No. 681,364. Patented Aug. 27, 1901.

C. ELIET.

CONCRETE FLOOR.

(Application filed Nov. 16, 1900.)

(No Model.) 5 Sheets—Sheet 1.

Fig. 1.

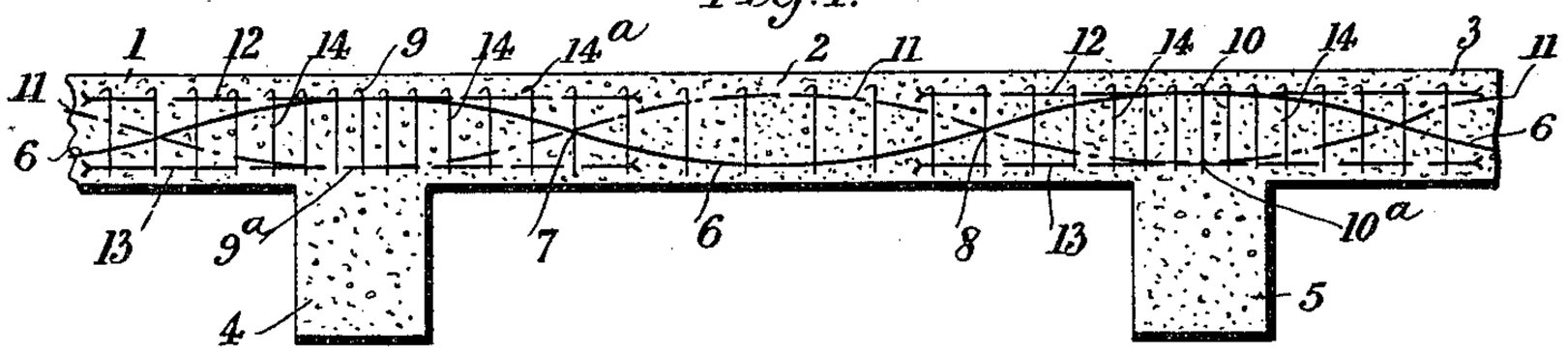


Fig. 2.

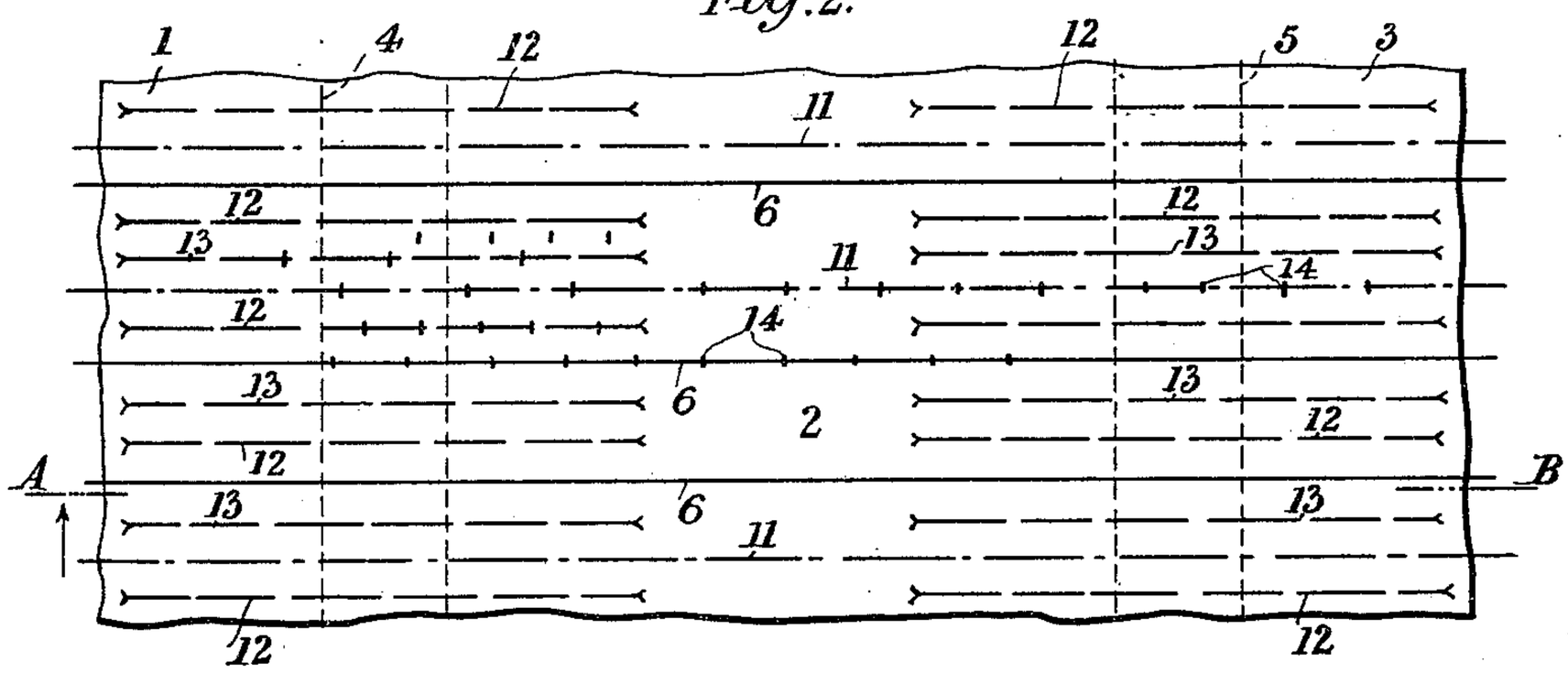


Fig. 3.

