Jan. 2, 1945. W. E. WOODARD 2,366,465

HIGH-WHEEL LOCOMOTIVE

Filed Aug. 16, 1941 4 Sheets-Sheet 1

Fig. 1.

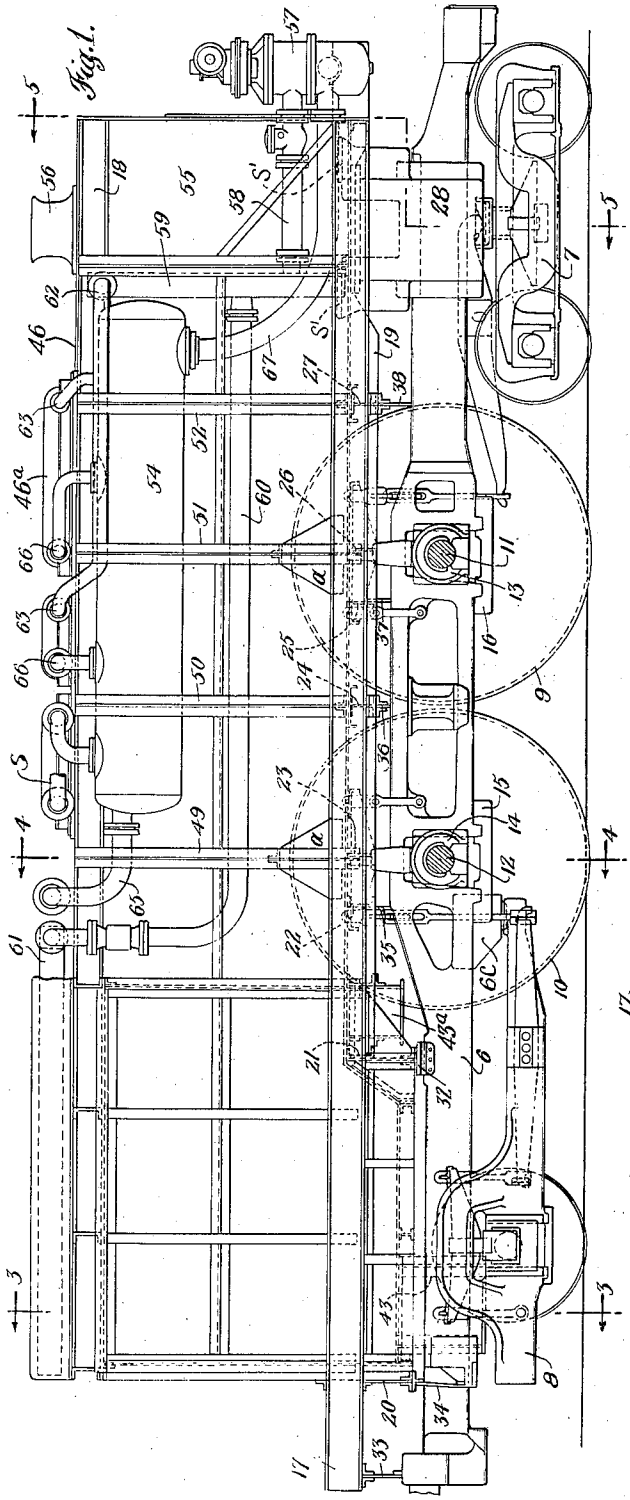

Fig. 2.

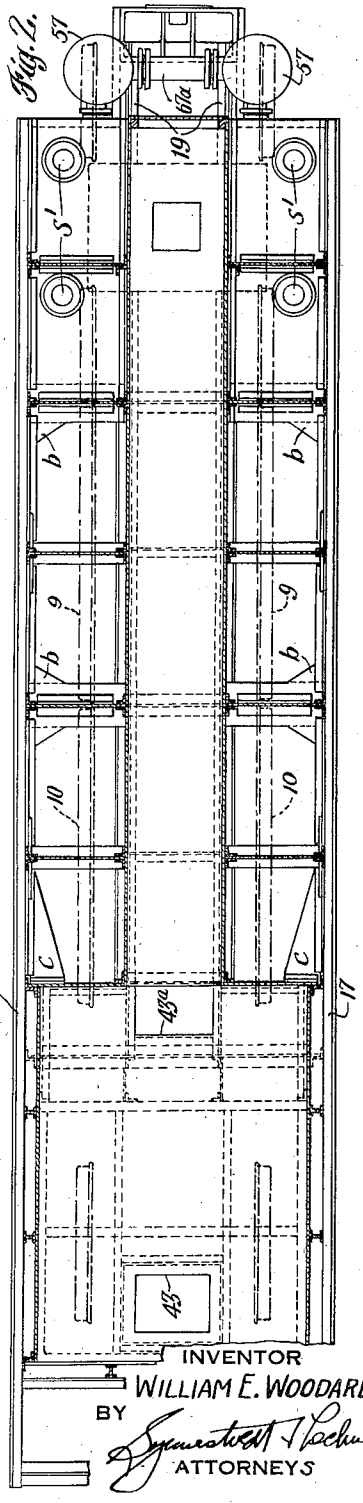

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Fig. 3.

