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Otto Lilienthal  
MUSEUM

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COMPLETE SPECIFICATION.

An Improved Tubular Boiler.

I, OTTO LILIENTHAL of Mückenstrasse 135 Berlin in the Empire of Germany Engineer do hereby declare the nature of this invention and in what manner the same is to be performed to be particularly described and ascertained in and by the following statement:—

5 This invention consists in a tubular boiler or steam generator substantially as herein-after described and illustrated in the accompanying drawings, in which water or liquid introduced is first warmed by radiation from the furnace and afterwards brought more directly under the heat of the flames thereof.

10 In the drawings, Fig. 1 is a vertical section through the boiler and furnace showing the inclined position preferred for the former—Fig. 2 is cross section through the boiler, Fig. 3 is a section of one of the side walls—Fig. 4 is a rear elevation and Fig. 5 a plan of the boiler.

The boiler or generator is preferably mounted in an inclined manner as shown, on the ash box A, and the opposite side walls B B<sup>1</sup> of the generator are formed of cast plates 15 having or containing the parallel tubes *a b c d e f g* and *a<sup>1</sup> b<sup>1</sup> c<sup>1</sup> d<sup>1</sup> e<sup>1</sup> f<sup>1</sup> g<sup>1</sup>* respectively—The said side walls are connected by the rear wall C, provided also with tubes *i l n*—When fixed together the tube *i* connects the tubes *b b<sup>1</sup>*, the tube *l* connects the tubes *c c<sup>1</sup>* and the *n* connects the tubes *d d<sup>1</sup>*—The tube *i* is provided with the inlet *k* for 20 junction with the supply pipe, the tubes *l* and *n* are in connection by the perforation or tube *m*—Furthermore the tubes *e* and *f* are connected by the elbow or curved joint *o* and the tubes *e<sup>1</sup> f<sup>1</sup>* of the other wall are connected together in a similar manner by the elbow or curved joint *o<sup>1</sup>*—The tubes *g g<sup>1</sup>* are closed at their terminations towards the wall C.

25 At the edges of the wall B and B<sup>1</sup> the tubes *b* and *c*, *d* and *e*, *f* and *g*, are connected together respectively by the joints *p q* and *s*, and the tubes *b<sup>1</sup>* and *c<sup>1</sup>*, *d<sup>1</sup>* and *e<sup>1</sup>*, *f<sup>1</sup>* and *g<sup>1</sup>* are similarly connected respectively by equivalent joints *p q* and *s* (not shown in drawings). The tubes *a* and *a<sup>1</sup>* are likewise connected at this side by a pipe *t*, having the outlet *u* for the steam or heated liquid the opposite ends of the pipes *a* and *a<sup>1</sup>* are closed at the wall C—The tubes *g* and *a* are connected by a suitable number 30 of parallel pipes *r* bent in the manner shown in Figs. 4 and 5, the tubes *g<sup>1</sup>* and *a<sup>1</sup>* are

*Lilienthal's Improved Tubular Boiler.*

likewise connected by similar parallel pipes  $r^1$  preferably interposed alternately with the pipes  $r$  aforesaid, as indicated in Fig. 4.

The lowermost coil or bend of the tubes  $r$  and  $r^1$  is contrived so as to leave free a space  $F$  the same being for the firing, the fuel is introduced through the door  $V$  in the front plate, and the ashes etc. emptied through the door  $W$  in the rear wall—The lower parts of the pipes  $r$   $r^1$  may be utilized as grating for supporting the fire, or firebars may be supported upon or over said pipes—The flues are contrived by the spaces divided off by plates  $x$   $x$  arranged within the windings of the pipes  $r$   $r^1$  as shown in Figs. 1 and 2, and by plates  $y$ . arranged outside said windings—The furnace gases thus pass in the direction indicated by arrows 1, 2, 3, 4 and eventually into the chimney in the wall  $z$ .

Water or liquid entering into the steam generator at  $k$ , or forced therein by a pump circulates through the tubes  $b$   $c$   $d$   $e$   $f$  and  $b^1$   $c^1$   $d^1$   $e^1$   $f^1$  and eventually arrives in the tubes  $g$   $g^1$ ; by this time it will have become heated almost to boiling by the heat radiated from the fire, and passing up through the pipes  $r$   $r^1$  will be evaporated therein, issuing from them into the tubes  $a$   $a^1$  in form of steam—The sediment contained in the water will be deposited in the tubes  $b$   $c$   $d$   $e$   $f$  and  $g$  and  $b^1$   $c^1$   $d^1$   $e^1$   $f^1$  and  $g^1$  and may be removed by cleaning the said tubes after removal of the back wall  $C$  and pipe joints  $p$ .  $q$ .  $s$ .

