(No Model.) 2 Sheets—Sheet 1.

S. R. WAGG.

LINING FOR PULP DIGESTERS.

No. 390,727. Patented Oct. 9, 1888.

Fig. 1.

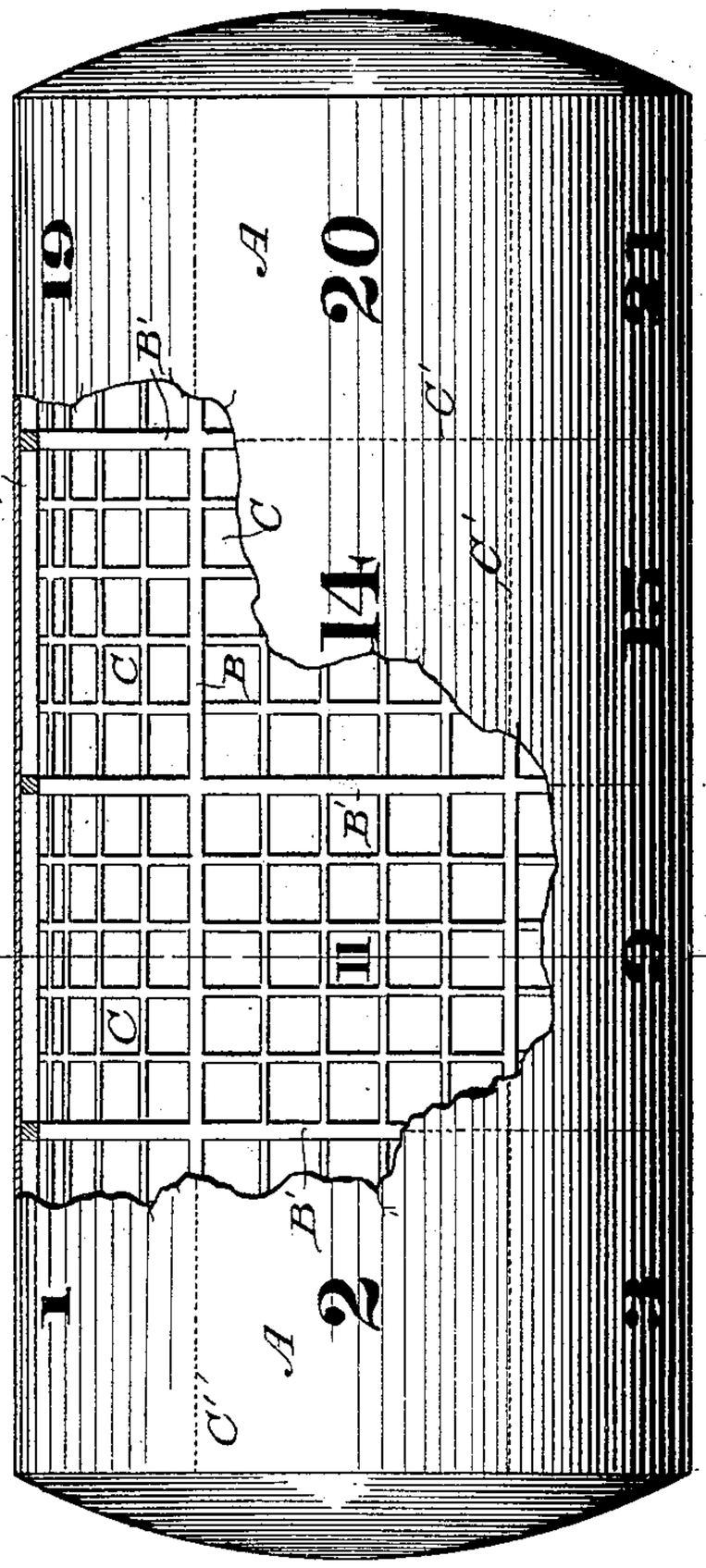

Fig. 2.

