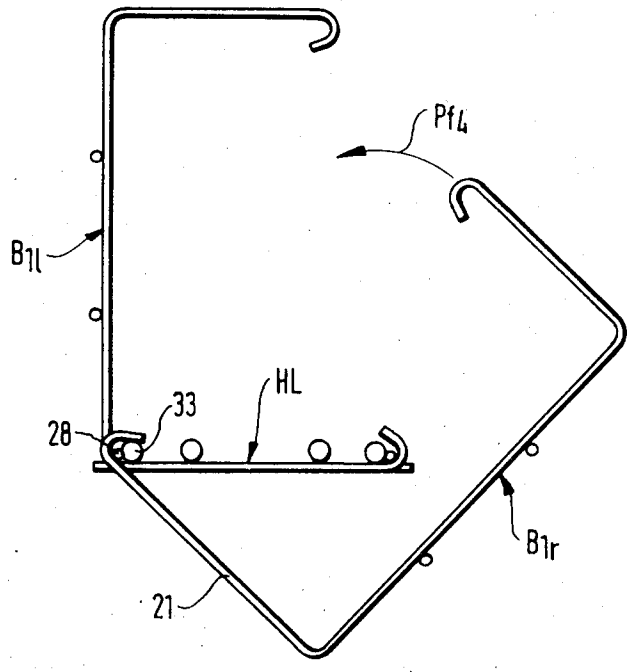


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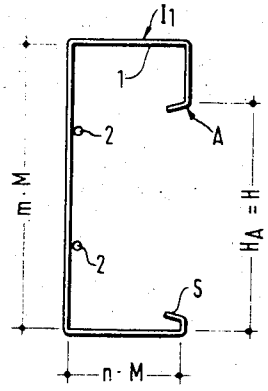
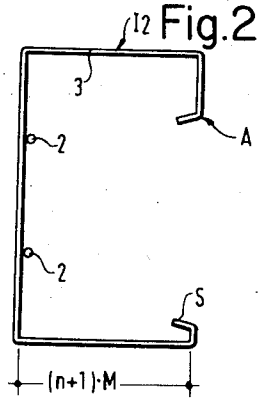


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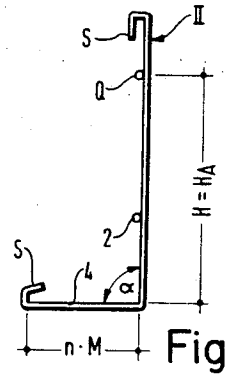


Fig.3

Fig. 4

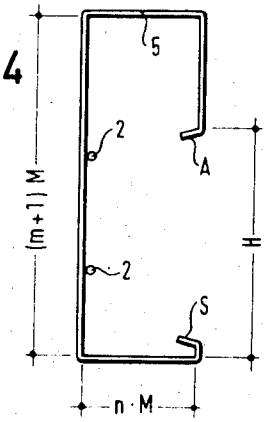


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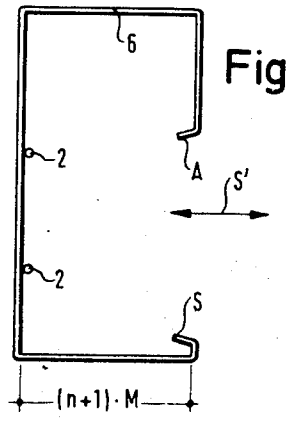
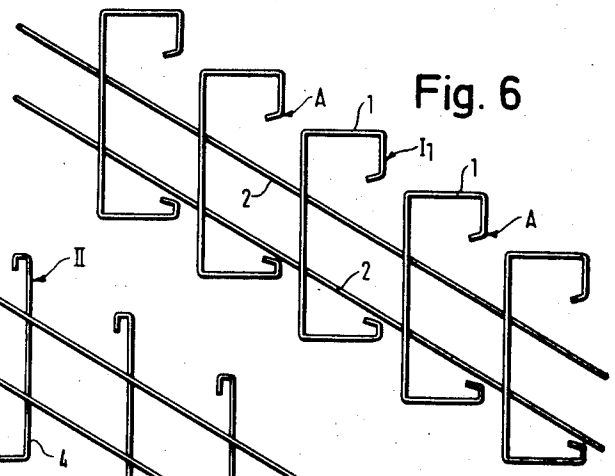


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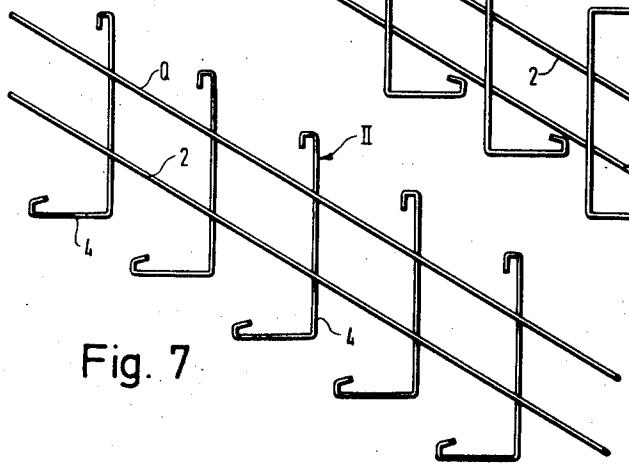


Fig. 7

Georgi OROSCHAKOFF

INVENTOR:

Karl F. Ross

Fig. 8

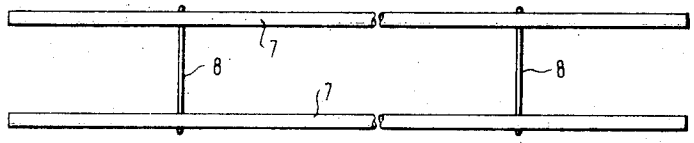


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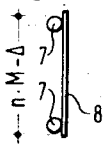


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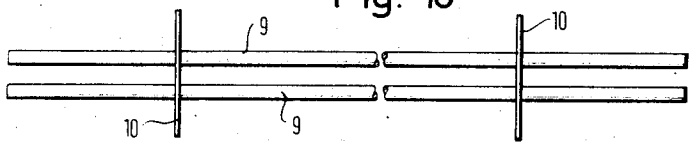


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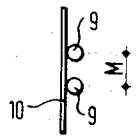


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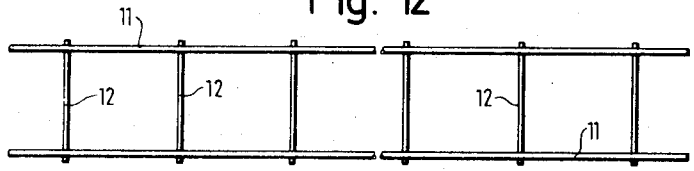


Fig. 13



Fig. 14

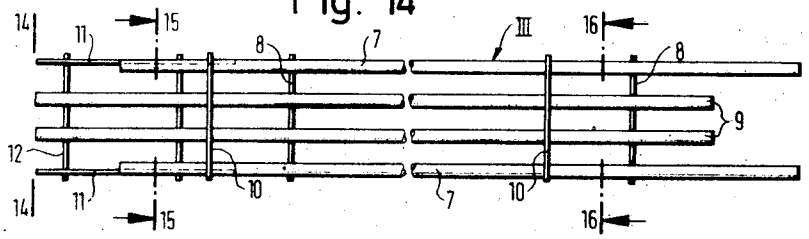


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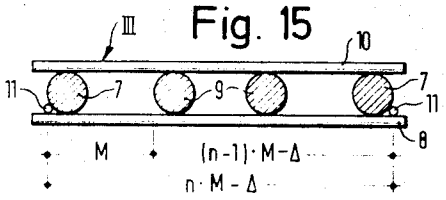


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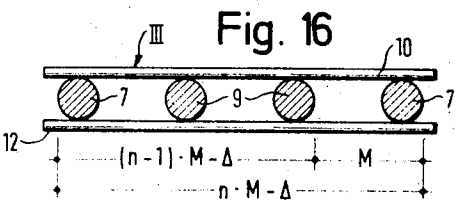
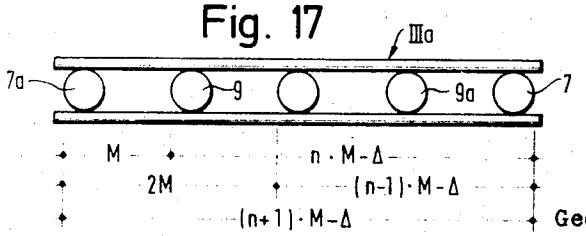


Fig. 17



Georgi OROSCHAKOFF
INVENTOR:

Karl F. Ross
BY:
Attorney

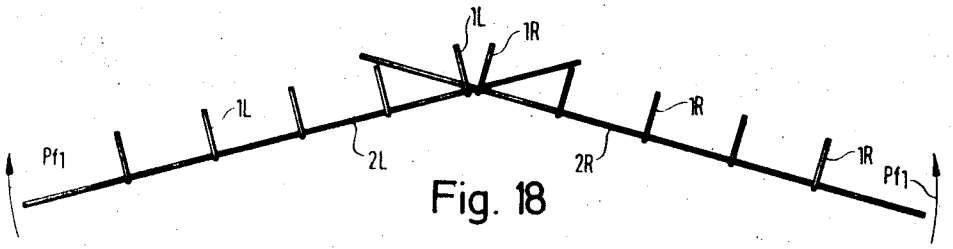


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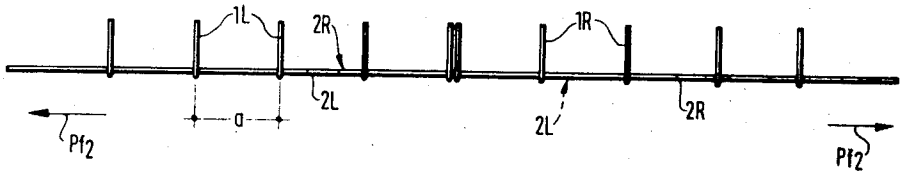


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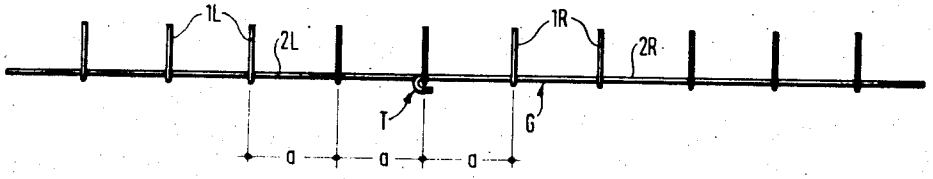


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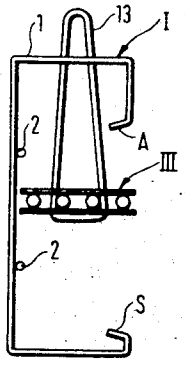


