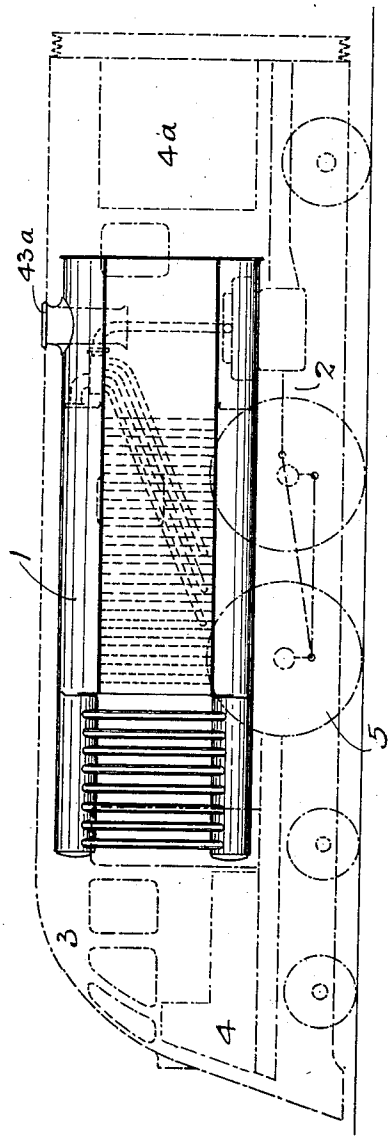
July 30, 1935. A. W. BRUCE 2,009,727

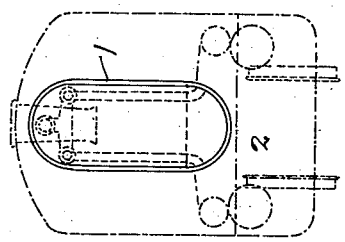
STEAM GENERATOR

Filed May 2, 1934 3 Sheets-Sheet 1

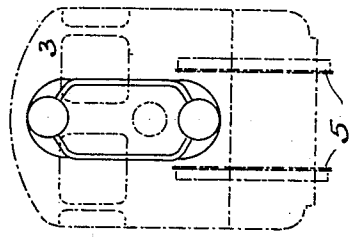
- FIG. 1. -



- FIG. 3. -



- FIG. 2. -