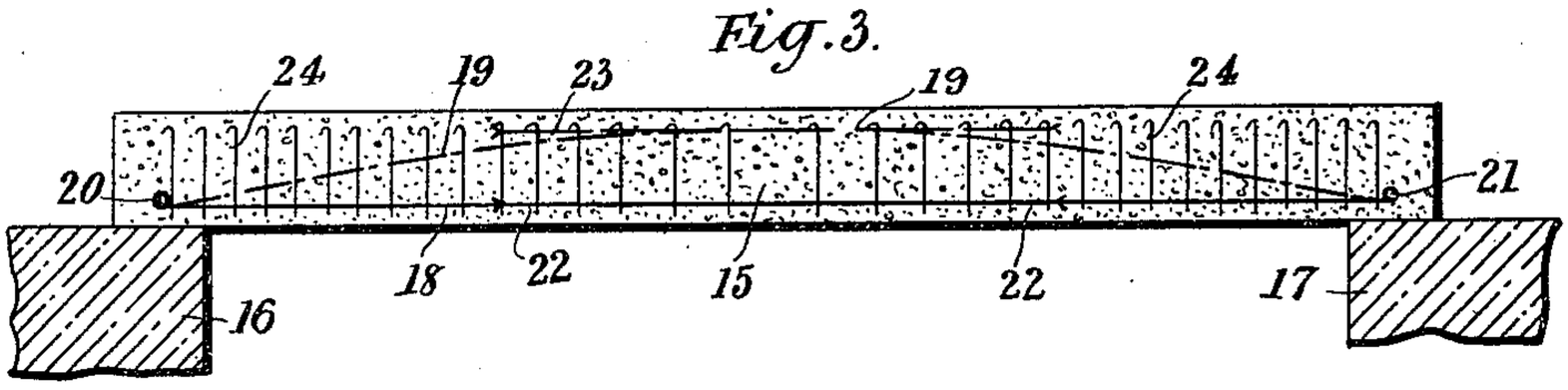
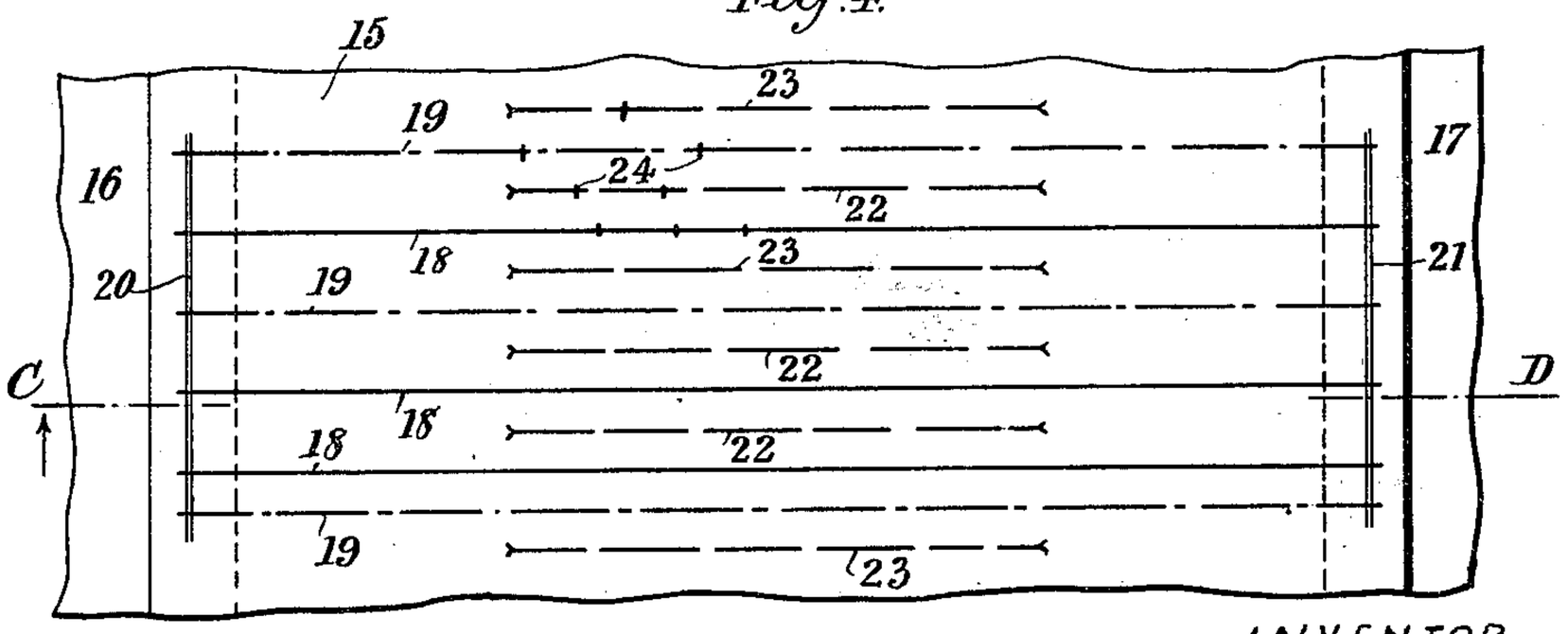


Fig. 4.



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By his Attorneys:

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No. 681,364. Patented Aug. 27, 1901.

C. ELIET.

CONCRETE FLOOR.

(Application filed Nov. 16, 1900.)

(No Model.) 5 Sheets—Sheet 2.

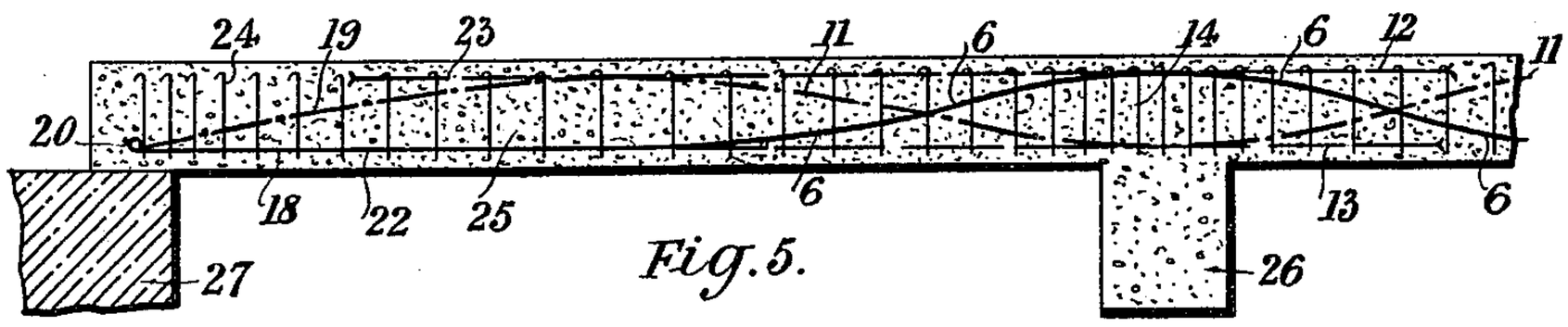


Fig. 5.

Fig. 6.

