

No. 794,090.

PATENTED JULY 4, 1905.

E. GEARING & W. RAINFORTH.

PROCESS OF MAKING CORRUGATED FURNACES AND FLUES FOR STEAM BOILERS.

APPLICATION FILED FEB. 16, 1904.

3 SHEETS—SHEET 1.

Fig. 1.

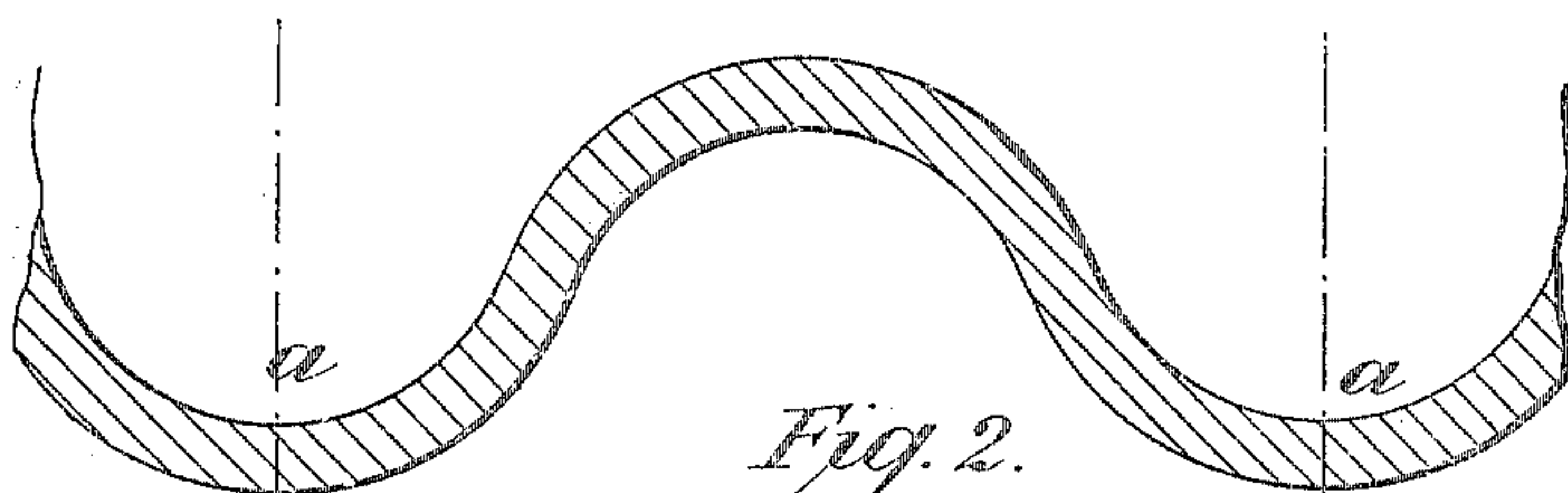


Fig. 2.

