No. 707,924. Patented Aug. 26, 1902.

F. HENNEBIQUE.

CEILING STRUCTURE COMPOSED OF BETON AND IRON.

(Application filed May 22, 1902.)

(No Model.) 3 Sheets—Sheet 1.

Fig. 1

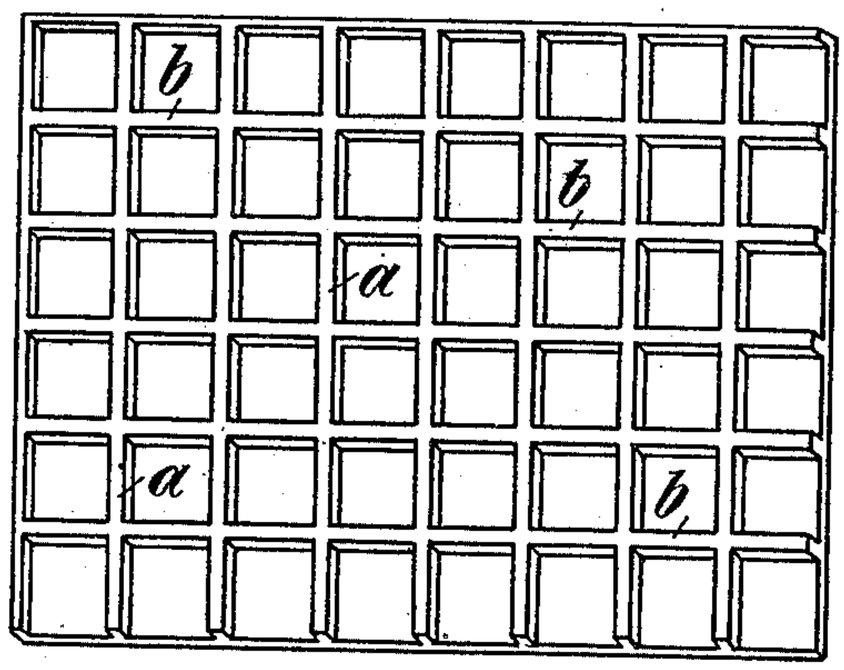