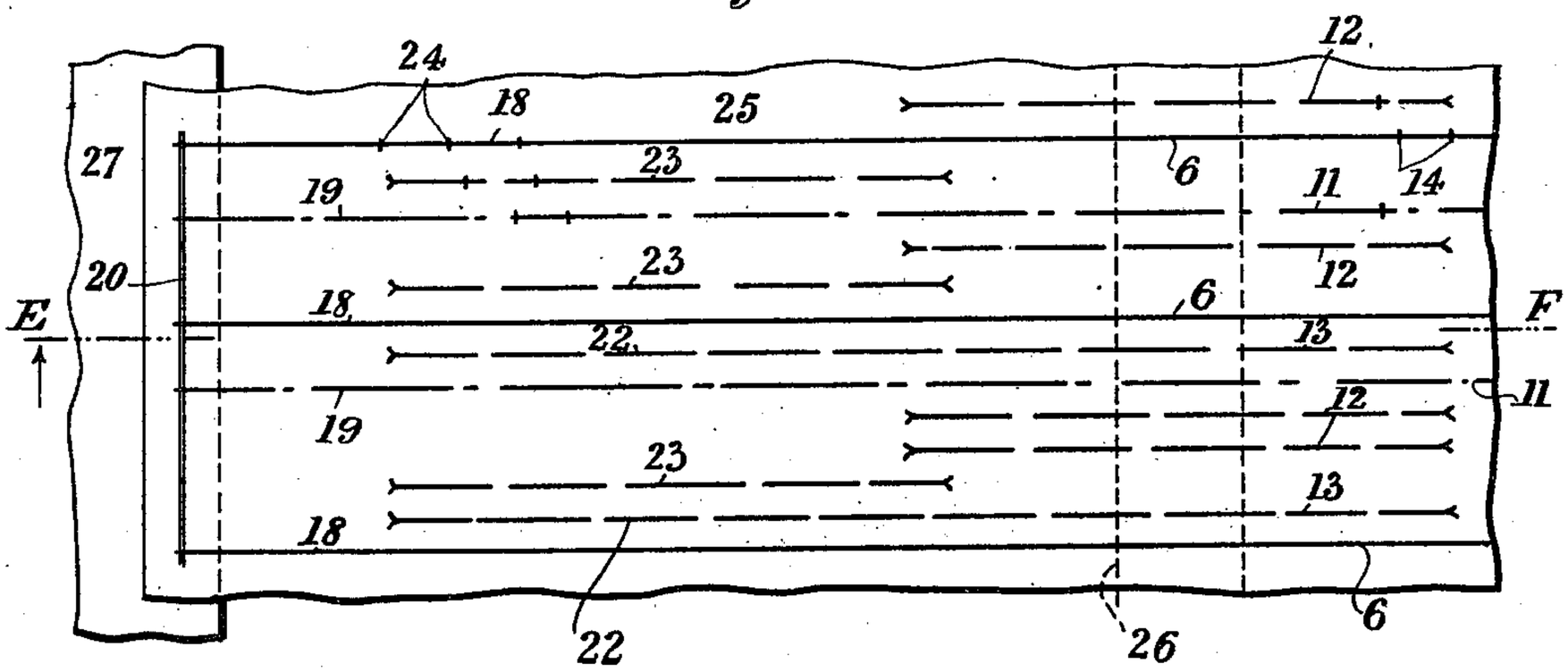
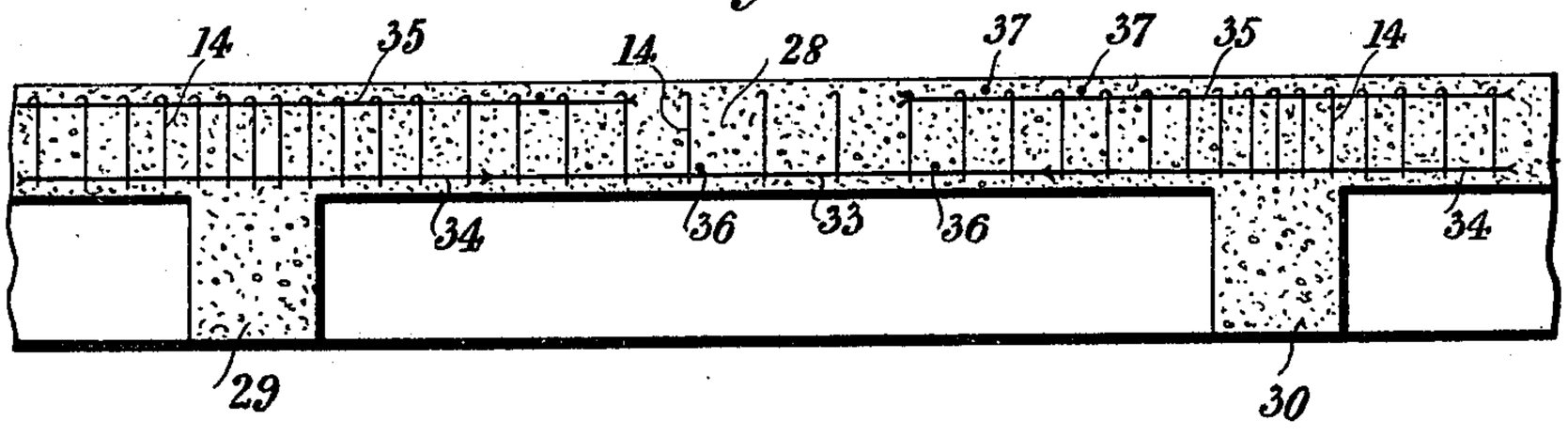


Fig. 7.



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No. 681,364. Patented Aug. 27, 1901.

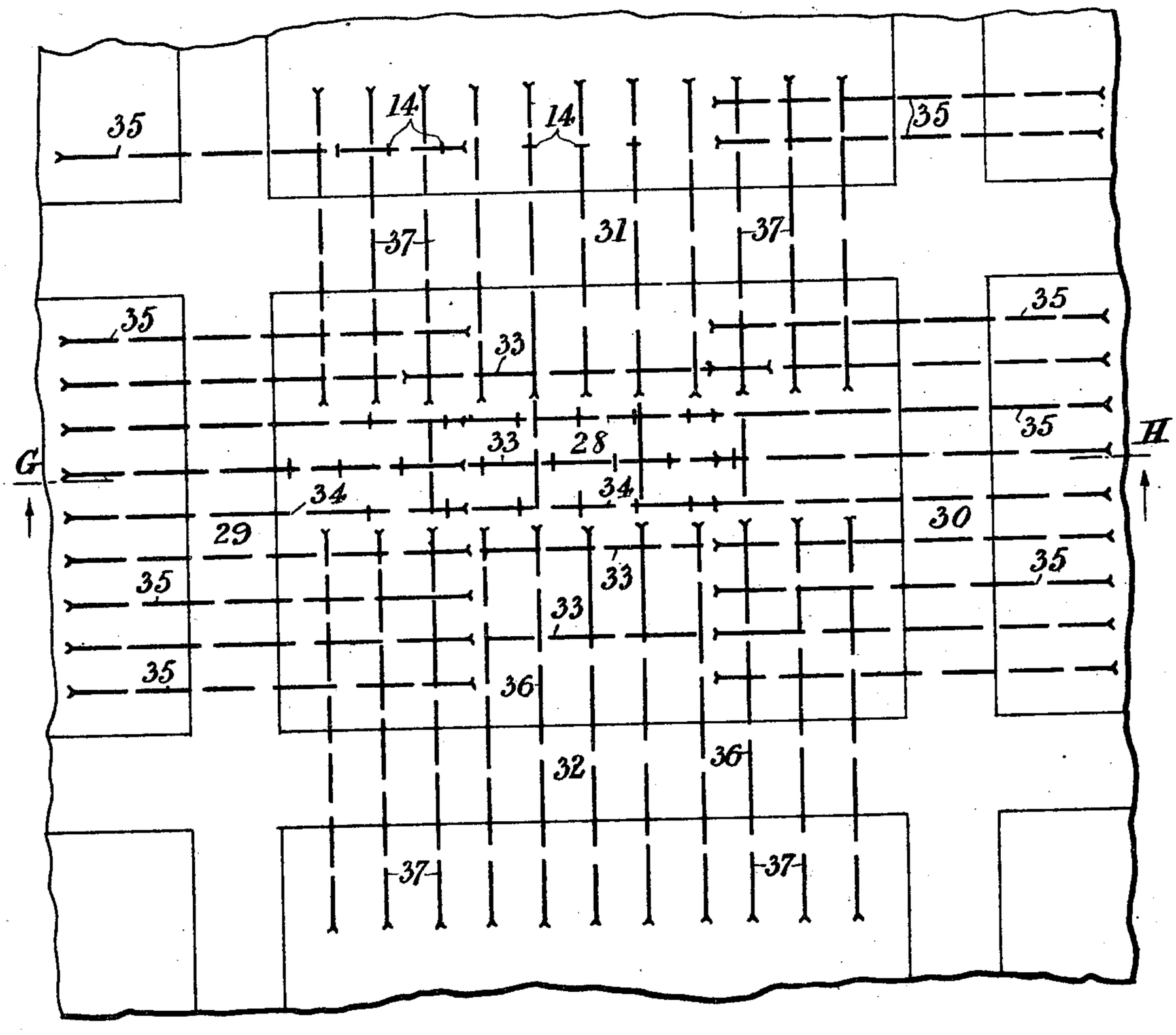
C. ELIET.

CONCRETE FLOOR.

(Application filed Nov. 16, 1900.)

(No Model.) 5 Sheets—Sheet 3.

Fig. 8.



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No. 681,364. Patented Aug. 27, 1901.

