H. H. TRACY & H. E. BOYRIE.

STEAM BOILER STRUCTURE.

APPLICATION FILED JUNE 12, 1911.

1,022,647.

Patented Apr. 9, 1912.

3 SHEETS—SHEET 1.

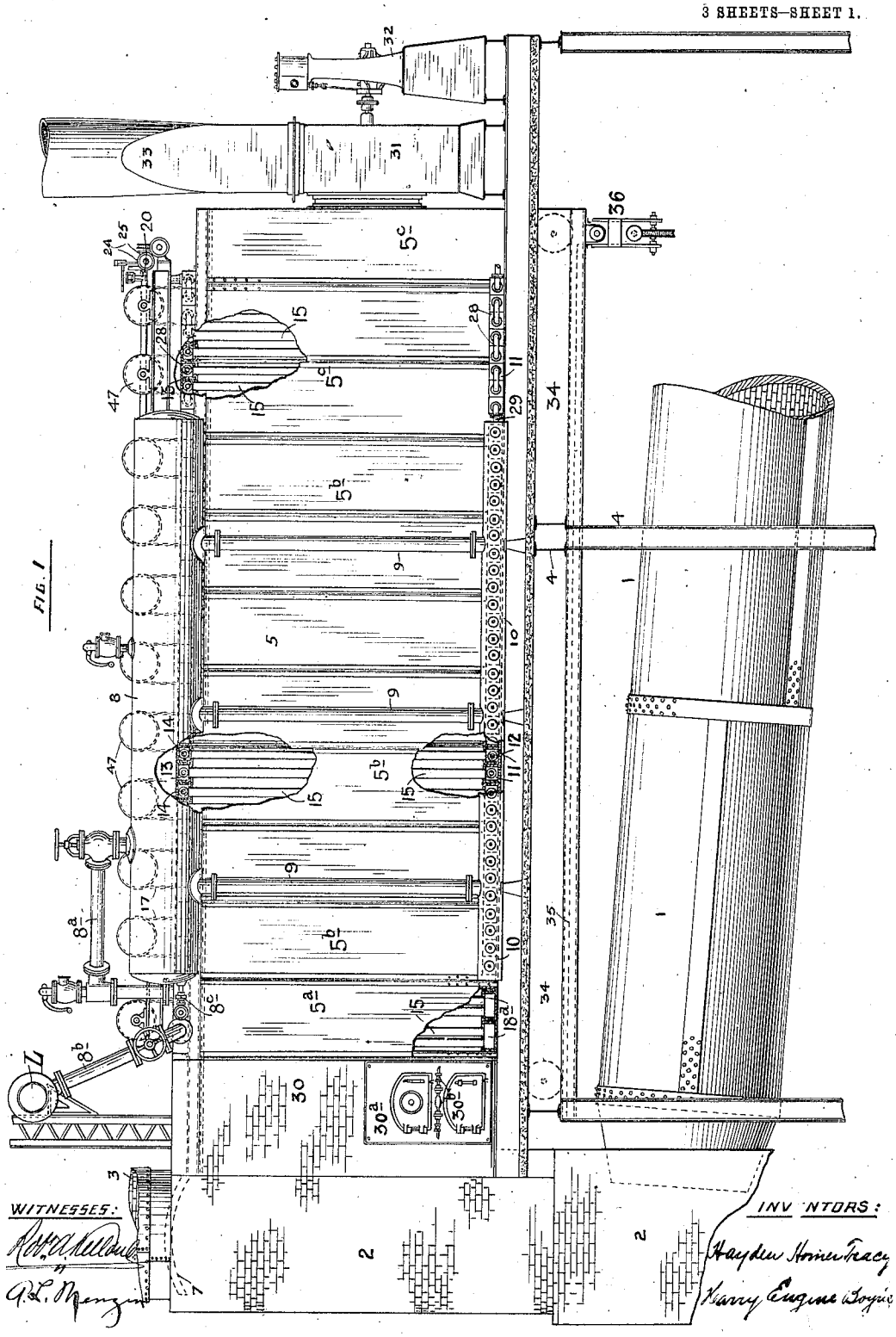


FIG. 1

WITNESSES:

INVENTORS:

Hayden Horner Tracy

Harry Eugene Boyrie

H. H. TRACY & H. E. BOYRIE.

STEAM BOILER STRUCTURE.

APPLICATION FILED JUNE 12, 1911.

1,022,647.

