

No. 864,022.

PATENTED AUG. 20, 1907.

R. R. L. DE MURALT.
FACING FOR EMBANKMENTS, DAMS, AND THE LIKE.
APPLICATION FILED AUG. 15, 1906.

4 SHEETS—SHEET 1.

Fig. 3.^a

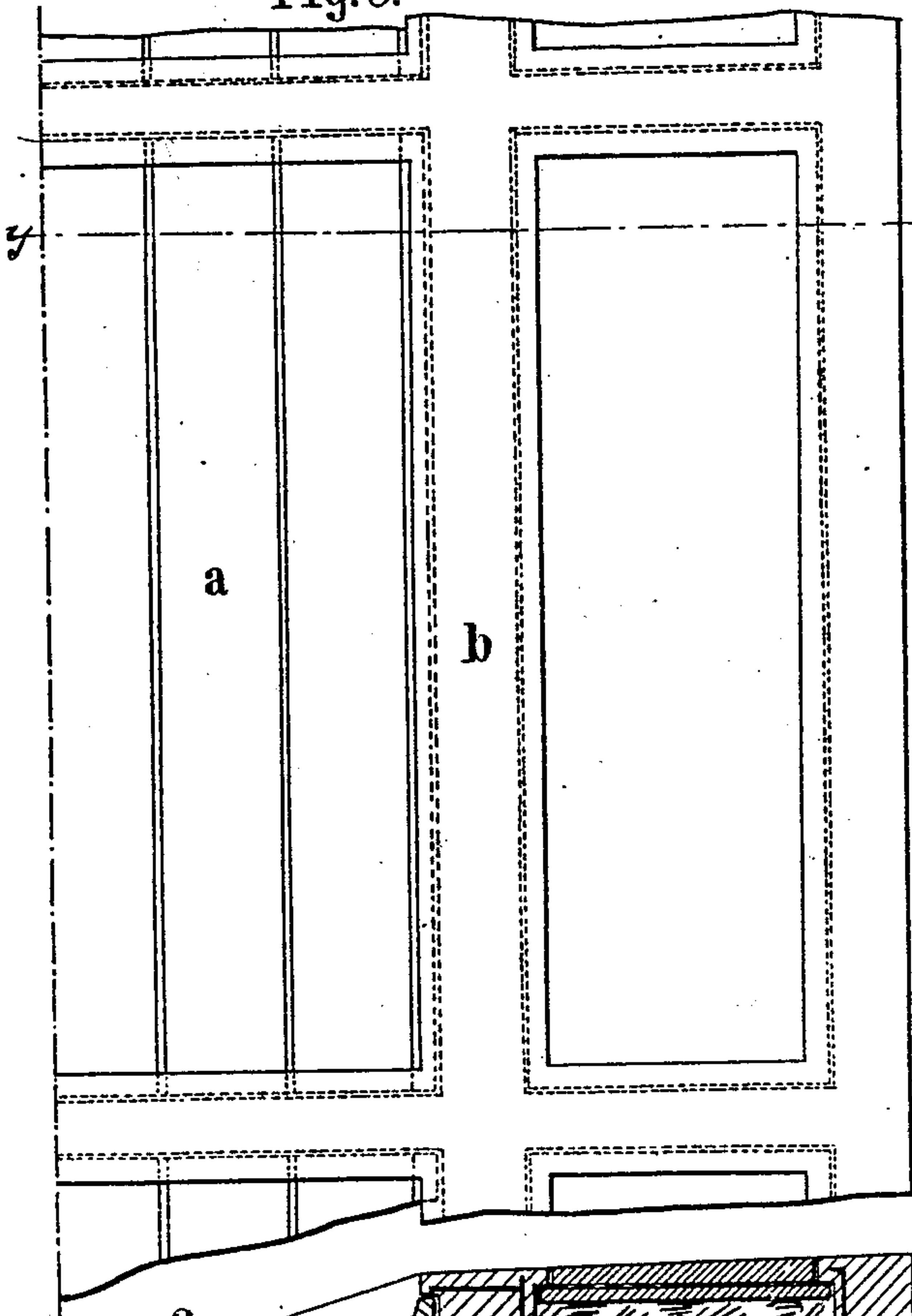


Fig. 4.