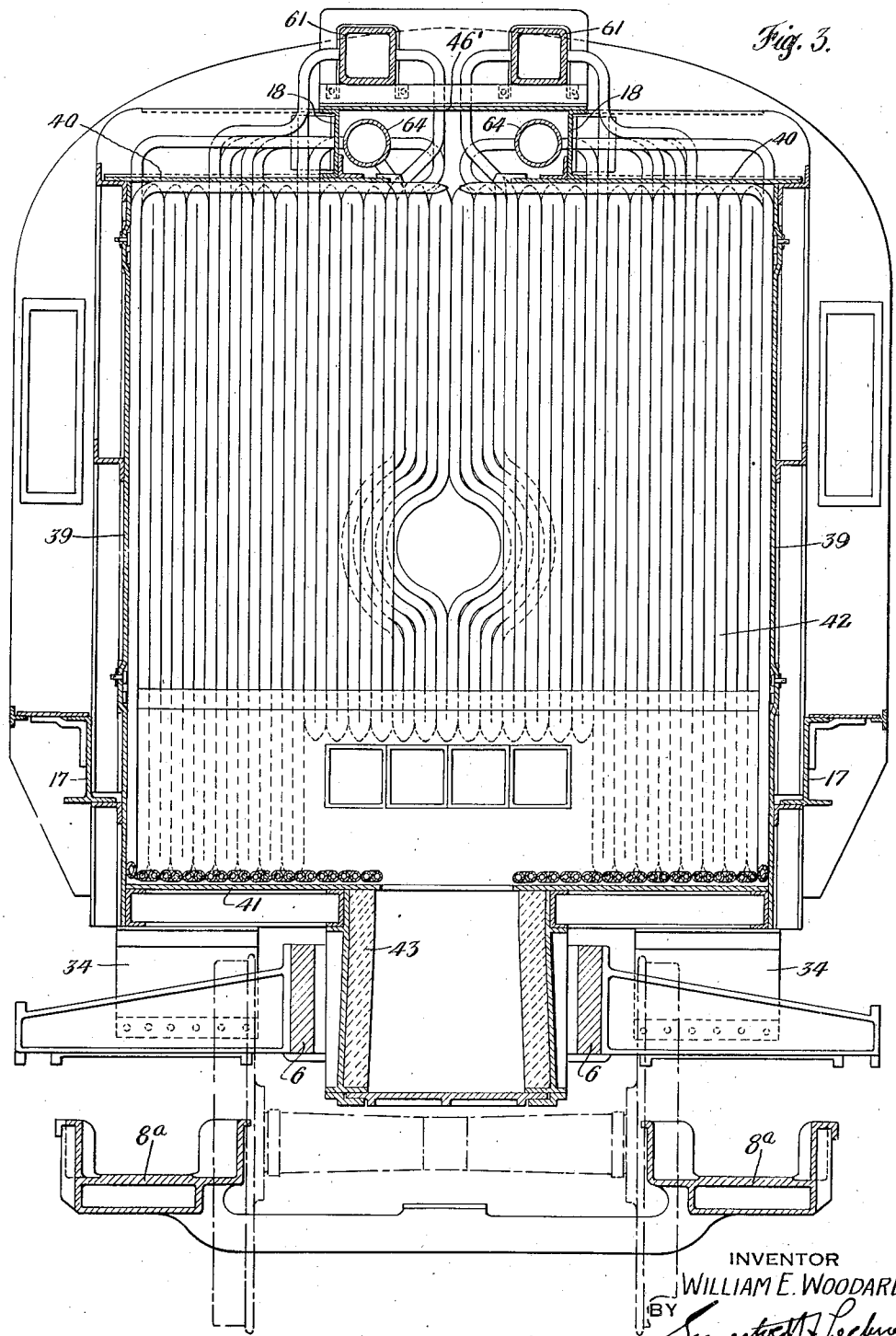

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Fig. 1.