Fig. 4

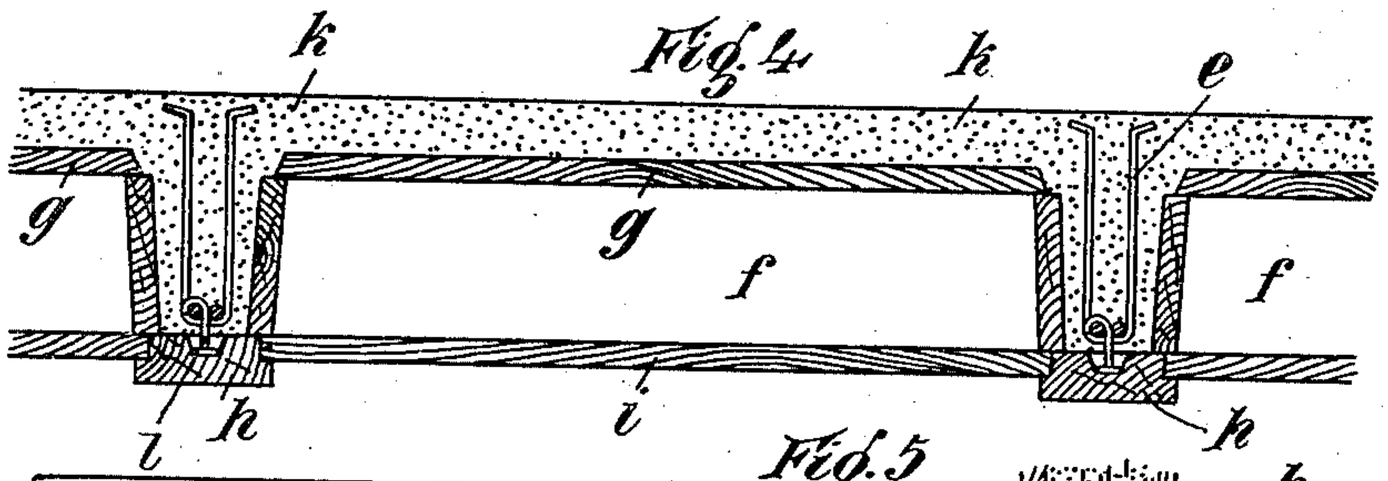
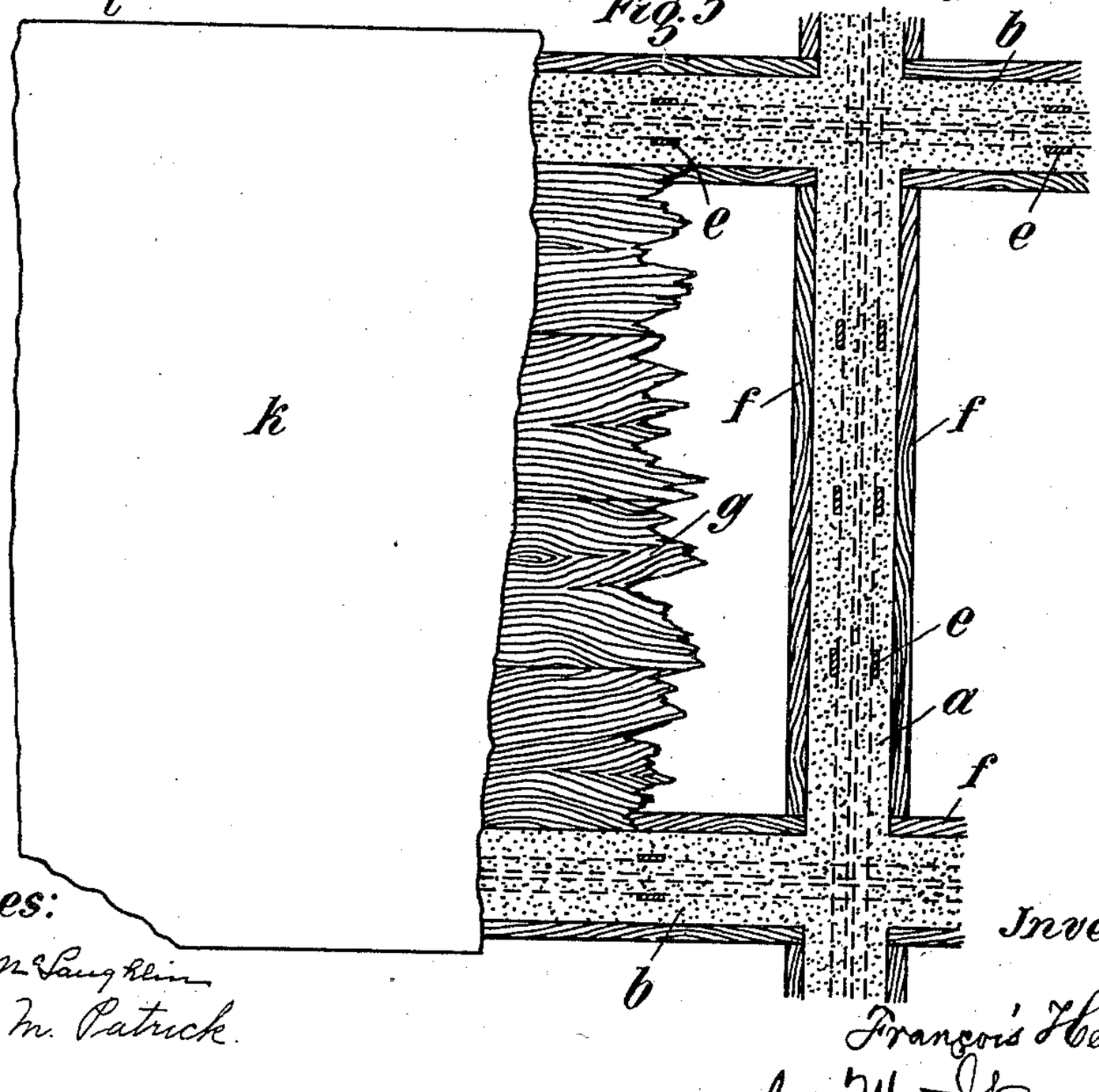


Fig. 5



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Florence M. Patrick.