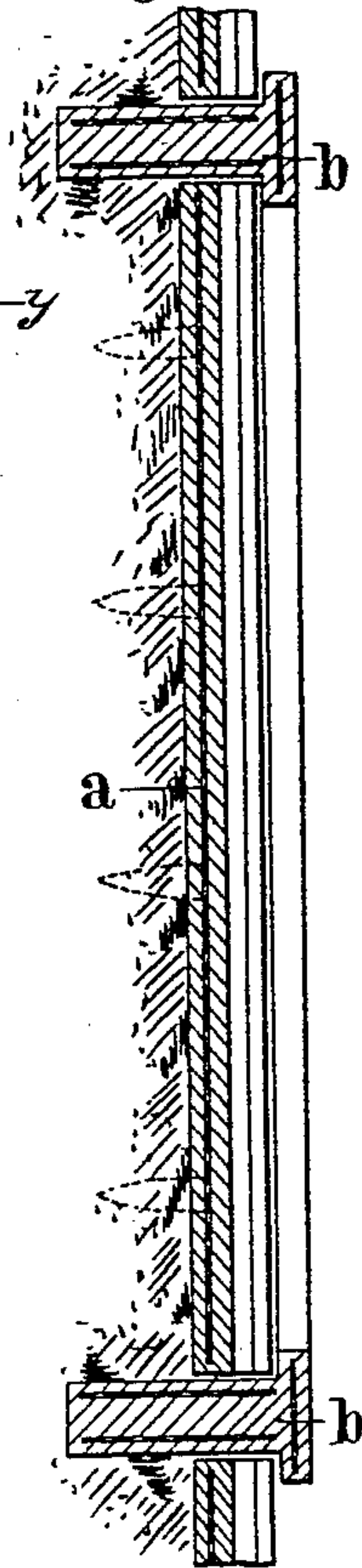


Fig. 2.^a