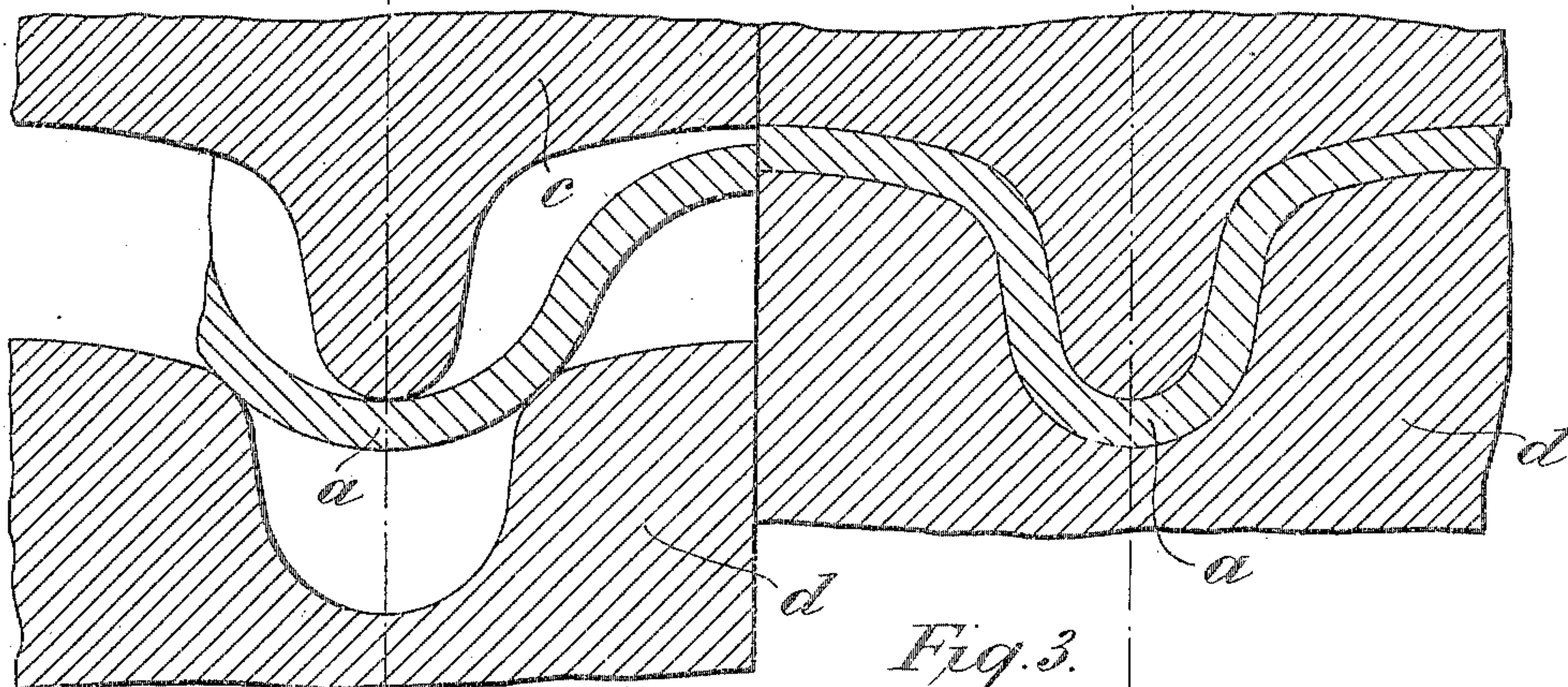
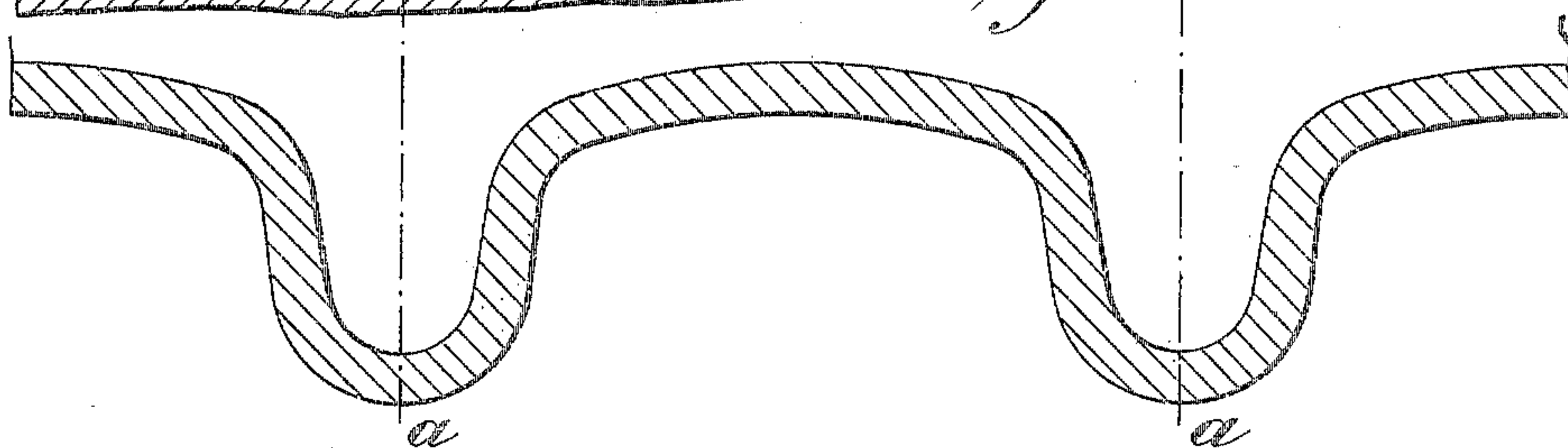


Fig. 3.



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3 SHEETS—SHEET 2.

Fig. 4.