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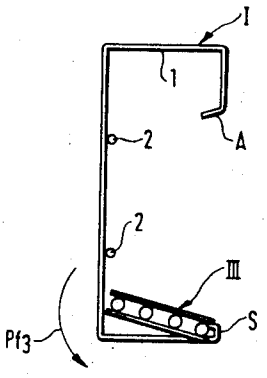
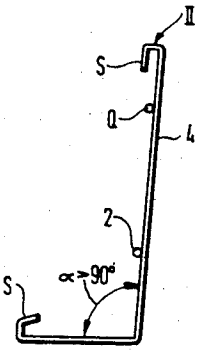


Fig. 23



Georgi OROSCHAKOFF
INVENTOR:

BY: Karl F. Ross

Attorney

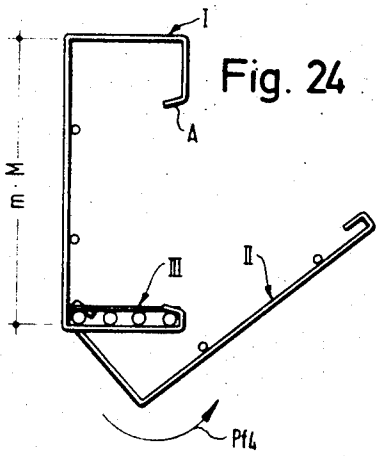


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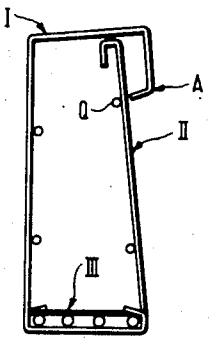


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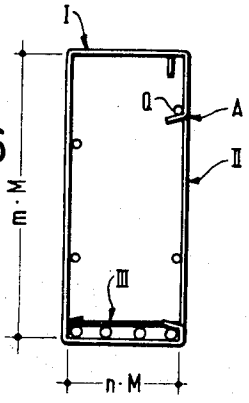


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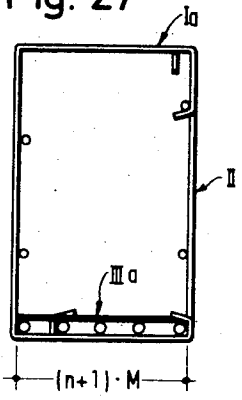


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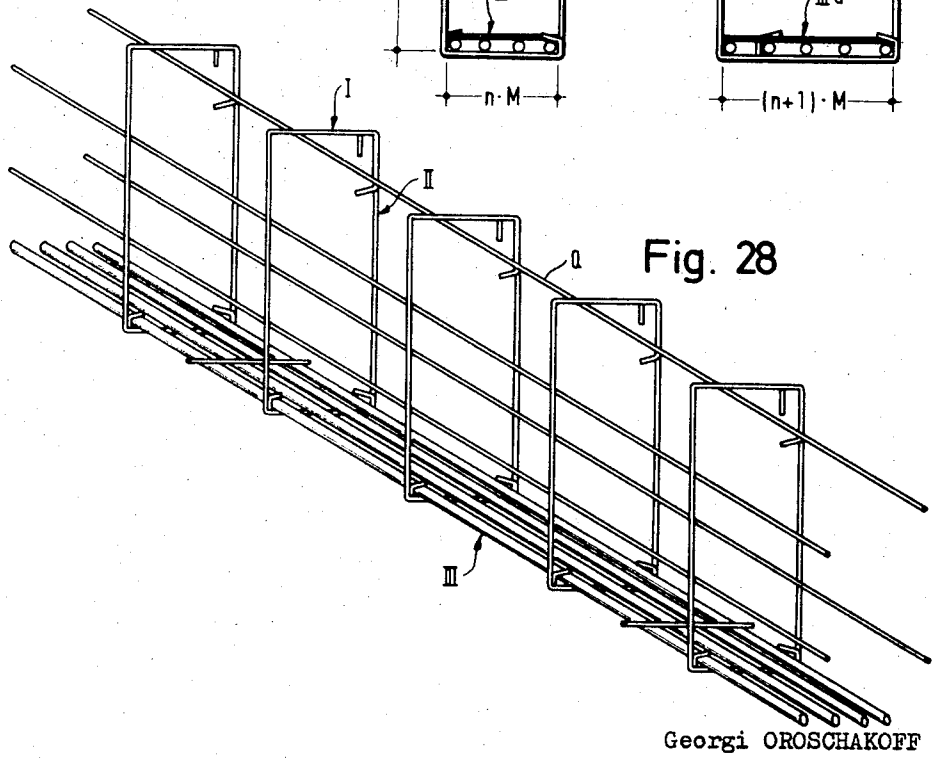


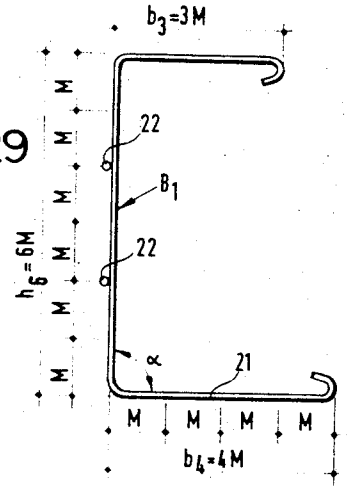
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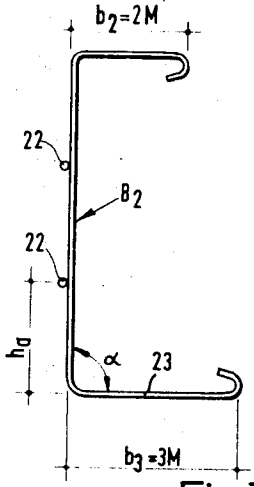
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INVENTOR:

BY: Karl F. Ross

Attorney

Fig.29





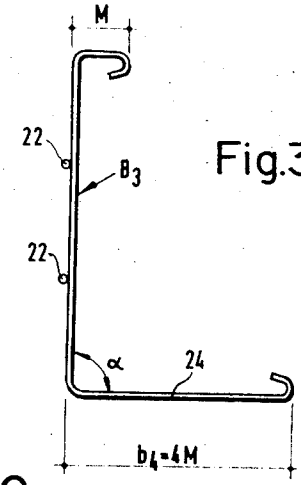


Fig.30

Fig.31

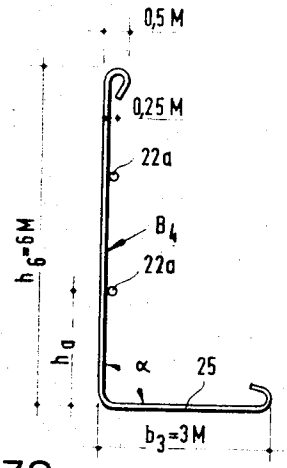


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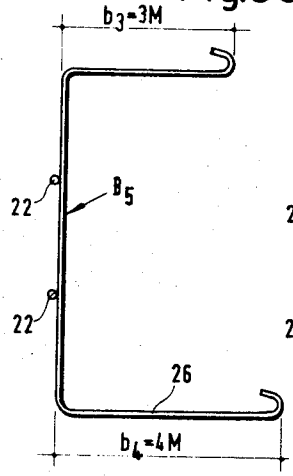


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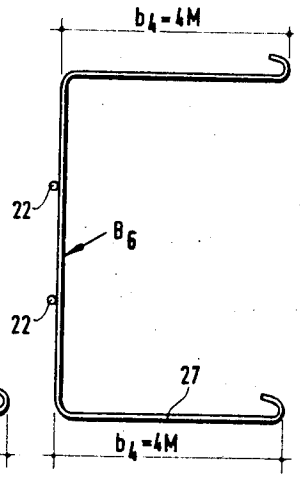


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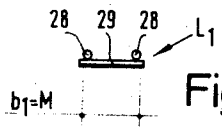


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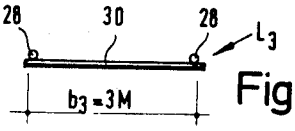


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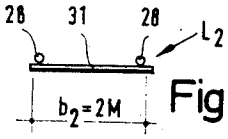


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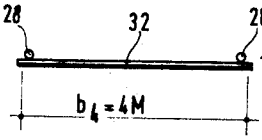


Fig.38

Georgi OROSCHAKOFF
INVENTOR:

Karl F. Ross

Fig.39

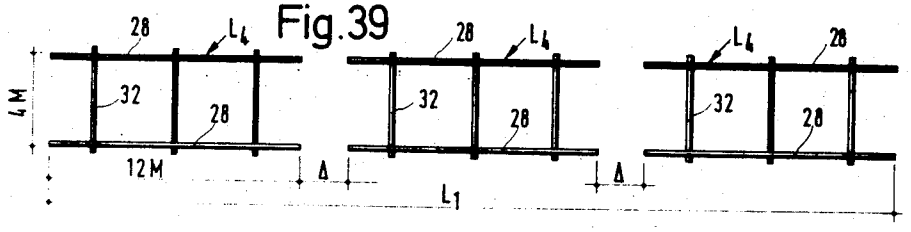


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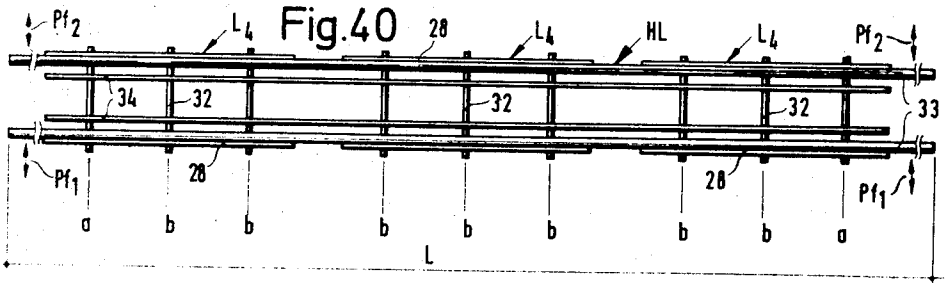


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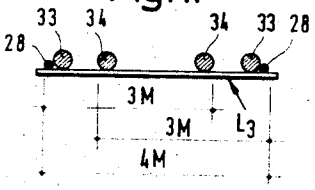


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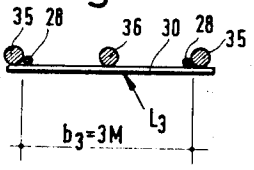