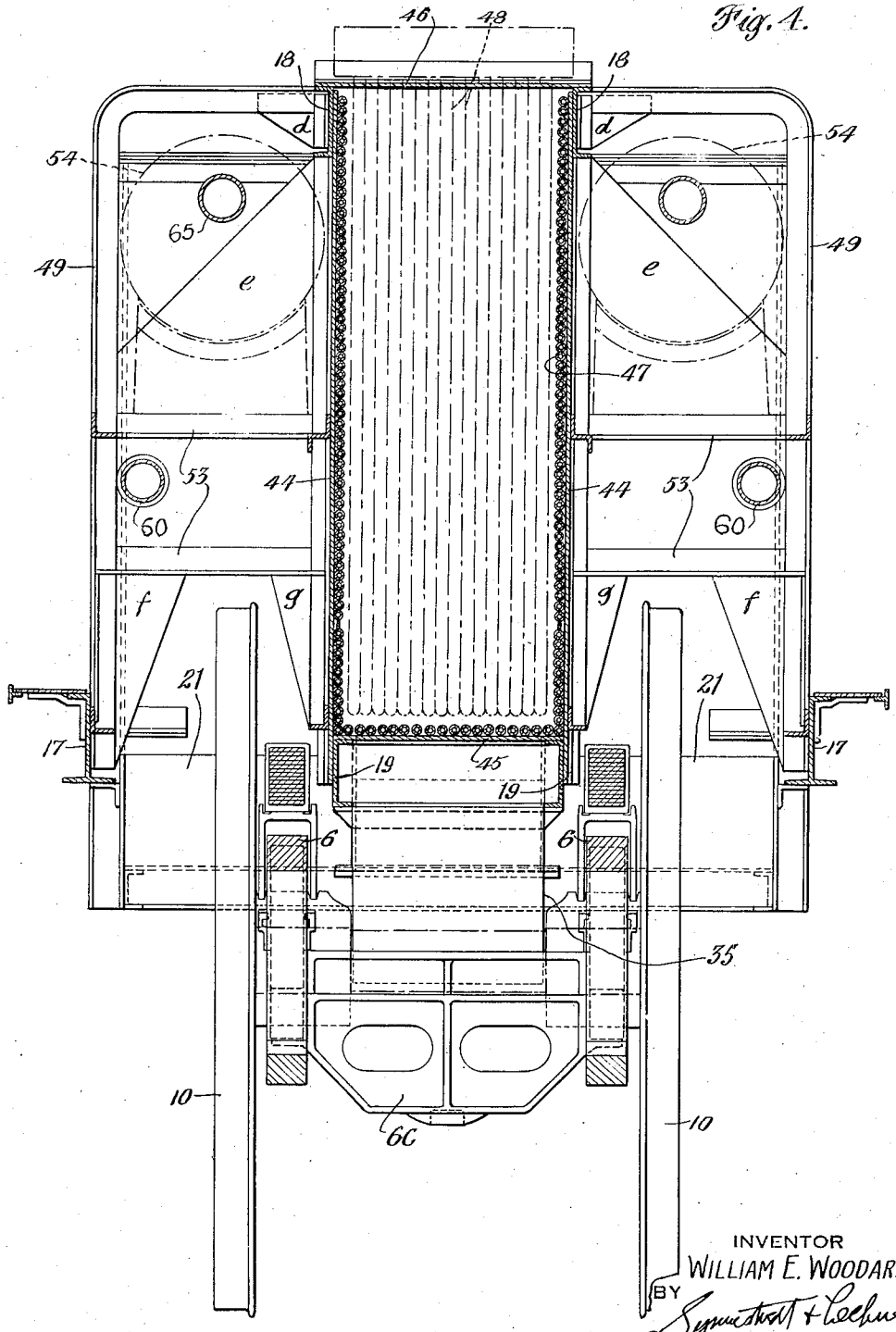

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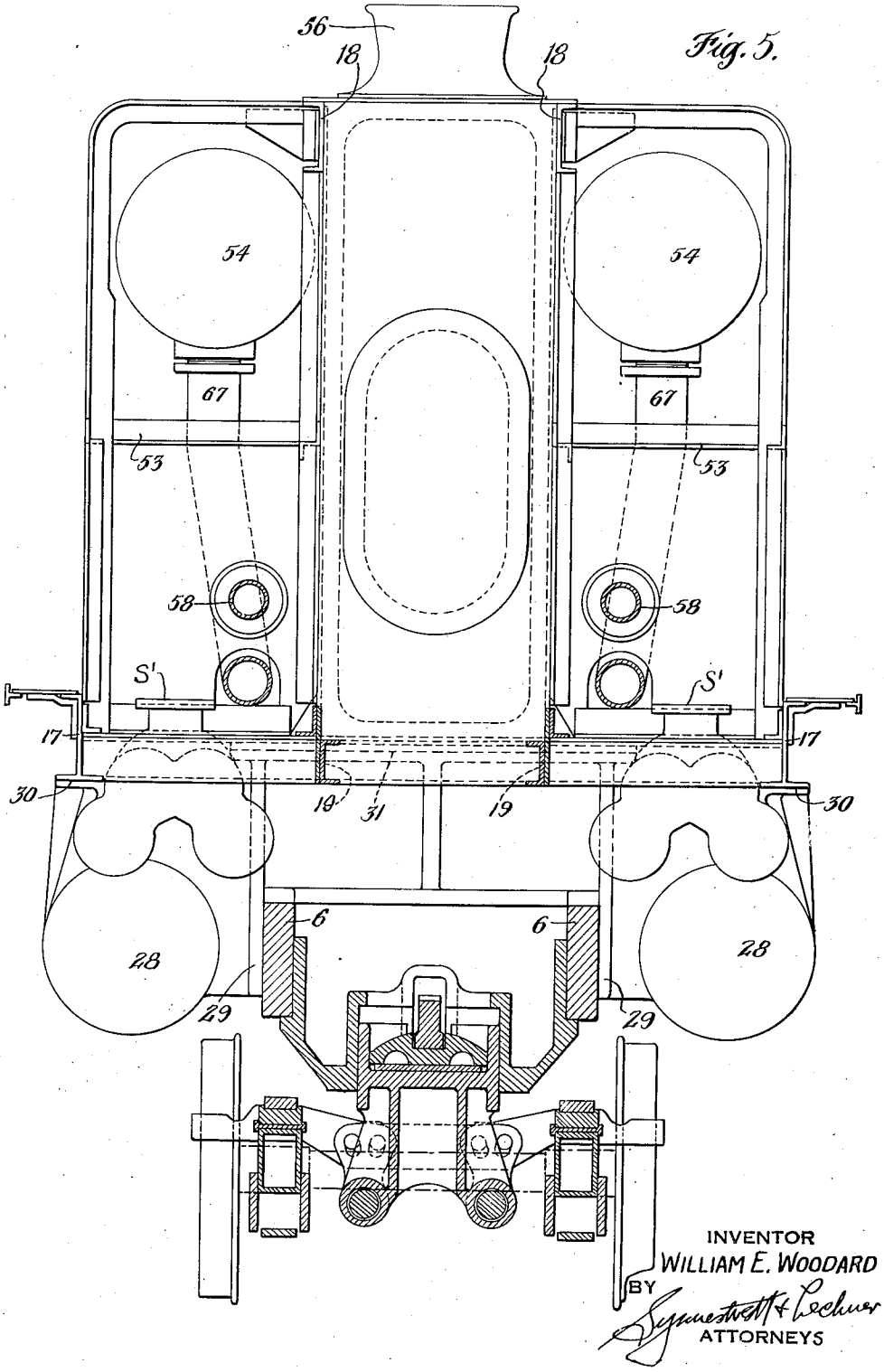
Fig. 5.



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UNITED STATES PATENT OFFICE

2,366,465

HIGH-WHEEL LOCOMOTIVE

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Application August 16, 1941, Serial No. 407,183

15 Claims. (Cl. 105—43)

This invention relates to locomotives and is especially concerned with a locomotive having relatively large diameter driving wheels and having a novel arrangement of boiler and superstructure.

The use of very high driving wheels has been desirable for certain purposes, notably to secure high speed operation, while retaining a moderate speed of the reciprocating parts, minimizing the counterbalancing problem, and reducing the wear and tear upon the track, but heretofore the general use of very large diameter driving wheels has been impracticable with usual types of boiler, for various reasons, such as the necessity for resorting to an excessively complex boiler and superstructure design, or the necessity for raising the boiler shell to a point where the standard clearance limitations would be exceeded and/or the center of gravity would be raised excessively.

It is the primary object of the present invention to dispose the driving wheels and various elements of the boiler of the locomotive in such relative arrangement as to permit the use of very high driving wheels and at the same time provide large boiler capacity, without encroaching on the clearance limitations, and to do this with a boiler and superstructure of simple and readily fabricated design without locating the center of gravity above what is considered to be good practice.

More specifically, in accomplishing the foregoing, the invention contemplates use of a tubular type boiler, the heat absorption surfaces of which are in general divided into two groups, one of which comprises radiant heat absorption tubes lining the firebox walls, and the other of which comprises convection heat absorption tubes disposed in a region extended forwardly from the firebox, the said region being of width less than the transverse spacing between the driving wheels, and the lower portions of the convection tubes being nested between the driving wheels.

In the arrangement contemplated, moreover, boiler drums are located at opposite sides of the convection tubes in the space vertically above the driving wheels.

In addition to the foregoing, the invention contemplates a novel arrangement of structural elements in the superstructure, in order to accommodate the upper portions of the driving wheels and at the same time provide adequate strength and support for the several boiler units.

Still further, the particular disposition of boiler tubes, the location and arrangement of headers and piping connections are all such as to accommodate the high driving wheels.