INVENTOR
Alfred W. Bruce
BY S. C. Yeaton
ATTORNEY

July 30, 1935. A. W. BRUCE 2,009,727

STEAM GENERATOR

Filed May 2, 1934 3 Sheets-Sheet 2

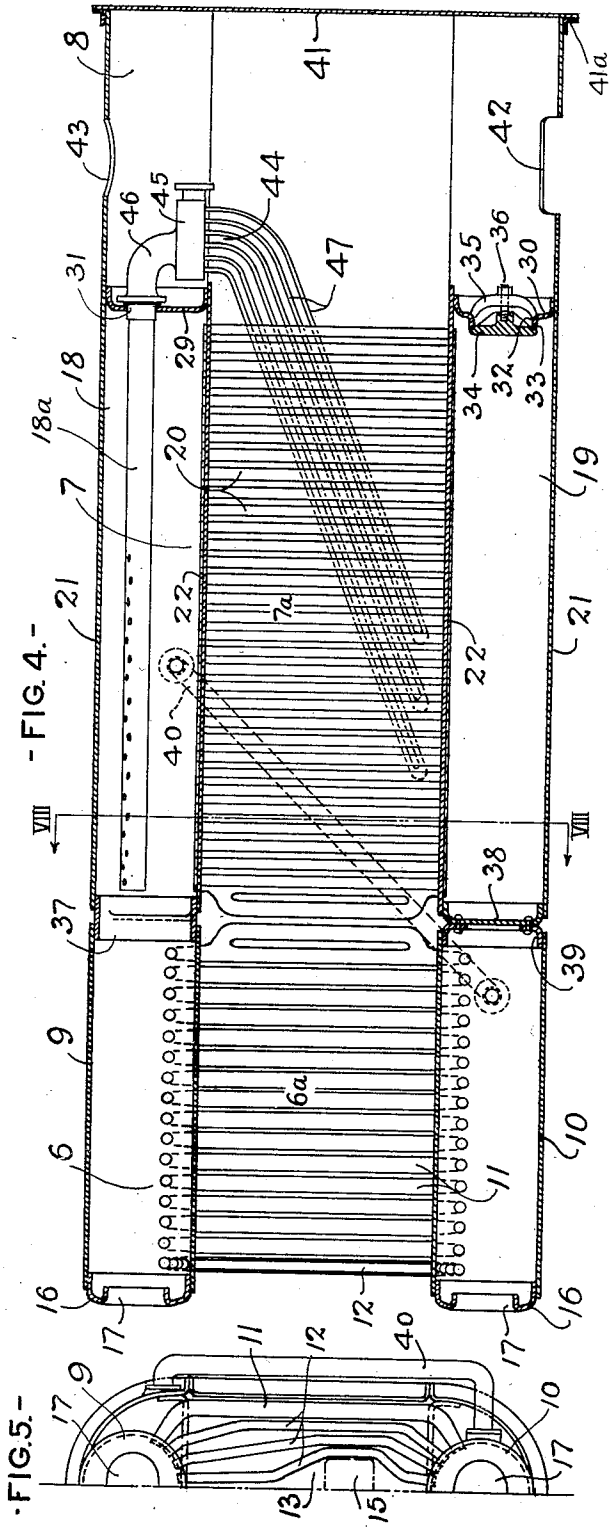


FIG. 4.

FIG. 5.

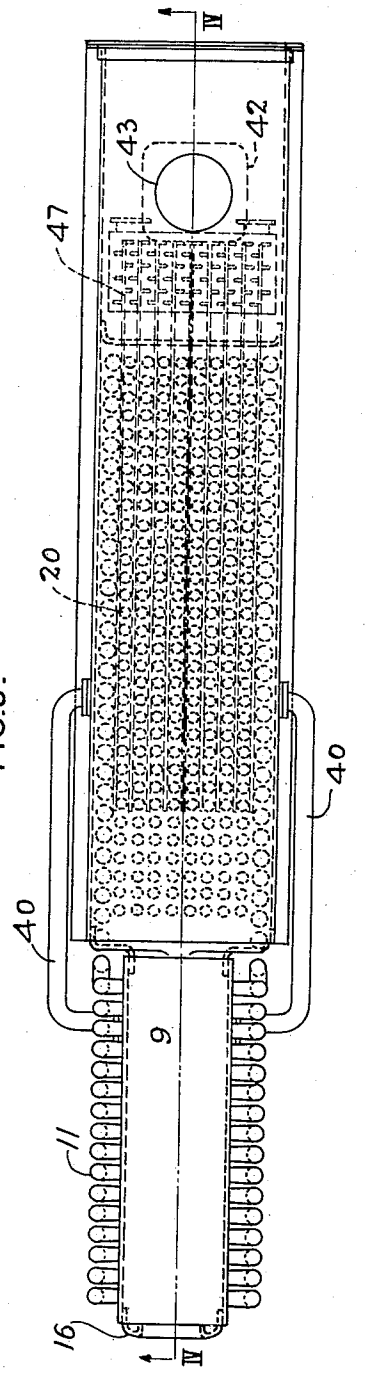


FIG. 6.