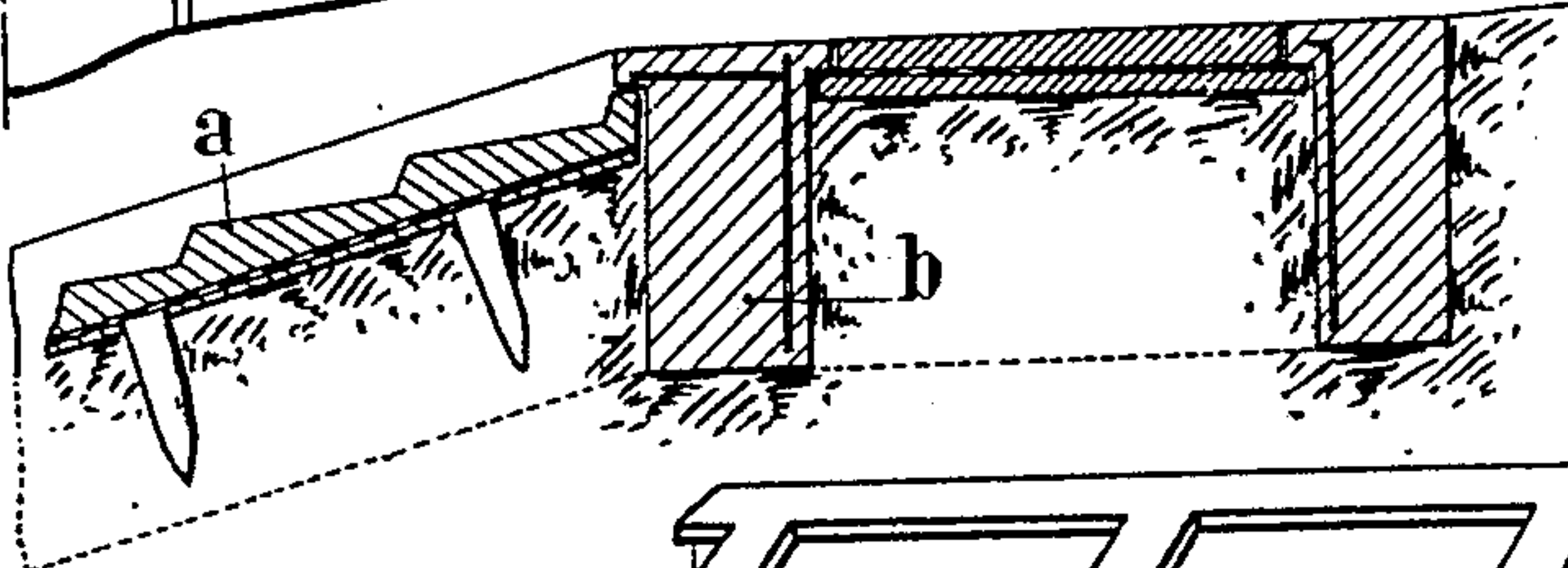
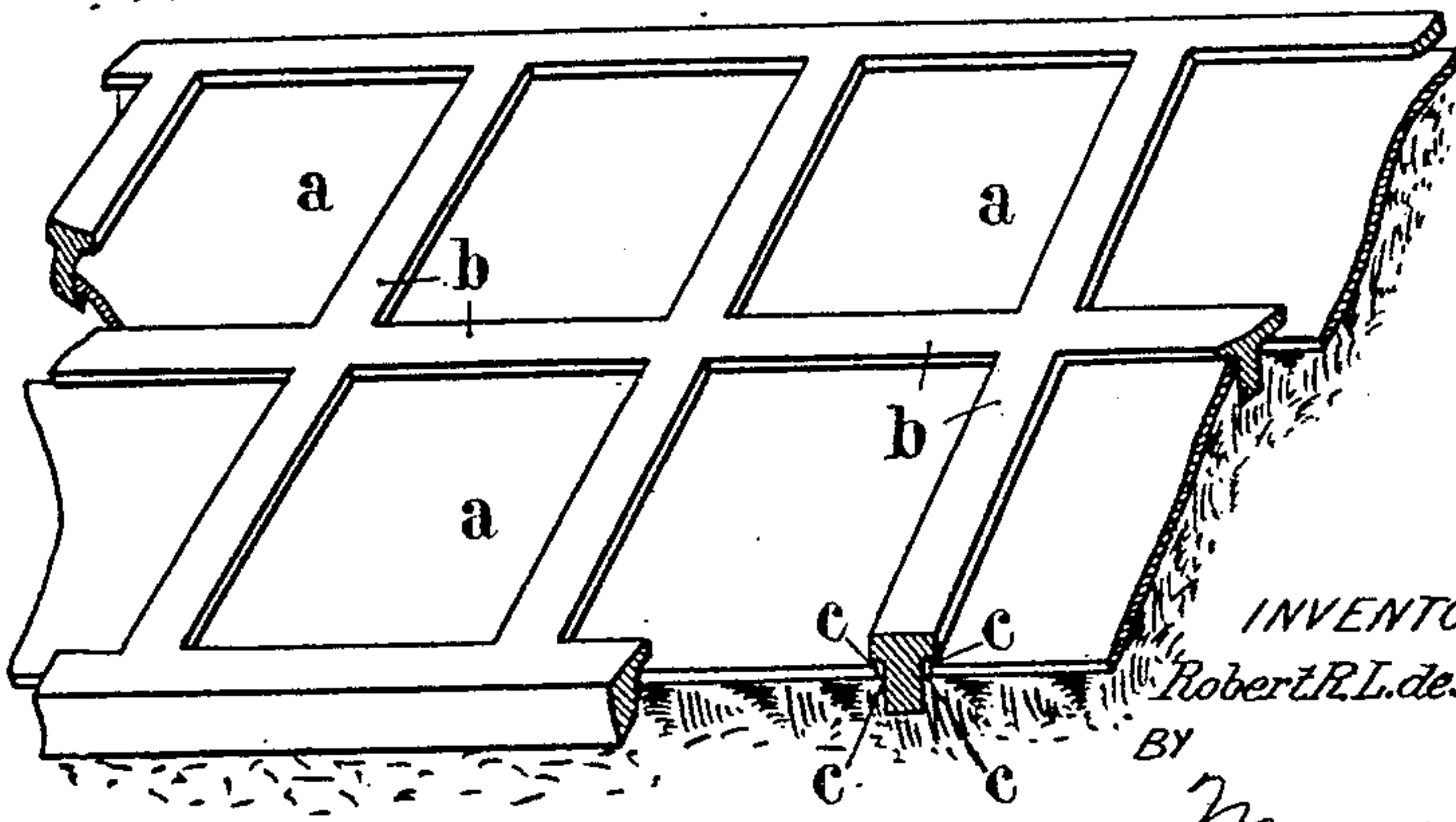