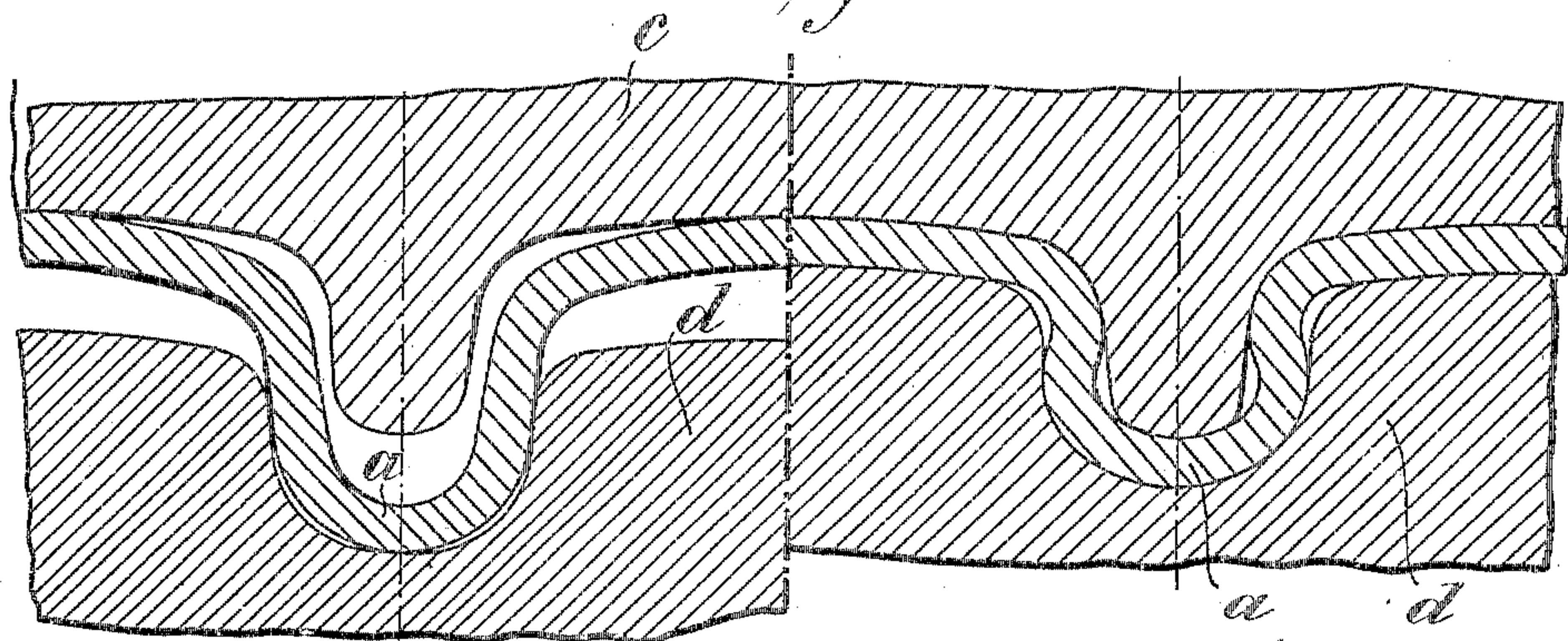


Fig. 4^a.

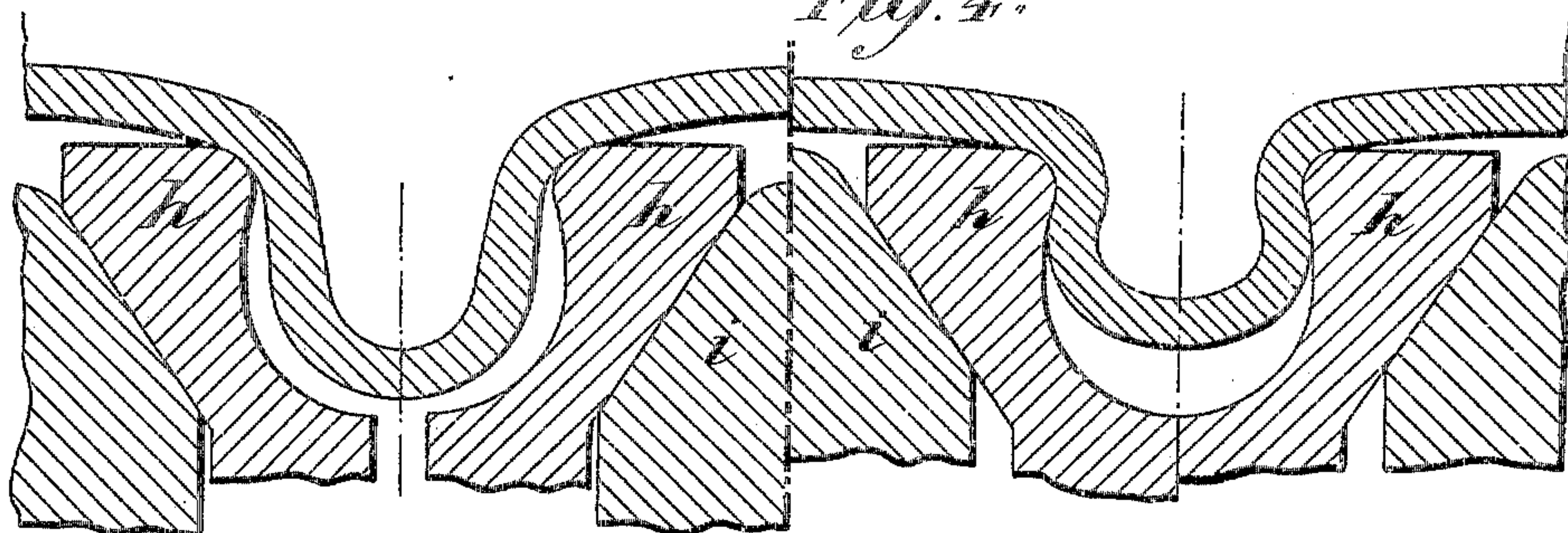
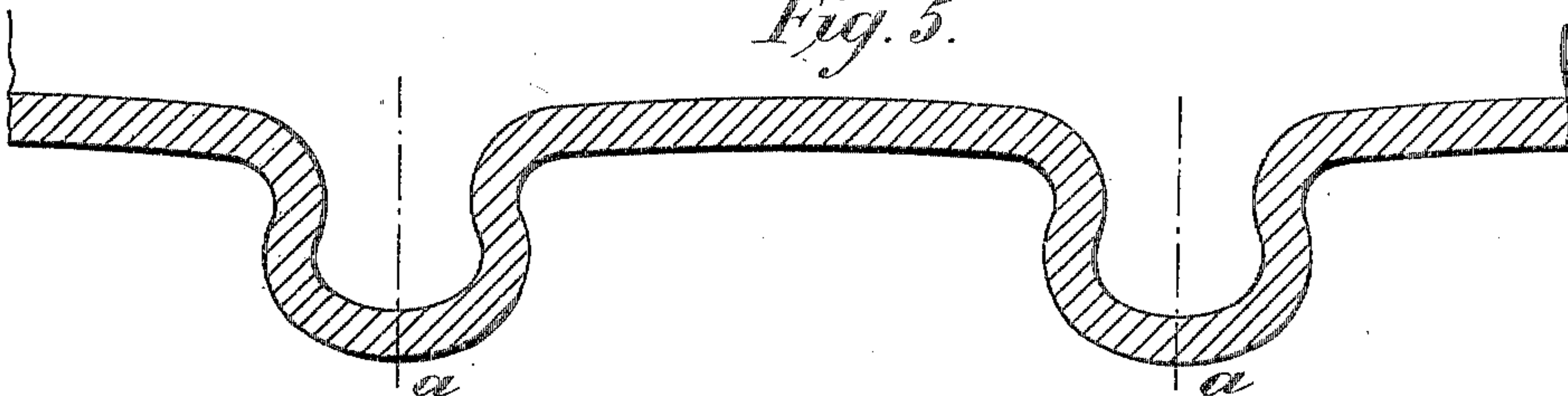