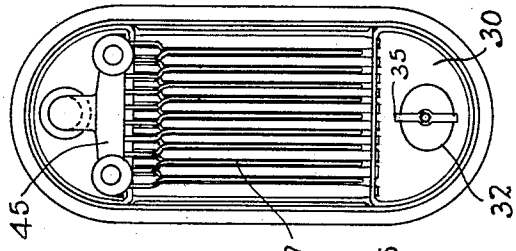
INVENTOR
Alfred W. Bruce
BY S. C. Yeaton
ATTORNEY

July 30, 1935. A. W. BRUCE 2,009,727

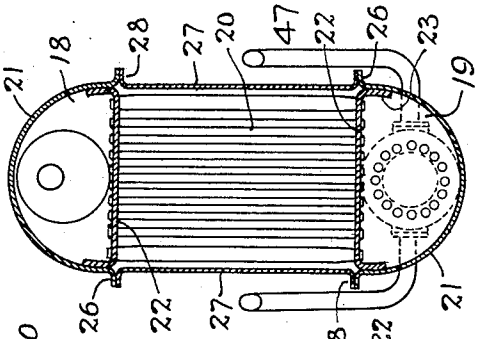
STEAM GENERATOR

Filed May 2, 1934 3 Sheets-Sheet 3

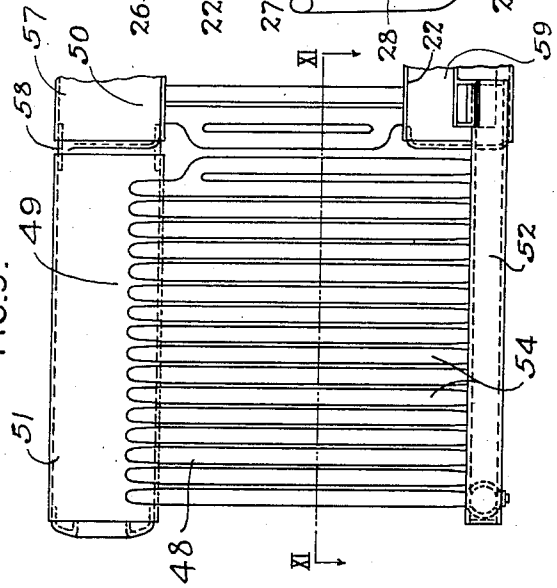
- FIG. 7. -



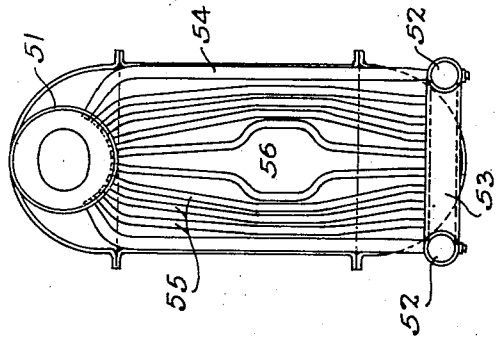
- FIG. 8. -



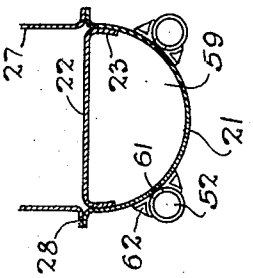
- FIG. 9. -



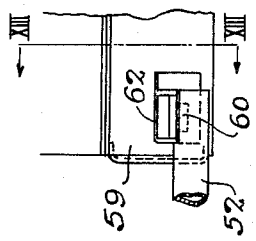
- FIG. 10. -



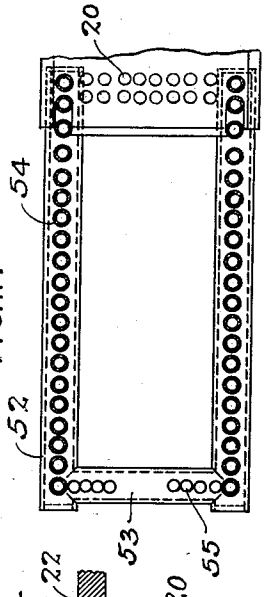
- FIG. 13. -



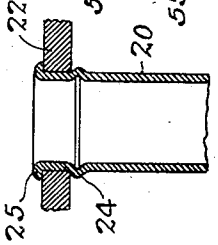
- FIG. 12. -



- FIG. 11. -



- FIG. 14. -



INVENTOR

Alfred W. Bruce

BY S. C. Yeaton

ATTORNEY

Patented July 30, 1935 2,009,727

UNITED STATES PATENT OFFICE

2,009,727

STEAM GENERATOR

Alfred W. Bruce, New York, N. Y., assignor to American Locomotive Company, New York, N. Y., a corporation of New York