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(No Model.) 3 Sheets—Sheet 2.

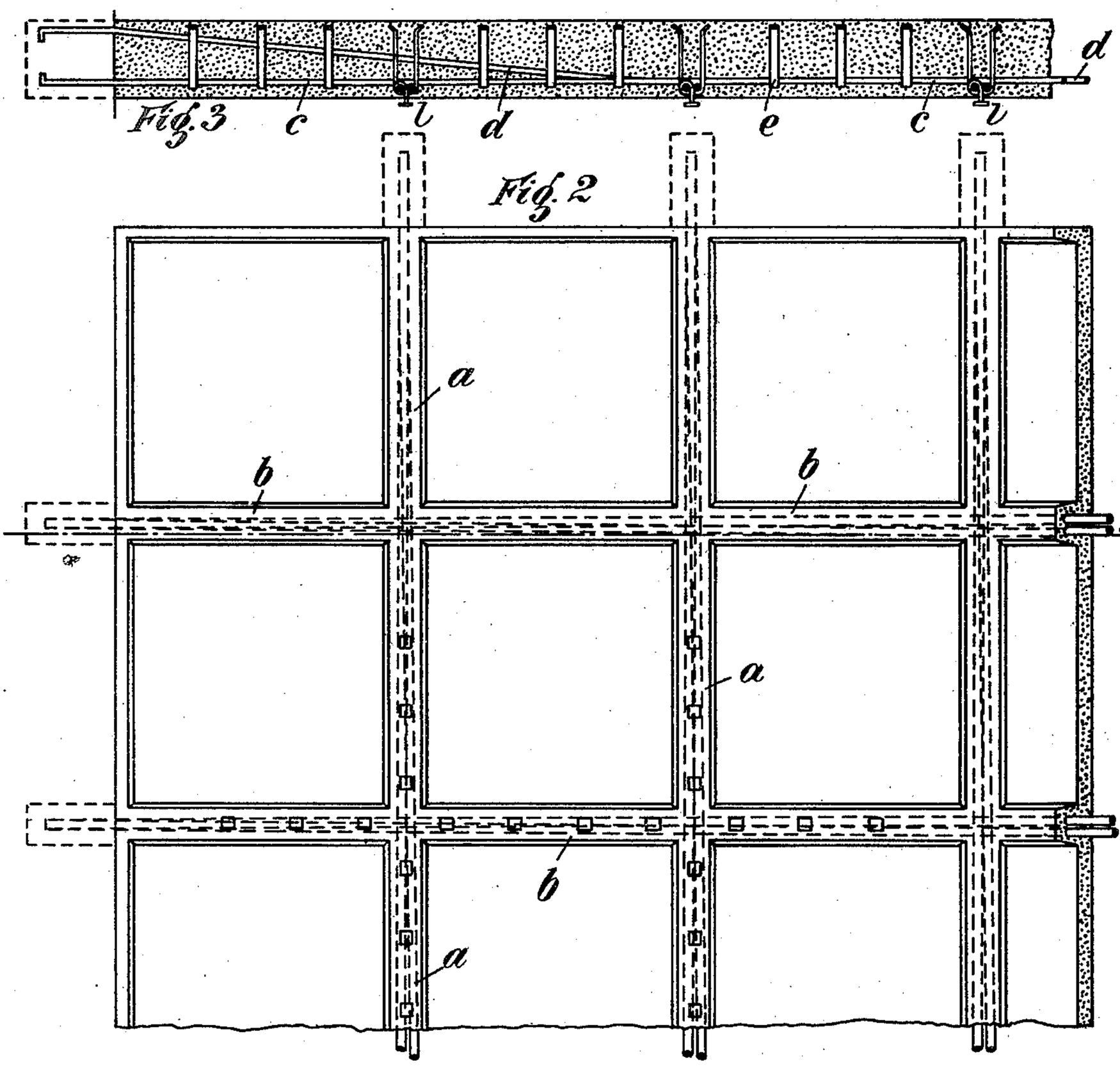

Fig. 3

Fig. 2

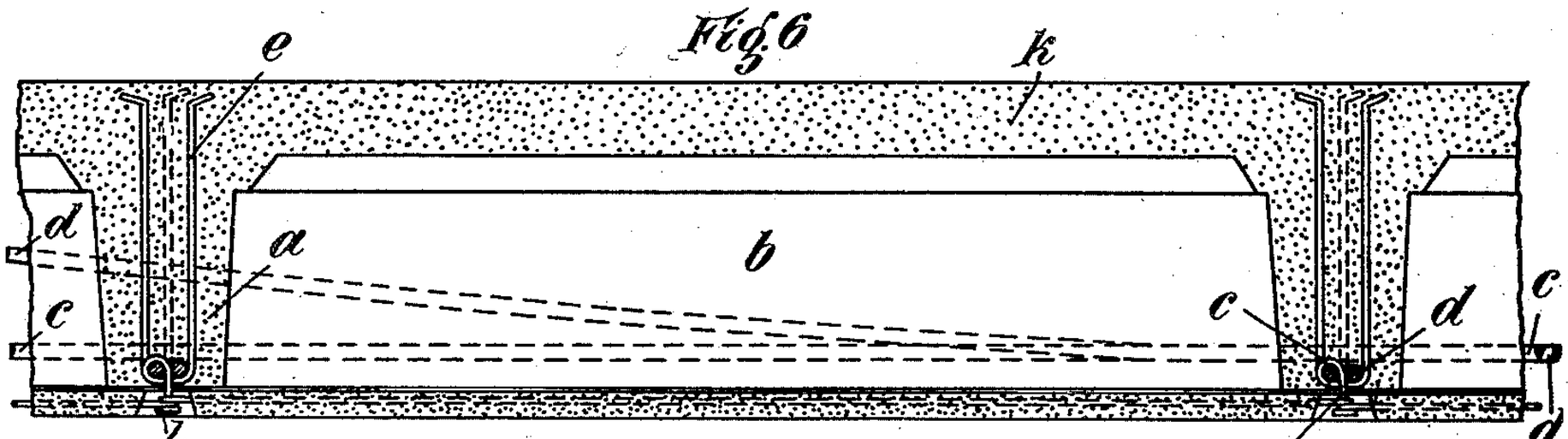

Fig. 6

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No. 707,924. Patented Aug. 26, 1902.

F. HENNEBIQUE.

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(No Model.) 3 Sheets—Sheet 3.