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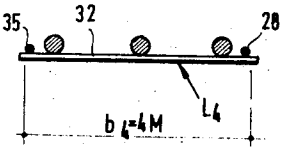
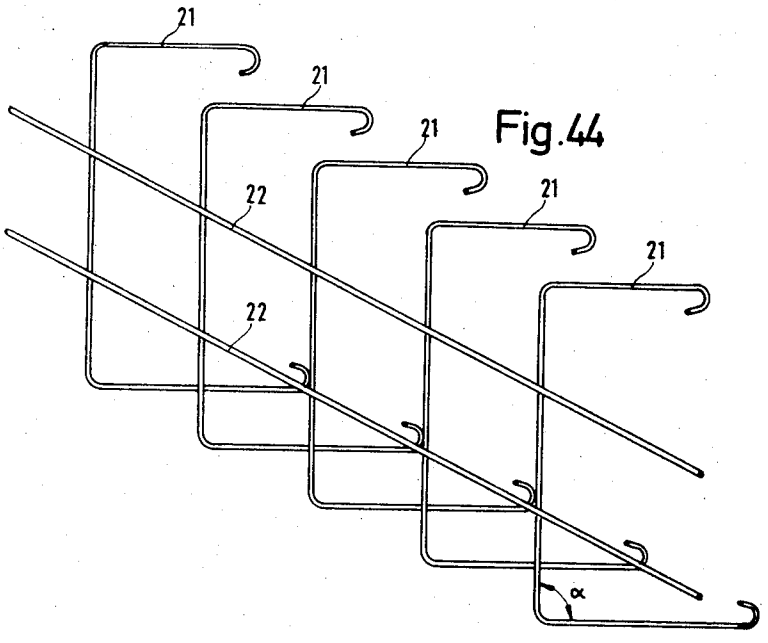


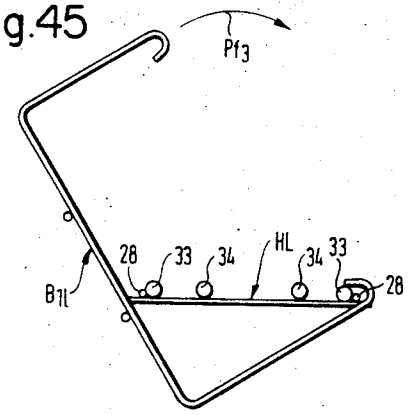
Fig.44



INVENTOR:

Karl F. Ross

Fig.45



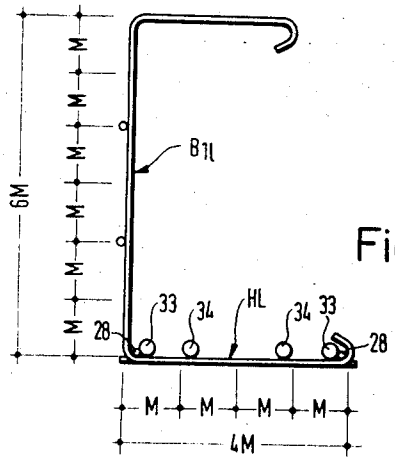


Fig.46

Fig. 47

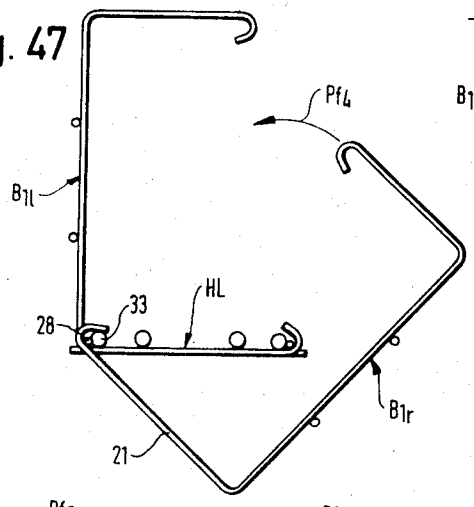


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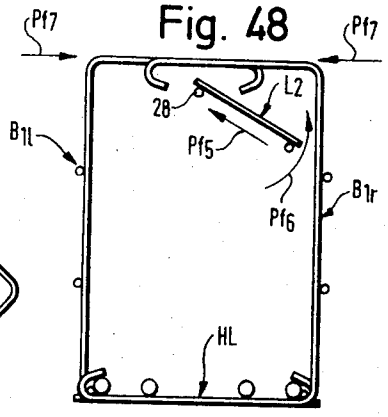


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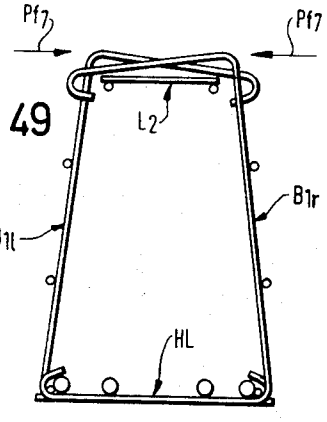
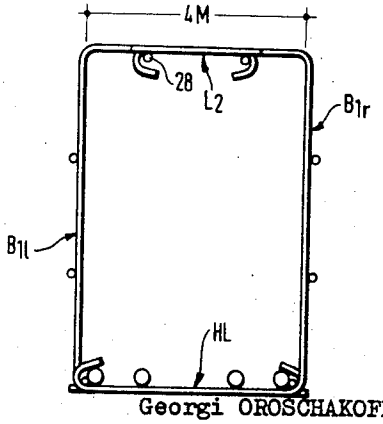


Fig. 50



Georgi OROSCHAKOFF
INVENTOR:

Karl F. Ross.

Fig.51

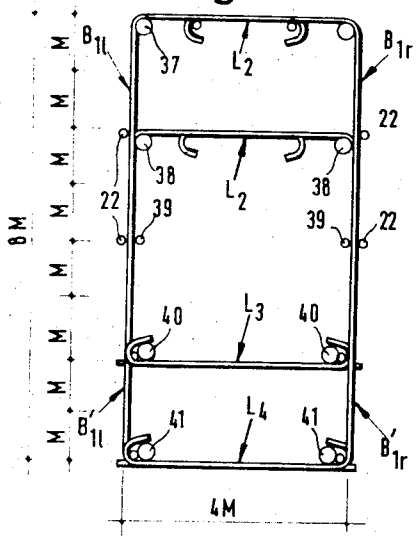


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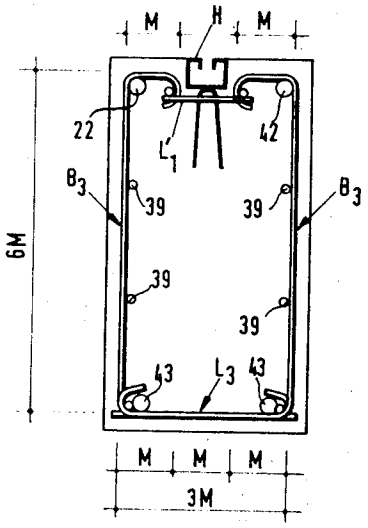


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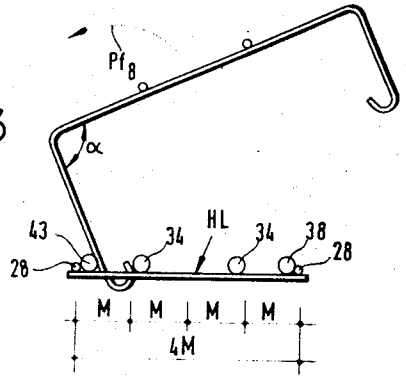


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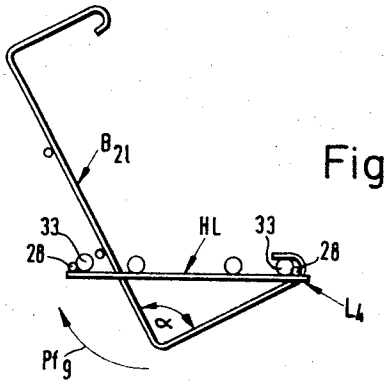


Fig.55

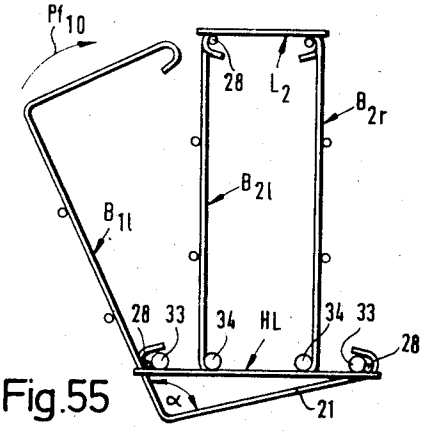
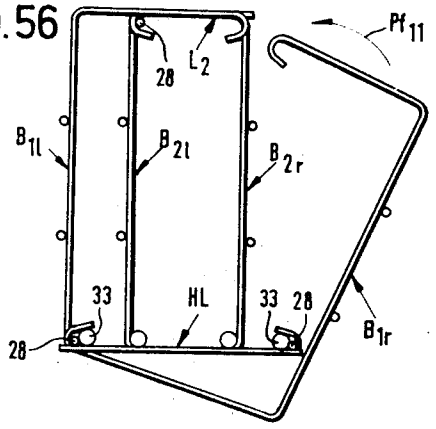


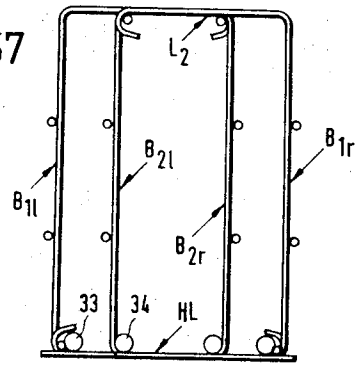
Fig.56



INVENTOR

Karl F. Ross

Fig.57



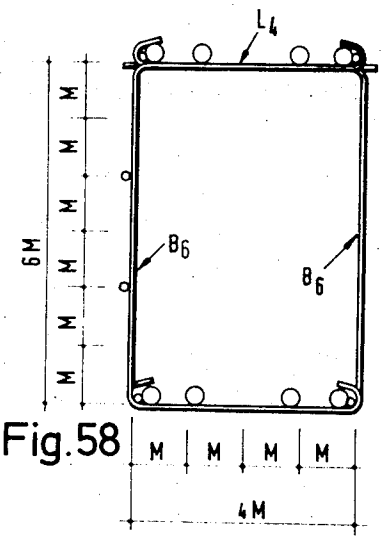


Fig.58

Fig.59

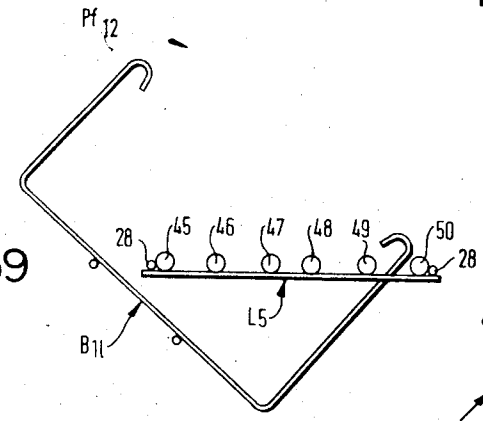
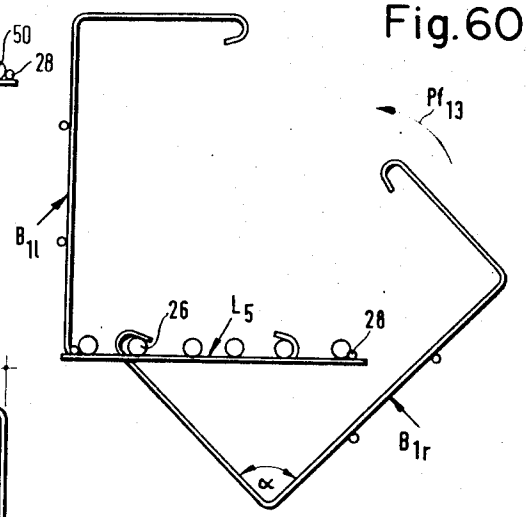