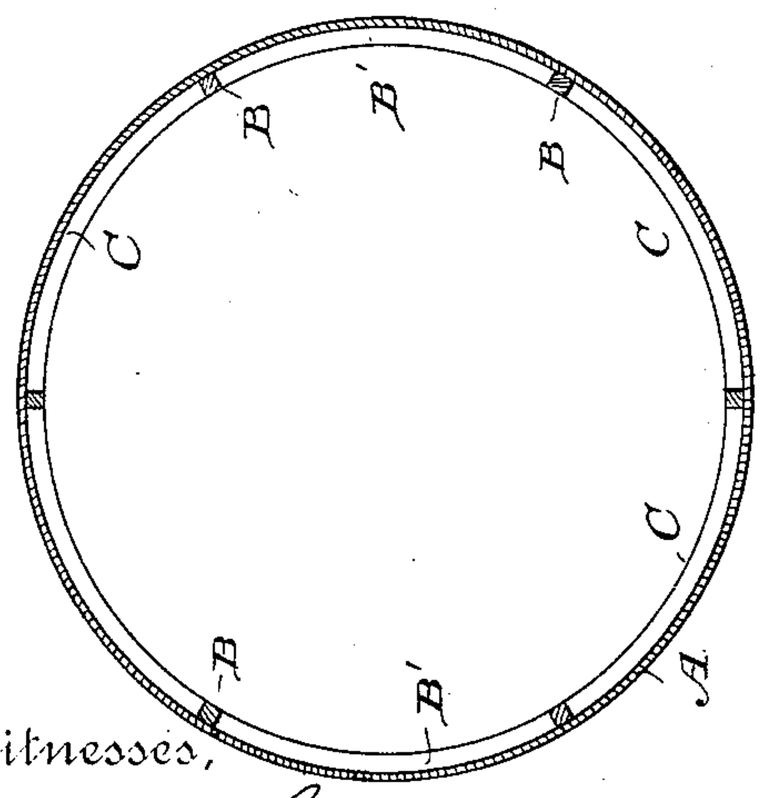

Fig. 3.

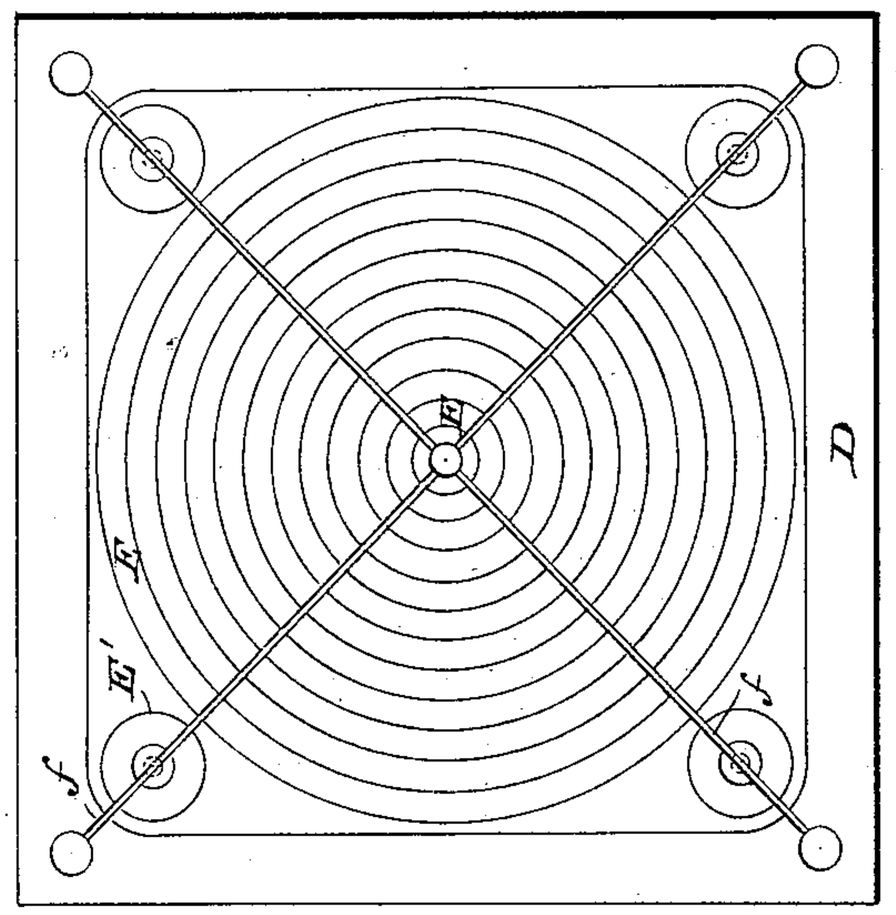

Fig. 4.