Fig. 5.



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3 SHEETS—SHEET 3.

Fig. 6.

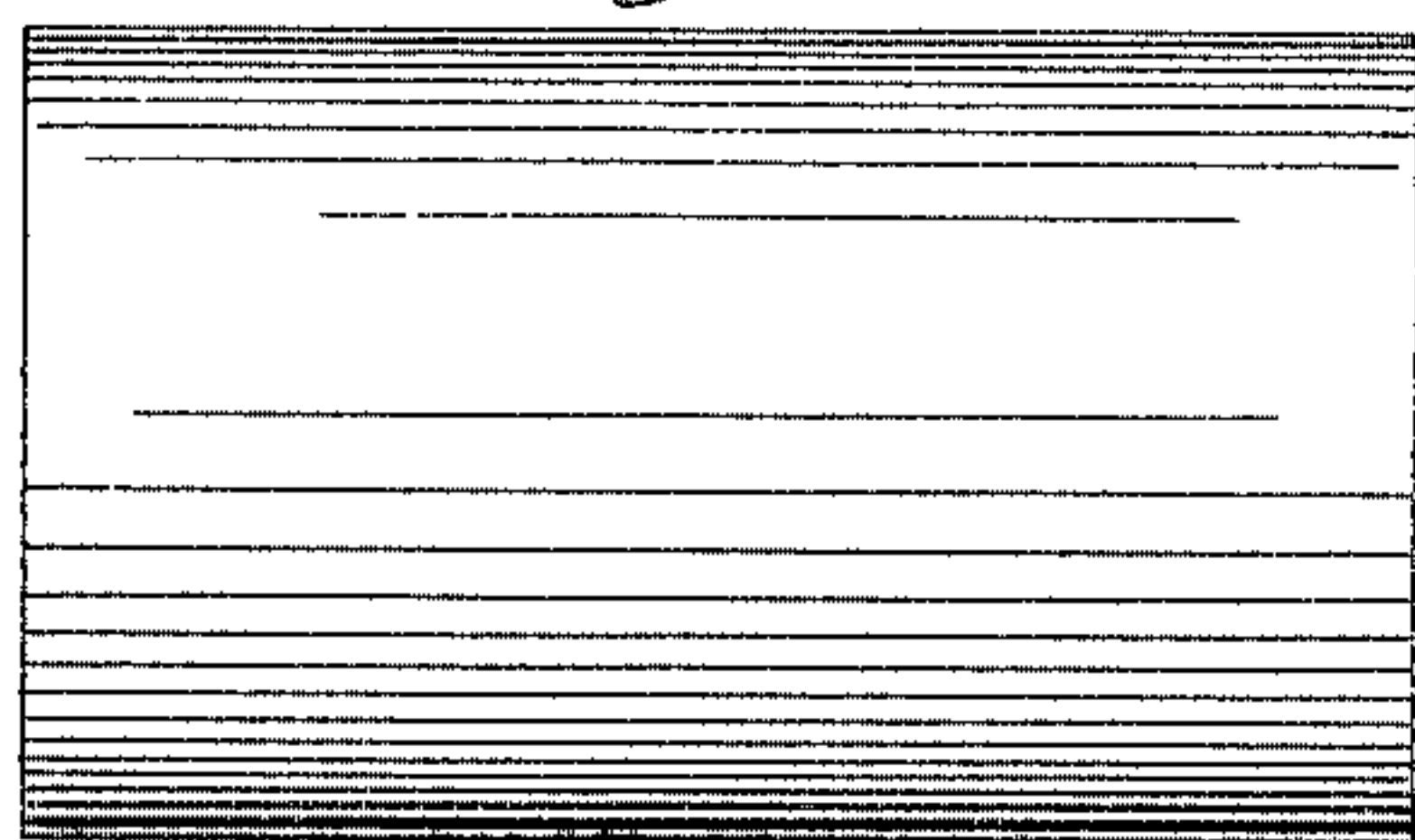


Fig. 7.