Patented Apr. 9, 1912.

3 SHEETS—SHEET 2.

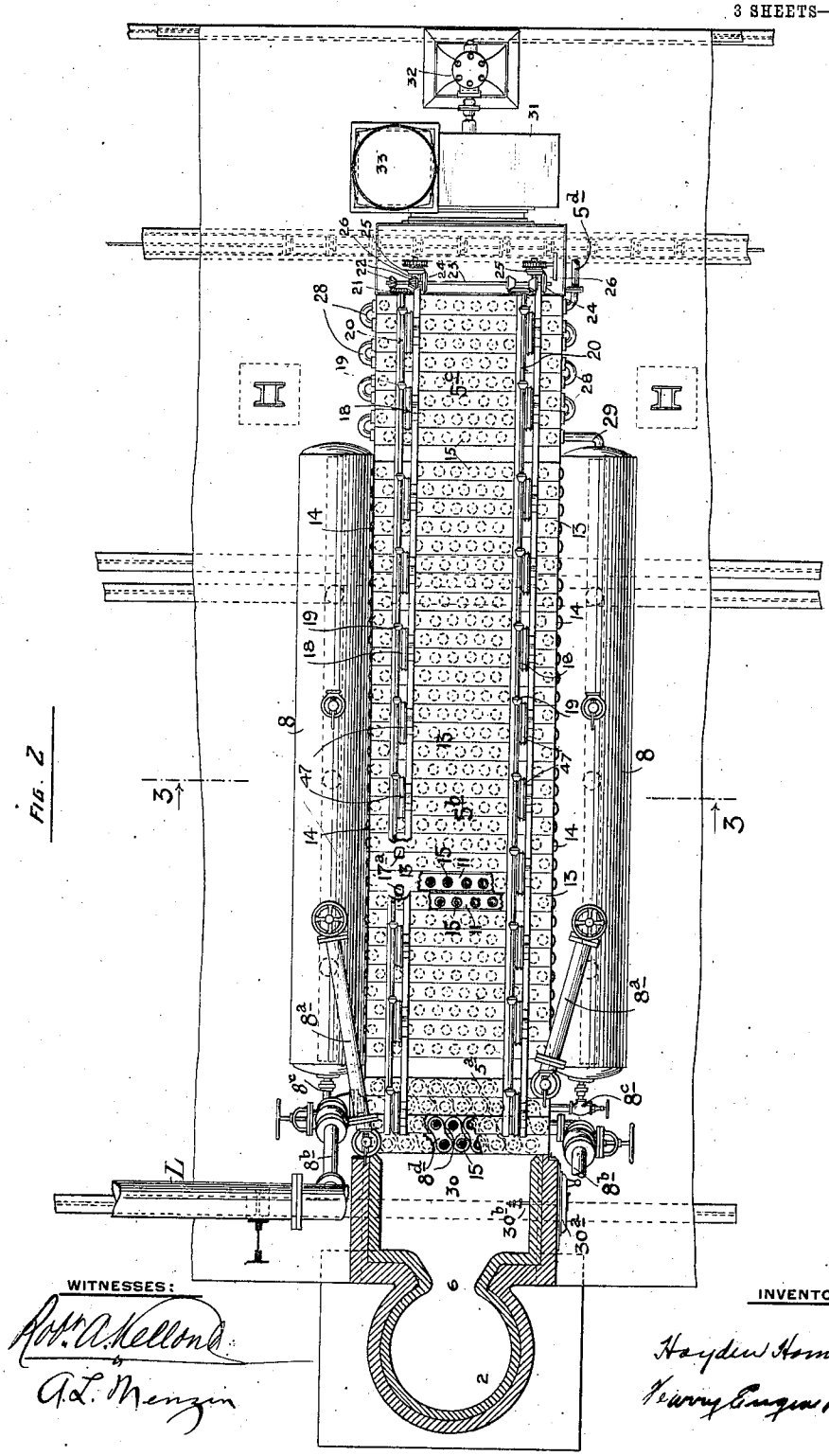


FIG. 2.

WITNESSES:

Robt. A. Kellond

A. L. Menzin

INVENTORS:

Hayden Homer Tracy

Henry Eugene Boyrie

H. H. TRACY & H. E. BOYRIE.

STEAM BOILER STRUCTURE.

APPLICATION FILED JUNE 12, 1911.

1,022,647.