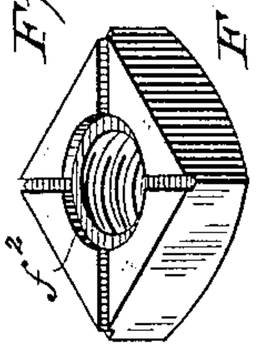

Fig. 5.

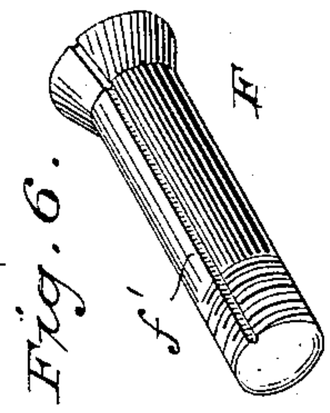

Fig. 6.

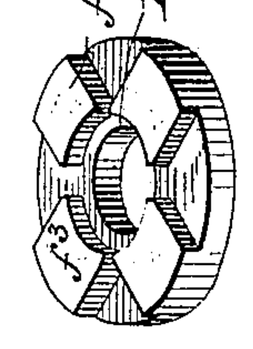

Fig. 7.

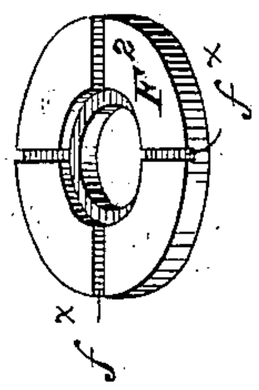

Fig. 8.

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By his Attorneys
Parkinson & Parkinson

(No Model.) 2 Sheets—Sheet 2.

S. R. WAGG.

LINING FOR PULP DIGESTERS.

No. 390,727. Patented Oct. 9, 1888.