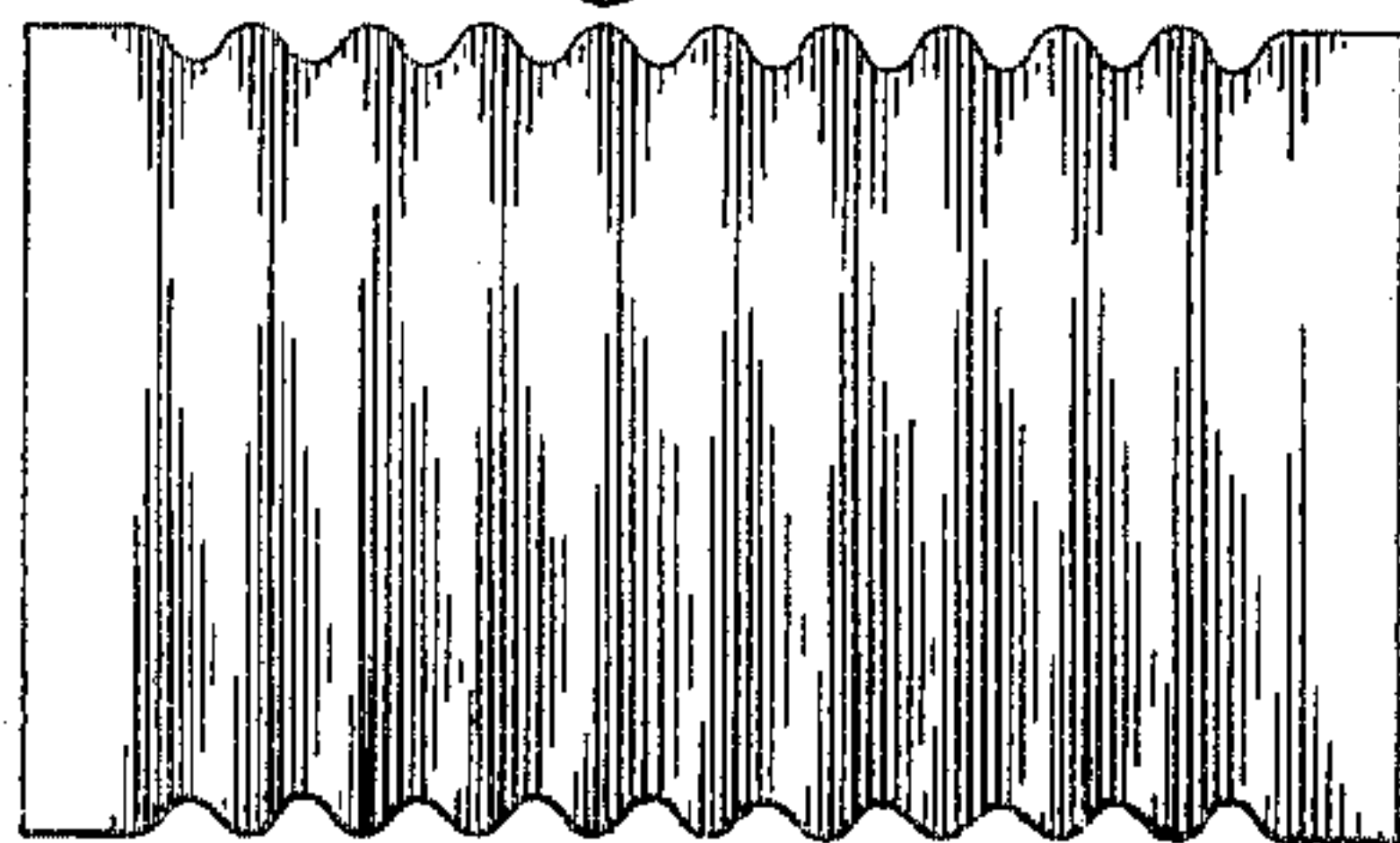


Fig. 8.