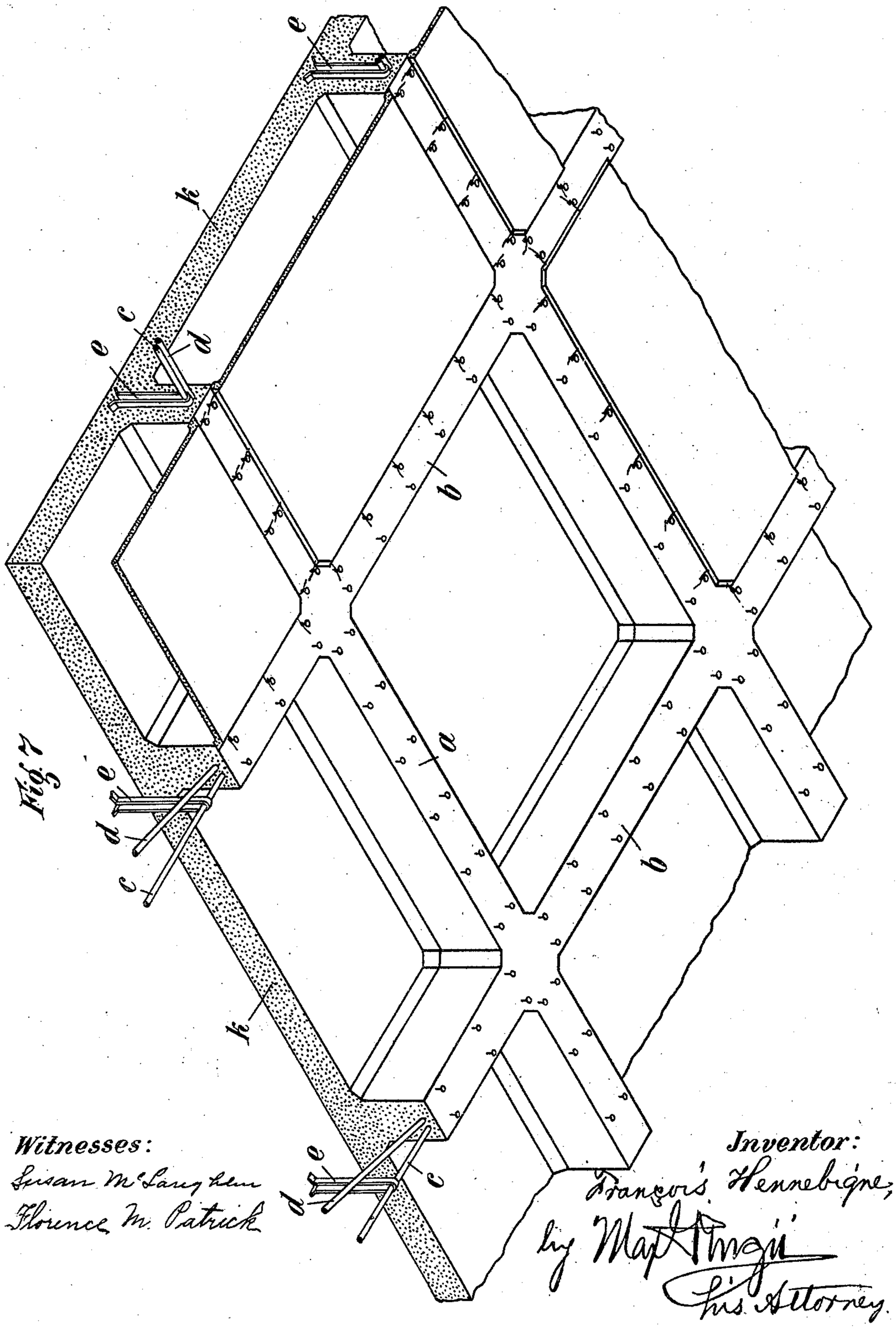

Fig. 7.

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UNITED STATES PATENT OFFICE.

FRANÇOIS HENNEBIQUE, OF PARIS, FRANCE.

CEILING STRUCTURE COMPOSED OF BETON AND IRON.

SPECIFICATION forming part of Letters Patent No. 707,924, dated August 26, 1902.

Application filed May 22, 1902. Serial No. 108,574. (No model.)

To all whom it may concern:

Be it known that I, FRANÇOIS HENNEBIQUE, civil engineer, a citizen of the Republic of France, and residing at Paris, in the Republic of France, have invented certain new and useful Improvements in Ceiling Structures Composed of Beton and Iron, of which the following is a specification.

My invention relates to ceiling constructions and similar structures composed of concrete or cement and iron.

In constructing ceilings of beton or concrete and iron, particularly such of large extent, two methods up to now have been employed, the one being intended for spaces of comparatively small width, the other for such of comparatively great width. In the first case a number of beams of medium strength are arranged across that space in sufficiently small distances from each other, and in the second case one or a few main beams of great bearing capacity are also arranged across the respective space, and smaller beams of the first-mentioned kind are arranged between and rectangularly to said big beams, so as to connect these with each other. In either case the beams consist of beton containing and enveloping iron bars, that are preferably also connected with each other within and covered by the beton. In the second case aforementioned the iron bars of the intermediate or subsidiary beams are also connected with those of the main beams, and the subsidiary beams transfer the load they carry to and upon the main beams, which in their turn transfer the load to and upon the walls.

In contradistinction to the old and usual method of constructing structures of the kind in question I construct the ceiling of two groups or systems of beams lying one crosswise to and in one plane with the other. In each of these beams—that is to say, in each beam of each system or group—the iron bars run from one end or point of support of the beam to the other end or point of support of the same, and the load carried by all the beams is transferred to the walls, not by the one group only, but by the other, too, the whole load being practically uniformly distributed over and upon all the surrounding walls of that respective space. Besides this remarkable advantage another one resides in the fact that the lower surfaces of all the beams may be in one horizontal plane, so that there is not any more any difficulty whatever in obtaining a flat ceiling, and if the lower parts of the beams shall remain visible the ceiling may at once be regarded or treated as a coffered or cofferwork ceiling, which is a further advantage as compared with ceilings with subsidiary beams in which the lower surface of the latter lie above those of the main or principal beams.