Fig. 1.



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4 SHEETS—SHEET 2.

Fig. 3.

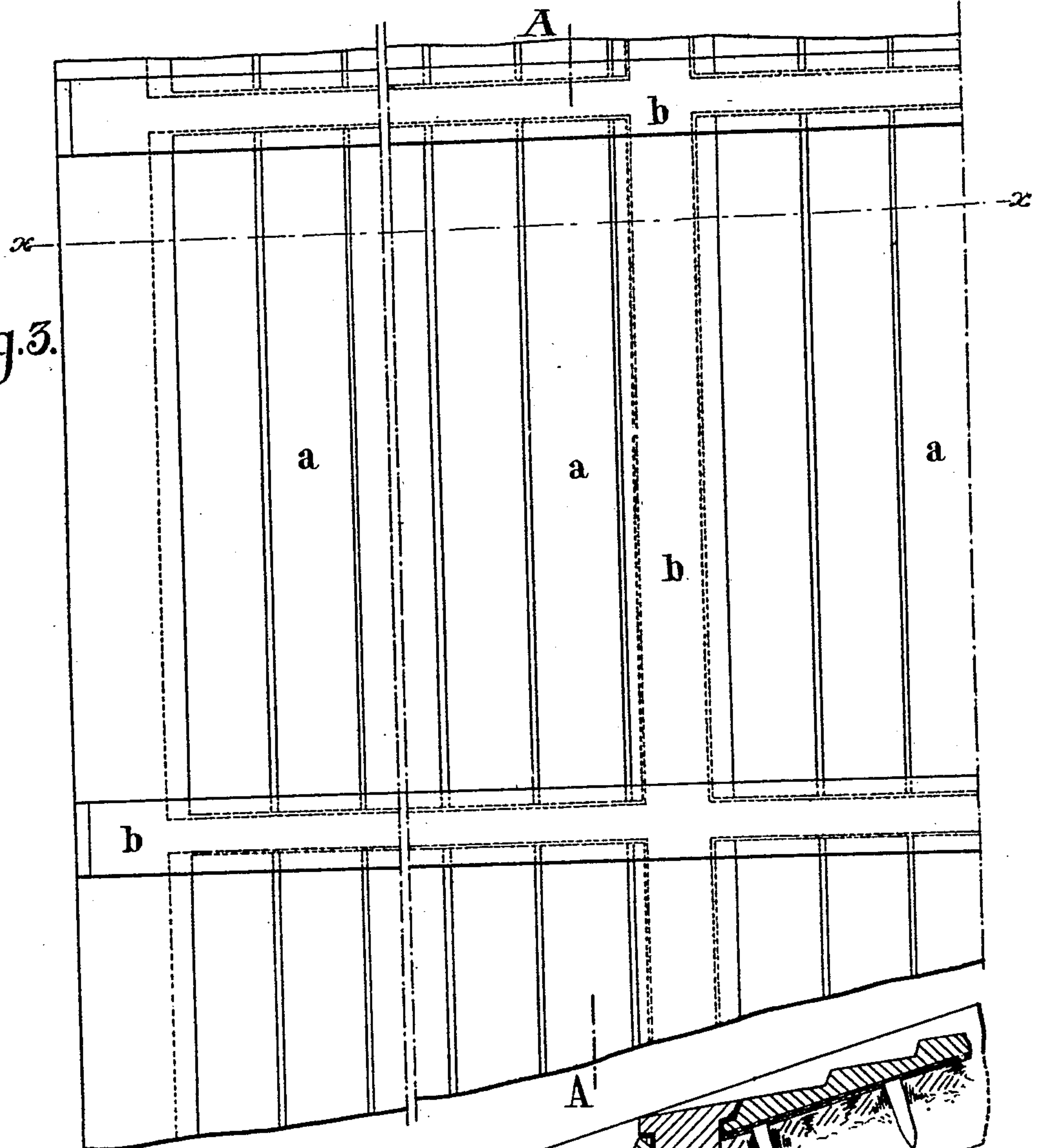
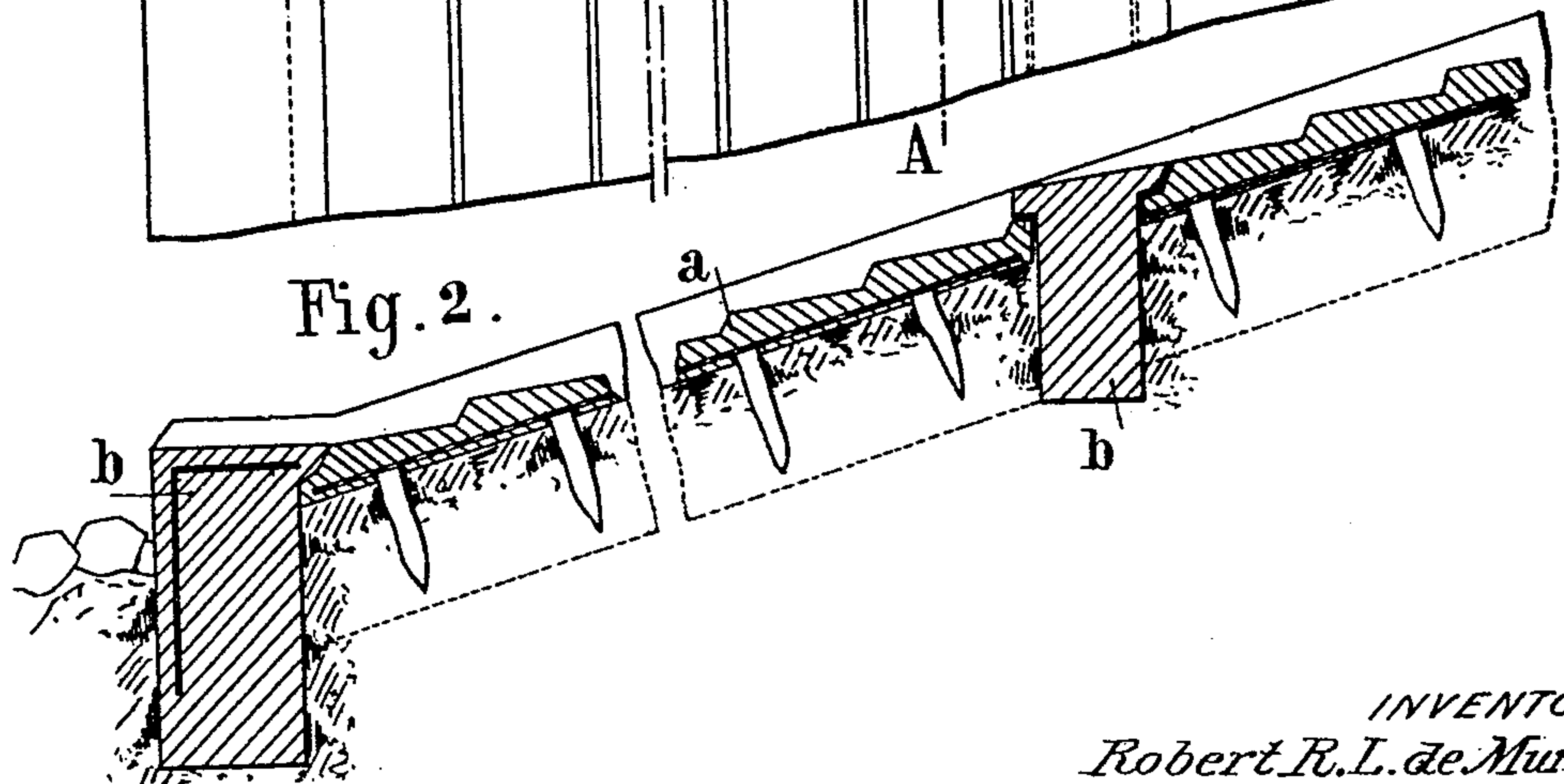


Fig. 2.



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4 SHEETS—SHEET 3.

Fig. 5.

Fig. 6.