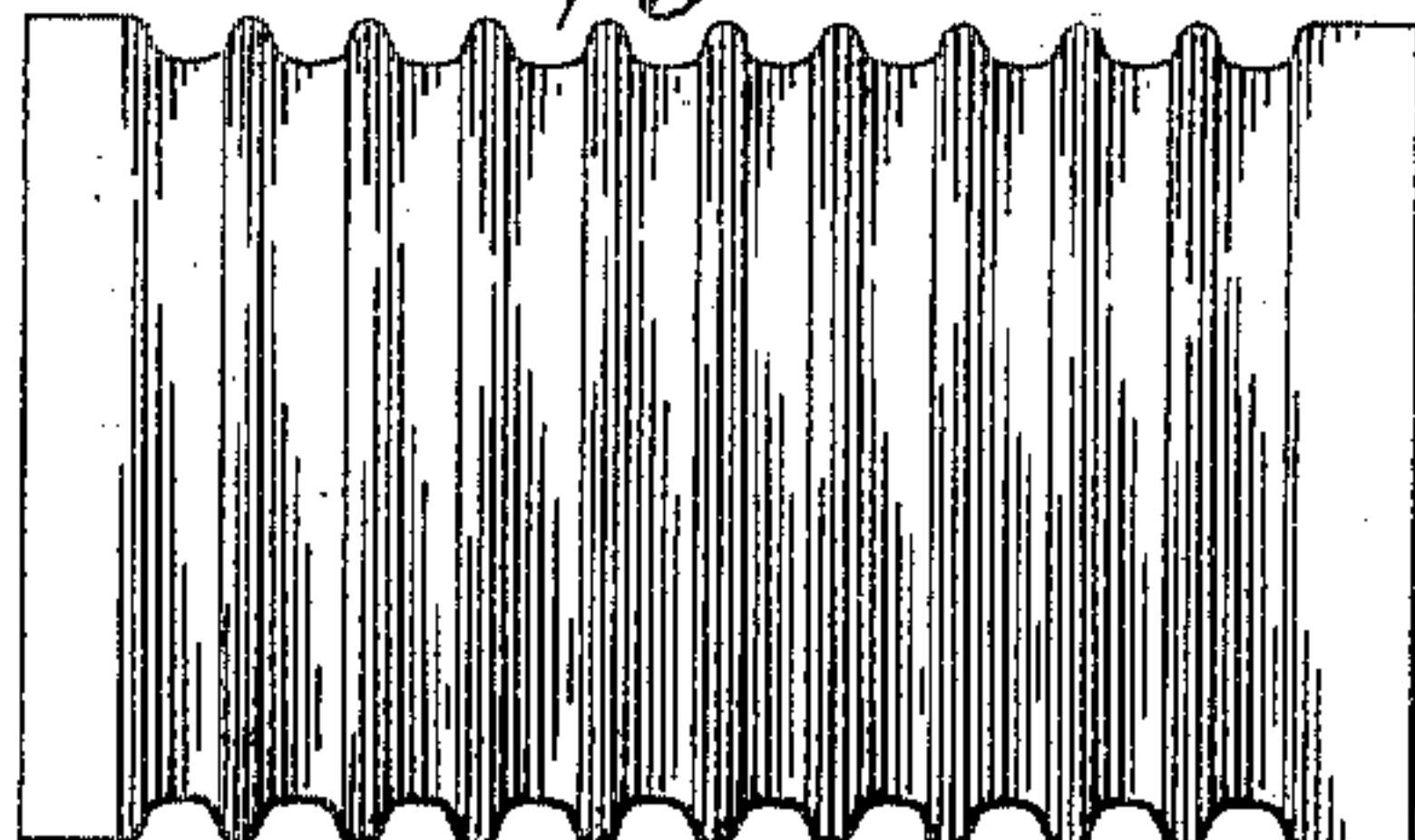
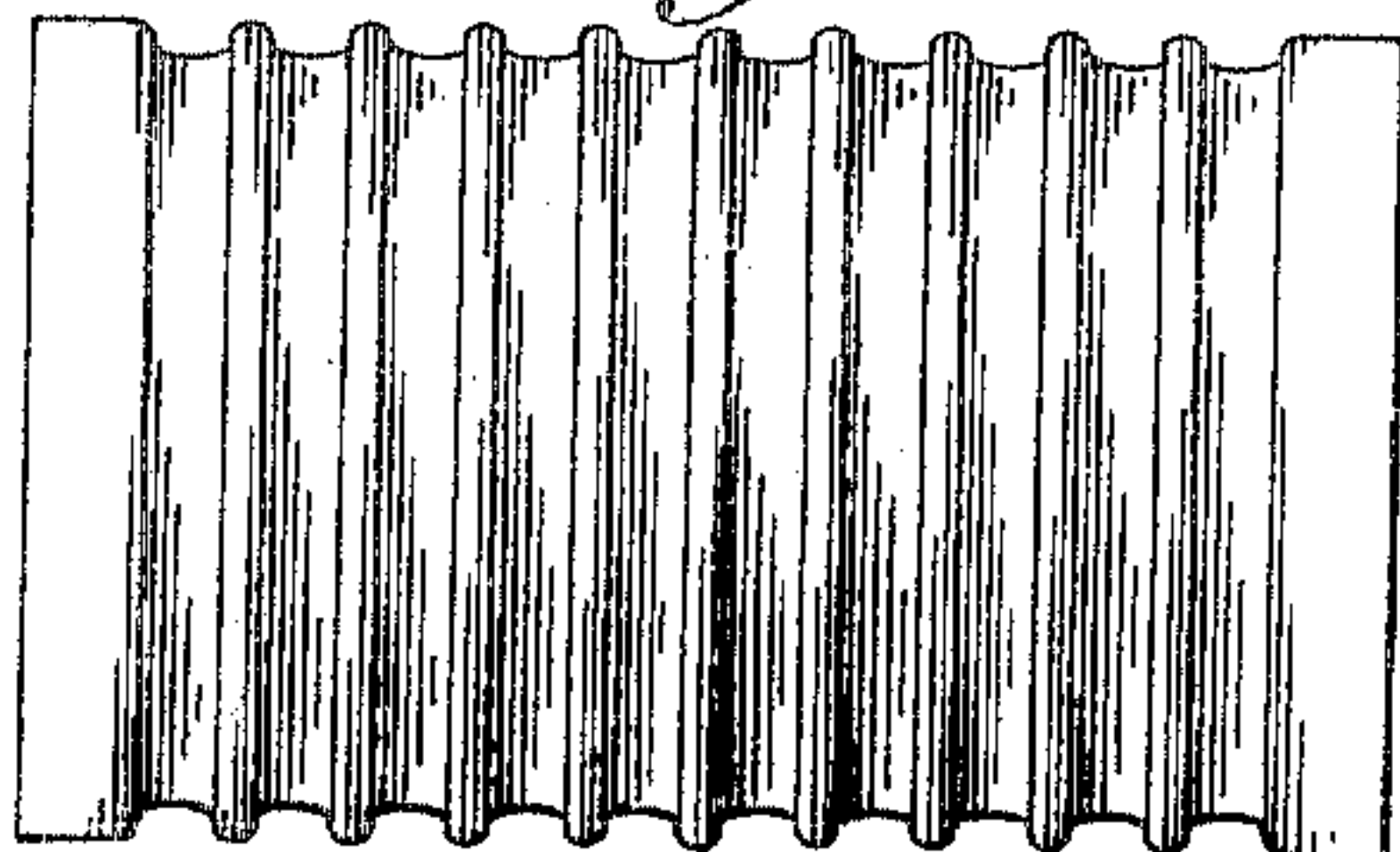


Fig. 9.