C. ELIET.

CONCRETE FLOOR.

Application filed Nov. 16, 1900.

(No Model.) 5 Sheets—Sheet 4.

Fig. 9.

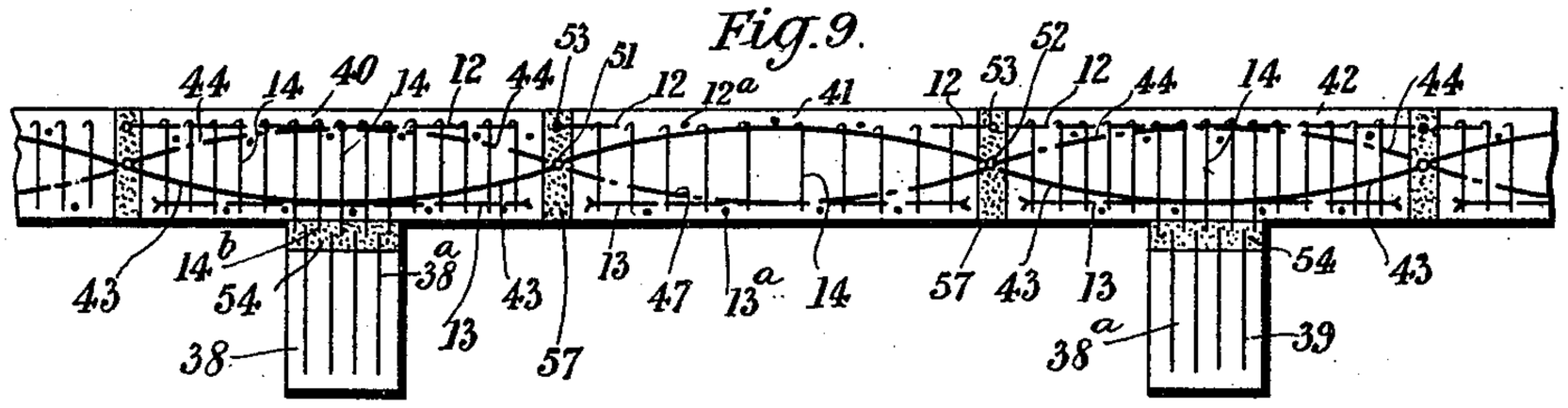


Fig. 10.

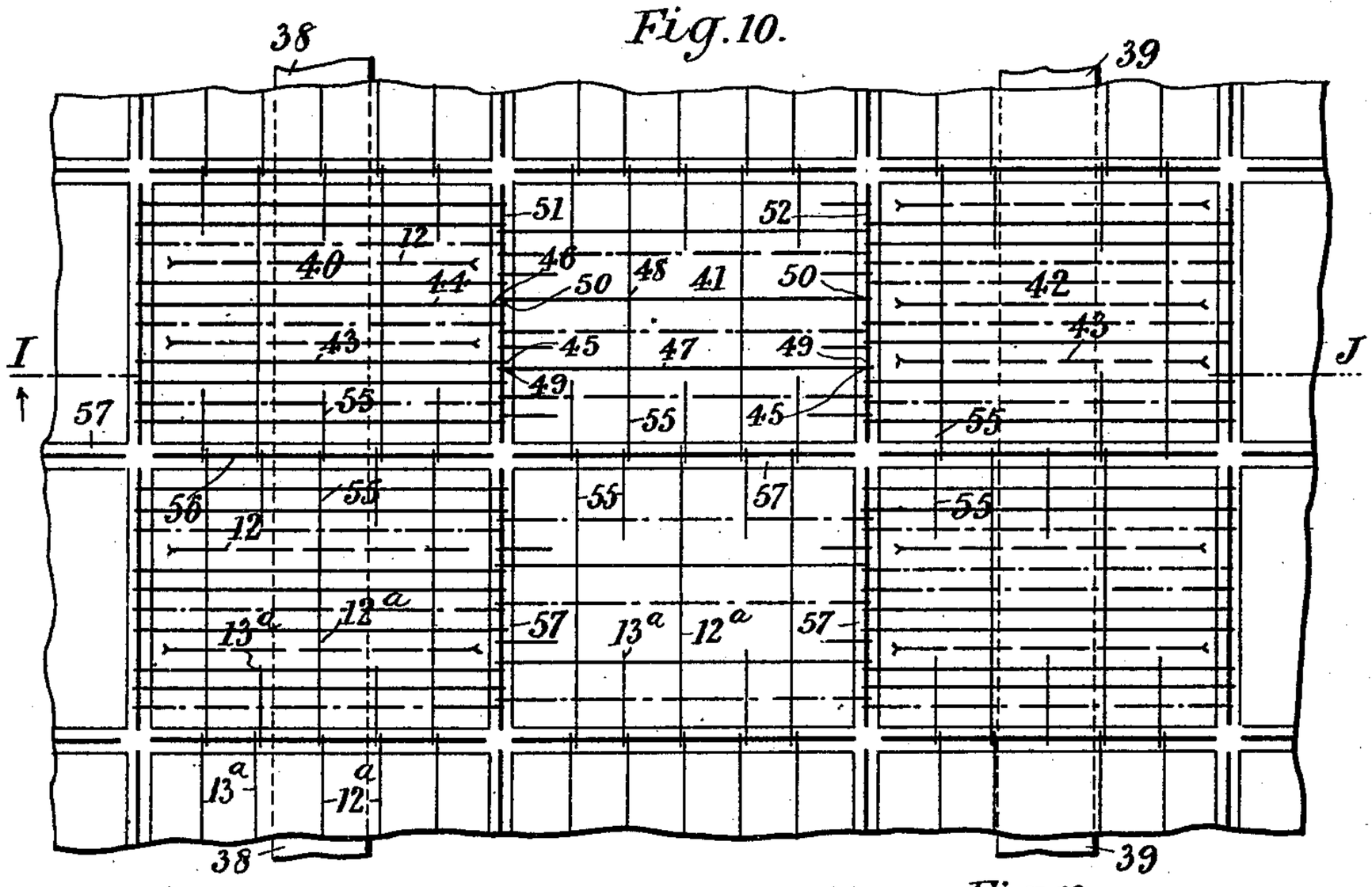


Fig. 11.

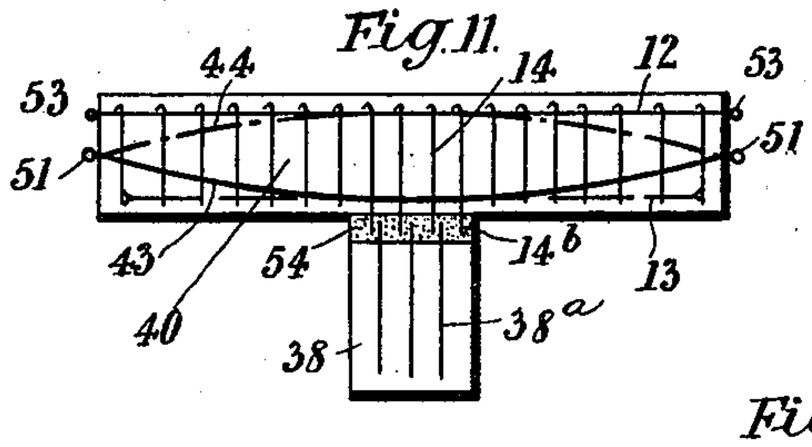


Fig. 12.