Application May 2, 1934, Serial No. 723,455

3 Claims. (Cl. 122—235)

This invention relates to steam generators and particularly to a steam generator for use in a locomotive.

An object of the invention is to provide an improved steam generator characterized by compactness, sturdiness and simplicity of construction.

A further object is to provide a steam generator particularly adapted for use in spaces of limited dimensions and arranged to have a relatively large steam generating capacity in proportion to its size.

A further object is to provide a steam generator particularly adapted for use on locomotives of the high speed type, so constructed as to have parallel vertical sides throughout its length, spaced apart a limited distance, permitting the generator to extend downwardly between the locomotive driving wheels, while providing a relatively great amount of surface for exposure to products of combustion.

Other and further objects of and advantages achieved by this invention will be apparent from the following description of certain embodiments thereof.

In the accompanying drawings, Figures 1 to 3 are views showing a locomotive embodying the present invention, certain parts being shown in dot and dash lines, Fig. 1 being a side view, Fig. 2 a front view, and Fig. 3 a rear view; Figs. 4 to 8 are enlarged views of the steam generator shown in Figs. 1 to 3, Fig. 4 being a section on the line IV—IV of Fig. 6, Fig. 5 a half front view, Fig. 6 a plan view, Fig. 7 a rear view with the end cover sheet removed, and Fig. 8 a section on the line VIII—VIII of Fig. 4; Figs. 9 to 13 are views of the front portion of a modified form of steam generator embodying the present invention, Fig. 9 being a fragmentary side view, Fig. 10 a front view, Fig. 11 a section on the line XI—XI of Fig. 9, Fig. 12 a fragmentary side view of certain parts shown in Fig. 9, and Fig. 13 a section on the line XIII—XIII of Fig. 12; and Fig. 14 is an enlarged fragmentary sectional view showing the connection of one end of one of the tubes of the combustion chamber section of the steam generator of Fig. 1 with its tube sheet.

Referring in detail to the drawings, a steam generator 1 is shown in Figs. 1 to 3 embodied in a locomotive of the high speed type indicated generally by the numeral 2.

The locomotive 2 is equipped with a cab 3 at its front portion, a fuel tank 4 below the cab, a water tank 4a at its rear portion, driving wheels 5 (two at each of the opposite sides of the locomotive) and the various other usual parts (forming no part of this invention) as well understood in locomotive practice, much of which has been omitted from tthe drawings and is not mentioned herein for the sake of brevity. The locomotive 2 is similar to that shown in Fig. 3 of the drawings of applicant's copending application for United States Letters Patent, Serial Number 678,125, filed June 29, 1933 wherein the firebox is at the front portion of the locomotive and the smokebox is at the rear portion thereof.

The steam generator 1, see particularly Figs. 4 to 8, comprises a firebox section 6 at its front portion adapted for burning oil, a combustion chamber section 7 adjoining and rearward of the firebox section and a smokebox section 8 adjoining and rearward of the combustion chamber section.

The firebox section 6 comprises an upper longitudinal cylindrical drum 9, a lower longitudinal cylindrical drum 10, longitudinal rows of substantially vertical tubes 11 extending between the upper and lower drums, one row at each side of the section and a transverse row of substantially vertical tubes 12 extending between the drums 9 and 10 at the front end of the section. The tubes 11 and 12 form the side and front walls respectively of the section and with the drums 9 and 10 define the interior of the section or the firebox 6a. The respective ends of the tubes 11 and 12 are bell-mouthed into the drums 9 and 10 in the usual manner. The tubes 12 are bent to provide an opening 13 through the front wall formed by these tubes.