Patented Apr. 9, 1912

3 SHEETS—SHEET 3.

FIG. 6

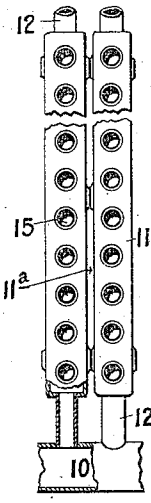


FIG. 7

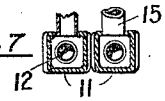


FIG. 3

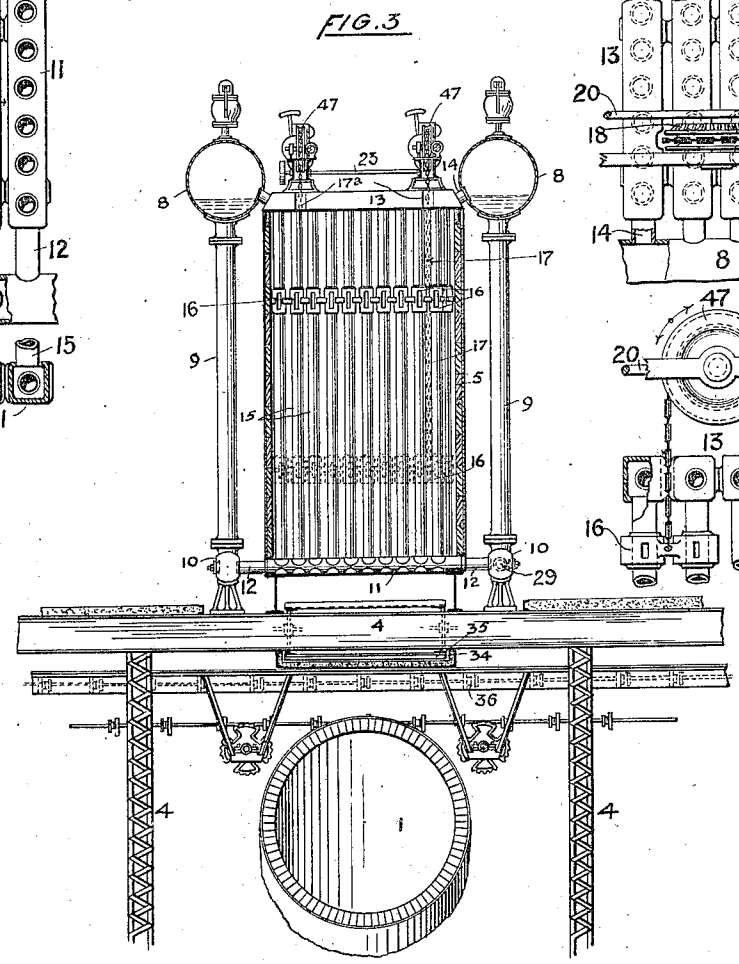


FIG. 4

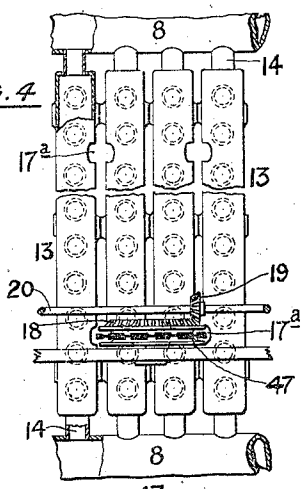
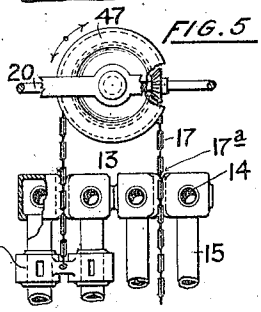


FIG. 5



WITNESSES:

Robt. A. Kellam.

A. L. Menzies

INVENTORS:

Hayden Homer Tracy

Harry Eugene Boyrie

UNITED STATES PATENT OFFICE.

HAYDEN HOMER TRACY, OF BERKELEY, AND HARRY EUGENE BOYRIE, OF SAN FRANCISCO, CALIFORNIA.

STEAM-BOILER STRUCTURE.

1,022,647. Specification of Letters Patent. Patented Apr. 9, 1912.

Application filed June 12, 1911. Serial No. 632,731.

To all whom it may concern:

Be it known that we, HAYDEN HOMER TRACY, a citizen of the United States, and resident of Berkeley, in the county of Alameda and State of California, and HARRY EUGENE BOYRIE, a citizen of the United States, and resident of the city of San Francisco, in the county of San Francisco and State of California, have jointly invented certain new and useful Improvements in Steam-Boiler Structures, of which the following is a specification.