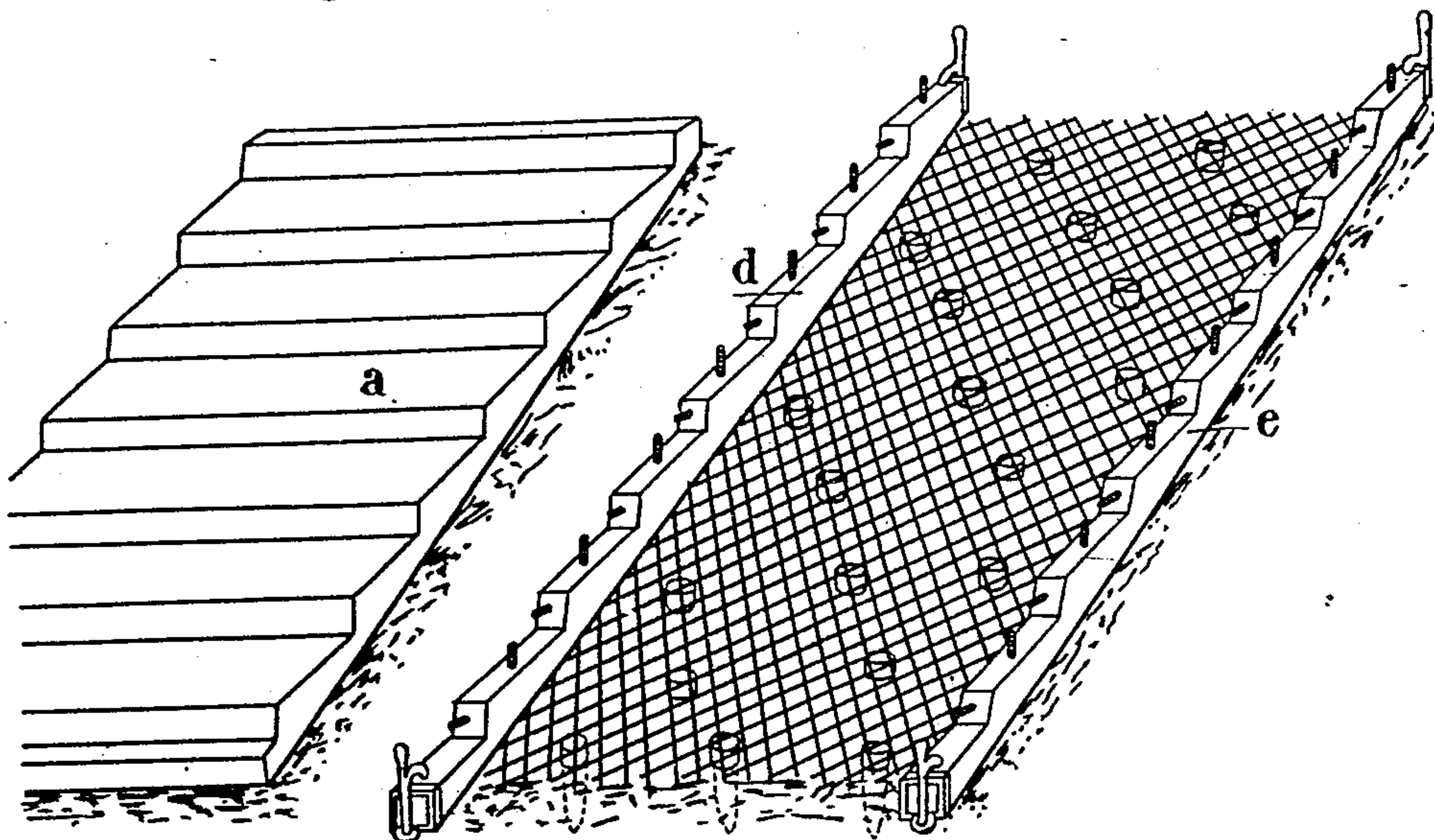
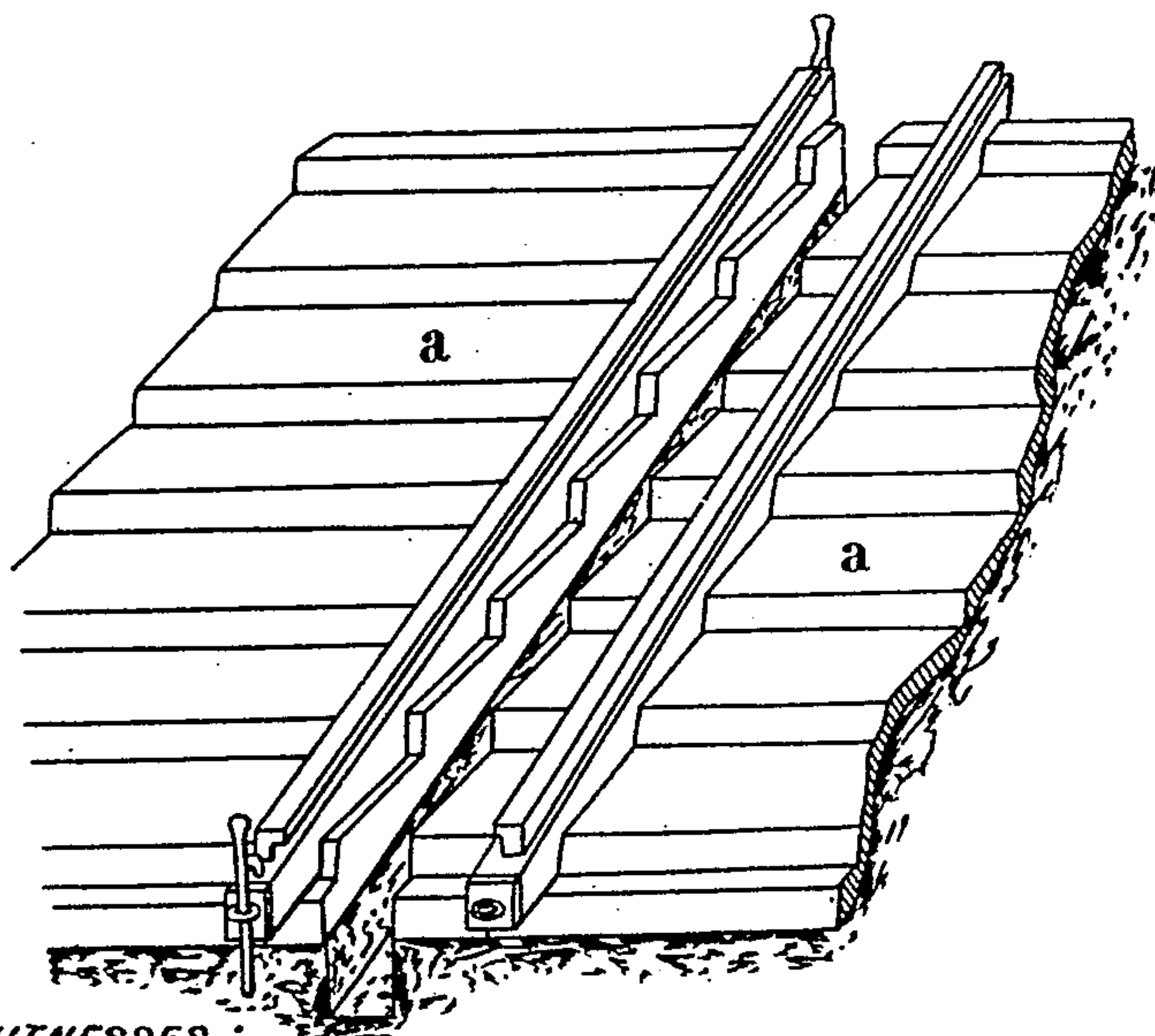