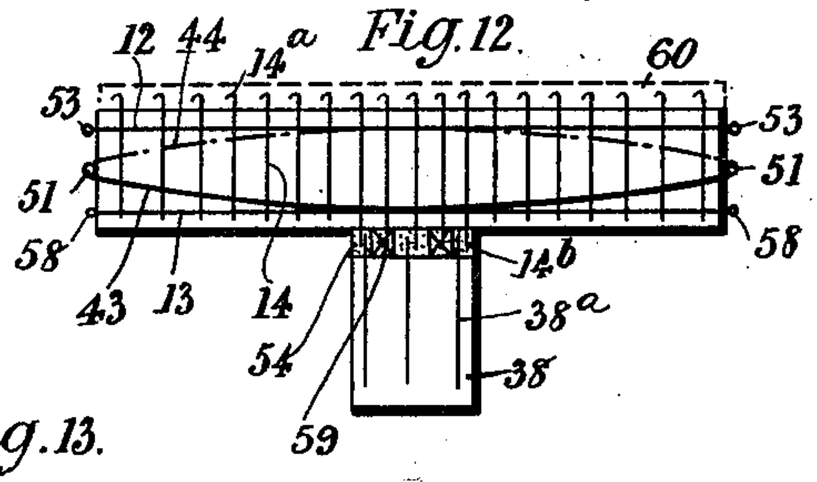
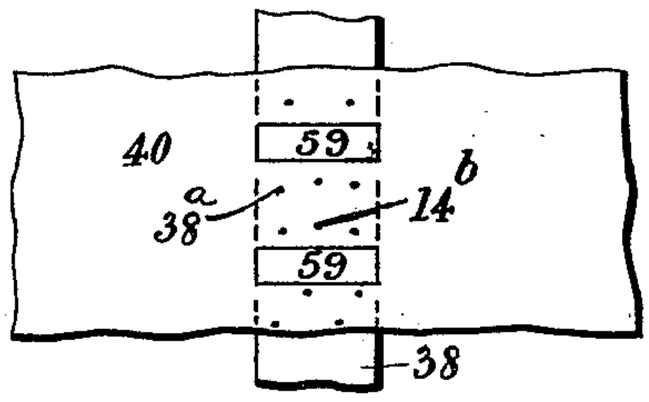


Fig. 13.



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No. 681,364. Patented Aug. 27, 1901.

C. ELIET.

CONCRETE FLOOR.

(Application filed Nov. 16, 1900.)

(No Model.) 5 Sheets—Sheet 5.

Fig. 14.

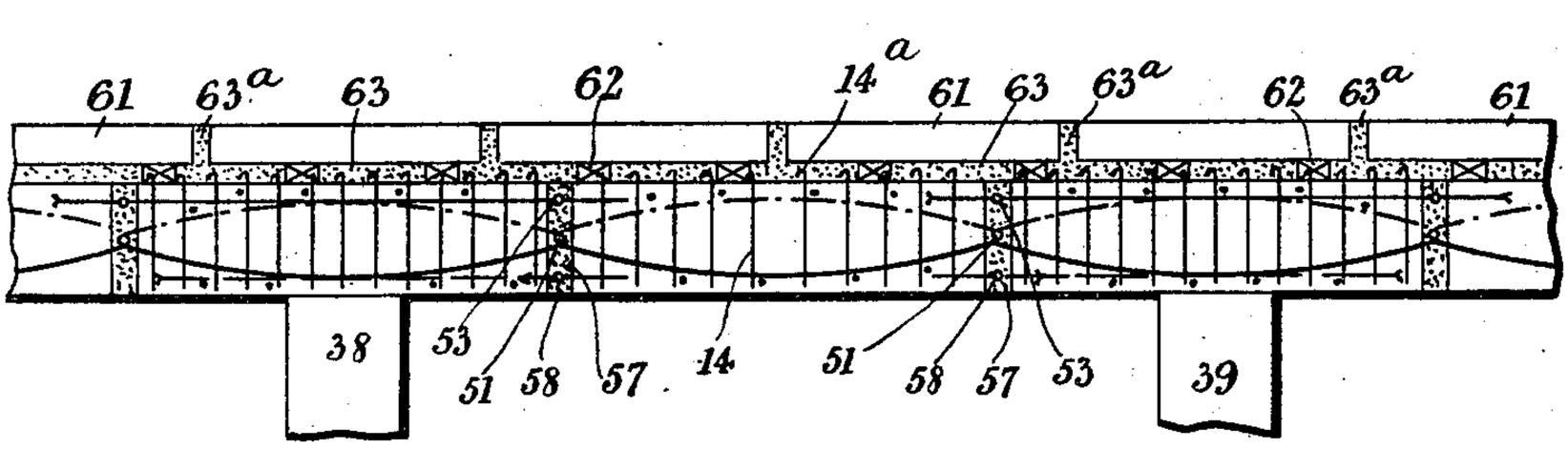


Fig. 15.

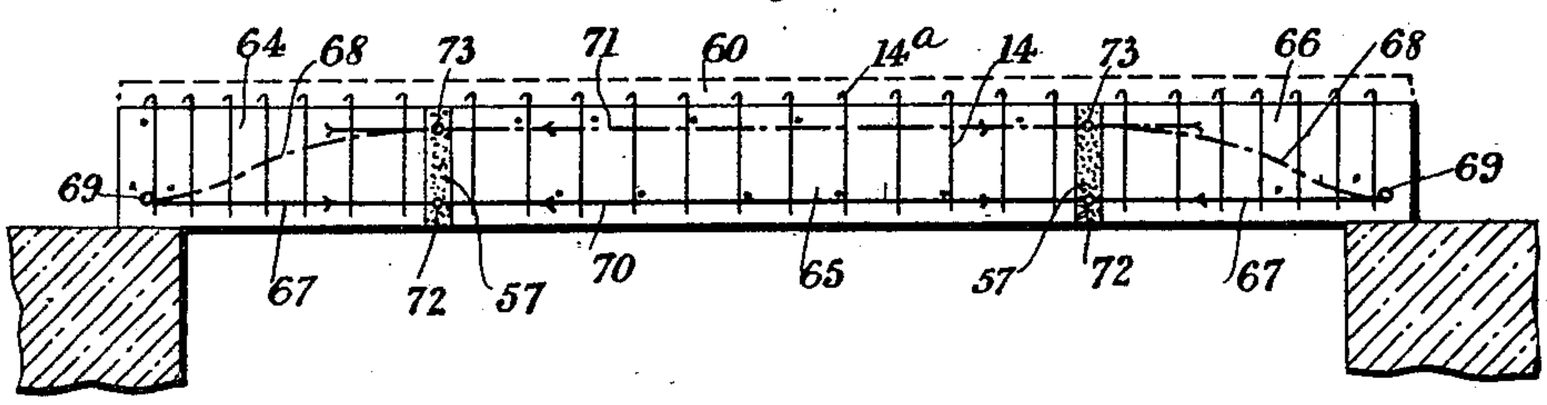


Fig. 16.