This invention relates more particularly to a class of steam boilers which may employ multiple series of water-tubes, some of the rows of which will be used as economizers, others for steam-raising, and a third series as a steam-superheater, and the present improvements are conveniently adapted to installations in connection with kilns for manufacture of Portland cement, lime, and the like, and similar drying or incinerating plants liable to give off a quantity of unconsumable fine dust with the products of combustion in such manner that this dust—being carried along by the gases—finds lodgment and accumulates upon the heating surfaces of the boiler to the detriment of its continuous efficiency.

The general structure involved in our invention, however, is intended for and applicable to the utilization—for increased steam production—of the waste heat, such as that usually lost—say—in a cement kiln,—by radiation through the shell of the rotary kiln proper,—in that remaining in the material discharged at its lower end, and also in the gases finding escape at the upper end. For instance, it is found according to present practice, that from 90 to 110 pounds of pulverized coal (or about 15 gallons of fuel oil) are used in the average kiln in the production of a barrel, or 380 pounds, of the fused mass known as "cement-clinker," and this calculation in amount of fuel must increase or decrease with the size of the kiln. Of the heat produced by the combustion of either fuel, only from 20 to 30 per cent. is usefully employed in the production of cement-clinker. The remainder is lost in the directions just stated.

Although in the past, many efforts have been made to utilize the heat of the waste gases from kilns in cement plants, no satisfactory results have been obtained, for the reason that a large amount of very fine rock-dust is carried along with the gases and deposited upon the major portion of the surfaces of the boiler and tubes primarily designed to be heated by said gases. This dust is almost impalpable, (it being the custom that the crushed rock and clay shall be passed through a 200 mesh screen previous to being injected into the kiln) with the result that it detaches itself from the gases and settles on all surfaces with which it comes in contact; unless dislodged frequently, it will pile up coatings several inches thick. Hence, while the employment of boilers to produce steam by the absorption of the heat in waste gases in some instances has been satisfactory for a short time, the heating surfaces of such boilers have always suffered from accumulation of dust to such an extent that eventually the heat radiation becomes defective, the performance of the boiler unsatisfactory, and the economical effort rendered abortive.

The object of our invention is not only to insure the utilization of this waste heat in such channels that it will be devoted to the generation of steam, either by itself, or augmented by extra fires or jets, if desired, but also to produce a boiler structure where waste heat is made to act with its fullest degree of efficiency upon tubes installed as well for superheating, as for others arranged for steam-raising and economizing.

The production of extra power for single or diverse purposes in a manufacturing plant, without of necessity using additional fuel, and the consequent reduction in cost of manufacture of such commodities as Portland cement, or the like, are other objects aimed at by our invention.

The performance of the above and other useful functions is made possible, and their practical application to existing industries insured, by our improved boiler structure in which every tube (whether employed in individual rows or banks, for steam-raising, superheating or economizing, or combined and assembled for performing all, or any two of these operations) may be continuously and automatically cleaned and preserved from accumulations of dust, with the minimum of expense and maximum of effi-

ciency. And further, by our invention, the convenient employment of such desirable adjuncts as high-level water and steam drums in connection with the steam-main and with cross-headers, pluralities of vertical water-tubes and suitable lower drums in the general circulation, efficient tube-scraping devices, conveying mechanism, induced draft appliances, and steam and smoke distributers or conduits,—is made possible with the greatest degree of economy in first cost and subsequent care and utilization of the plant.

We will first describe a complete boiler structure such as we contemplate using in connection with a rotary cement kiln, explain its operation in practice, and then point out the novel features and arrangements claimed.

For full comprehension of our invention, reference must be had to the accompanying drawings forming part of this specification, and to the following detailed description thereof, similar characters of reference being employed to indicate like parts throughout.

In said drawings: Figure 1 is a side elevation, with parts in section, of a complete installation embodying our invention. Fig. 2 is a sectional plan view. Fig. 3 is a cross-sectional elevation on line 3, 3, Fig. 2. Figs. 4 and 5 are enlarged detail views of the top-headers and scraping devices. Figs. 6 and 7 are similar details of the bottom headers.