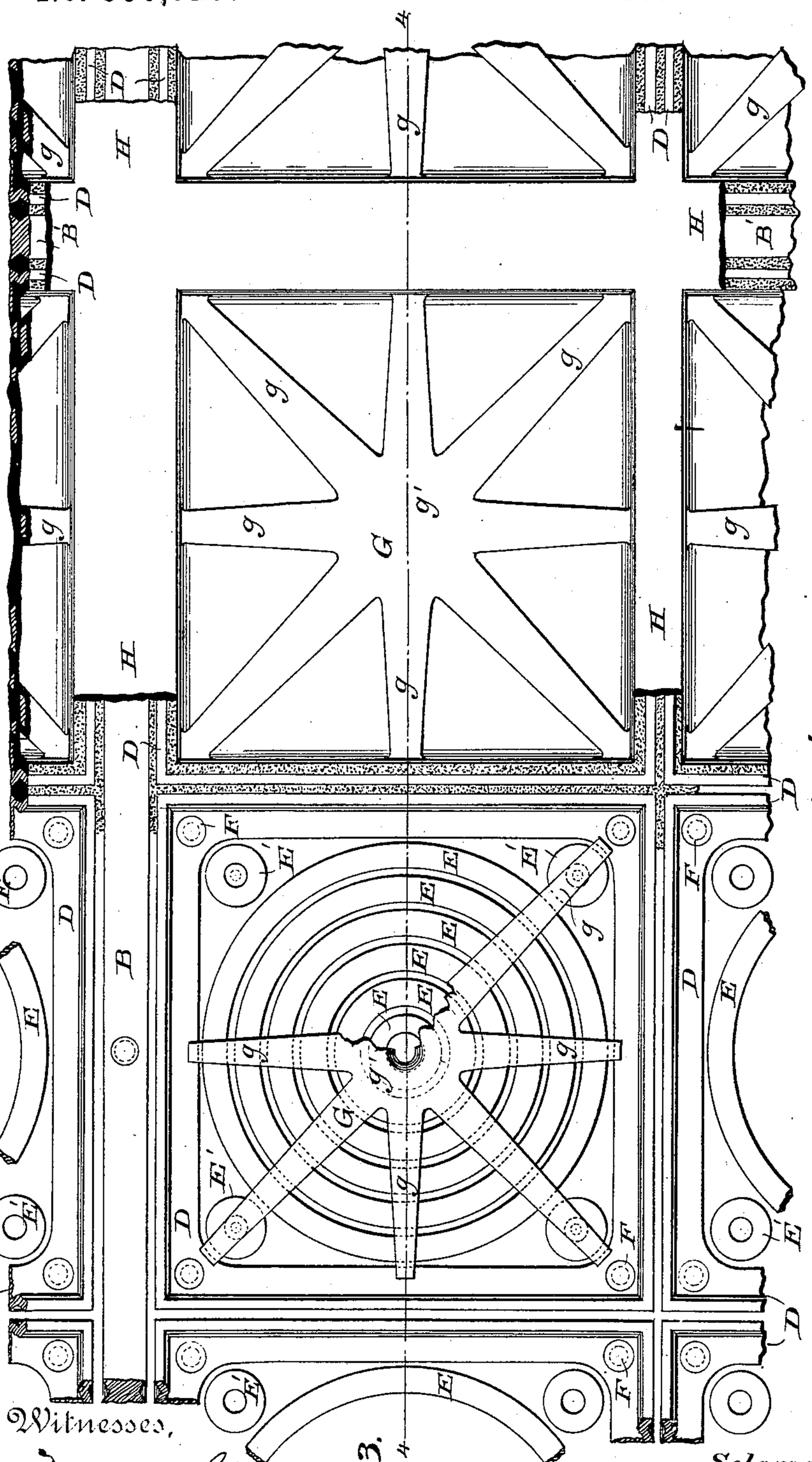

Fig. 3.

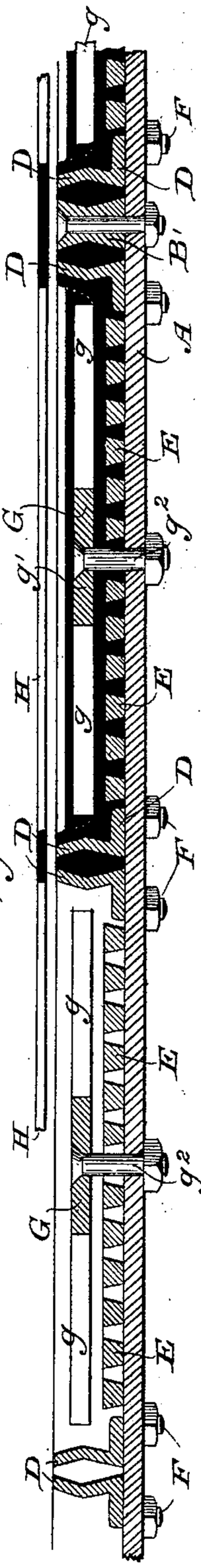

Fig. 4.

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UNITED STATES PATENT OFFICE.

SOLOMON R. WAGG, OF NEENAH, WISCONSIN.

LINING FOR PULP-DIGESTERS.

SPECIFICATION forming part of Letters Patent No. 390,727, dated October 9, 1888.

Application filed March 21, 1887. Serial No. 231,634. (No model.)

To all whom it may concern:

Be it known that I, SOLOMON R. WAGG, a citizen of the United States of America, residing at Neenah, in the county of Winnebago and State of Wisconsin, have invented certain new and useful Improvements in Lining for Boilers and Pulp-Digesters or other Vessels Exposed to the Action of Acids, of which the following is a specification.