Fig. 8.



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4 SHEETS—SHEET 4.

Fig. 7.

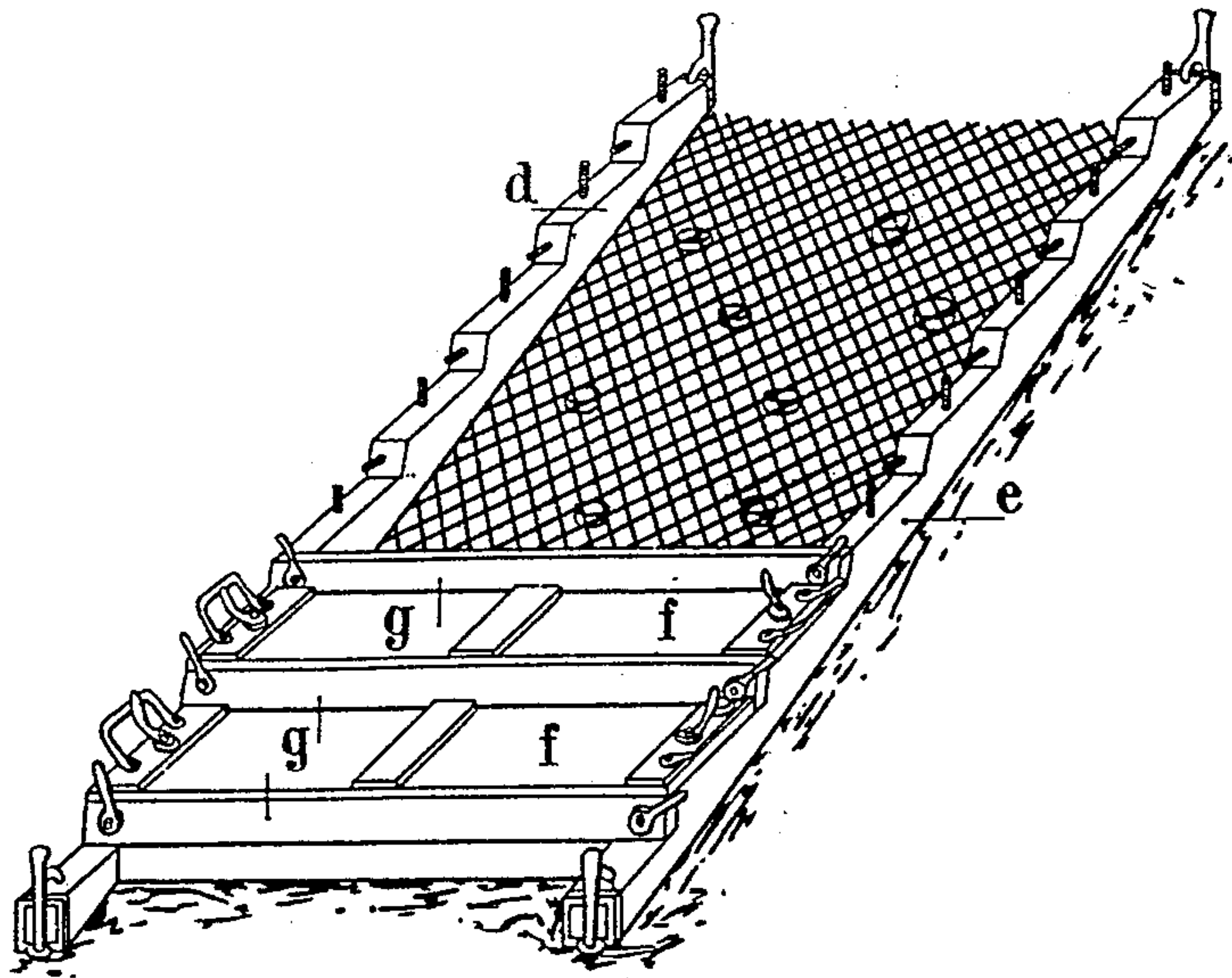
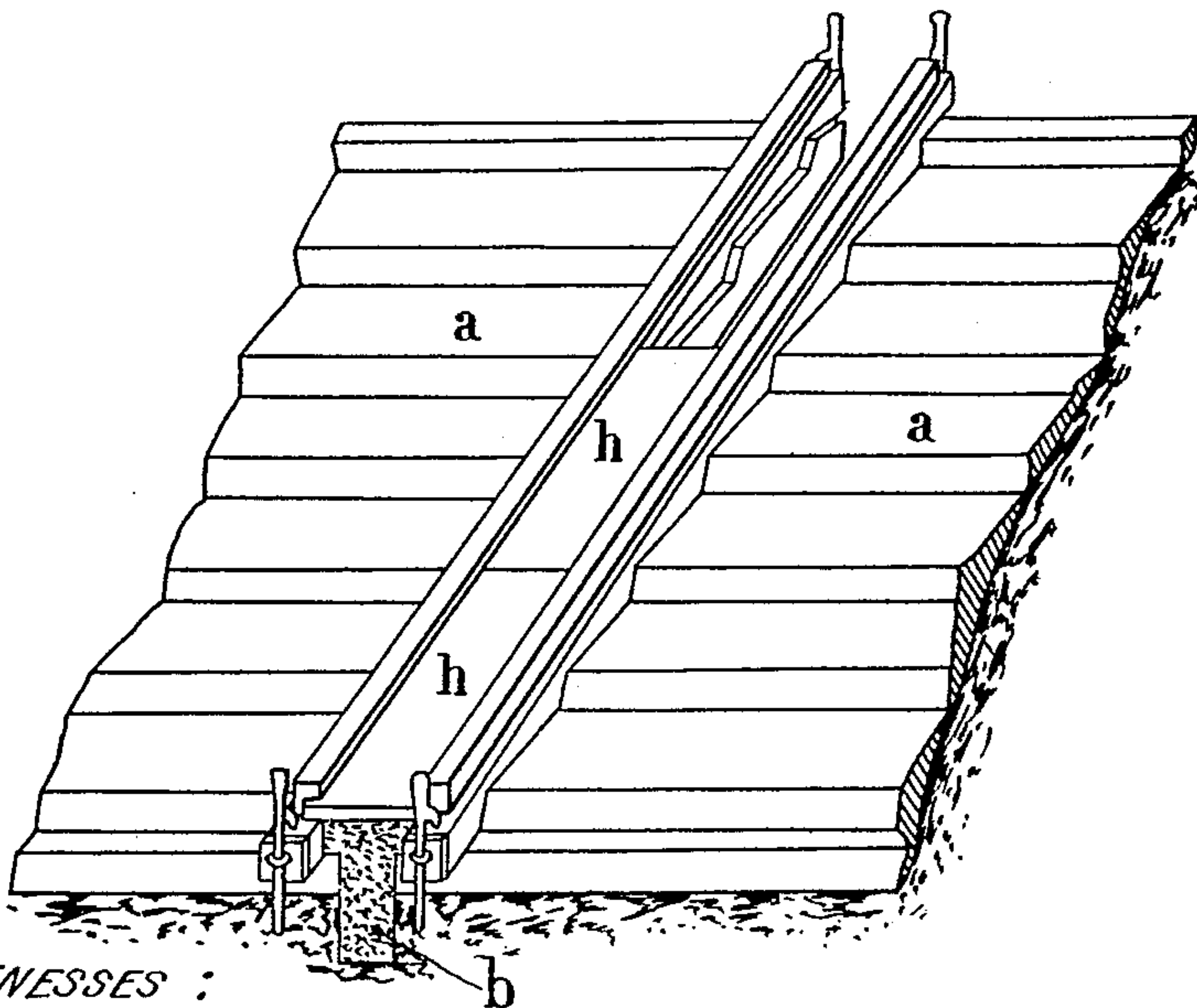