Fig.60



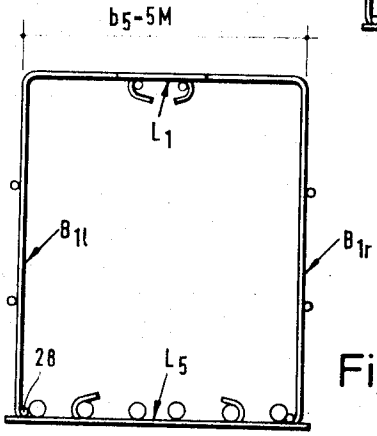
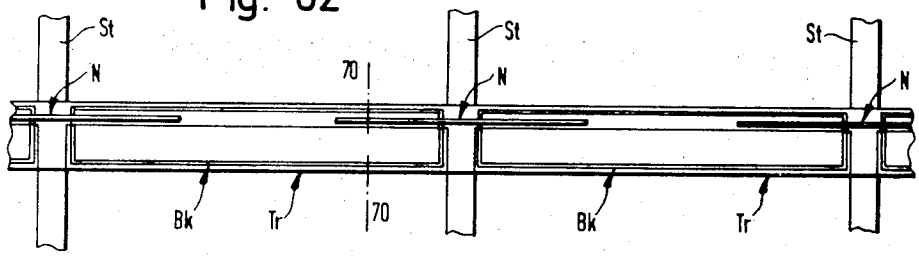


Fig.61

Georgi OROSCHAKOFF
INVENTOR:

Karl F. Ross

Fig. 62



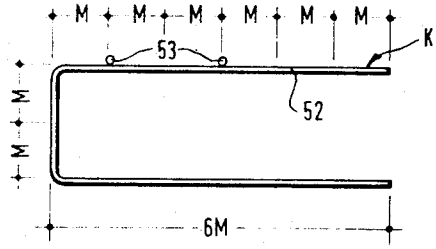


Fig. 63

Fig. 64

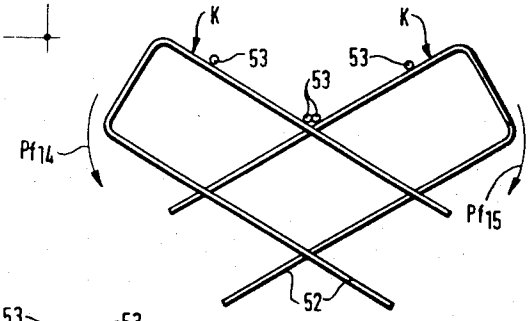


Fig. 65

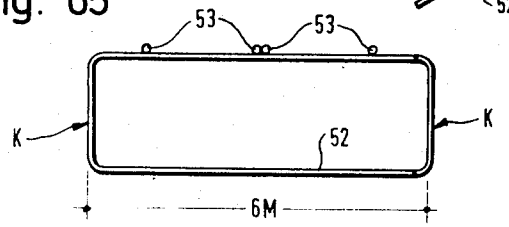
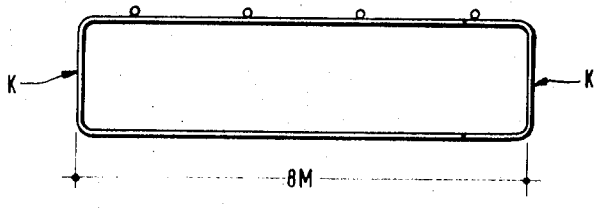


Fig. 66



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INVENTOR

Karl F. Ross

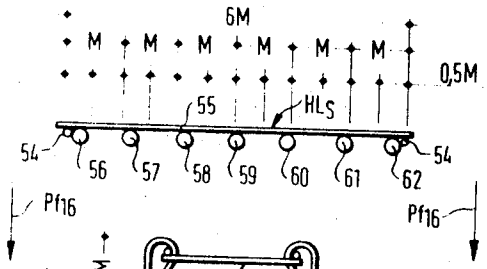


Fig. 67

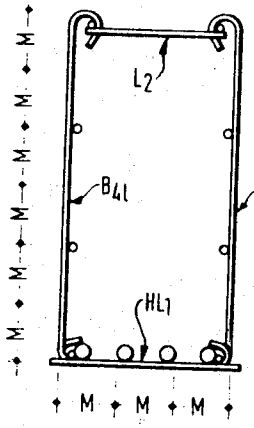
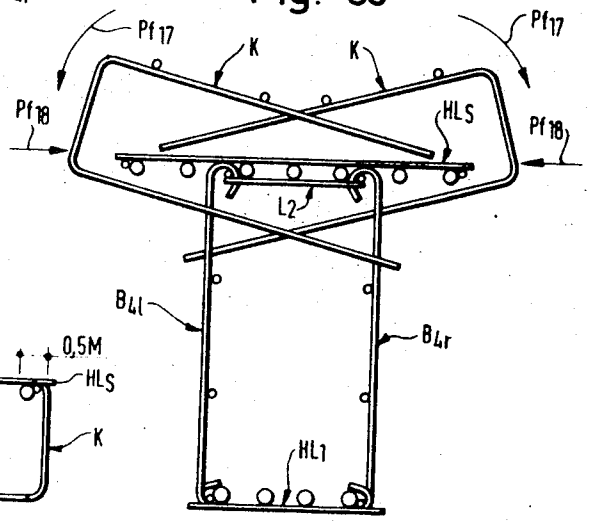


Fig. 68

Fig. 69



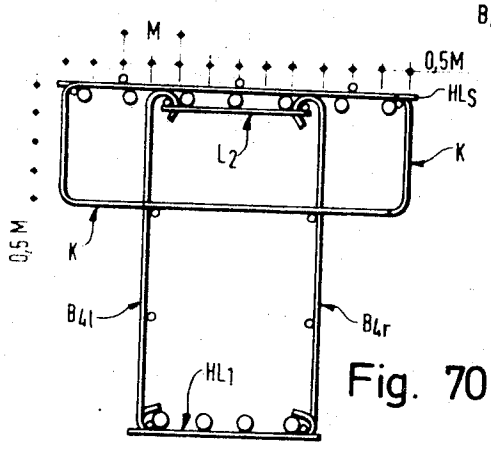
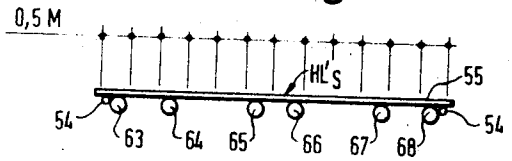