The numeral 1 indicates the upper portion of any ordinary rotary cement kiln, from which the gas is discharged into the usual brick flue 2 upon which has heretofore been mounted a stack 3, this stack being now out of employment for general operative purposes in connection with the rest of our improved structure, and is only shown to illustrate how the essential features of the latter may be readily incorporated with existing installations, or how such stack can remain as an auxiliary to be brought into service during repairs or closing off of the allied appliances.

6 is a passage leading from the flue 2 into an adjoining auxiliary chamber 30, preferably also of brick, which is open at its opposite side and in free communication with the front end of the boiler proper 5 which is supported on frame work 4 above the kiln, and is of a special construction to be hereinafter more particularly described. The gases pass from said flue 2 into the boiler by the passage 6 which is of sufficient dimensions to properly accommodate all of the gases arising from the kiln 1.

7 indicates (in dotted lines Fig. 1) an arch which we build in at the top of the flue 2 when the stack 3 is abandoned or finally closed off, to prevent the gases escaping to the atmosphere; but, instead of an arch an adjustable or slidable horizontal damper may be used, if it is preferred to let the stack remain for use in any of the emergencies mentioned.

The boiler proper, 5, is divided into three sections, that marked 5^a being a superheater, 5^b devoted to water-circulation and steam-raising, and 5^c an economizer, all of these sections being formed of pluralities of tubes 15 of substantially equal diameter and length, and disposed vertically between front and rear of the installation in the order named. Elevated steam drums 8 are mounted at each side, longitudinally of the boiler 5, and having their water-spaces connected by vertical circulating conduits or stand-pipes 9 to longitudinal water-circulating drums 10, exteriorly of the boiler casing. Lower headers 11 are connected to these drums 10 by nipples 12, while upper headers 13 are connected to the steam spaces (above the water-level) of the steam drums 8 by nipples 14. The water tubes 15 connect the upper and lower headers, and these tubes are maintained clean and free from dust by scraping-devices 16 consisting of sectional sleeves surrounding the tubes, and cutting-edges loosely contacting same, which devices rise and fall through the movement of connecting chains 17, passing over sheaves 47, and these latter, by means of bevel gears 18 cast or fixed on their faces, and bevel pinions 19 are driven from longitudinal shafts 20, each having fixed on its end a bevel wheel 21 adapted to be operatively connected with either of two oppositely-directed bevel pinions 22 on a transverse shaft 23, rotated by bevel wheels 24 meshing with bevel wheels 25 on separate short shafts 26, rotated, and the whole caused to reverse automatically, by any suitable connection to the engine 32, or other source of power. The chains 17 pass from the sheaves 47 to connection with the scraping devices 16, through channels 17^a formed in the front and rear walls of the top headers 13, as shown in Figs. 3, 4, and 5, our beneficial arrangement of heating, superheating, and economizing tubes close together in sections in the same longitudinal plane, being thus permitted while the full benefit is derived from the use of scrapers upon all of the tubes in the system, instead of the limitation to such use imposed by constructions at present known. (Similar scrapers and reversible gearing are used in what is known in commerce, as "fuel-economizers", and in themselves are not claimed by us, although by virtue of our special construction we are enabled to use scrapers with mechanical convenience and advantage upon all of the water and steam heating tubes throughout the entire system.)

There is an upper header 13 and a lower

header 11 for each transversely-arranged row of tubes 15, whether in the superheater, steam-raising, or economizer sections of the boiler, an equal plurality of the nipples 14 being employed to connect the ends of the upper headers of the steam-raising section 5^b to the steam-spaces of the high-level steam drums 8, 8, and a corresponding plurality of the nipples 12 to connect the ends of the lower headers of this section 5^b to the longitudinally-arranged water-circulating drums 10, 10.

The upper-headers 13 need have no spaces between them other than the channels 17^a for the scraper-chains. We have shown these headers close together in Figs. 1 and 2, and with slight intervening spaces in Figs. 4 and 5. The lower-headers 11, however, must have spaces 11^a between them, as shown in Figs. 6 and 7, to permit of the free gravitation of the scrapings from the tubes 15 to the receptacle 34.

The feed-water inlet to the economizer section 5^c is marked 5^d, in Fig. 2, and the headers (both upper and lower) are linked at their outer ends by curved pipes 28 which afford a continuous circulation through the headers and the connected vertical tubes 15, and thence, by the medium of a longer pipe 29, the water is led into the adjacent end of one of the circulating-drums 10.