How the foregoing objects and advantages are attained will appear more fully from the following description referring to the accompanying drawings, in which—

Figure 1 is a side elevational view of a locomotive (cab and tender omitted) constructed in accordance with the invention, the side cover plates of the boiler shell being removed in order to illustrate the location of certain of the boiler units;

Figure 2 is a horizontal sectional view through the superstructure, the boiler tubes and other parts being omitted in order to illustrate the arrangement of structural elements;

Figure 3 is a transverse sectional view, to a larger scale, through the superstructure in the region of the firebox, as indicated by the section line 3—3 on Figure 1, and showing also the contour of the cab and the location of the running boards (both of which are omitted in Figures 1 and 2);

Figure 4 is a transverse sectional view taken as indicated by the section line 4—4 on Figure 1; and

Figure 5 is a view similar to Figures 3 and 4 but taken as indicated by the line 5—5 on Figure 1.

From the drawings it will be seen that the embodiment of the invention illustrated comprises a locomotive of the 4-4-2 type. It is to be understood, however, that the invention is also adaptable to locomotives with other wheel arrangements.

The main frame includes a pair of longitudinal frame members 6—6 and cross members 6c (see Figure 4), the main frame being supported at its forward end by a four wheel truck generally indicated at 7 and at its rear end by a two wheel truck indicated at 8. Centering rockers or the like (not shown) may be mounted in the seats 8a. The two pairs of large diameter driving wheels are designated 9—9 and 10—10, the axles 11 and 12 for which are mounted in driving boxes 13 and 14 received in pedestal jaws formed in the main frame members 6—6, the pedestal jaws being closed by binders 15 and 16. It will be noted from Figure 1 that the wheels of trucks 7 and 8 are of about ordinary proportions, but that the driving wheels 9 and 10 are of exceptionally large diameter. (The driving wheels and rods on the near side are omitted in this view, in order that the spring rigging may appear more clearly.)

Although other forms of spring suspension may be employed, in the arrangement illustrated the front truck 7 is equalized with the pair of drivers 9 (through a longitudinal equalizer associated with the truck center pin and with a cross equalizer), while the rear truck 8 is equalized with the rear drivers 10 (through the medium of a pair of longitudinal equalizers, one mounted on each side of the radius bar of the truck).

The principal longitudinal strength members of the superstructure include a pair of longitudinal beams 17—17 arranged one on either side of the locomotive and spaced outside of the planes of the driving wheels, these members further being disposed at an elevation below the top of the driving wheels. Additionally, upper and lower pairs of spaced longitudinal beams 18—18 and 19—19 are located intermediate the planes of the driving wheels, as appears to best advantage in Figure 4. The longitudinal members, just described, form parts of a skeletal framework to which the pressure-free boiler shall (hereinafter described) is secured.

The upper pair of members 18—18 extend substantially throughout the entire length of the superstructure and the lower pair 19—19 extend from the forward end of the locomotive rearwardly to a point under the forward portion of the firebox.

The several lower longitudinal members 17—17 and 19—19 are interconnected and interbraced by cross-ties some of which appear at 20 to 27 inclusive, these being referred to more fully hereinafter. The extreme rearward extension of the beams 17 (Fig. 1) serves to support the deck of the cab (not shown), and the extreme forward extension of the beams 19 (Fig. 2) serves to carry the circulating pump equipment 57 (later to be referred to).

At the forward end a cylinder unit, which may be a separate casting or may be formed integrally with the frame members 6—6, incorporates not only the cylinders 28—28 but also the distribution valve mechanism, this unit having depending portions 29—29 adapted to fit over the frame members 6—6, as clearly appears in Figure 5. The cylinder unit, which is here illustrated as an independent casting, also is formed with a pair of horizontally disposed pads 30—30 toward opposite sides of the locomotive on which rest the longitudinal superstructure beams 17—17. In addition, the cylinder casting has a central support 31 cooperating with portions of the superstructure intermediate the sides of the locomotive. Preferably, the superstructure is rigidly secured to the cylinder casting.

The superstructure further has additional support on pads 32, one arranged on each frame member 6 below the forward portion of the firebox, there being at that point also a transverse vertical stiffener plate 21 (Figure 4), constituting one of the series of transverse members such as 20 to 27 inclusive. Freedom of longitudinal motion of the superstructure with respect to the frame is permitted at pads 32. Flexible transverse braces also interconnect the frame and superstructure as indicated, for example, at 33 to 38 inclusive (see Figure 1). The flexible supports 33 to 38 are associated with superstructure cross-ties 20—27 and also with various cross-ties disposed between the main frame members 6, one such being indicated at 6c in Figures 1 and 4.

The firebox is located toward the rear of the superstructure and is built up of side, top and bottom wall plates such as indicated at 39—39, 40—40 and 41 (see Figure 3). A separate central roof plate 46' is provided. The wall plates are suitably connected with the primary longitudinal structural members of the superstructure as by angle members. Front and rear end closure walls are also provided, the central area of the front wall being open to communicate with a central region in the forward portion of the superstructure, as described hereinafter.