Fig. 70

Fig. 71



Georgi OROSCHAKOFF

INVENTOR

Karl F. Ross

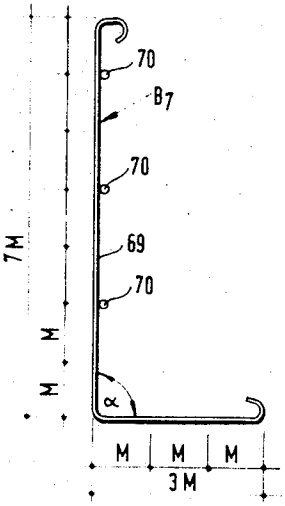


Fig.72

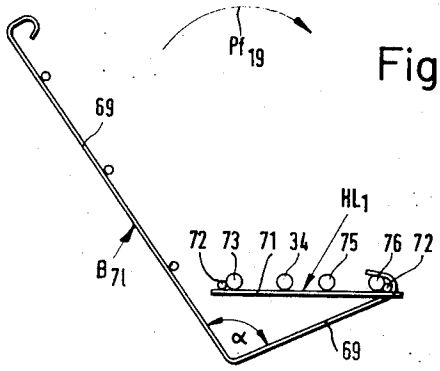


Fig.73

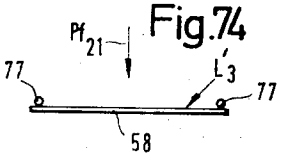


Fig.74

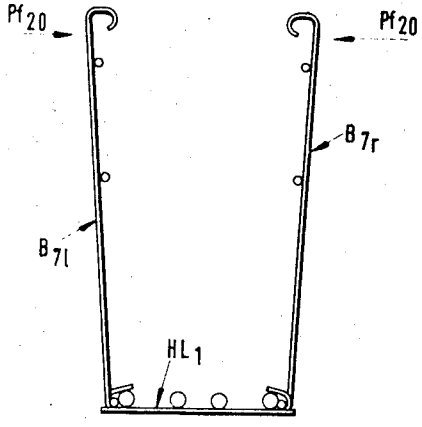


Fig.75

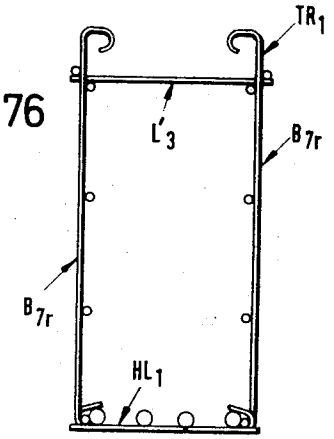


Fig.76

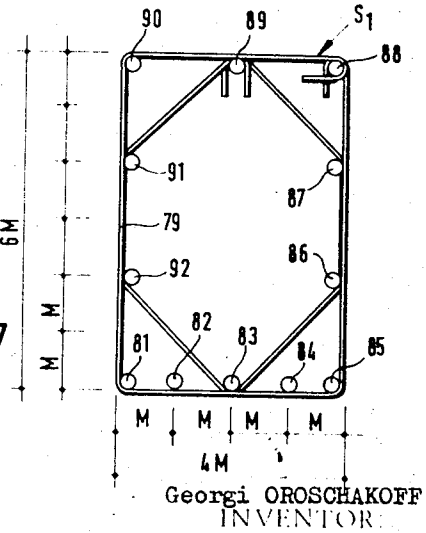


Fig.77

Georgi OROSCHAKOFF
INVENTOR

Karl F. Ross

Fig. 78

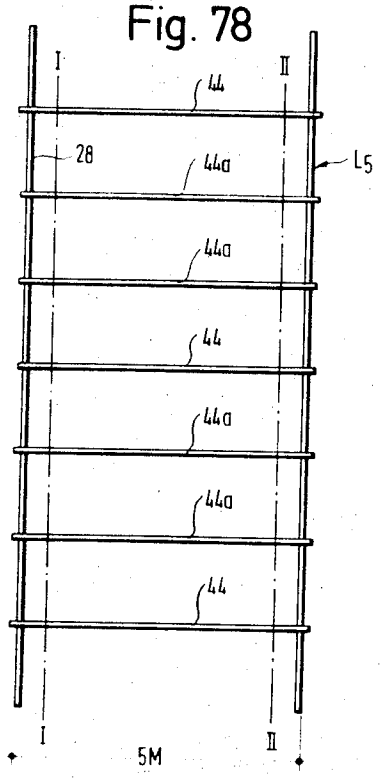


Fig. 79

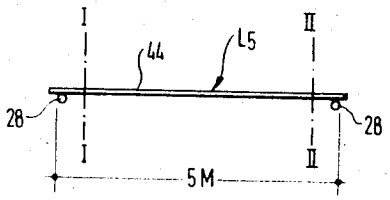


Fig. 80

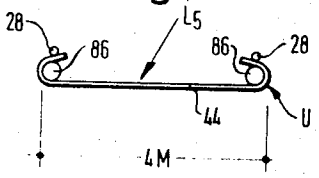


Fig. 81

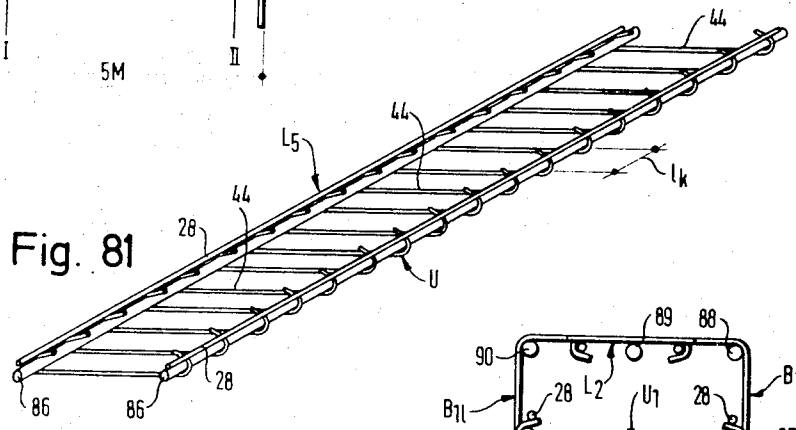
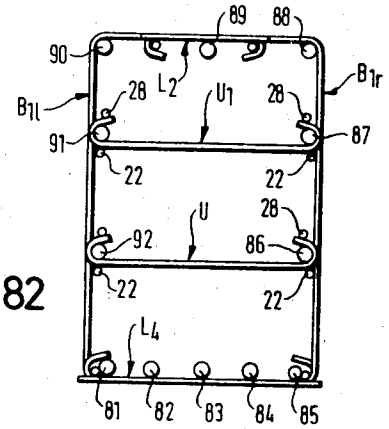


Fig. 82



Georgi OROSCHAKOFF
INVENTOR:

Karl J. Ross

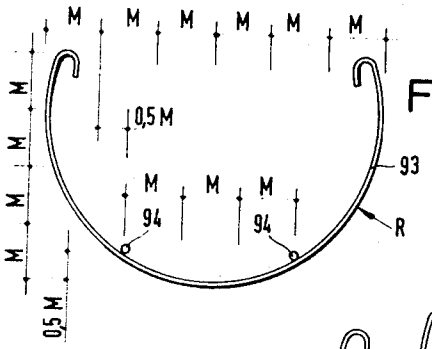


Fig.83

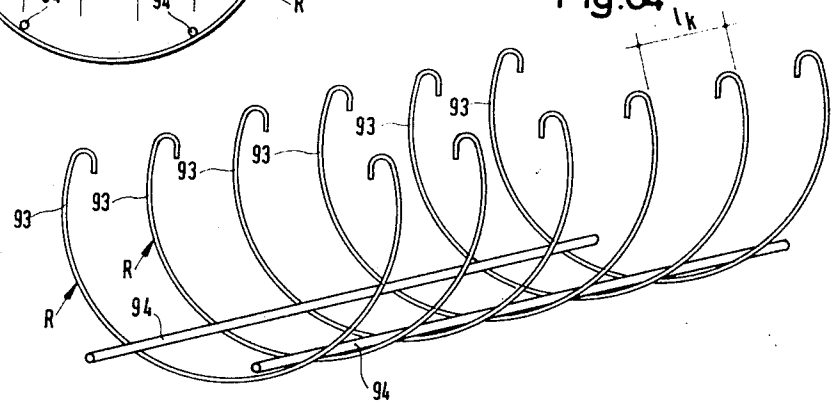


Fig.84

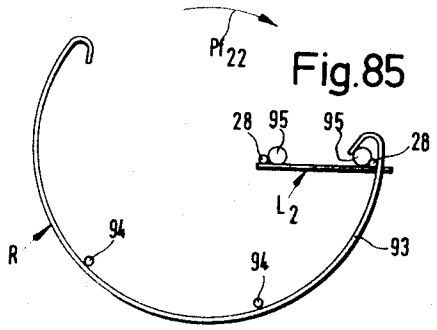


Fig.85

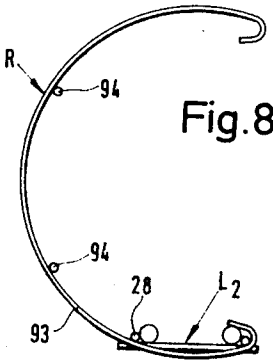


Fig.86

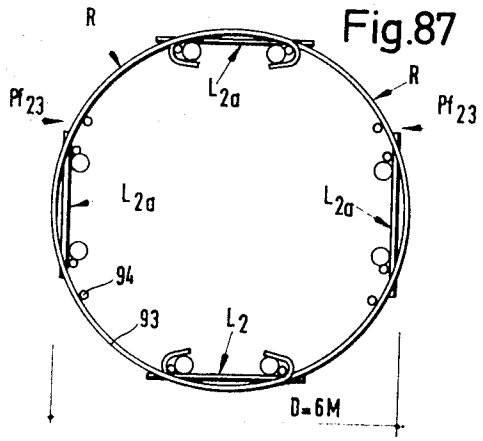


Fig.87

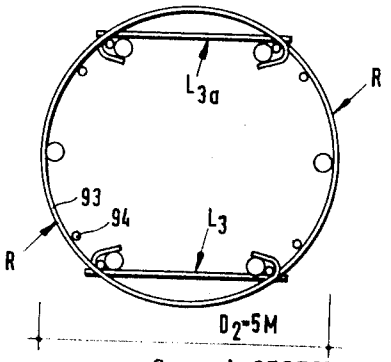


Fig.88

Georgi OROSCHAKOFF
INVENTOR:

Karl F. Ross

REINFORCEMENT FOR REINFORCED CONCRETE STRUCTURES

FIELD OF THE INVENTION

This invention relates to a reinforcement for reinforced-concrete structures, such as slabs, beams, columns or the like, which reinforcement consists of at least two separate, standardized two-dimensional or angular reinforcing sections of a modular system having graded lengths and heights, which sections can be assembled to form two-dimensional or basket-shaped reinforcements of any dimensions and any steel cross-section in such manner that the two-dimensional and/or angled reinforcing sections can be non-positively interengaged to form self-supporting reinforcements of any desired shape, which are rigid at least in one direction.

BACKGROUND OF THE INVENTION

In the previous reinforcements, individual rods which were forced into prefabricated eyes were used as a main tension reinforcement.

SUMMARY OF THE INVENTION

In order to enable the reinforcing sections to be rigidly connected in a manner which is more reliable, simpler and faster by a mere assembling operation without further joining operations such as tying and other operations so as to locate the reinforcing sections relative to each other, and to provide assembled basket-shaped reinforcements which are not only rigid but resist tension and compression so that they can be lifted, transported and inserted into the formwork without need for additional joining work, the invention provides a main tension reinforcement in the form of standardized separate elements instead of the previously used individual rods of the modular system; the system of the invention also allow an increase of the arrangements in which the elements can be combined by employing C-shaped reinforcing sections which can be stacked and wherein all elements are deformed at least at one end either to form an angle or a reversely bent, open loop.

The reinforcement according to the invention comprises reinforcing sections which are two-dimensional or angled and/or C-shaped can be non-positively connected at least in pairs to form self-supporting reinforcements which have any desired shape and are rigid and resist tension and compression, the sections being connected by causing them to extend one into the other, hooking one onto the other and snapping one onto the other. In a preferred embodiment, a first reinforcing element has an angled or loop-shaped end portion, which is hooked onto a longitudinal rod of a second reinforcing element and has been turned or pressed, or is turned and pressed at the same time, to snap onto the transverse rod of the second reinforcing element. The invention also relates to special reinforcing elements for such reinforcement.

According to another feature of the invention, basket-shaped reinforcements are made, which are open or closed and have two, four or more tiers and may have the configuration of a polygon having four or more corners or a round or rounded configuration, and wherein a closing ladder (L) is inserted to close the basket-shaped reinforcement at its upper portion and at its lower portion.

BRIEF DESCRIPTION OF THE DRAWING

Further features and advantages of the invention will become apparent from the subsequent description of illustrative embodiments of the invention with reference to the drawing, in which

FIG. **1** is an end elevation showing a C-shaped reinforcing element.

FIGS. **2**, **4** and **5** are end elevations showing three modifications of the reinforcing element of FIG. **1**.

FIG. **3** is an end elevation showing an angular reinforcing element.

FIG. **6** is a perspective view showing the reinforcing element of FIG. **1**.

FIG. **7** is a perspective view showing the reinforcing element of FIG. **3**.

FIGS. **8** and **10** show in plan view, reinforcing elements in which the main reinforcement is combined.

FIGS. **9** and **11** are end elevations showing the reinforcing elements shown in FIGS. **8** and **10**.

FIG. **12** shows an element used to supplement the main reinforcement.

FIG. **13** is an end elevation showing the component of FIG. **12**.

FIG. **14** shows a reinforcing section (in plan view) which is composed of reinforcing elements as shown in FIGS. **8**, **10** and **12**.

FIGS. **15** and **16** are sectional views taken along lines **15—15** and **16—16**, respectively, in FIG. **14**.

FIG. **17** is an end elevation showing a modification of the reinforcing section.

FIGS. **18**, **19** and **20** show successive steps in the assembling of two elements (in side elevation) as shown in any of FIGS. **1**, **2**, **4**, **5**, and **6**.

FIGS. **21** to **27** show successive steps in the assembling of a basket-shaped reinforcement (in end elevation) according to the invention.

FIG. **28** is a perspective view showing a completely assembled, basket-shaped reinforcement as assembled in the states of FIGS. **21** to **27**.

FIG. **29** is an end elevation showing another C-shaped reinforcing element.

FIGS. **30** and **31** are end elevational views showing the same reinforcing element with shortened upper and lower legs and with a shortened upper leg, respectively.