Connection is made between the elevated steam drums 8 and the superheater-section 5^a of the boiler, by means of steam-conduits 8^a, extending from the upper portions or steam-spaces of the drums to the top-headers of the superheater, one to the front and the other to the rear, as seen in Fig. 2, and the superheated steam is finally led off to a steam-main L, through valve-controlled conduits 8^b, as shown in Figs. 1 and 2. 8^c is a flooding-valve-connection for conveying water to the superheater to prevent burning out when the tubes are dry at the commencement of the operation of the boiler. It extends between the water-space of one of the elevated drums 8, and the top-headers of the superheater. The superheater-section 5^a is preferably made up of two sub-sections, as shown in Fig. 2, and in which each of the tube-rows is provided with top-headers of similar construction to those in the steam-raising and economizer sections; the lower ends of the superheater tubes are connected in pairs from front to rear by separate cross-boxes 8^d, extending from the tubes in one row to the second row of the same sub-section, and have no direct connection with the longitudinal water-circulating drums 10.

31 is an induced-draft fan, of any approved type, in open communication with that end of the main boiler casing which contains the economizer 5^c, and also with the smoke-stack 33 which is now placed at this end, such fan being driven by an engine 32, operated by steam from the steam-main L, or by an electric or other motor, if desired.

A receptacle 34, extends underneath the boiler for practically its entire length so as to receive the dust detached by the scrapers from the tubes of all of the different sections above, and a suitable conveyer 35 travels longitudinally in this receptacle and delivers the dust and scrapings to a cross-conveyer 36 for re-using or final disposal, all of which mechanism is constructed and driven in any approved manner.

The lower part of the auxiliary gas-chamber 30 has a manhole opening provided with a normally-closed door 30^a, and through this may be introduced a supplementary heating medium, as a jet of oil or gas, through the nozzle 30^b, (or coal and a grate might be used) to raise the temperature of and augment the waste gases before they enter the boiler; or even in case the kiln should be out of operation below, and steam has to be made, our general structure is such that same could be done by these auxiliary means alone, if amplified and designed for that purpose, it being apparent that the main features of our construction are capable of producing highly useful results in several directions, apart from the arbitrary use of the waste heat and gases from a cement kiln.

While the operation and useful results of our invention will be readily understood and appreciated by those skilled in the art, from the foregoing, we may call attention to the conditions whereby the hot waste gases passing from the kiln 1 through the main flue 2 and passage 6 into the auxiliary chamber 30, and thence into the front end of the boiler, first meet the superheating instrumentalities 5^a and impart their greatest heat thereto, raising the temperature of the steam passing through same accordingly, and fitting it for final discharge through the conduits 8^b, 8^b, to the steam-main L. Leaving the superheater-section, the gases next encounter the tubes of the main steam-raising section 5^b and impart heat thereto while passing between its vertical tubes. The gases having now cooled considerably—by reason of a large portion of their heat having been absorbed by the preceding instrumentalities—now enter the coolest section—that of the economizer 5^c,—and are drawn into the fan 31 and thence discharged into the smoke-stack 33 in connection therewith, such fan having induced the draft from the beginning of, and all through the operation, and the scrapers 16 having kept all of the tubes in all of the sections clear of dust accumulation, leaving their heating surfaces clean and in condition to receive the greatest benefit from the gases.

The water circulation is in the opposite direction to that of the gases, that is to say,

the feed-water enters the economizer-section 5^c by the inlet-pipe 5^d, thence through its transverse headers and vertical tubes into one of the longitudinal circulating-drums 10, through the nipples 12 to the lower headers 11, and thence to the upper headers 13 by the vertical tubes 15, connections being also made for the wet steam with the elevated steam drums 8, 8, at the sides, by the nipples 14 entering the steam spaces thereof, and by the external conduits or stand-pipes 9, 9, entering their water spaces below. The steam passes from the upper portions of the drums 8, 8, through the steam conduits 8^a, 8^a, to and through the superheater headers and tubes, and thence by the conduits 8^b, 8^b, to the line L for use at the points required.

While we have thus described and illustrated a combination waste-heat boiler of definite construction and arrangement suited to incorporate with a rotary cement kiln, the whole or any appreciable unit or units thereof may be employed with advantage in the general art of steam-raising, and we do not limit ourselves to precise details either of construction or arrangement, as these may be varied according to judgment under different conditions, without departing from the principles or sacrificing the advantages accruing from our invention.