A cover sheet (not shown) is provided at the front end of the firebox section at the outside of the tubes 12 and extends between and is suitably secured to the drums 9 and 10 by studs and welding (not shown).

In the following description of the various parts of the generator, where one part is said to be connected with or secured to another unless otherwise specified it will be understood that the parts are connected by rivets, welding or both according to usual boiler practice.

An opening indicated by dot and dash lines at 15 will be provided in the cover sheet opposite the opening 13 and a suitable firebox door will be provided for the opening at 15.

A flanged head 16 is provided on the front end of each of the drums 9 and 10. An opening 17 is formed in each of the heads 16 and a suitable removable cover plate (not shown) is provided for each opening 17. These cover plates may be of any well-known construction such as for in-

stance that hereinafter described for the opening in the head at the rear end of the lower drum of the combustion chamber section 7.

The combustion chamber section 7 comprises an upper longitudinal drum 18, a lower longitudinal drum 19 and a plurality of vertical tubes 20. Each of the drums 18 and 19 is of semi-circular shape in cross section and comprises a longitudinal curved sheet 21 and a longitudinal flat tube sheet 22, the sheet 22 being flanged at its opposite longitudinal margins as indicated at 23 and these flanges being secured to the longitudinal margins of the sheet 21. The sheet 21 of the drum 18 is at the top of this drum and the sheet 21 of the drum 19 is at the bottom thereof, the sheets 21 thus providing the top and bottom walls of the section 7.

The sheets 22 of the respective drums 18 and 19 are oppositely disposed to and vertically spaced from each other and the tubes 20 extend vertically therebetween and are secured at their respective opposite ends in openings formed in the respective sheets 22 by the Prosser method, one of said connections being illustrated in Fig. 14. An annular abutment or shoulder 24 is thus provided at each end portion of each tube 20 adjacent the outer surface of the respective sheet 22 in which it is connected around its respective tube opening in this sheet and an annular lip or bead 25 is formed on each end of each tube 20 at the inner surface of the respective sheet 22 around the respective tube opening.

The opposite longitudinal margins of each of the curved sheets 21 of the drums 18 and 19 are flanged outwardly as indicated at 26. Vertical longitudinal cover sheets 27 are provided, one at each of the opposite sides of the section 7. The opposite longitudinal margins of each sheet 27 are flanged outwardly as indicated at 28 and the respective adjacent flanges of the sheets 27 and the sheets 21 are secured together. The sheets 27 thus provide side walls for the section 7.

The space between the drums 18 and 19 and the sheets 27 comprises the combustion chamber 7a. The front end of the combustion chamber is open to the rear end of the firebox 6a, and the rear end of the combustion chamber is open to the front end of the smokebox section 8. The vertical tubes 20 are disposed in spaced relation entirely across and entirely throughout the length of the section 7 with only relatively small amounts of space between adjacent tubes leaving only sufficient space for the products of combustion to pass therethrough around these tubes from the firebox to the smokebox section and to permit the tubes of the superheater hereinafter described to extend into the combustion chamber therebetween.

Flanged heads 29 and 30 are secured at the rear ends of the drums 18 and 19 respectively. A perforated dry pipe 18a is longitudinally disposed in the drum 18. An opening 31 is provided in the head 29 for a connection between a superheater duct and the dry pipe 18a as hereinafter described and an opening 32 is provided in the head 30 to permit access to the drum 19. A flange seat 33 is formed on the head 30 around the opening 32 and a removable cover plate 34 is held on the seat 33 within the drum 19 by a clamp 35 which engages the outer surface of the head 30 and a stud 36 which connects the clamp and cover plate.