FIG. **32** is an end elevation showing an angle-shaped reinforcing element.

FIGS. **33** and **34** show modifications of the reinforcing elements of FIGS. **29** to **31**.

FIGS. **35** to **38** are end elevations showing reinforcing ladders or closing ladders.

FIGS. **39** and **40** are top plan views illustrating the assembling of a main reinforcing element with the aid of the closing ladder of FIG. **28** and of the main reinforcing rods.

FIG. **41** is an end elevation showing the reinforcing element of FIG. **40**.

FIGS. **42** and **43** show in section, modifications of the main reinforcing element of FIG. **41**.

FIG. **44** is a perspective view showing the reinforcing element of FIG. **40** comprising five U-shaped members.

FIGS. **45** to **50** are end elevations showing successive steps in the assembling of a basket-shaped reinforcement from the reinforcing elements of FIG. **29**, the main reinforcing element of FIG. **40** and the closing ladder of FIG. **37**.

FIG. 51 shows in and new, a basket-shaped reinforcement which comprises four vertically spaced tiers and is assembled in the same manner.

FIG. 52 shows a similar basket-shaped reinforcement, which comprises reinforcing elements as shown in FIG. 31 and in which a tie bar has been built into the corresponding reinforced-concrete elements.

FIGS. 53 to 57 are end elevations showing successive stages in the assembling of a basket-shaped reinforcement having tiers spaced in the direction of the width of the element.

FIG. 58 shows (in end view) a modified basket-shaped reinforcement which has been assembled in a different manner from elements as shown in FIG. 34.

FIGS. 59 to 61 show in end views, successive stages in assembling the variations which are enabled by the elements shown in FIG. 29 because the same elements as shown in FIGS. 45 to 50 may be used to form a basket-shaped reinforcement.

FIG. 62 is a plan view showing a continuous beam or a portion of a reinforced-concrete frame. In this view, the holding-down beam reinforcement is indicated by a solid line. In the previous arrangements, that hole-down beam reinforcement always had to be threaded above the columns into the stirrups of the beams disposed on the left and right of the column.

FIG. 63 is an end elevation showing a reinforcing element which serves to enclose the hold-down beam reinforcement.

FIG. 64 shows (in end view), the assembling of two elements of the type shown in FIG. 63 to form a closed basket-shaped reinforcement.

FIGS. 65 and 66 illustrate how the width of the basket-shaped reinforcement may be varied.

FIG. 67 is an end elevation showing a hold-down beam reinforcement which has been assembled with the aid of one or more closing ladders.

FIG. 68 is an end elevation showing an assembled, open basket-shaped reinforcement.

FIG. 69 is an end elevation showing the basket-shaped reinforcement of FIG. 68 with a hold-down reinforcement as shown in FIG. 67 applied and reinforcing elements as shown in FIGS. 63 and 64, which latter elements are to be inserted as closing elements.

FIG. 70 is an end elevation showing the completely assembled basket-shaped reinforcement of FIG. 69.

FIG. 71 is a side elevation showing a modification of the hold-down beam reinforcement of FIG. 67.

FIGS. 72, 73, 75 and 76 are end elevations showing successive the assembling of an open basket-shaped reinforcement with the aid of a closing reinforcing ladder of FIG. 74 in an arrangement in which the longitudinal rods of the closing ladder embrace the assembled basket assemblies from the outside.

FIG. 77 is a top plan view showing a basket-shaped reinforcement for a column.

FIG. 78 is a developed top plan view showing a closing ladder which may be used in a reinforcement as shown in FIG. 77.

FIG. 79 is an end elevation showing the ladder of FIG. 78.

FIGS. 80 and 81 are an end elevation and perspective view showing the reinforcing section which comprises the elements of FIGS. 78 and 79 and main reinforcing rods.

FIG. 82 shows a basket-shaped reinforcement which comprises on top the closing ladder arranged according to the invention and two sections as shown in FIGS. 52 and 53 below said ladder to form a basket-shaped reinforcement in accordance with the invention, which reinforcement is similar to that of FIG. 49.

FIG. 83 is an end elevation showing a circular segment element.

FIG. 84 is a perspective view showing the element of FIG. 83.

FIGS. 85 to 87 are end elevations showing successive stages in the assembling of such elements to form a round basket-shaped reinforcement.

FIG. 88 is an end elevation showing a round basket-shaped reinforcement which is a modification of that of FIG. 87.

SPECIFIC DESCRIPTION

FIGS. 1, 2, 4 and 5 show a C-shaped reinforcing element. In accordance with the invention, the dimensions of all elements are graded in accordance with a modular system. For this reason, the height and width always are a multiple of a selected grid line spacing M. This is required to ensure that the reinforcing elements can be combined with similar and different elements and to enable a rigid connection of all elements without additional work, such as tying and the like.

The reinforcing element generally designated I_1 in FIG. 1 consists of C-shaped stirrups 1 and straight longitudinal rods 2, which extend transversely to the stirrups 1, the latter lying in parallel prependicular to rods 2. This is also apparent from FIG. 6. The upper end of stirrup 1 has an inwardly angled end portion A and the lower end has a hook or loop S also open inwardly. The reinforcing element L_2 shown in FIG. 2 has the same height m M as that of FIG. 1 and is wider by one selected grid line spacing M. Hence, the element I_1 has a width n M and the element I_2 a width $(n+1)$ M.

Additional elements of the modular system comprise a third element, which is wider by 2 M, and a fourth element which is wider by 3 M than the element shown in FIG. 1. A variation in height is enabled in that each succeeding element is higher by one grid line spacing or a multiple thereof. Hence, the element shown in FIG. 5 is higher and wider by one grid line spacing than the reinforcing element of FIG. 1.

The storage,transport and generally the stacking or requirements should be taken into account in the design of such C-shaped elements. In the reinforcing elements according to the invention, this is accomplished in that in the stacking direction (arrow S' in FIG. 5), the rods 2 are provided only in the zone outside of the loops S or angled end portions A. As an additional measure it is contemplated to thread the reinforcing elements onto pallets which are made for this purpose and have vertical rods for guiding the rods 2 so that a canting or interlocking of the reinforcing elements in the stack is prevented.

In addition to the C-shaped elements, angular elements may be used, such as are shown in FIGS. 3 and 7. These elements are generally designated II and distinguished by some special features, namely:

The rod Q (FIG. 3) must be provided on the level H of the angled end portion A of the C-shaped element shown in FIGS. 1, 2. The angle Δ should preferably exceed 90°.

Without changes in dimension, the reinforcing elements II shown in FIG. 3 may be combined with the reinforcing elements I shown in FIGS. 1, 2, 4 or 5 to form

a basket-shaped reinforcement. This is indicated in FIGS. 26 and 27.

A proper design of the main tension reinforcements in beamlike reinforcement has not been provided so far. It is virtually impossible to join the main tension reinforcement to the elements of the basket-shaped reinforcement in the factory, either because the tension rods must not be interrupted or because they must be varied too much. It has been attempted so far to solve that problem by the use of individual rods. In accordance with the invention, that problem is solved in that the main tension reinforcement is also combined in separate reinforcing elements. The main tension reinforcement may consist of a single, inseparable element, but desirably consists of two separate elements, which can be assembled. This is shown in FIGS. 8, 9 and 10, 11, respectively. Two longitudinal reinforcing rods 7 or 9 are connected by straight transverse rods 8 or 10, either at their ends (FIGS. 8, 9) or in an intermediate portion (FIGS. 10, 11). A simple ladderlike element is also used, which consists of spars 11 and rungs 12 (FIGS. 12, 13).

As a result, these elements may be graded as to steel cross-section and dimensions in accordance with the modular system so that two elements may be combined to provide the required reinforcement in the form of a reinforcing section III, e.g., a basket-shaped reinforcement, as is shown in FIGS. 14, 15, 16 and 17.

As is apparent in FIG. 14, the reinforcing elements, namely, an element of FIG. 8 and an element of FIG. 10, can be shifted in the direction of the rods 7, 9 to provide a reinforcement which has the required overall length and in which the region between lines 14—14 and 15—15 remains without edge rods 7. For this reason, that region must be closed with a portion of the ladder like element of FIG. 12, as is clearly apparent from the transverse sectional view shown in FIG. 15. The width of each of the resulting reinforcing sections III is a multiple of the selected grid line spacing less a tolerance Δ. Hence, the width of the element of FIG. 15 equals n M − Δ. The next wider element in the modular system equals (n + 1) M − Δ.

FIG. 17 shows an element III*a* in which the distance from the outer edge of rod 9 to the outer edge of rod 7 as well as the distance from the outer edge of rod 7a to the outer edge of rod 9*a* also equals n M − Δ. This enables the reinforcing element II of FIG. 3 to be hooked onto the rods 9 or 9*a* by means of the loops S.

The assembling of two reinforcing elements I in the longitudinal direction is illustrated in FIGS. 18, 19, and 20. As shown in FIG. 18, the two elements are assembled at an angle until the rods 1L and 1R abut. They are then rotated in the direction of the arrows Pf1 in FIG. 18 about the point of contact between rods 1L and 1R until the rod 2L engages a rod 1R and a rod 2R engages a rod 1L (FIG. 19).

The two elements are then pulled in the direction Pf_2 until the spacing a has been obtained everywhere (FIG. 20). A loop T may be formed in the factory or during the assembling in order to ensure rigidity in all directions. The reinforcing section III is then inserted in accordance with FIGS. 14 to 17 to form the main tension reinforcement. This insertion may be effected by means of a handling appliance or, with light reinforcements, by hand. For this purpose, the lifting device shown in FIG. 21 consists of a carrying stirrup 13 and is either joined in the factory for use in prefabricated reinforced-concrete parts or consists of a detachable part for use in cast-in-situ concrete structures.

To insert the reinforcing section as a main tension reinforcement, one end is hooked into the loop S of the reinforcing element I and the section III is then turned in the direction Pf_3, as is illustrated in FIG. 22. When the reinforcing section III has been inserted, the reinforcing elements II such as shown in FIG. 3 or FIG. 23 are hooked in. The design shown in FIG. 23 has the advantage that when all elements have been assembled the joint A is completely closed under the slight stress. When the reinforcing element II is rotated in the direction Pf_4 in FIG. 24 to the position shown in FIG. 25, the transverse rod Q snaps onto the angled end portion A of element I. The resulting basket-shaped reinforcement is entirely rigid and resists tension and compression although it need not be tied. FIG. 28 is a perspective view showing the assembled basket-shaped reinforcement which consists of sections I, II and III.

FIG. 29 shows a reinforcing element B_1, which consists of transverse C-shaped reinforcing stirrups 21 and longitudinal reinforcing or retaining rods 22 (see FIG. 44), which are welded or joined by other means to the stirrups 21 at the crossings.