It will be observed, especially from Figure 1, that the bottom of the firebox or combustion chamber is located somewhat below the longitudinal members 17—17 and also considerably below the top of the driving wheels. Note also that the firebox is of full width, i. e., of a width considerably greater than the distance between the driving wheels.

The walls of the firebox are lined with radiant heat absorption tubes 42, the circulation through which is referred to herebelow. In the embodiment illustrated, moreover, the firebox is designed for the burning of pulverized coal, being equipped with a main slag hopper 43 (best shown in Figures 2 and 3), and a supplemental hopper 43a (Figures 1 and 2) in which spongy fly ash may accumulate. Suitable fire arch and/or baffle means (not shown) may be used to divide the main combustion zone of the firebox from the forward zone beneath which lies the hopper 43a; and in general such means may, if desired, take the form shown in the copending application of Woodard and Filander, Serial No. 379,772, filed February 20, 1941, which issued as Patent No. 2,346,715 on April 18, 1944.

Turning now to Figure 4, it will be seen that within the forward portion of the superstructure a longitudinally extended pathway for the products of combustion is defined by vertical walls 44—44, these being connected with the beams 18—18 adjacent their upper edges and with the beams 19—19 adjacent their lower edges. A floor plate 45 supported by members 19—19 closes the bottom of this central passage and a roof plate 46 closes the top. This central passage is also lined with heat absorption tubes as indicated at 47 in Figure 4, and is further designed to receive groups or bundles of generally vertically disposed convection heat absorption tubes 48, at least most of which are insertible in and removable from the top of the locomotive through openings covered by lids 46a. The forward end of the gas passageway opens into the smokebox 55, from which the gases are discharged through a stack 56.

It is to be noted particularly that the central convection region of the boiler and the vertical tubes therein are nested between the pairs of driving wheels, this disposition of the parts being plain from the showing of Figure 4.

The superstructure also incorporates a plurality of upright members such as indicated in Figure 1 at 49, 50, 51 and 52, all of which are interbraced with the supports for the vertical walls 44—44 defining the central gas passageway, as by cross braces 53 shown in Figures 4 and 5. These members (49 to 53) and others which need not be described in detail herein, serve as a skeleton for supporting additional boiler closure sheets, lagging, etc.

In view of the foregoing, when viewed in cross section, as in Figure 4, the portion of the superstructure forward of the firebox may be considered as having three side-by-side zones, each of which is of vertical dimension substantially

equivalent to the height of the superstructure; the central zone forming a gas passageway containing the tube bundles.

The upper region of each of the two outside zones is utilized to house a boiler drum **54** referred to again herebelow in the description of the boiler circulation.

The upper portions of the driving wheels, springs, etc., project upwardly into the lower portions of each of the two outside zones, as is plainly shown in Figure 4; and from examination of this figure along with Figure 1, it will be seen that the transverse bracing of the longitudinal members of the superstructure is worked out so as to avoid interference with the driving wheels and yet provide adequate strength in the superstructure. Thus (referring to Figure 1) the transverse braces **21**, **24** and **27** include elements interconnecting the outside longitudinal members **17** with the inside longitudinal members **19** at each side of the locomotive, while transverse members **22**, **23**, **25** and **26** are located intermediate the two central longitudinal beams **19—19**.

The arrangement of the lower portion of the superstructure is, therefore, such as to provide pockets for receiving the upper portions of the several driving wheels.

The superstructure should of itself be sufficiently rigid to house and support the various elements of the boiler. It also preferably constitutes rigid foundation structure for the locomotive (either serving that purpose wholly, or in conjunction with its interconnection with an under-frame or bed structure **6**, as already described). To these ends, the main beam members **17**, **18**, **19**, the cross beams, and the plates which define the passageway for the products of combustion, are not only stiffened by various angle bars and the like (as seen in Figure 4), but also by the several contour-defining frames such as **49** to **52**, etc., which further serve to carry insulating and/or streamlining sheathing. Various of these parts are also interbraced by the drums **54** and by triangulated bracing plates *a*, *b*, *c*, *d*, *e*, *f* and *g* (Figures 1, 2 and 4).

The boiler circulation need not be considered in detail herein, although a few features thereof are of importance to the present invention, as follows:

In the arrangement illustrated, the boiler is of the forced circulation type, one or more pumps **57** being provided for this purpose. The outlet **58** of each pump delivers to a distributing conduit **59**, one branch **60** of which is extended rearwardly for connection with inlet headers **61** for the tubes lining the combustion chamber. The other branch **62** of the distributing conduit **59** is connected to headers **63** for the convection tubes **48**. The outlet headers **64** for the radiant heat absorption tubes in the combustion chamber are connected by pipes **65** with the drums **54**. The outlet headers **66** of the convection tubes in the forward portion of the boiler are connected to the drums **54** as shown.