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is;—

1. A tubular boiler or steam generator having a series or series of bent pipes arranged in parallel planes, and so bent as to define spaces suitable one for reception of firing, others for flue or flues, said pipes being connected at one end alternately to two feed pipes and at the other end alternately to other two pipes substantially as and for the purpose set forth.

2. A tubular boiler or steam generator comprising in combination a series of bent pipes arranged in parallel planes and defining spaces substantially as and for the purpose set forth, together with walls enclosing said series, said walls having tubes connected in series and communicating by the last two tubes of the series, with one end of each pipe, alternately, of the aforesaid pipe series the other ends of said pipes being connected alternately with tubes likewise contrived in said walls, said tubes being in communication with an outlet for the purpose set forth.

Dated this 1st day of December 1887.

OTTO LILIENTHAL.

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Agents to Applicant.

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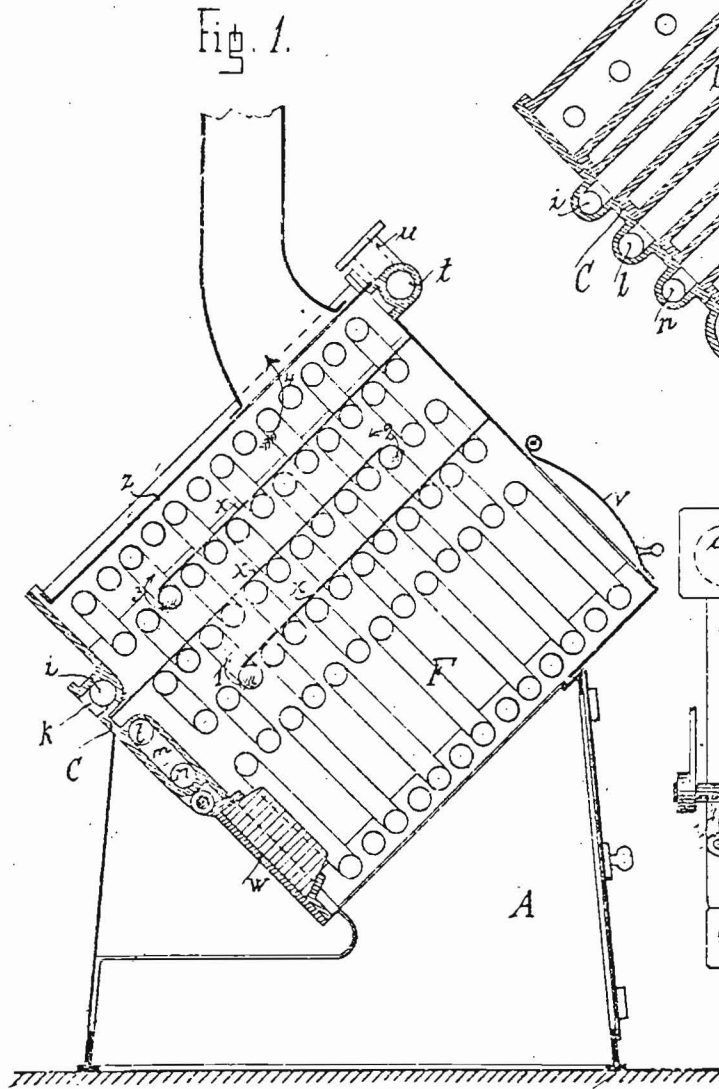


Fig. 1.

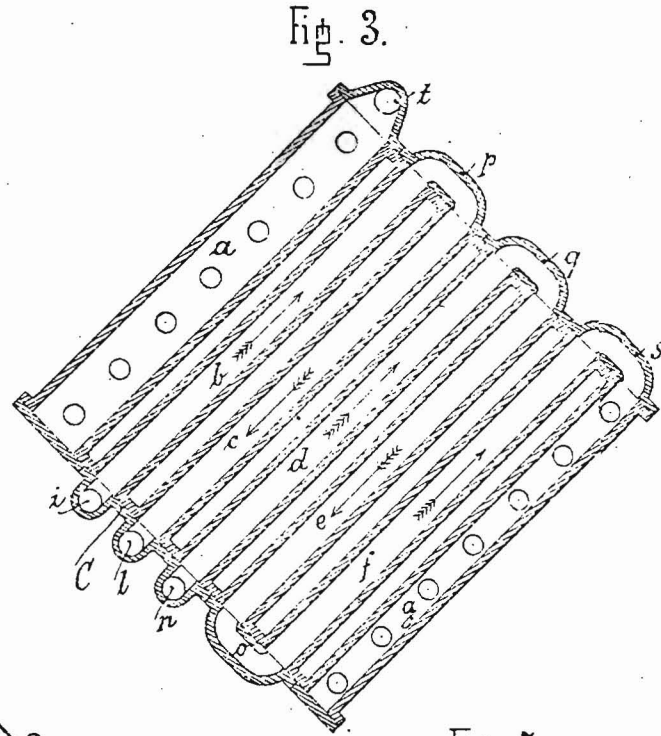


Fig. 3.