Heretofore boilers used in the treatment of wood fiber by the bisulphite process have been lined with lead in sheets to protect the shell from corrosion and the contents from stain; but a defect in all boilers thus lined has been that the steel or iron shell and the lead lining do not expand and contract equally, and that after short use the lining begins to creep and crack and admits the acid to contact with the shell. To obviate the effects of this unequal expansion and contraction of the lead and prevent cracks and consequent leakage and injury to the shell and to the contents of the boiler or material under treatment, numerous devices have been placed before the public with varying degrees of success. Some manufacturers have supplied boilers with an interior lining made in practically one homogeneous piece by soldering the edges of one or more sheets together. Others have divided the lining into sections and covered the joints with strips. Others have inclosed finely-perforated sheet-iron in a casing of lead, making plates or broad sheets to be applied as lining. Still others have covered woven-wire cloth with lead. None of these constructions, however, have been entirely free from objections or have been entirely satisfactory in use.

In my improvement I propose, first, to apply the lead lining in small sections or tiles, each of these sections in itself containing several independent anchors or local resistances to the expansion and contraction, and practically shutting off the areas so confined from being affected by other areas and more nearly harmonizing them with the expansion and contraction of the shell; second, I partition the interior of the boiler-shell, by means of ribs or stays of metal bolted to the interior wall of said shell, into a number of practically equal shallow compartments, each of which will be independently lined by tiles coated with lead or other acid resistant, so that any leak or defect may be readily remedied within the compartment in which it is found without disturbing the tiles in the other compartment; third, I employ a peculiar bolt and nut for securing the tiles independently to the boiler-shell, having a groove cut in said nut and bolt, so that leakage is at once conducted to the outside and the locality of leakage indicated, for which purpose the exterior may have designating-lines corresponding with those of the interior partitions, and, if desired, be furnished with a number reproduced on the interior; fourth, I propose to electroplate the interior of the iron or steel boiler-shell with phosphor-bronze or other equivalent composition before applying the lead or acid-resistant lining to more perfectly guard against damage by leakage; fifth, I have found that an alloy hereinafter stated expands and contracts in nearly equal measure with the iron and steel shell of the boiler while resisting the destructive effects of acids as well as or even better than lead, and such I propose to use and to claim herein.

Other features of my invention will appear from the ensuing description.

In the drawings, Figure 1 is a side elevation of a boiler embodying my invention, the shell being partly broken away to expose the internal construction; Fig. 2, a transverse section therethrough; Fig. 3, an enlarged detail of a portion of the inside of the boiler, showing at the right hand a lining-tile with lead covering in place and at the left the adjacent tile uncovered; Fig. 4, a longitudinal section on the correspondingly-numbered line in the preceding figure; Fig. 5, a bottom plan view of one of my improved tiles, showing the channels or ducts to conduct air or leakage to the bolt-holes through the boiler-shell; Figs. 6 and 7, respectively, enlarged details in perspective of a fastening-bolt and its nut for securing the lining to the boiler-shell, and Figs. 8 and 9 enlarged details of alternative forms of washers which may be used with said nut.

A represents a boiler-shell, of iron, steel, or other suitable material, of any approved outline, depending in some measure upon whether it is to be stationary or rotary. To the interior walls of this shell are bolted longitudinal bars or stays B and transverse bars or stays B′, of metal, dividing said walls off into a number of shallow and independent com-

partments or cells, C, rectangular in outline. These compartments may be indicated upon the exterior of the boiler by lines or marks C′, corresponding with the longitudinal and transverse stays which define their limits, and by numerals 1, 2, &c., to be reproduced on the interior, so that any compartment may be immediately located from the outside. Each compartment is to be filled with acid-resistant tiles, as will presently appear, and one or more tiles, or every tile, will advisably have communications with the exterior surface of the shell that will permit leaks within the compartment to be traced on the outside and immediately located by the designating-number of the compartment.