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UNITED STATES PATENT OFFICE.

ERNEST GEARING, OF HARROGATE, AND WILLIAM RAINFORTH, OF
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PROCESS OF MAKING CORRUGATED FURNACES AND FLUES FOR STEAM-BOILERS.

SPECIFICATION forming part of Letters Patent No. 794,090, dated July 4, 1905.

Application filed February 16, 1904. Serial No. 193,867.

To all whom it may concern:

Be it known that we, ERNEST GEARING, residing at Harrogate, and WILLIAM RAINFORTH, residing at Leeds, in the county of York, England, subjects of the King of Great Britain and Ireland, have invented a Process of Making Corrugated Furnaces and Flues for Steam-Boilers, of which the following is a specification.

Hitherto it has been impracticable to roll in a plain tube steep-sided hollow outwardly-projecting strengthening portions or ribs (hereinafter called "hollow ridges") of adequate depth to afford the requisite strength to withstand modern working boiler-pressures because of the thinning of portions of the wall when the attempt is made to roll deep steep-sided ridges in the ordinary manner.

Now the object of this invention is to produce from a plain tube and by rolling a steam-boiler furnace or flue having deep steep-sided hollow ridges without rendering any portion of the furnace or flue wall unduly thin. For this purpose hollow ridges formed on a tube by a preliminary corrugating process are converted to the required section by the application of rolling pressure to the tube-wall in a direction normal to the axis of the tube and in such wise as to reduce the depth of the hollow ridges from their summits to the bottoms of the valleys and by the application of pressure to the opposite sides of individual ridges, the result being that the valleys are widened and the sides of each ridge caused to approach each other. Usually the preliminary corrugating process is effected in two stages, and the ridges formed by the preliminary corrugating process are given the required shape by one or more sets of compound collapsible and expandible segmental formers that are adapted when in the collapsed condition to enter the valleys between the hollow ridges on the exterior of the furnace or flue and are then during the rotation of the furnace or flue by suitably corrugated or ribbed internal and external main rolls adapted to reduce the depth of the ridges, expanded sideways, so as to embrace the hollow ridges between them and simultaneously press the side

portions of each ridge toward each other, the shape of the formers being such that there is between each adjacent pair a space or groove corresponding in cross-sectional shape to that which it is desired to impart to each hollow ridge, so that by the continued rotation of the furnace or flue the whole of the hollow ridges thereon will be simultaneously pressed to the required finished shape, the valleys between them being widened without altering the pitch of the ridges.

In the accompanying drawings, Figure 1 is a sectional view of a corrugated partially-formed tube-wall. Fig. 2 shows the same formation, but indicates the application thereto of the rolls used to impart to the tube-wall shown in Fig. 1 the formation shown in Fig. 3. The left and right hand portions of the figure, respectively, show the rolls at the commencement and end of their operation. Fig. 3 is a similar view to Fig. 1 of the tube-wall after having been subjected to a two-stage preliminary corrugating process, the second stage being effected between the rolls indicated in Fig. 2. Fig. 4 illustrates the application of the rolls to the formation shown in Fig. 3. In the left-hand portion the rolls are shown in the positions they occupy at the commencement of their operation, and in the right-hand portion they are shown in the positions they occupy at the end of their operation. Fig. 4^a illustrates the application of the formers to the formation shown in Fig. 3. In the left-hand portion of the figure the formers are shown in the positions they occupy at the commencement of their operation, and in the right-hand portion they are shown in the positions they occupy at the end of their operation. Fig. 5 shows the formation resulting from the operation of the rolls and formers. Figs. 6, 7, 8, and 9 illustrate, respectively, the original plain tube and the same tube after the preliminary corrugating operation, the same tube after the depth of the ridges has been deepened and their sides steepened, and the completed furnace or flue tube.

The furnace or flue tube is preferably first rolled in stages to the sectional form shown in Fig. 3, the first rolling operation forming

deep and wide but not steep-sided corrugations, as shown in Fig. 1, and a subsequent rolling operation applying pressure (by means of an internal roll *c* and an external roll *d*, as indicated in Fig. 2) in a direction normal to the axis of the tube to the sides of the ridges or outward corrugations *a*, so as to steepen and deepen the ridges without altering their pitch and widen the intermediate valleys, giving to the flue-wall substantially the sectional form shown in Fig. 3. The application of rolling pressure to a tube-wall of the form shown in Fig. 3 and normally to its axis and of pressure to the sides of individual ridges by means of formers *h* is illustrated in Figs. 4 and 4^a. It will be seen from Fig. 4 that the rolls *c* and *d* reduce the depth of the ridges. They also slightly increase the smallest internal diameter and slightly decrease the greatest external diameter, thus causing the wall of the flue to move a little toward the formers, which are situated to one side of the rolls. This movement is indicated in Fig. 4^a. The final formation of the tube-wall (shown in Fig. 5) is produced by the closing up of the rolls, as illustrated by Fig. 4, and the expanding of the formers *h* by means of wedges *i* while the tube is rotated by the rolls, as illustrated by Fig. 4^a.