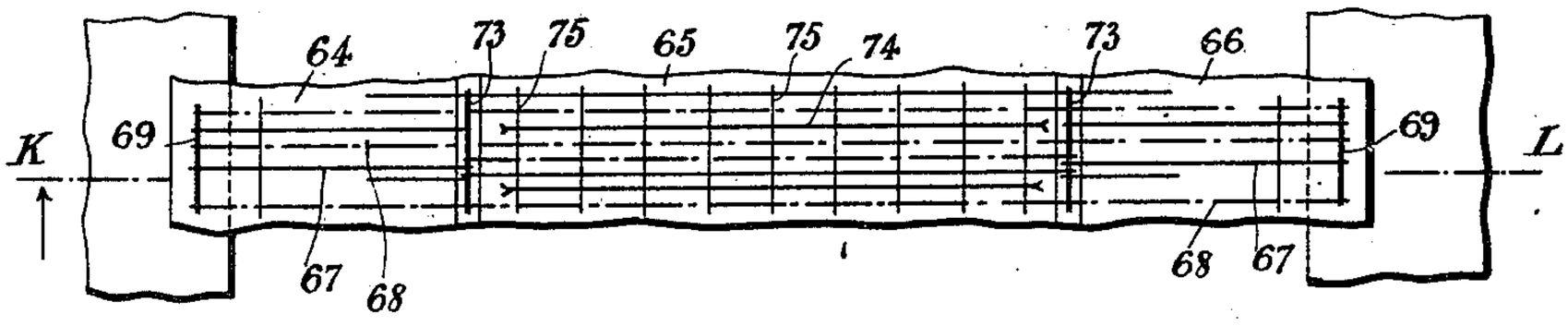
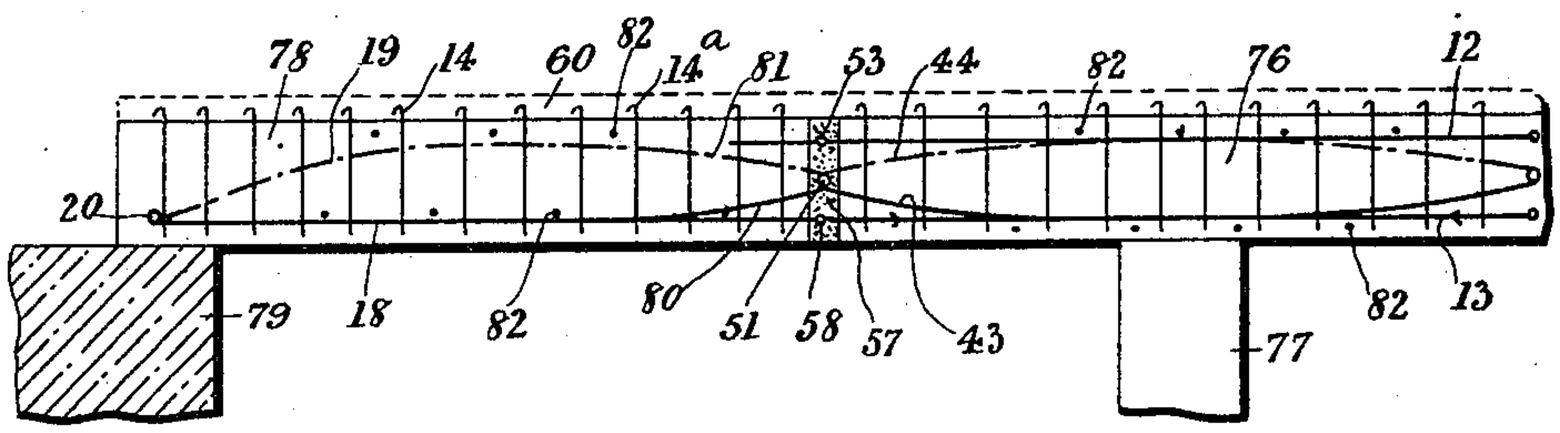


Fig. 17.



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By his Attorneys:

Arthur G. Fraser & Co.

UNITED STATES PATENT OFFICE.

CONSTANT ELIET, OF LORIENT, FRANCE, ASSIGNOR TO HIMSELF, AND GUSTAVE LOUIS MOUCHEL, OF LONDON, ENGLAND.

CONCRETE FLOOR.

SPECIFICATION forming part of Letters Patent No. 681,364, dated August 27, 1901.

Application filed November 16, 1900. Serial No. 36,704. (No model.)

To all whom it may concern:

Be it known that I, CONSTANT ELIET, civil engineer, of 24 Rue Bellefontaine, Lorient, France, have invented certain new and useful Improvements in Concrete Floors, of which the following is a specification.

This invention relates to improvements in concrete floors; and it has for its object to construct such floors with strengthening skeletons composed of rods or bars of any cross-section and dimensions and of any suitable metal embedded in the concrete of the floors and arranged in such a manner as to effectually counteract the strains set up in a concrete floor subjected to shearing and bending stresses. As a floor may be considered to be composed of a number of beams arranged close together side by side, the improvements of this invention will be equally applicable to concrete beams.

According to this invention a floor is preferably constructed of concrete of uniform thickness between its supports, and the reinforcing of the floor necessitated by the different strains of the various parts of a floor is effected by arranging metal bars at those parts to take up the greater portion of said strains. Thus metal bars are arranged in those parts of the concrete floor which are subjected to tension because concrete has a comparatively low tensile strength. Metal bars may also be arranged in those parts of the concrete floor which are subjected to compression; but in such cases, as concrete has a comparatively high compression strength, their main object is to counteract the tendency of the concrete to slide upon itself and become disintegrated in the form of horizontal layers under high bending stresses. These last-mentioned bars combined with the first-mentioned bars form a kind of cantaliver, and thereby increase the strength of the floor. All or any of the above-mentioned bars of one kind of strain may be continuous or suitably connected together or they may be suitably disconnected. They may be straight or curved and preferably extending over the several parts of the floor subjected to the said kind of strain. Adjacent disconnected bars of one kind of strain are preferably arranged to overlap each other at their adjacent ends. When the bars of one kind of strain are continuous or connected together, they may form a continuous curve extending from one to another of similarly-strained parts throughout the length of the floor. To counteract the shearing strains in the floor, straight metal bars are arranged in the concrete at the points where the variations of bending moments are a maximum. These bars are preferably arranged at an angle equal to or less than a right angle to the axis of the floor, considered as a beam at those points.

Concrete floors constructed according to this invention may be molded in one piece during erection or they may be built up of a number of floor sections or slabs constructed on the same principle and connected together by grouting or in any other suitable manner.

The tension and compression bars of any one floor section or slab are connected together, preferably, by connections arranged at the points of the least bending moments. In this manner floors of large size may be built of a number of floor sections or slabs of convenient size, which, having been made long beforehand, are properly set and seasoned. By this means time and money are saved, as there is no necessity for erecting complicated and costly centering for the concrete of the floor nor is there any necessity for waiting for the concrete of the floor to dry and set before being put into use.

In the accompanying drawings, Figure 1 is a vertical section on the line A B of Fig. 2, and Fig. 2 a plan of a floor fixed at both ends. Fig. 3 is a vertical section on the line C D of Fig. 4, and Fig. 4 is a plan of a floor free at both ends. Fig. 5 is a vertical section on the line E F of Fig. 6, and Fig. 6 is a plan of a floor fixed at one end and free at the other end. Fig. 7 is a vertical section on the line G H of Fig. 8, and Fig. 8 is a plan of a modification. Fig. 9 is a vertical section on the line I J of Fig. 10, and Fig. 10 is a plan of a floor built up of ready-made sections. Figs. 11 and 12 are vertical sections, and Fig. 13 is a part plan showing details. Fig. 14 is a vertical section of a cantaliver floor with cement pavement. Fig. 15 is a vertical section on the line K L of Fig. 16, and Fig. 16 is a plan

of a sectional floor resting freely on its end supports. Fig. 17 is a vertical section of a sectional floor resting freely on one end support and fixed at the other end.