So far as the division of the shell into independent internal compartments is concerned, any suitable form of acid-resistant tile or lining may be employed without departing from my invention; but the tile which I have devised and prefer to use is constructed as follows: I form a frame, D, of hard metal, preferably of angle-iron, of the shape desired for the outside margin or edge of the tile or section, either rectangular, as shown in the drawings, or a polygon, that will allow the tiles to be laid and matched edge to edge—for instance, a hexagon or octagonal and square tiles may be combined in the same structure. The upright flange of this frame will be recessed, grooved, or undercut around its exterior side, as described in an application heretofore filed by me, in order to admit between it and the adjacent tile when in position a sort of dovetail seam or tamping of acid-resistant material, and the stays which define the compartments to be filled by these tiles or sections may also be undercut along their sides, that with the tiles coming adjacent to them such a seam or tamping may be formed.

Within the angle-iron frame I lay a series of strong iron, steel, or other metal rings, E, of successively diminishing diameter. These rings will be comparatively thin and shallow and ordinarily will not rise to the height of the angle-iron frame which incloses them. A large ring is first taken, having such diameter as to just lie within the frame without touching its walls, giving a minimum clearance all around of, say, one-half an inch to a full inch. The next ring is laid within the first with a clearance all around from said first ring of about the same, care being taken that their walls shall be equidistant at every point. The next smaller ring is laid within the second, with like clearance, and so on until the full series of rings are interposed, the last or central ring preferably being not over three inches in diameter. When the inclosing-frame is rectangular in outline, the outer ring will leave large triangular spaces at the corners, which will be filled with smaller series, E′, of diminishing rings; but when it is hexagonal or octagonal the outer ring will practically correspond with its outline, and the spaces at the angles will be immaterial. The angle-iron frame and the rings having been previously prepared with a coating of any suitable solder to cause the lead to adhere firmly when poured upon them in its molten state, the next proceeding after they are thus assembled is to pour upon them, while they rest upon a suitable table to cut off escape of the fluid metal, molten lead or equivalent acid-resistant alloy, forming the whole into a single section or tile, and protecting all the exposed iron or steel parts with an unbroken covering.

The tile-table, when square, should preferably have at each corner a bolt-hole with a bolt, F, set therein before the reception of the lead covering, such bolt to be of sufficient length to reach to the outside of the boiler-shell. A small groove or channel, *f*, is made from the edge of the angle-iron to the bolt-hole, and such groove may be extended over the under side of the plate or tile and may branch therebeneath. The shank or spindle of the bolt is channeled, grooved, or fluted longitudinally, as at *f*′, to afford one or more ducts leading from the head to the exterior wall of the boiler-shell and to or adjacent to its end, which is screw-threaded, so that after being passed through the shell it may receive a nut, F′, whereby the tile can be firmly clamped to said shell. If this nut alone is used it will have an annular undercut groove, f^2, or be countersunk on its inner face, so as to connect with the groove or flutes in the spindle of the bolt, and will have ducts $f^\times$ leading from this countersink or groove to its exterior; but preferably a washer, F^2, is employed, either grooved similarly to the inner face of the nut and having ducts or else struck up with three or more feet, f^3, to lift it somewhat from the boiler-shell. Thus any leakage which finds its way beneath the tile and attacks the inner wall of the boiler will eventually enter the ducts or channels on the under side of the tile and be conducted to the bolt at one or the other corner, then pass along its grooved spindle to the exterior wall of the shell, and eventually escape from beneath the washer or nut, making its presence at once known, when it will be located according to the compartment where it makes its appearance. Another purpose of this grooving and fluting is that when placing the tile or section in position any air confined underneath it may escape to the exterior as the bolts are tightened. Such air, if permitted to remain confined beneath the section, would expand as soon as the boiler became heated in use, and would in the end, by repeated expansion and contraction, cause bubbles or bulging in the tile and cracking in the plate.