FIG. 30 shows a reinforcing element B_2, which consists of transverse C-shaped stirrups 23 and longitudinal reinforcing rods 22. The difference from the reinforcing element shown in FIG. 1 resides in that the horizontal legs differ in length.

The element shown in FIG. 29 has an upper horizontal leg having the length b_3 = 3M and the element shown in FIG. 30 has an upper horizontal leg having the length b_2 = 2M. The lengths of the lower legs equal b_4 = 4M in the element shown in FIG. 29 and b_3 = 3M in the element shown in FIG. 30. For a combination of the reinforcing sections shown in FIGS. 29 and 30 in a modular system, series of such elements must be provided, in which the width b_n and the height h_n differ in accordance with said modular system.

TABLE 1

h_n	b_n upper leg/b_n lower leg		
3 M	M/2 M	2 M/3 M	
4 M	M/2 M	2 M/3 M	3 M/4 M
5 M	M/2 M	2 M/3 M	3 M/4 M
6 M		2 M/3 M	3 M/4 M

The steel cross-section of these several types may also be graded. For instance, the reinforcing element in which h = 3 M and the upper leg has a length M and the lower leg has the length 2 M is suitably designed with steel cross-sections Fe_1 and Fe_2, the next with the steel cross-sections Fe_1, Fe_2, Fe_3, etc.

FIGS. 31 to 34 show additional modifications of the elements shown in FIGS. 29 and 30 and provided with stirrups. The reinforcing elements B3, B4 shown in FIGS. 31, 32 are intended to be assembled to form open basket-shaped reinforcements and the reinforcing elements B5, B6 shown in FIGS. 33 and 34 are intended to be assembled to form closed basket-shaped reinforcements. The upper leg of the reinforcing element B3 shown in FIG. 31 has, e.g., the length M.

FIGS. 35 – 38 show reinforcing ladders or closing ladders which are graded in length and consist of the spars 28 and rings, which are designated 29 in the reinforcing ladder L_1 of FIG. 7, 31 in the reinforcing ladder L_2 of FIG. 9, 30 in the reinforcing ladder of FIG. 8 and 32 in the reinforcing ladder L_4 of FIG. 10. The spars 28

are preferably welded or joined by other means to the rings 29, 30, 31 and 32 at the crossings.

The requirements of the modular system will be met if the reinforcing ladders or closing ladders are graded merely in width in such a manner that L_1 has a width $b_1 = M$, L_2 has a width $b_2 = 2M$, L_3 has a width $b_3 = 3M$ etc., L_n has a width n M. The reinforcing ladders may have a constant length $L = m$ M.

The main reinforcing elements have a different design because all main reinforcing rods or at least two thereof, the edge rods, are secured to closing ladders extending one behind the other in accordance with FIG. 39.

The required length L indicated in FIG. 40 can easily be obtained because the reinforcing ladders L_4 do not abut but are spaced by a tolerance dimension Δ. At least the main reinforcing rods 33 and preferably also the rods 34 (FIG. 40) should be arranged above the reinforcing ladders L_4 shown in FIG. 39 and should be joined to the reinforcing ladders L_4. The crossings between the main reinforcing rods 33 and 34 and the transverse rods 32 of the reinforcing ladders L_4 suitably consist of welded joints so that the main reinforcing element is rigid. The crossings in the end axes must be left unjoined so that the main reinforcing rods can be slightly shifted in the direction of arrows Pf_1 or Pf_2 when the reinforcement is placed into a formwork.

FIG. 41 is a sectional view showing the main reinforcing element shown in FIG. 40. FIGS. 42 and 43 are sectional views showing modifications of these embodiments of main reinforcing elements. The main reinforcing element shown in FIG. 42 consists of the closing ladder L_3, main reinforcing rods 35 placed over the ladder L_3 in accordance with the grid line s of the modular system, and a rod 36 which is offset by one-half grid line spacing. The width of this main reinforcing element is, e.g., $b_3 = 3\ M + 2$. Another difference resides in this embodiment in the arrangement of the main reinforcing rods 25, which differs from the arrangements of FIGS. 40 and 41 in that these rods are secured to the outside of the spars 28. FIG. 43 shows a main reinforcing element in which the main reinforcing rods are joined to the reinforcing ladder L_4 at the edge between two grid lines, in accordance with a grid which is offset by one-half grid line spacing.

FIG. 44 is a perspective view showing a reinforcing element as shown in FIGS. 1 and 2. The angle α preferably exceeds 90° so that two reinforcing sections of this type may be assembled to clamp each other.

FIGS. 45 to 50 show the assembling of a basket-shaped reinforcement from the reinforcing elements according to the invention. FIG. 45 indicates how the looped end of the reinforcing element B_{1l} is hooked over the edge rod 28 or 33 of the main reinforcing element. The reinforcing element B_{1l} is then turned in the direction of the arrow Pf_3 to the position shown in FIG. 46. The same element B_1, which is designated B_{1r} in FIGS. 47 to 49, is then again hooked onto the opposite rods 28 and 33 of the reinforcing ladder and like the first reinforcing element is rotated in the direction of the arrow Pf_4 until the rod 21 engages the main reinforcing element.

Before the two reinforcing elements B_{1l} and B_{1r} are closed, the closing ladder L_2 (FIG. 48) should be inserted in the interior of the reinforcing basket. The ladder L_2 is first inserted on one side with an inclination into the loops of the upper legs of the stirrups until the spar 28 engages one reinforcing element B_{1r} at the left-hand end in FIG. 48 of the upper leg, as is shown in FIG. 48. Hence, one end of the closing ladder L_2 must be inserted in the direction of the arrow Pf_5. The reinforcing elements B_{1l} and B_{1r} are then pushed one into the other in the direction of arrows Pf_7 (FIG. 48) until the position of FIG. 49 is reached.

The second end of the closing ladder L_2 is then rotated in the direction of the arrow Pf_6 (FIG. 48) to the position of FIG. 49. When the reinforcing elements B_{1l} and B_{1r} have been released, the looped stirrup ends thereof resiliently engage both sides of the spars 28 of the closing ladder L_2, as is shown in FIG. 50, which illustrates the completely assembled basket-shaped reinforcement. To enable an increase of the resilient clamping force, it is desirable, as has been mentioned, to select an angle α which exceeds 90° (FIGS. 29 to 32 and 44).

FIG. 51 shows a basket-shaped reinforcement which consists of four vertically spaced tiers. When it is desired to assemble that reinforcement, a basket-shaped reinforcement as shown in FIG. 50 is assembled first. In such cases it will be desirable to arrange the longitudinal rods (which are designated 22 in the reinforcing elements B_1) on the inside rather than on the outside, like the rods 39 of the reinforcing elements B'_{1l} and B'_{1r}.

When the two-tier basket-shaped reinforcement has been assembled in the manner described with reference to FIG. 50, the looped stirrup ends of the reinforcing elements B_{1l} and B_{1r} are hooked onto the longitudinal rods 39, which replace the closing ladders. The basket-shaped reinforcement is closed like the two-tier one.

FIG. 52 illustrates a special design. The width of the upper legs of the reinforcing elements B_3 equals only one grid line spacing M so that the basket-shaped reinforcement may be closed with one closing ladder L'_1 as previously. The reinforcing elements B_3 are pushed one into the other until the closing ladder L_1 can be connected to the looped ends of the upper legs. This embodiment is highly desirable for beam reinforcements which do not require closed stirrups, or for column reinforcements, in which inserts must be provided, such as Jordal bars, which are designated H in FIG. 52.

FIGS. 53 to 57 show the assembling of a basket-shaped reinforcement which comprises four tiers spaced apart in the direction of the width of the reinforcement. The main reinforcing element must be prepared in accordance with FIG. 40 or in another manner. It is important that the longitudinal rods 33, 34 should lie on the grid. The lower leg of the reinforcing section B_{21} is first threaded between the rods 33 and 34. The reinforcing element B_{21} is then rotated in the direction of arrow Pf_8 to the position shown in FIG. 54. When the looped stirrup end has been hooked onto the spars 28 of the ladder element L_4 and the longitudinal rod 33 of the reinforcing element HL, the reinforcing section B_{21} must be turned back in the direction of the arrow Pf_9. The other section B_{2r} must be secured in the same manner on the other side of the closing ladder and the main reinforcing element. The basket-shaped reinforcement is closed as is indicated in FIGS. 48 to 50. To provide the four-tier basket-shaped reinforcement, another reinforcing element of the type B_{1l} must be hooked onto the spars 28 of the ladder element and on the rod 33 of the main reinforcing element and must then be turned in the direction of the arrow Pf_{10}, as

shown in FIG. 55. When the rod 21 has engaged the longitudinal rods of the main reinforcing element, the reinforcing section B_{1l} must be forced forwardly in the direction of the arrow Pf_{10} until the loops of the upper leg snap in over the spar 28 of the upper closing ladder L_2. FIG. 56 shows the insertion of the other element B_{1r}.

When the two reinforcing elements B_{1l} and B_{1r} have been forced in until the upper stirrup legs hook onto the spars 28 of the closing ladders L_2, the basket-shaped reinforcement having four tiers has been completed, as is shown in FIG. 57.

FIG. 58 shows a two-tier, basket-shaped reinforcement which has been assembled from reinforcing sections B6 such as are shown in FIG. 34. This embodiment is desirable when a down-holding beam reinforcement is to be inserted, as is shown in FIG. 58. The down-holding reinforcement is secured to the closing ladder L_4 and can easily be inserted from above.

FIGS. 59 to 61 show the advantage of the modular system because the same reinforcing sections B_1 may be used to assemble a basket-shaped reinforcement having the width b_4 32 4 M in FIG. 50 or a basket-shaped reinforcement having the width b_5 = 5M as shown in FIG. 61. It will be sufficient if a closing ladder having a suitable width is selected. The main reinforcing element shown in FIG. 59 has been assembled from the closing ladders L_5. The closing ladder L_5 consists again of two spars 28 which are connected by rungs 44.+/(+/ The main reinforcing rods are designated 45 to 50.) The end of the lower leg of the reinforcing element B_{1l} is first threaded between the rods 49 and 50 and then rotated in the direction of the arrow Pf_{12}. When the position shown in FIG. 60 has been reached, the end of the other section B_{1r} is hooked onto the rod 46 and these two parts are then turned in the direction of the arrow Pf_{13} . As has been described, the basket-shaped reinforcement is closed in that the closing ladder L_1 is inserted, as is shown in FIG. 61.

A special difficulty in practice arises at the crossings between beam and beam or between a beam and columns etc. This difficulty resides in that the down-holding beam reinforcement must be threaded over the column on the site. Because the moments usually reach their maximum in this range, a lot of reinforcing material must be concentrated in this area so that the placing of the concrete becomes more difficult. FIG. 62 shows a continuous beam or a portion of a floor frame. The structure comprises beams Tr, columns St, a beam stirrup reinforcement Bk and a down-holding beam reinforcement N. The section taken on line 70—70 through the beam reinforcement is applicable where the reinforcement elements according to the invention and as shown in FIG. 70 are used.