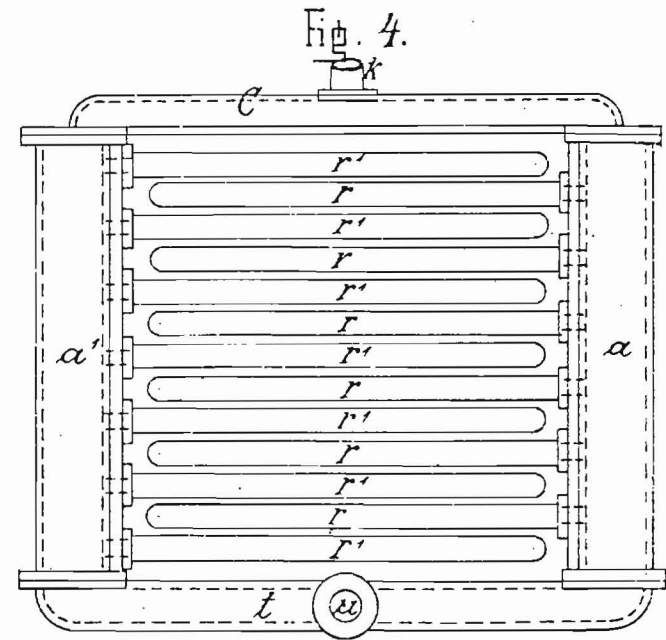


Fig. 4.

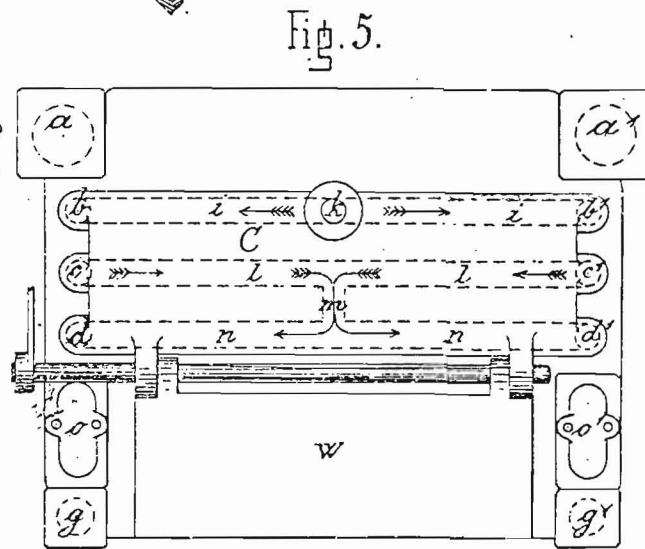


Fig. 5.

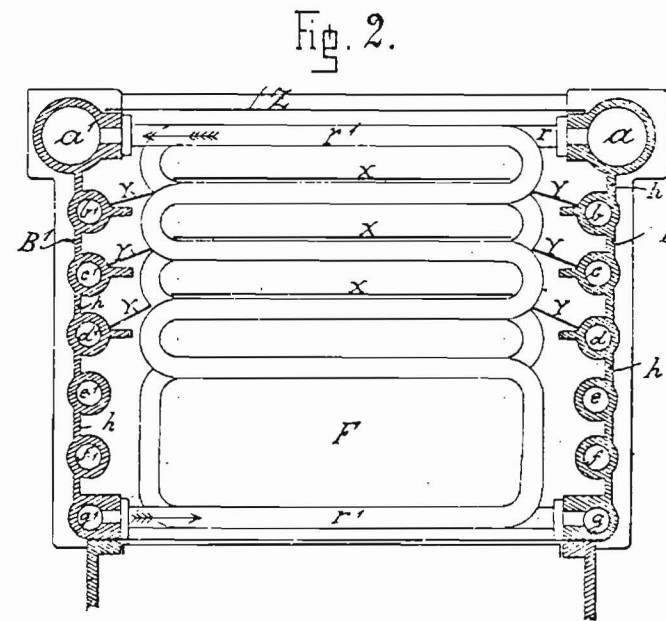


Fig. 2.

[This Drawing is a reproduction of the Original on a reduced scale]