In case it should be desired to leave out the fastening-bolts while casting the lead lining about the angle-iron frame and rings, the bolt-holes can be filled with clay and the lining cast over them, and when cool, or when ready to place in position, the lining can be partially cut with a suitable tool and turned up, leaving the bolt-hole clear. The bolt can then be inserted and the lining turned to its original posi-

tion and fused acid-tight; or the bolt-hole can be elongated and the bolt-head formed as a sort of T, so that this hole being stopped up with clay while the lining is being poured can be cleared out without puncturing the lining after it becomes cool, the bolt-head then being inserted and given a quarter-turn, thus confining it. The lining may be hammered down upon it to prevent its escaping by a reverse movement. A series of these sections prepared with rings and acid-proof linings will be laid in each compartment of the internal wall of the shell, the diameter of the tiles or sections being so proportioned to the size of the compartments that a given number may perfectly fill a compartment. The seams between these tiles and between the tiles and stay-rods or partition-bars will be filled and tamped with lead, which will also be carried over the stay-rods, so that no destructible material may be exposed to the action of the acids within the boiler.

As an additional precaution against buckling or bulging or warping, I propose to employ a hard-metal radial-armed frame or spider, G, its arm *g* extending close up to the edge of the angle-iron frame, and having a common center or hub, *g'*, corresponding with the axis of the central ring in the tile. This will be placed in position upon the rings and their lead covering and secured by a bolt, g^2, passing through the axis of the central ring and the exterior of the boiler-shell, and, if desired, by other bolts passing through the ends of the radial arms, as shown. Then the frame or spider itself, including the heads of its securing-bolts, will be covered with lead or other acid resistant, unless this has previously been done. A lead washer may be placed beneath the spider at the point where its bolt passes through the lead lining of the tile, so that when the bolt is tightened up the washer may be jammed down upon the lining and make a tight joint. The spider holds all the rings flat down against the boiler-wall, thereby assisting to keep said rings in position, so they can work in harmony to counteract the expansion of the lead or alloy and establish a uniform rate of expansion for the lining and boiler-walls as near as may be. Instead of this spider frame, however, I may employ one or more straight bars laid over the rings parallel to each other and bolted at their ends or centers to the boiler-shell; but as ordinarily a single bolt at the center of the tile alone will be sufficient when the radial-arm spider is used, I prefer this, as it diminishes the chances of leakage.

Over all of the seams, after the filling and calking are completed, I place a ribbon, H, of lead or alloy, and by solder or any other convenient method unite the same to each of the conjoining tiles at the upper edges or outside of their lead-covered angle-iron frames, making the union acid-tight by using blow-pipe or solder-iron, thereby causing the seam to form a compound joint and preventing against possible leakage. When desirable, the filling can be fused at its edges with the covering of the angle-iron walls before placing the ribbon over such filled seam.

As an additional security against acid attacking the boiler-shell, as it may sometimes do by leaking through the tiles or seams, or through the lead or other lining in case no tiles are used, I propose to clean the boiler-walls and prepare them in a suitable manner for receiving a cover of any acid-resistant metal or material by electro plating or deposition applied in the usual way, or by such means and appliances as are in use and best suited for the purpose. Such electroplate deposition can be made on sheets or sections of the shell before making up or upon the shell after construction. The material I propose to employ for this electro deposition is phosphor-bronze or deoxidized copper or alloy. This, as above intimated, should be applied to the walls before the lead lining or acid-resisting tiles are placed thereon. Thus far I have described a lining of lead or acid-resisting surface of lead alone, although it has been suggested that any other acid-resistant metal or alloy might be utilized. Lead, when heated, expands much more than iron or steel, which are the usual materials for boiler-shells of this nature, (in this art,) and when it cools it does not return quite to its original form or size like iron or steel, but each time it is heated it stretches out or creeps, thickening up in one place, thinning down in another, and buckles up and soon cracks through, admitting the corrosive liquor to contact with the shell, which, being vulnerable to acid, is speedily destroyed, while conversely the pulp in the process of being cooked is spoiled by the resulting metallic salts. I have ascertained that an alloy composed of lead, bismuth, and antimony, which may be so regulated as to expand and contract in practically the same degree as or in harmony with the expansion and contraction of the metal boiler-shell, whether that be iron, steel, or other metal, by varying the proportions of the bismuth or the antimony to the lead, will at the same time resist effectively the corrosive action of the powerful acids employed in the bisulphite process. Bismuth and antimony are both what is known as "volatile," and must be melted with care and not left long exposed to the heat, or the nature of the expected expansion will be affected thereby. It will therefore be advisable to melt the bismuth and antimony in inclosed tight vessels, and to pour them, when fluid, into the melted lead and stir quickly together therewith.