In this specification and in the claims we use the expression "pressure to the side portions of the individual ridges" and the expression "pressure in a longitudinal direction," and for the purpose of illustrating our process we have shown diagrammatically an arrangement of devices adapted to exert pressure against the respective side walls of a hollow ridge in opposite directions parallel to the tube-axis, which we consider to be the best; but it is a feature of our invention that in addition to the pressure in planes substantially at right angles to the axis of the tube under treatment there is exerted against the side walls of the hollow ridges other pressure, such as cannot be exerted by the same rolls which exert the pressure in the planes substantially at right angles to the axis of the tube. This being so, it will be understood that the respective expressions "pressure to the side portions of the individual ridges" and "pressure in a longitudinal direction" are not used by us in the sense of limiting ourselves strictly to pressure in a direction parallel to the tube-axis, but are intended to include as equivalent of such pressure any pressure not exerted by the inner and outer rolls which will have the effect of reducing the distance apart of the two side walls of a hollow ridge. Thus, for example, it will be obvious that, assuming formers having grooved cheeks adapted to be turned slightly about axes at right angles to the tube-axis instead of being adapted to slide parallel to said axis be employed, the effect of wedge action would be to cause the formers to move

the side walls of individual ridges nearer together.

What we claim is—

1. The herein-described process of treating partially-formed hollow strengthening-ridges in the wall of a furnace or flue tube which consists in the application of rolling pressure to the tube-wall in a direction normal to the axis of the tube so as to reduce the depth of the ridges and intermediate valleys, and of pressure to the side portions of the individual ridges so as to press the side portions of each ridge toward one another.

2. The herein-described process of treating partially-formed hollow strengthening-ridges in the wall of a furnace or flue tube which consists in the application of rolling pressure to the tube-wall in a direction normal to the axis of the tube so as to reduce the depth of the ridges and intermediate valleys, and of pressure to the side portions of the individual ridges in a longitudinal direction so as to press the side portions of each ridge toward one another.

3. The herein-described process of treating partially-formed hollow strengthening-ridges in the wall of a furnace or flue tube which consists in the application of rolling pressure to the tube-wall in a direction normal to the axis of the tube so as to reduce the depth of the ridges and intermediate valleys, and of pressure to the side portions of the individual ridges so as to press the side portions of each ridge toward one another, the pitch of the ridges being maintained constant.

4. The herein-described process of treating partially-formed hollow strengthening-ridges in the wall of a furnace or flue tube which consists in the application of rolling pressure to the tube-wall in a direction normal to the axis of the tube so as to reduce the depth of the ridges and intermediate valleys, and of pressure to the side portions of the individual ridges in a longitudinal direction so as to press the side portions of each ridge toward one another, the pitch of the ridges being maintained constant.

5. The herein-described process of making a steam-boiler furnace or flue of the kind having hollow strengthening-ridges, which consists in rolling hollow ridges and intermediate valleys in the wall of a tube and afterward subjecting such tube-wall to a combined rolling and pressing operation whereby pressure is applied to the tube-wall in a direction normal to the axis of the tube and the depth of the ridges reduced and whereby pressure is applied to the side portions of the individual ridges so as to press the said side portions toward each other, as set forth.

6. The herein-described process of making a steam-boiler furnace or flue of the kind having hollow strengthening-ridges, which consists in rolling hollow ridges and intermediate

valleys in the wall of a tube and afterward subjecting such tube-wall to a combined rolling and pressing operation whereby pressure is applied to the tube-wall in a direction normal to the axis of the tube and the depth of the ridges reduced and whereby pressure is applied to the side portions of the individual ridges in a longitudinal direction so as to press the said side portions toward each other, as set forth.

7. The herein-described process of making a steam-boiler furnace or flue of the kind having hollow strengthening-ridges which consists in successively corrugating the tube-wall by rolling, the pressure being applied normally to the tube-axis, deepening and steepening the side portions of the outward corrugations in the tube-wall by rolling, the pressure being applied normally to the tube-axis, and afterward subjecting it to a combined rolling and pressing operation whereby pressure is applied to the tube-wall in a direction normal to the axis of the tube and the depth of the ridges reduced and whereby pressure is applied to the side portions of the individual ridges so as to press the said side portions toward each other, as set forth.

8. The herein-described process of making a steam-boiler furnace or flue of the kind having hollow strengthening-ridges which consists in successively corrugating the tube-wall

by rolling, the pressure being applied normally to the tube-axis, deepening and steepening the side portions of the outward corrugations in the tube-wall by rolling, the pressure being applied normally to the tube-axis, and afterward subjecting it to a combined rolling and pressing operation whereby pressure is applied to the tube-wall in a direction normal to the axis of the tube and the depth of the ridges reduced and whereby pressure is applied to the side portions of the individual ridges in a longitudinal direction so as to press the said side portions toward each other, as set forth.

9. The herein-described process of treating partially-formed hollow strengthening-ridges in the wall of a furnace or flue tube which consists in the simultaneous application of rolling pressure to the tube-wall in a direction normal to the axis of the tube so as to reduce the depth of the ridges and intermediate valleys, and of pressure to the side portions of the individual ridges so as to press the side portions of each ridge toward one another.

Signed at Leeds, county of York, England, this 1st day of February, 1904.

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