A throat sheet 37 connects the rear end of the drum 9 to the front end of the drum 18. The throat sheet is suitably shaped to engage and is connected with the inner margin around the rear end of the drum 9 and the inner margin around the front end of the drum 18 and provides an open circulation passageway between these drums. A flanged head 38 is provided at the front end of the drum 19 and serves to close both the front end of the drum 19 and the rear end of the drum 10. The flange of the head 38 is secured to the inner margin around the front end of the drum 19 and a joint ring 39 is secured to the inner margin around the rear end of the drum 10 and to the front surface of the head 38.

Oppositely disposed pipes 40 are disposed one on each side of the generator. Each pipe 40 is connected at one end to its respective side of the drum 10 at the rear portion thereof and extends rearwardly and upwardly and is connected at its opposite end to its respective side of the drum 18 near the central portion thereof. The pipes 40 provide circulation connections for the flow of fluid from the section 7 to the section 6. In some instances pipes 40 may prove unnecessary.

The curved sheet 21 of the drum 18 and the curved sheet 21 of the drum 19 are extended rearwardly beyond the section 7 and the extended portions provide upper and lower walls respectively for the smokebox section 8. Similarly the side sheets 27 are extended rearwardly beyond the section 7 and their extended portions provide side walls for the section 8. The adjacent longitudinal edges of the sheets 21 and 27 are secured together similarly as described with reference to section 7. A rear cover plate 41 is bolted to angle irons 41a secured on the rear ends of the sheets 21 and 27.

The section 8 is disposed over the locomotive cylinder saddle and the respective lower and upper sheets 21 are provided with openings 42 and 43 respectively for steam ducts connected with the valve chests and for a chimney 43a, the usual parts being provided in their proper places in the smokebox section as well understood in locomotive practice.

A superheater indicated generally at 44 is provided for the generator. The superheater comprises a header 45 disposed in the upper portion of the smokebox section 8. The header 45 is connected to the dry pipe 18a by a duct 46 leading from the header to the opening 31 formed in the head 29, the dry pipe and duct being secured together and to the head 29 in the usual manner. The superheater also comprises a plurality of tube units 47 each of which units includes an outlet reach and a return reach connected by a return bend in the usual manner. The header 45 and tube unit connections therewith are of well-known constructions, such for instance as shown in United States Patent No. 1,833,314, issued to the applicant herein November 24, 1931. The units 47 extend downwardly and in a forwardly slanting direction into the combustion chamber 7a between longitudinal rows of the vertical tubes 20. The superheater is connected with the distribution valve chests in the usual manner.

A modified form of steam generator 48 embodying the present invention is illustrated in Figs. 9 to 13. The generator 48 comprises a firebox section 49 and a combustion chamber section 50. The section 50 is of the same construction, excepting at its front end, as the section 7 of the generator 1.

The section 49 is designed for burning solid fuel and comprises an upper longitudinal cylindrical drum 51, two lower longitudinal cylindrical drums 52, one at each side of the section, and a

lower transverse cylindrical drum **53** at the front end of the section. The drum **53** connects the drums **52** and provides communication therebetween. The drums **52** and **53** form in effect a mud ring above which a fire grate (not shown) is disposed in the usual manner. Longitudinal rows of vertical tubes **54** are provided, one row on each side of the section **49**, the tubes thereof extending between the respective drum **52** and the drum **51** and providing a side wall for the section. A transverse row of vertical tubes **55** is provided at the front end of the section **49**, the tubes **55** extending between the drum **53** and the drum **51** and forming a front wall for the section. The tubes **55** are bent so as to provide an opening **56** for feeding fuel to the firebox. The respective ends of the tubes **54** and **55** are connected in their respective drums in the usual manner. The front ends of the drums **52** are closed by suitable covers and an end cover sheet (not shown) is provided for the front end of the section **49** at the outside of the tubes **55**.