Return lines **67** run from the bottoms of the drums back to the pumps, the two pump inlets being cross connected by the pipe **67***a* (Figure 2). The various headers also constitute cross connections, so that the pumps operate in parallel; and if one pump fails, the entire circulating system will be maintained in operation by the other pump.

The steam connections from the superheater outlet pipes S (Figure 1) to the cylinder steam inlet pipes S' (Figure 2) are not shown, but such connections as well as numerous details of the circulating system are fully disclosed in the said copending application of Woodard and Filander, Serial No. 379,772, filed February 20, 1941, now Patent 2,346,715.

Location of the boiler drums **54** with their major axes extended longitudinally of the locomotive in positions vertically above the driving wheels also is important in effective utilization of the available space, so as to provide a boiler of high capacity and at the same time accommodate the very high driving wheels.

The type of superstructure above referred to lends itself readily to the formation of pockets in its lower portion to receive the upper edges of the driving wheels, while at the same time retaining simplicity in design and adequate strength and bracing, transversely as well as lonigtudinally of the locomotive.

The bundles of convection tubes may also readily be withdrawn and inserted, notwithstanding the fact that when in position portions of these tubes are actually nested between the driving wheels of the locomotive. This removal and insertion of the tube bundles is further facilitated by the arrangement of headers and connections therefor, most of which are disposed at the top of the locomotive and are, therefore, readily accessible. In addition to being accessible, the disposition of the headers at the top of the locomotive also simplifies connection of the headers with the boiler drums **54** which lie along the sides of the central compartment in the superstructure adjacent the said headers.

I claim:

1. A locomotive including main framing, axles with relatively large-diameter driving wheels journalled in the main framing, a superstructure comprising a pressure-free boiler and firebox housing and a skeletal framework supporting the same of greater overall transverse dimension than the gauge of said wheels, which housing and framework together are interbraced with the main framing at a plurality of points and constitute a rigid foundation structure for the locomotive, said skeletal framework incorporating a pair of longitudinal structural members on either side of the locomotive, the members of each pair being spaced apart to provide inverted longitudinally-extending pockets for the upper portions of the driving wheels, and a primary structural element extending transversely of the locomotive at an elevation below the tops of the driving wheels and interconnecting longitudinal structural members between adjacent pairs of driving wheels.

2. A construction in accordance with claim 1, and further incorporating boiler tubes mounted and housed in the superstructure, with a portion thereof in a central region nested between and below the tops of the driving wheels, and boiler drums mounted on the superstructure in zones located vertically above the driving wheels.

3. In a locomotive having a plurality of pairs of driving wheels, a boiler and firebox superstructure one end portion of which extends beyond the pairs of driving wheels to enclose a firebox combustion chamber which latter is of width greater than the transverse spacing between the driving wheels, substantially parallel framing elements in the adjacent portion of the superstructure positioned to define walls of a gas passage communicating with the combustion chamber to receive gas flow therefrom, said passage being of width

less than the transverse spacing between the driving wheels and being in part nested between and below the tops of said driving wheels, and convection heat absorption tubes disposed in said passage, the superstructure incorporating primary longitudinal structural elements disposed outside the planes of the driving wheels at an elevation below the top of said wheels, and primary transverse structural elements extending between longitudinal structural elements at an elevation below the top of the driving wheels and below said central zone.

4. In a locomotive having a plurality of pairs of driving wheels, a firebox disposed toward one end of the locomotive at least in large part beyond said pairs of driving wheels and of width greater than the transverse spacing between the wheels, tubular heat absorption elements disposed in a compartment communicating with the firebox and extending longitudinally therefrom, the lower portion of said compartment being of width less than the transverse space between the planes of the driving wheels and being nested between and below the tops of the wheels of said pairs, said compartment further being of vertical dimension such as to project above the driving wheels substantially to the top of the superstructure, and a pair of steam drums disposed with their major axes lengthwise of the locomotive one at each side of the upper portion of said compartment above the driving wheels at that side but not substantially above the level of the top of said compartment.

5. In a locomotive having a plurality of pairs of driving wheels, a boiler and firebox superstructure one end portion of which extends beyond the pairs of driving wheels to enclose a firebox combustion chamber which latter is of width greater than the transverse spacing between the driving wheels, the adjacent portion of said superstructure being divided by vertical partition means into three longitudinal zones one arranged generally centrally and communicating with the combustion chamber to receive gas flow therefrom, the said central zone being of width less than the transverse spacing between the driving wheels and being in part nested between and below the tops of said driving wheels, the other two longitudinal zones being disposed one at either side of the central zone vertically above the driving wheels at that side, convection heat absorption tubes disposed in said central zone and boiler drums associated with said tubes and disposed in said side zones.