A precise and arbitrary rule of weights and proportions is not practicable, and as results will be only closely approximate I can only give an approximate statement of such proportions, bearing in mind that if melted in an open vessel the fluid metals will lose slightly more than in a covered vessel, and in such case a little more must be used to get the same result.

In forming an alloy for the lining, if iron, I combine the stated metals in about the following proportions, to-wit: Of lead I take eighty-four parts, of antimony twelve parts, and of bismuth four parts, thus obtaining an alloy that has but a very slight expansion over iron and that is a superior acid resistant. By the addition of slightly more antimony and bismuth the alloy can be made to expand less. Should a very tough alloy be required, I propose to add a small quantity of phosphor-bronze or deoxidized copper. This will interfere with the unity of expansion and contraction, if much is used, and to bring the expansion and contraction down to the point aimed at there must be an increase in the amount of antimony and bismuth according to the quantity of phosphor-bronze used. The proportions, for instance, may then be stated as follows for lining an iron shell, to-wit: lead, seventy-five per cent.; antimony, fourteen per cent.; bismuth, five per cent., and phosphor-bronze six per cent. I have used copper in place of phosphor-bronze with fair results, but not as good, and give the bronze preference.

I do not intend to limit myself to the employment of separate and independent rings in constructing my improved tile, nor to the material of which they are made, provided that material expands and contracts in correlation with the expansion and contraction of the boiler-shell, but may form these rings (and their frame as well) by sinking or indentation in a homogeneous plate or by raising or striking up the same from the surface, and upon said plate or surface cast the acid-resistant coating or lining, or place it thereon by other or equivalent means; nor do I confine myself to the precise means for fastening said tiles, nor to the precise shape of the divisions or compartments on the inner wall of the boiler-shell, since these can be materially varied without departing from the principle of my invention.

I claim—

1. A boiler-shell having its interior walls divided into shallow compartments by ribs or stays, combined with independent acid-resistant lining in each of said compartments and acid-resistant covering to said stays.

2. A boiler-shell having its interior walls divided by ribs or stays into shallow compartments independently filled with acid-resistant lining and its exterior walls marked to correspond with said compartments.

3. A boiler-shell having its interior walls divided into shallow compartments by ribs or stays bolted to said walls, combined with acid-resistant lining for said ribs or stays and with acid-resistant tiles lining the walls within said independent compartments.

4. The tile herein described, consisting of a border-frame of hard metal, a series of diminishing rings of steel or iron, and an acid-resistant covering incorporating said rings and the border-frame.

5. The tile herein described, consisting of a frame of angle-iron, a series of diminishing rings of steel or iron, and an acid-resistant covering incorporating said rings and the angle-iron.

6. The tile herein described, consisting of a frame of angle-iron, a series of independent rings of steel or iron diminishing in size and set within said frame, and a lead covering incorporating the exposed faces of the frame and rings.

7. The combination, with tiles for the lining of boilers grooved at the inner side, of fastening-bolts having their spindles grooved to connect with the grooves of the tiles and secured by channeled nuts on the outside of the boiler.

8. The combination, with a tile composed of an angle-iron frame, a series of diminishing rings placed therein, and an acid resistant covering incorporating said ring and frame, of an acid-resistant covered spider composed of radial bars or equivalents, and having a central bolt passing centrally through the tile and covering the rings, and itself covered with acid resistant.

9. The combination, substantially as hereinbefore set forth, with the boiler-shell, of an electroplating of phosphor-bronze or equivalent material covering its internal walls and an acid-resistant lining secured over said plating.

10. The combination, substantially as hereinbefore set forth, with the shell of a paper-pulp boiler or digester, of an acid-resistant lining composed of antimony, bismuth, and lead, in about the proportions set forth, and with or without phosphor-bronze or equivalent.

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