Fig. 9.



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FACING FOR EMBANKMENTS, DAMS, AND THE LIKE.

No. 864,022.

Specification of Letters Patent.

Patented Aug. 20, 1907.

Application filed August 15, 1906. Serial No. 330,694.

To all whom it may concern:

Be it known that I, ROBERT RUDOLF LODEWYK DE MURALT, of Zierikzee, Netherlands, engineer, have invented Improvements in Facings for Embankments, Dams, and the Like, of which the following is a full, clear, and exact description.

This invention relates to a facing of ferro-concrete for the protection of the slopes of dams, banks, walls of canals, and of other trenches or cuttings. Hitherto in such works armored concrete has been employed either in monolithic form or in the form of somewhat large slabs simply joined together and separated by artificial joints of different kinds; a mode of construction presenting the disadvantage that flexions due to the thrust of the earth, to frost, to the action of the waves, etc., give rise, at the principal surfaces of the concrete, to fissures through which the water finds its way and is enabled to attack the armoring of the concrete and to disintegrate the facing so that the constituent portions thereof are speedily detached. Moreover the water which penetrates through these fissures, secretly undermines the slopes in such a way that the real is always greater than the apparent injury. According to the present invention these objections are completely obviated.

The improved system of ferro-concrete is constituted essentially by slabs of comparatively small area, independent of one another, and held in place by a frame, also of ferro-concrete, which is anchored to the ground and covers the margins of the slabs so as to form rabbeted or lap joints. In this system of facing, the joints of the slabs, being calked by the frame, are completely closed, each slab being however free to become displaced in its frame without affecting the neighboring slabs.

The external surface of the slabs is by preference of stepped form, with a view of diminishing (when they are applied for the protection of marine embankments) the upward wash of the water, to break the waves as they strike, and to reduce their destructive scouring action when returning, this form of the slabs possessing the further advantage of enabling the embankment to be walked on whatever may be its inclination.

The present invention relates moreover to the mode of constructing the stepped slabs. As is well known, the concreting of a sloping embankment (the inclination of which may be 45° or even greater) presents certain difficulties. Hard ramming is usually almost impossible unless special precautions are taken, but according to the present invention this difficulty is overcome by the employment of a temporary timber structure with movable boards which permit of vertical ramming throughout the whole height of the slope, with the absolute certainty of all parts of the concrete,

up to its exterior surface, being equally pressed one against another.