Referring first to Figs. 1 and 2, 1 2 3 are successive spans of a concrete floor supported by beams 4 and 5. These spans are molded in one piece with one another and with the beams 4 5, so that the middle span 2 is to be considered as a floor fixed at both ends—that is to say, at the junctions with the adjacent spans 1 3 in the vertical central planes of the supporting-beams 4 5. 6 represents bars of iron, steel, or other metal of any suitable cross-section and dimensions embedded in the concrete of the floor-span 2 and arranged parallel to one another, as indicated in full lines in Fig. 2. These bars 6 take up the tensile strains in the span 2. For this purpose they are arranged in the center of the span as near as practicable to the lower surface of the floor, and each bar is continued thence in both directions in an upward curve, having its concave side facing upward to the horizontal center plane of the floor, (indicated by the points 7 8,) whence each bar is further continued in an upward curve, having its concave side facing downward to the points 9 10, which are located as near as practicable to the upper surface of the floor in the central vertical planes of the beams 4 5. From these planes, which may be considered as dividing the span 2 from its adjacent spans 1 and 3, the bars 6 are continued in downward curves to near the lower surfaces of their respective spans 1 3 in a similar manner to that shown in span 2. Each tension-bar 6 is preferably made continuous from end to end of the floor either by being made in one complete length, as shown, or by being made up of successive shorter lengths connected together in any suitable way or simply overlapping each other at their ends. 11 represent bars of iron, steel, or other metal, of any suitable cross-section and dimensions, embedded in the concrete of the floor-span 2 and arranged parallel to one another, as indicated in dash-dotted lines in Fig. 2. These bars 11 take up principally the horizontal shearing strains and also in part the compression strains arising in the span. These compression-bars 11 are arranged in the reverse manner to that of the tension-bars 6—that is to say, each bar 11 starts from the upper central portion of the span 2 and is continued thence in both directions with a downward curve, having its concave side facing downward, to the planes 7 8, whence the downward curve of the bar is continued with its concave side facing upward to the points 9^a 10^a, located as near as practicable to the lower surface of the floor in the central vertical planes of the beams 4 5. From these points the bars are carried into the adjacent spans 1 3. The bars 11 are preferably also made continuous in the same way as described in connection with the bars 6. The combined arrangement of the bars 6 and 11, embedded in the concrete of the floor over each beam, constitutes a skeleton cantaliver which is supported by the beam and which is connected by the central skeleton girder, composed of the central curved portions of the bars 6 11, to the cantaliver or the other beam. 12 represents straight bars of iron, steel, or other metal, of any suitable cross-section and dimensions, embedded in the concrete of the floor. They are arranged parallel to one another horizontally over the supporting-beams 4 5. They aid in taking up the tensile strains at the points where these are at their maximum—namely, over the beams or points of support where the ends of the floor are rigidly fixed. 13 represents bars embedded parallel to one another in the concrete of the lower portion of the floor, over the supporting-beams 4 5, to help to take up the compression strains at these points. 14 represents short bars of iron, steel, or other metal, of any suitable cross-section and dimensions, embedded in the concrete parallel to one another in vertical planes, to take up the shearing strains. These bars 14 are arranged closer together over the supporting-beams 4 5 and farther apart in the center of the spans. They may be quite straight, but they are preferably hooked at their upper ends as shown at 14^a, to overlap the bars 12. The bars 14 may also be hooked at their lower ends to overlap the bars 13. A few only of these bars 14 are shown in Fig. 2.

In the floor shown in Figs. 3 and 4, in which the concrete span 15 is not molded in one piece with its supports 16 17, but rests freely thereon, the bending moments are least at the supports and are greatest at the center, while the shearing strains are greatest at the supports. Consequently the tension-bars 18 are arranged near the lower surface of the floor and are made straight. The compression-bars 19 are led in a downward curve in both directions from the center of the upper part of the floor, with the concave side of the curve facing downward to the theoretical bearing-centers of the supports 16 17, where the ends of the bars 18 and 19 are preferably connected together in any suitable way conveniently by passing rods 20 21 through the adjacent ends of the bars 18 19, the ends of these bars being bent to form eyes to receive said rods. These bars may, however, be connected together in any other suitable manner. 22 23 are horizontal straight bars to take up, respectively, the tension and compression strains in the lower and upper parts of the center of the floor. 24 represents vertical straight bars to take up the shearing strains in the floor.

Figs. 5 and 6 illustrate the application of this invention to a concrete floor 25, which is supported at one end by and molded in one piece with a beam 26 and which at its other end rests freely on a support 27. In this case that half of the floor which is nearest to the beam 26 is provided with a metal cantaliver-

framework, constructed as shown in Figs. 1 and 2—that is to say, with curved tension-bars 6, curved compression-bars 11, and with horizontal upper straight bars 12 and lower bars 13 for taking up, respectively, the tension and compression strains, and also with straight vertical bars 14 for taking up the shearing strains. That half of the floor nearest to the support 27 will have its metal framework constructed as shown in Figs. 3 and 4—that is to say, with straight tension-bars 18 and curved compression-bars 19 connected together at their ends in any suitable way on the support 27 by means of a rod 20. It will also have straight horizontal bars 22 extending across the lower central portion of the span and straight horizontal bars 23 extending across the upper central portion of the span. 14 and 24 are the straight vertical bars to take the shearing strains near the beam 26 and support 27, respectively. It is preferred to connect the bars 6 18 together and the bars 11 19 together and also the bars 13 22 together either by means of suitable connections or, as shown, by making the said bars continuous.

Figs. 7 and 8 illustrate a floor 28, whose length is not more than about twice its width and which is supported on and molded in one piece with four beams 29 30 31 32, arranged at right angles to one another. In this case it would be logical to arrange curved tension and compression bars both lengthwise and across the floor; but as the use of curved bars has been found to be very inconvenient in this particular case it is preferred to employ straight horizontal bars 33, extending from end to end of the floor, with shorter straight horizontal bars 34 in the lower portion of the floor and short straight horizontal bars 35 in the upper portion of the floor in one direction, and in the other direction to employ in the lower part of the floor straight horizontal bars 36, extending from end to end of the floor, and in the upper portion of the floor shorter straight horizontal bars 37, while an increased number of vertical straight bars 14 are used.