In order to make my invention more clear, I refer to the accompanying drawings, in which similar letters denote similar parts throughout the several views, and in which—

Figure 1 is a bottom view of a diagrammatical representation showing two systems or groups of beams *a b*, the beams *a* lying rectangular to and in one plane with the beams *b* and forming or inclosing quadrangular spaces (coffers) with the same. Fig. 2 is an enlarged view of a portion of Fig. 1. Fig. 3 is a vertical section in line 8 9 of Fig. 2. Figs. 4 and 5 show, on a still larger scale, the manner of manufacturing a ceiling with beams of my novel arrangement. Fig. 6 is a view similar to Fig. 4, showing, on again a larger scale, a portion of a finished ceiling with a flat ceiling. Fig. 7 is a perspective view of a larger portion of an unfinished ceiling, drawn on a still more enlarged scale.

Every beam of each group *a* and *b* is constructed according to the well-known Hennebique system—that is to say, each beam contains at least one longitudinal iron rod *c*, Figs. 6 and 7, extending throughout its whole length through the tensile zone of the beam and at least one longitudinal iron rod *d*, only the middle part of which lies in the tensile zone, whereas the other parts rise to and into the zone of compression, as represented in Fig. 3. These iron bars are embraced at certain distances by vertical iron hoops *e*, which are also embedded in the beton and extend with their upper ends also to and into the zone of compression or into the ceiling proper, *k*, respectively.

In constructing a ceiling of my improved kind I make use of box-like wooden bodies *f g*, composed of a somewhat-pyramidal frame

or case *f* and of a cover or lid *g*, Figs. 4 and 5. These parts *f*, as well as the parts *g*, are preferably not attached to each other, so that they may more easily be removed when the beams and the upper portion of the ceiling or the ceiling proper are or is finished. The boards of the frame or case *f* are supported by boards *i* which in their turn are supported by boards *h*, having grooves or rabbets or the like for the reception of the boards *i*, and are supported from below by any suitable means, such as wooden beams or the like. The frames or cases *f* are arranged at such distances from each other that the spaces remaining between them are the molds for the beams *a* and *b*, and into these molds are placed the iron rods *c* and *d* and the iron hoops *e*, and finally the beton is introduced into the said mold, so that the iron parts *c d e* are perfectly surrounded by and embedded in the same. As soon as the molds in question have been filled out the bringing up of the beton is continued, and the latter is distributed upon and over the boards *g* until also the ceiling proper has been formed. The parts *a*, *b*, and *k* of the whole structure may be regarded as a kind of monolith, because the whole is one rigid piece of uniform structure or texture, in which the beams *a b* and the ceiling proper, *k*, do not form separate pieces that are merely connected with each other. The upper surface of the boards *h* may be provided with small cavities, and nails or hooks *l* may be put into said cavities in a reverse position, the pin proper of the nail or hook reaching up into the mold, so as to become embedded or fixed in and by the beton. The downwardly-projecting heads of the nails or hooks serve for securing the ceiling to the beams.

Having now described my invention, what I desire to secure by Letters Patent of the United States is—

1. In a ceiling structure of concrete and metal the combination of a series of concrete beams with another series of concrete beams lying crosswise to and in one plane with the first, and metal rods extending through both series of beams from the points of support through the tensile zones of the beams, and another set of metal rods from the points of support through the zones of compression and dipping at their middle points into the tensile zones of the beams, both sets of metal rods being embedded in the concrete beams.

2. In ceiling structures a series of concrete beams and with another series of concrete beams crossing the first in combination with metal rods embedded in the beams and extending from the points of support through the tensile zones of the beams, another set of metal rods similarly embedded and extending from the zone of compression at the points of support to the tensile zone at their middle portion and metal stirrups also embedded in the beams and embracing both rods in each beam and extending up into the zone of compression.

In witness whereof I have hereunto set my hand in presence of two witnesses.

F. HENNEBIQUE.

Witnesses:
DUCHEY,
ZETTMAN.