What we claim and desire to secure by Letters Patent is as follows:—

1. In a steam-boiler structure, the combination of a boiler comprising a plurality of vertical water-tubes disposed in transverse rows or banks within the boiler-casing, transverse top and bottom headers, one of each for each transverse row or bank of tubes, steam drums disposed longitudinally above and exteriorly of the tubes and having their steam spaces connected to the top headers water circulating drums located at a lower level outside of the boiler and connected to the bottom header, and conduits or pipes forming external connections between such high-level steam drums and low-level water drums independently of the tube and header circulation.

2. In a steam-boiler structure, the combination of a boiler comprising a plurality of vertical water-tubes disposed in transverse rows or banks within the boiler casing, transverse top and bottom headers, one of each for each transverse row or bank of tubes, steam drums disposed longitudinally above and exteriorly of the tubes and having their steam spaces connected to the top headers, water circulating drums located at a lower level outside of the boiler and connected to the bottom headers, conduits or pipes forming external connections between such high-level steam drums and low-level water drums, a draft-inducing fan at the rear end of the boiler serving to draw gases around the tubes and between the headers, and a smoke stack in close connection with such fan.

3. In a steam-boiler structure, the combination of a steam boiler comprising a plurality of rows or banks of water-tubes disposed within the boiler casing, transverse top and bottom headers, one of each for each row or bank of tubes, steam drums disposed horizontally above and exteriorly of the tubes and connected to the top headers, water-circulating drums located at a lower-level outside of the boiler and connected to the bottom headers, and conduits or pipes forming external connections between such high-level steam drums and low-level water drums.

4. In a steam-boiler structure, the combination of a boiler comprising an external elevated steam drum, a plurality of vertical water-tubes disposed in transverse rows or banks within the boiler casing, a plurality of closely adjoining transverse top headers, (having external vertical channels on their adjoining faces) in connection with the steam drum, and receiving the upper ends of said tubes, and bottom headers connecting said tubes with the general circulation.

5. In a steam-boiler structure, the combination of a steam boiler having a casing, said boiler comprising an external elevated steam drum, a plurality of vertical water-tubes disposed in transverse rows or banks within the boiler casing, a plurality of transverse top headers, (having external vertical channels on their adjoining faces), in connection with the steam drum, and receiving the upper ends of said tubes, and bottom headers connecting said tubes with the general circulation, such pluralities of tubes and headers being arranged in sections with spaces between such sections and at both ends between them and the boiler casing, and said bottom-headers having open spaces between them.

6. In a boiler for utilizing the waste heat of kilns, furnaces and the like, the combination of a boiler casing having a source of initial heat supply at one end and discharge stack at the other, a series of vertical water tubes, in the casing connected at their top and bottom by headers, a steam drum outside and on each side of the casing, said drums having their steam spaces connected to the top headers, water circulating drums, located at a lower-level and also outside the casing and connected with the bottom headers.

7. In a boiler for utilizing the waste heat of kilns, furnaces and the like, the combination of a boiler casing having a source of initial heat supply at one end and discharge stack at the other, a series of vertical water tubes in the casing connected at their top and bottom by headers, a steam drum outside and on each side of the casing, said

drums having their steam spaces connected to the top headers, water circulating drums, located at a lower-level and also outside the casing and connected with the bottom headers, and water conduits or pipes outside the casing connecting the steam and water drums on each side of the casing.

8. In a boiler for utilizing the waste heat of kilns, furnaces and the like, the combination of a boiler casing having a source of initial heat supply at one end and discharge stack at the other, a series of vertical water tubes in the casing connected at their top and bottom by headers, a steam drum outside and on each side of the casing, said drums having their steam spaces connected to the top headers, water circulating drums, located at a lower-level and also outside the casing and connected with the bottom headers, a series of superheater vertical tubes in the casing having steam connections direct with the steam drums and independent of said first series of tubes, and a service pipe connected with said superheater series.

9. The combination with a source of initial heat supply having a smoke stack, of a boiler casing in which is installed a series of vertical water tubes, a fire box between the smoke stack and casing and in communication with both, said series of water-tubes arranged in connected series to provide first a steam superheating, second a steam-raising section and third an economizer section and means for circulating the fluid to be heated through said sections in reverse to the order named.

In witness whereof, we have signed in the presence of the two subscribing witnesses.

HAYDEN HOMER TRACY.
HARRY EUGENE BOYRIE.

Witnesses:
ROBT. A. KELLAND,
A. L. MENZIN.