The invention is illustrated in the accompanying drawings wherein

Figure 1 is a schematic view showing the principle of the invention. Fig. 2 is a section on line $x-x$ of Fig. 3, Fig. 3 is a plan view of a portion of the improved facing, Fig. 2^a is a section on line $y-y$ of Fig. 3^a, Fig. 3^a is a plan view of another portion of the facing. Fig. 4 is a longitudinal section on line A A Fig. 3. Fig. 5 shows a stepped slab. Figs. 6 to 9 show in perspective different stages in the construction of the slabs and of the concrete frame.

As will be seen in Fig. 1, the improved facing comprises (1) slabs a of ferro-concrete of a size for example of 1.80 m. in the horizontal direction of the embankment and 2.40 m. in the direction of the line of greater inclination, and (2) a monolithic frame b of ferro-concrete strongly bedded in the earth at a certain depth and presenting a series of compartments corresponding to the several slabs, the sides of each compartment being rabbeted and fitting over the margins of the slabs. The armoring of the concrete slabs a and frame b (if it be deemed advisable to armor these) would consist by preference of "expanded metal", but any other system of armoring may be employed. The slabs are placed alongside of one another (see Fig. 8) a space being left between adjacent slabs, of a width equal to the thickness of the frame b .

It may be necessary, in consequence of the length of the slope in the direction of the greatest inclination, to employ several consecutive rectangular slabs from top to bottom of the slope, a space being also left between the rows of slabs, of a width preferably equal, as before, to that of the horizontal block constituting the upper and lower sides of the frame b .

The arming of the blocks constituting the frame b is completely independent of that of the slabs a . Moreover, the concrete of these blocks is executed in such manner that, being all molded upon the concrete of the slabs, it is yet entirely distinct therefrom; this result being obtained, for example, by the application of a film or coating of oil to that portion of the concrete of the slabs which is to come into contact with the framing, so as to insure the existence between the slabs a and frame b of a very small space c (Fig. 1) invisible to the eye but nevertheless constituting a solution of continuity which leaves to each slab a certain individual independence. The frame b thus provides, under these conditions, a lap or rabbeted joint adapted to prevent water from finding access between the slabs but maintaining the latter in position and affording to each slab a certain freedom so that the movements or subsidence

of one of them will in no way affect the others. When the inclination of the facing is steeper than 45° or when the nature of the ground necessitates such a course, the slabs *a* and frame *b* may be secured by means of spikes, preferably made of ferro-concrete, which prevent them sliding down.

The surfaces of the slabs *a*, instead of being even, would usually present salient portions having the form of steps, footpaths or the like, whose edges follow the horizontal contour of the ground, as seen in Figs. 2, 3, 4 and 5. This arrangement has for effect, in embankments, to lessen the rise of the swell, to break up the waves as they strike, and to cause the speed of the surge to become reduced in consequence of the latter successively encountering the different risers of the steps. On the other hand when the wave returns, the flow being over surfaces which are almost horizontal, does not acquire an accelerated speed, and in consequence the concrete is less rapidly worn out and seaweed, shellfish, etc. are permitted to attach themselves to the concrete which accordingly is protected thereby. This arrangement of slabs in the form of steps of a staircase has the further advantage of permitting the face of the embankment being climbed by foot passengers.

In forming the slabs I preferably use a removable timber frame the employment of which considerably facilitates the construction of the slabs of concrete and particularly of those slabs where the surfaces are not united. As will be seen by reference to Figs. 6 and 7, this frame consists essentially of two beams *d e* of which the upper surface is notched to form steps. Upon these steps are fixed shutters *f* and cross bars *g* proportioned according to the requirements of the work and constituting small molds in which the concrete is successively rammed from the foot of the slope to the summit.

In the construction of the inclined blocks of the monolithic frame *b*, either beams such as *d e* or other beams of analogous form may be employed, care being taken to place these beams (as will be seen by reference

to Fig. 8) in such manner that their steps register with those of the slabs *a*. As the concrete is filled in, small shutters *h* are placed in position as shown in Fig. 9.

Claims:

1. A facing of concrete composed of slabs of armored or not armored concrete, independent the one from the other and of a frame also of armored or not armored concrete, anchored to the ground between these slabs, the sides of the frame being rabbeted over the slabs so as to maintain the latter in position but not connected to the slabs so as to leave the same a certain individual independence.

2. A facing of concrete composed of slabs of armored or not armored concrete independent the one from the other and a frame also of armored or not armored concrete, anchored to the ground between these slabs having a series of compartments corresponding to the several slabs, having laps or rabbeted edges adapted to maintain the said slabs in position but not connected to the latter so as to leave the same a certain individual independence.

3. A facing of concrete composed of slabs of armored or not armored concrete, independent the one from the other, a frame also of armored or not armored concrete anchored to the ground between these slabs presenting a series of compartments corresponding to the several slabs and having rabbeted laps adapted to maintain these slabs; a layer of insulating material such as oil applied to the edges of the slabs and adapted to prevent any adherence between the frame and the slabs so that every one of these slabs will have a certain individual independence.

4. A facing of concrete composed of slabs of armored or not armored concrete, having projecting portions in the form of steps the edges of which are horizontal, independent the one from the other and of a frame also of armored or not armored concrete, anchored to the ground between these slabs having a series of compartments corresponding to the several slabs having laps or rabbeted edges adapted to maintain the said slabs in position but not connected to the latter so as to leave the same a certain individual independence.

The foregoing specification of my improvements in facings for embankments, dams and the like, signed by me this 23d day of July, 1906.

ROBERT RUDOLF LODEWYK DE MURALT.

Witnesses:

PAULUS BOEKHOUT.

MARINUS Y. PARTEM.