It is desirable to provide an arrangement in which the down-holding column reinforcement need only be placed from above, without being threaded, and can yet be joined to the stirrup basket. This object is accomplished by the use of reinforcing sections such as are shown in FIG. 63. These elements are generally designated K and consist of U-shaped rods 52 and retainers 53, which are transverse to the rods 52. These retainers may consist of rounds of steel having the same quality or of a different material. The elements shown in FIG. 63 may be made as flat two-dimensional reinforcements and may then be angled twice. The assembling of two such reinforcing elements K is shown in FIG. 64. Two identical elements are pushed one into the other until the intermediate rods 53 abut, and the elements are then rotated in the direction of the arrows Pf_{14} and Pf_{15} until the rods 52 of one element engage the rods 53 of the other element. The completely assembled basket which is thus obtained is shown in FIG. 65. The elements which have thus been assembled can be varied as shown in FIG. 66. The assembled element shown in FIG. 65 has a width of, e.g., 6 M and the element shown in FIG. 66 has a width of 8 M; in this case the increment of the modular system is 8 M − 6 M = 2 M.

The assembling of a basket-shaped reinforcement for a beam is shown by way of example in FIGS. 67 to 70. FIG. 67 shows an assembled main reinforcing element for taking up the uplifting moments. This element consists of juxtaposed closing ladders, which comprise spars 54 and rungs 55. The carrying rods 56 to 62 are secured as required on top of the closing ladders, which have been juxtaposed in accordance with FIG. 39. This main reinforcing element is generally designated HL_s.

The main reinforcing rods 56 to 62 are preferably arranged in accordance with the grid of the modular system and this grid may be offset by 0.5 M, as is apparent from FIG. 67. The overall dimension 6 M of the main reinforcing element is disclosed only by way of example. Another dimension of the modular system may readily be used.

FIG. 68 shows an open basket-shaped reinforcement which is assembled from the reinforcing sections B_{4r} and B_{4l}, the main reinforcing element HL_1 and the closing ladder L_2. The main reinforcing element shown in FIG. 67 is simply placed from above in the direction of the arrow Pf_{16} onto the assembled basket shown in FIG. 68. The negative main reinforcement HL_s is enclosed as shown in FIG. 64 in that the reinforcing sections K are fitted one into the other and rotated in the direction of the arrows Pf_{17} and pushed one into the other in the direction of the arrows Pf_{18} as far as is desired.

It is apparent from FIG. 69 that the use of modular dimensions has the result that all rods of the main down-holding reinforcement are orderly arranged in the area between the stirrups and these rods are placed as an entire element. The upper edge of the main reinforcing rods is aligned with the upper edge of the basket-shaped reinforcement.

FIG. 70 shows the basket-shaped reinforcement which has been completely assembled in this manner and indicates that the reinforcing sections K serve also to take up peak uplifting moments which are effective in the slab.

A modification of the main reinforcing elements HL'_s of FIG. 67 is shown in FIG. 71.

The offsetting of the rods 65 and 66 by one-half grid line spacing enables an additional coordination of the main reinforcing rods at the node with those of the column reinforcement so that a desirable design of that node, which comprises a lot of steel, can be obtained.

The reinforcing element shown in FIG. 71 consists again of the same closing ladder L_6, which is composed of the spars 54 and the transverse rungs 55. The main reinforcing rods may be secured on top of this closing ladder as desired and as shown in FIG. 71. An offsetting of the grid has also been shown in this case; the offset grid lines are designated R'.

A modification for open basket-shaped reinforcements is shown in FIGS. 72 to 76. The reinforcing sec-

tions B_{7r} (FIG. 72) consist of angled rods **69**, which are provided with hooks at both ends, and of transverse rods **70**. The angle α preferably exceeds 90° so that the assembled baskets are rigid as a result of the internal stress.

FIG. **73** shows how the reinforcing section B_7 is hooked around the rod **76** at the main reinforcing element HL_1. The main reinforcing element HL_1 consists of the closing ladders L'_3, which comprises spars **72** and rungs **71**, and of the main reinforcing rods **73** to **76**, which are secured to the ladders L_3 as required. The reinforcing section B_7 is turned in the direction of arrow Pf_{19} until the rod **69** engages the rods **72**. Another section B_7 is then hooked onto the main reinforcing element on the other side and is turned until both reinforcing elements are in the position shown in FIG. **75**. The ends of the reinforcing sections B_7, or B_{71} and B_{7r}, are then approached to each other in the direction of arrows Pf_{20} to such an extent that the closing ladder L'_3 consisting of the rods **77** and **78** (FIG. **74**) can be applied in the direction of the arrow Pf_{21} onto the basket to form the open basket-shaped reinforcement TR_1 of FIG. **76**.

FIG. **77** shows a conventional column which is heavily reinforced. The basket-shaped reinforcement is generally designated S_1 and consists of the stirrups **79** and **80** and the main reinforcing rods **81** to **92**. The stirrup **80** serves in known manner to prevent a buckling of rods **86, 87, 91,** and **92**. The column reinforcement shown in FIG.**77** is only an example and has a width of 4 M and a height of 6 M. The same column reinforcement may be made from the modular system elements according to the invention, as shown in FIGS. **78** to **82**. FIG. **78** shows a reinforced closing ladder L_5 consisting of the spars **28** and rungs **44**. The ladder is reinforced by additional rungs **44***a*, which are aligned with the grid lines.

The closing ladder L_5 is angled about the axes I—I and II—II in FIG. **78**. This is shown in FIG. **80**. FIG. **79** is a sectional view showing the closing ladder. The main reinforcing rods **86** are secured on top of closing ladders L_5, which have been juxtaposed as required and have been angled. This is apparent from FIG. **80** and from the perspective view in FIG. **81**.

The resulting main reinforcing ladder is designated U. The distance between the reinforcing rungs **44***a* corresponds to the effective length of the main reinforcing rods **86** and **92**.

FIG. **82** shows the assembled column reinforcing basket-shaped column reinforcement, which consists of the reinforcing sections B_{1l} and B_{1r}. The main reinforcing ladders U and U_1 bear on the longitudinal rods **22** of the reinforcing sections B_1. The main reinforcing ladders U and U_1 can thus be fixed by simple manipulations.

The same concept has been embodied in the reinforcing sections which are shown in FIG. **83** and intended for elements of construction which are round in cross-section. The reinforcing sections consist of the circular rods **93**, which are joined to the retaining rods **94** at the crossings. The reinforcing sections are generally designated R and may be prefabricated as mesh elements and be subsequently bent. These reinforcing sections may be used in circular basket-shaped reinforcements.

FIG. **84** is a perspective view showing such reinforcing section. The spacing l_k between the rods **93** corresponds to the effective length of the carrying rods and may be selected to meet the requirements of a hooped column.

The assembling of the reinforcing sections R as shown in FIG. **83** to form circular basket-shaped reinforcements is shown in FIGS. **85** to **88**.

It is apparent from FIG. **85** how the reversely bent, hook-shaped end portion of an element R is hooked onto the edge rods **28** of the above-described main reinforcing ladder or closing ladder L_2. The main reinforcing sections R are then rotated in the direction of the arrow Pf_{22} until the rods **73** engage the spars **28** of the closing ladder L_2. The other section is hooked onto the closing ladder L_2 on the other side, as described, and is turned and the sections are thereafter pushed one into the other in the direction of arrows Pf_{23} until the closing ladder L_{2a} can be inserted in the upper portion of the reinforcing basket, as is apparent in FIG. **87**.

To illustrate how the assembly of the reinforcing section may be modified in this case too, FIG. **88** shows a column reinforcement which is made from the same reinforcing sections R but is smaller in diameter ($D_2 = 5$ M) than the reinforcement shown in FIG. **87**, where the diameter D = 6 M. The additional reinforcement is added as may be required either in the form of main reinforcing ladders designated L_{2a} in FIG. **87** or of an individual rod designated **96** in FIG. **88**.

I claim:

1. A reinforcement assembly for reinforced-concrete structures such as slabs, beams, columns and the like, said assembly comprising at least two reinforcing sections each comprising a plurality of stirrups lying in respective parallel planes and in mutually spaced relationship, said stirrups each having at least two legs at substantially right angles to one another, the ends of one leg of each of said stirrups being bent inwardly toward the other of said legs to form a loop, and at least one pair of longitudinal reinforcing rods lying in a common plane perpendicular to the planes of said stirrups and permanently affixed to the other leg thereof; and a further reinforcement member having longitudinally extending reinforcing rods parallel to the reinforcing rods of said sections, said sections and said member being interfitted so that said loops of said stirrups of said sections hook onto said reinforcing rods of said member.

2. The assembly defined in claim **1** wherein said member is of ladder construction with said rods thereof forming structures bridged by spaced apart rungs, said reinforcing rods of said member having a transverse spacing substantially equal to the distance between the bights of the loops of said stirrups and said other legs thereof as measured along said one legs thereof.

3. The assembly defined in claim **2** wherein said stirrups of said sections interdigitate with one another along said assembly.

4. The assembly defined in claim **3** wherein the stirrups of at least one of said sections are of generally C-shaped configuration and having a further leg projecting substantially at right angles from the other leg thereof and having a hooked extremity engaging one of the reinforcing rods of the other section.

5. The assembly defined in claim **3** wherein said sections and said members and dimensioned such that two legs of each stirrup must be deflected into an angle in excess of 90° upon assembly of said member and said section whereby said member and said sections are re-

tained under internal stress against relative displacement.

6. The assembly defined in claim 3 wherein said longitudinal rods of each section and said member are transversely spaced by a distance equal to the product of an integer and in unit distance.

7. The assembly defined in claim 3 wherein said member is provided with an eye and enabling manipulation thereof by a lifting device.

8. The assembly defined in claim 3 further comprising a planar reinforcement structure consisting of longitudinal and transverse reinforcing bars permanently fixed together overlying said sections parallel to said member and a hold-down structure engaging the longitudinal rods of said sections for locking said reinforcement structure thereagainst.

9. The assembly defined in claim 8 wherein said hold-down structure includes a pair of C-profile elements inserted between said stirrups of said sections from opposite direction and interfitting to retain said reinforcement structure in place.

10. The assembly defined in claim 3 wherein the stirrups of each of said sections generally of C-shaped configuration having further legs extending generally at right angles to their relative other leg and provided with loops at the extremity of said further legs, said assembly further comprising another member of ladder construction having parallel reinforcing rods interconnected by rungs and engaged by said loops of said further legs.

11. The assembly defined in claim 10 further comprising structures extending parallel to said members along the respective reinforcing rods thereof and interconnecting said members together.

12. The assembly defined in claim 11 wherein said structures are formed by transverse reinforcing stirrups hooked over the reinforcing rods of both said members and reinforcing rods extending longitudinally across said stirrups of said structures and permanently bonded thereto.

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