6. In a locomotive having a plurality of pairs of driving wheels, a boiler and firebox superstructure one end portion of which extends beyond the pairs of driving wheels to enclose a firebox combustion chamber which latter is of width greater than the transverse spacing between the driving wheels, the adjacent portion of said superstructure being divided into three longitudinal zones one arranged generally centrally and communicating with the combustion chamber to receive gas flow therefrom, the said central zone being of width less than the transverse spacing between the driving wheels and being in part nested between and below the tops of said driving wheels, the other two longitudinal zones being disposed one at either side of the central zone vertically above the driving wheels at that side, convection heat absorption tubes disposed in said central zone and boiler drums associated with said tubes and disposed in said side zones with their axes extended generally longitudinally of the locomotive, said longitudinally extending drums being interconnected with the superstructure to stiffen the same in said side zones.

7. A construction in accordance with claim 5, in which the central longitudinal zone is of substantially uniform generally rectangular cross section throughout the length thereof adjacent the driving wheels, and in which the convection heat absorption tubes comprise bundles of tubes disposed vertically in said central zone.

8. A construction in accordance with claim 5, in which the central longitudinal zone is of substantially uniform generally rectangular cross section throughout the length thereof adjacent the driving wheels, and in which the convection heat absorption tubes comprise bundles of tubes disposed vertically in said central zone, and tube headers superimposed above the tube bundles, with lateral connections extended therefrom to the boiler drums.

9. A construction in accordance with claim 5, in which the superstructure incorporates primary longitudinal structural elements disposed outside the planes of the driving wheels at an elevation below the top of the driving wheels and in which the floor of the central boiler zone lies approximately in the horizontal plane of said longitudinal structural elements, and primary structural elements extend transversely of the locomotive at an elevation below the top of the driving wheels and support the floor of the central zone and interconnect the same with said longitudinal structural elements, one of the primary transverse structural elements being disposed between adjacent pairs of driving wheels.

10. In a locomotive having at least one pair of large diameter driving wheels, a boiler and firebox superstructure incorporating a combustion chamber disposed toward one end thereof beyond said pair of driving wheels, the combustion chamber being of width greater than the transverse spacing between the wheels, and a bundle of generally vertically disposed convection heat absorption tubes of overall width less than the transverse spacing between the driving wheels, with the lower portions of the tubes nested between the wheels of said pair, and means defining a gas flow passage communicating at one end with the firebox combustion chamber and serving to enclose said convection tubes, said construction further incorporating a boiler drum disposed to one side of the bundle of convection tubes and vertically above a driving wheel but not substantially above the level of the top of said bundle, and a header for said tubes at the upper ends thereof, with a lateral connection extended therefrom to the boiler drum.

11. In steam locomotive construction, a pressure-free rigid foundation structure for the locomotive, comprising main strength members running longitudinally adjacent the outer sides of the structure and a main boiler-enclosing casing running longitudinally and extending centrally downwardly close to the bottom of the structure, main driving wheels of substantial diameter extending upwardly to embrace the sides of the lower part of said casing but located between said main strength members, and triangulated bracing straddling said wheels and rigidly interconnecting said casing and main strength members.

12. A construction in accordance with claim 11, wherein rigid boiler elements overlie said wheels and are mounted on said structure in positions to stiffen the same.

13. A locomotive having cross-sectional dimensions conforming to standard clearance limitations and having driving wheels of a height greater than such limitations would ordinarily permit, said locomotive incorporating in its superstructure a boiler of the water-tube type constructed and positioned to occupy a space between the perpendicular planes of the driving wheels and between a horizontal plane lower than the tops of said wheels and a horizontal plane substantially at the top of the superstructure, said locomotive being provided with steam drums for the boiler, which drums are positioned at either side of said boiler above the top level of said driving wheels.

14. A locomotive having cross-sectional dimensions conforming to standard clearance limits, and having driving wheels of greater height than such limits would normally permit, said locomotive incorporating in its superstructure a firebox and a central gas passageway extending longitudinally therefrom, said pasageway being of less width than the gauge of said wheels, and extending from below the tops of said wheels substantially to the top of the superstructure, and further containing spaced heat-exchange tubes substantially throughout its vertical dimension.

15. A locomotive having cross-sectional dimensions conforming to standard clearance limits, and having driving wheels of greater height than such limits would normally permit, said locomotive incorporating in its superstructure a firebox and a central gas passageway extending longitudinally therefrom, said passageway being of less width than the gauge of said wheels, and extending from below the tops of said wheels substantially to the top of the superstructure, and further containing spaced heat-exchange tubes substantially throughout its vertical dimension, said locomotive incorporating steam drums with connections to said heat-exchange tubes, said drums being mounted in the superstructure below the top thereof but above the level of the tops of said wheels.

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