The rear end of the upper drum **51** is connected with the front end of the upper drum **57** of the section **50** by a throat sheet **58** in the same manner as described with reference to the connection between the drums **9** and **12** of the generator **1**. Each of the drums **52** is connected at its rear end portion with the lower drum **59** of the section **50** in the following manner. The rear end portion of each drum **52** is disposed at a side of the front end portion of the drum **59** and registering openings **60** and **61** are formed in the respective adjacent side portions of the drums **52** and **59**. Brackets **62** are provided adjacent the openings **60** and **61** tightly securing the drums **52** and **59** together, the openings providing communication therebetween. The drums **52** are closed at their rear ends by suitable covers (not shown).

The generator (either the generator **1** or the generator **48**) is carried on the locomotive frame by suitable supports (not shown) and extends downwardly between the oppositely disposed drive wheels **5** as clearly shown in Fig. 2, its limited width permitting this arrangement. It will be apparent that the sides of the generator are parallel throughout the length thereof making possible a locomotive with a streamline contour. Further the generator is designed to provide a relatively great amount of surface exposed to the products of combustion so as to afford a relatively great steam generating capacity, and the arrangement and proportions of the parts of the generator are such as to make for a compact, sturdy and simple construction of relatively small dimensions. These characteristics also make the generator particularly adaptable for use in a locomotive of the relatively light weight streamline type.

While certain embodiments of the invention have been hereinbefore described, it will be understood that many and various changes and modifications in form, arrangement of parts and details of construction thereof may be made without departing from the spirit of the invention and that all such changes and modifications as fall within the scope of the appended claims are contemplated as a part of this invention.

The invention claimed and desired to be secured by Letters Patent is:

1. A steam generator comprising a fire box section having a cylindrical upper drum, a cylindrical lower drum, and substantially vertical tubes extending between said drums and connected at their opposite ends therewith to permit circulation therebetween, said drums and tubes defining a firebox; a combustion chamber section adjoining said firebox section having an upper drum, a lower drum, the two last mentioned drums being semi-circular in cross section and vertically spaced apart providing a combustion chamber therebetween, and a plurality of vertical tubes extending between said combustion chamber drums through said combustion chamber and connected at their opposite ends with said combustion chamber drums providing circulation passageways therebetween; and means connecting the respective upper drums of said sections permitting circulation therebetween, said firebox and said combustion chamber being open at their adjacent ends to permit the passage of products of combustion from said firebox to said combustion chamber.

2. A steam generator comprising a firebox section; a combustion chamber section adjoining at one of its ends said firebox section; and a smokebox section adjoining the opposite end of said combustion chamber section, said combustion chamber section comprising an upper drum, a lower drum, and a plurality of tubes extending between and connecting said drums, each of said drums being semi-circular in cross section and including a longitudinal curved sheet and an oppositely disposed longitudinal flat sheet with said curved sheet and said flat sheet connected at their adjacent longitudinal edges, said curved sheets of said drums providing top and bottom walls respectively for said combustion chamber section and being extended beyond said combustion chamber section and providing top and bottom walls for said smokebox section.

3. A steam generator comprising a firebox section; a combustion chamber section adjoining at one of its ends said firebox section; and a smokebox section adjoining the opposite end of said combustion chamber section, said combustion chamber section comprising an upper drum, a lower drum and a plurality of tubes extending between and connecting said drums, each of said drums being semi-circular in cross section and including a longitudinal curved sheet and an oppositely disposed longitudinal flat sheet with said curved sheet and said flat sheet connected at their adjacent longitudinal edges, said curved sheets of said drums providing top and bottom walls respectively for said combustion chamber section and being extended beyond said combustion chamber section and providing top and bottom walls for said smokebox section, and longitudinal side sheets, one disposed on each of the opposite sides of said combustion chamber section, said side sheets extending between said drums and providing side walls for said combustion chamber section and extending beyond said combustion chamber section and providing side walls for said smokebox section.

ALFRED W. BRUCE.