Figs. 9 and 10 show a floor-span, fixed at both ends, built up of a number of floor sections or slabs constructed beforehand on the principles of the arrangement shown in Figs. 1 and 2 and supported by two transverse beams 38 39. I shall describe first, by way of example, the three floor sections or slabs 40 41 42. The slabs 40 42, arranged centrally on their respective supporting-beams 38 39, are constructed with a metal framework on the cantaliver system described with reference to Figs. 1 and 2. 43 indicates the curved compression-bars, and 44 indicates the curved tension-bars, arranged as described, and shown in these figures, and leading, respectively, from the lower and upper central portions of the slabs to near the horizontal center lines of the ends of the said slabs, where the said bars project from the concrete respectively in the form of eyes 45 46, situated in the horizontal center line of the floor. The center slab 41 is constructed with curved tension-bars 47 and compression-bars 48, which are similarly carried out from the ends of the slab and are formed, respectively, with eyes 49 50, situated in the horizontal center line of the floor. Rods 51 52 are passed through the eyes 45 46 50 at the ends of the slab 41. Any suitable connections other than rods and eyes may also be used to connect the bars together. 12 indicates the bars for taking up the vertical shearing strains in the upper portion of the slabs. The corresponding bars of adjacent slabs are arranged to project into the space between the slabs, where they are connected together by any suitable means, preferably by means of rods 53, which pass through the eyed ends of the said bars. (Shown more clearly in Fig. 11.) 13 indicates the bars for taking up the shearing strains in the lower portions of the slabs. 14 indicates the vertical bars for taking up the shearing strains in the slabs. 12^a and 13^a are bars for taking up the transverse shearing strains in the upper and lower parts, respectively, of the slabs. The slabs 40 42 are conveniently secured on the beams 38 39 by allowing some of the vertical bars 14 to project with their lower ends 14^b below the lower surface of the slabs and arranging vertical bars 38^a, embedded in the beams, to project beyond the upper surface of the beams and filling the space between the beams and the slabs and between and around the bars 14^b and 38^a with grout 54, whereby a firm connection is produced between the slabs and the beams. Transverse horizontal bars 55 are embedded in the slabs and project into the space between the slabs and may be connected in any suitable manner, preferably by rods 56, passing through their eyed ends. Grout 57 is run into the spaces left all around the slabs, whereby a firm joint is produced between adjacent slabs. If desired, corresponding bars 13 of adjacent slabs may also be formed with eyes and connected together by means of transverse rods 58, as shown in Fig. 12, or they may be connected together in any other suitable manner. Figs. 12 and 13 show a method of obtaining additional firmness of joint between the slabs and the beams, which consists in forming lugs 59 on the under side of the slabs, said lugs bearing upon the beams. The space between the slabs and the beams and around and between the lugs is then filled with cement 54, which also surrounds the rod ends 14^b. The rods 14 are arranged to project with their upper ends 14^a beyond the upper surface of the slabs for the purpose of being embedded in, and thereby securing an upper pavement of cement 60, Fig. 12.

Fig. 14 shows a cantaliver-floor carrying an upper pavement composed of ready-made slabs 61, formed with lugs 62, resting on the upper surface of the floor, so as to leave a space into which project the hooks 14^a of the

bars 14. The slabs 61 are connected to the floor by means of grout 63, run in between the slabs and the beams or supports, and the said slabs are also connected to one another by grout joints 63^a.

Figs. 15 and 16 show a floor resting freely on supports at its ends and made up of three sections or slabs 64 65 66. The two end slabs 64 66 are constructed, in accordance with the principles described with reference to Figs. 3 and 4, with straight horizontal tension-bars 67 and curved compression-bars 68, connected at their outer ends in any suitable manner, preferably by means of eyes and rods 69. The central slab 65 has straight longitudinal tension-bars 70 and straight longitudinal compression-bars 71. The tension-bars 70 are connected at their ends by rods 72 to the tension-bars 67 of the other slabs, and the compression-bars 71 are connected at their ends by rods 73 to the compression-bars 68 of the said slabs. 74 indicates longitudinal bars to take up the tensile strains. They may similarly be connected to the corresponding bars in the other slabs. 75 indicates transverse bars.

Fig. 17 shows a floor comprising a slab 76, which is fixed over the support 77, and a slab 78, which rests freely on a support 79. The slab 78 is constructed with straight tension-bars 18 and curved compression-bars 19 in its left-hand half and with curved tension-bars 80 and curved compression-bars 81 in its right-hand half. The tension-bars 18 and 80 form continuous bars, which are carried up to the horizontal center line of the end of the slab, where they are connected by a rod 51 to the corresponding tension-bars 44 of the slab 76. The compression-bars 19 and 81 also form continuous bars which are similarly connected to the corresponding compression-bars 43 of the slab 76. 82 indicates transverse bars in each slab.

In all the constructions hereinbefore described the horizontal bars for taking up the shearing strains may be arranged at any desired angle with the longitudinal axis of the floor.

Beams and girders may also be constructed according to this invention.

Walls of reservoirs and silos, retaining-walls, and, in general, all walls subjected to lateral pressure (which may be considered as being upright floors) may be constructed, as above described, either in one piece or of sections or slabs, in accordance with this invention by suitably arranging the supports to take up lateral pressure.

What I claim, and desire to secure by Letters Patent, is—

1. In a concrete floor, the combination of a concrete body, curved metal tension-bars embedded in said concrete body, and arranged with their concave sides facing upward at the center of said body, and with their concave sides facing downward over the supports of said body, and curved metal compression-bars embedded in said concrete body and arranged with their concave sides facing downward at the center of said body and with their concave sides facing upward over the supports of said body, substantially as set forth.

2. In a concrete floor, the combination of a concrete body, metal tension-bars embedded in and connecting the parts of said body which are subjected to tensile strains, metal compression-bars embedded in and connecting the parts of said body which are subjected to compression strains, and horizontal metal shear-bars embedded in the parts of said body which are subjected to shearing strains, substantially as set forth.

3. In a concrete floor, the combination of a concrete body, straight horizontal metal tension-bars embedded in the lower stratum of said body, curved metal compression-bars embedded in the upper stratum of said body and arranged with their concave sides facing downward between the supports of said body, straight horizontal metal shear-bars embedded in the upper stratum of said body, straight horizontal metal shear-bars embedded in the lower stratum of said body and straight vertical metal shear-bars embedded in said body, substantially as set forth.

4. In a concrete floor, the combination of metal tension-bars embedded in the upper stratum of said body over the supports thereof, metal compression-bars embedded in the lower stratum of said body over the supports thereof, horizontal metal shear-bars embedded in the upper stratum of said body, and horizontal metal shear-bars embedded in the lower stratum of said body, substantially as set forth.

5. In a concrete floor, the combination of longitudinal metal tension-bars embedded in said body, longitudinal metal compression-bars embedded in said body, vertical metal shear-bars embedded in said body and transverse bars embedded in said body, substantially as set forth.

6. In a concrete floor, the combination of a concrete body, curved longitudinal metal tension-bars embedded in said body and arranged with their concave sides facing downward between the supports of said body and curved longitudinal metal compression-bars embedded in said body and arranged with their concave sides facing upward between the supports of said body, substantially as set forth.

7. In a concrete floor, the combination of a concrete body, curved metal tension-bars embedded in the upper stratum of said body and arranged with a downwardly-facing concave curvature from near the highest central point of said body to near the central points of the ends of said body, curved metal compression-bars embedded in the lower stratum of said body and arranged with an upwardly-facing concave curve from near the lowest central point of said body to near the central points of the ends of said body, and a support ar-

ranged centrally under said body, whereby said body is rendered a cantaliver carried by said support, substantially as set forth.

8. In a concrete floor, the combination of supports carrying said floor, a concrete body arranged over each support and having embedded in it curved metal tension-bars and curved metal compression-bars forming a cantaliver, concrete bodies arranged between the aforesaid bodies, means for connecting the metal tension-bars of each body with the corresponding metal tension-bars of the adjacent bodies, means for connecting the metal compression-bars of each body with the corresponding metal compression-bars of the adjacent bodies, and cement filling up the space between adjacent bodies and around the aforesaid means for connecting the metal bars of adjacent bodies, substantially as set forth.

9. In a concrete floor, the combination of a concrete body, metal tension-bars embedded in said body, metal compression-bars embedded in said body, horizontal metal shear-bars embedded in said body and vertical metal shear-bars embedded in said body and projecting with retaining ends beyond the surface of said body, substantially as set forth.

In witness whereof I have hereunto signed my name in the presence of two subscribing witnesses.

CONSTANT ELIET.

Witnesses:
ALEXANDRE LOUIS CHARPENTIER,
PIERRE MARIE FÉFEU.