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 nestled 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 riding 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, which is clearly apparent), while the rear truck 10 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 shell ( Reinhardt-3 ) 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 smokebox.

The several lower longitudinal members 17–17 and 18–19 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 beam 17–17 (not shown) is secured to the deck of the cab (Fig. 2) and serves to carry the circulating pump equipment 57 (later to be referred to).

At the forward end of 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 casing has a central support 51 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 movement 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 33 inclusive (see Figure 1). The flexible supports 33 to 35 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 8a 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 the members 42 and 43. 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 hereinafter. In the embodied illustration, 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 Woodward and Filander, Serial No. 797,722, filed February 21, 1914, which issued as Patents 17–17, 3,467,715 on April 13, 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 16–19 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 integrable in and removable from the top of the locomotive through openings covered by lids 49a. 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 walls 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 45, 58, 51 and 52, all of which are interconnected with those for the vertical walls 44–44 defining the central gas passageway, as by cross braces 55 shown in Figures 4 and 5. These members (49 to 53) and others which need not be described in detail hereinafter, 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; 79
the central zone forming a gas passageway con-
containing the tube bundles. 80
The upper portion of each of the two outside 81
zones is utilized to house a boiler drum 54 re-
ferred to again herebelow in the description of 82
the boiler circulation.

The upper portions of the driving wheels, 83
springs, etc., project upwardly into the lower por-
tions of each of the two outside zones, as is 84
plainly shown in Figure 4; and from examination 85
of this figure along with Figure 1, it will be seen 86
that the transverse bracing of the longitudinal 87
members of the superstructure is worked out so 88
as to avoid interference with the driving wheels 89
and yet provide adequate strength in the super-
structure. Thus (referring to Figure 1) the 90
transverse braces 21, 24 and 27 include elements 91
interconnecting the outside longitudinal mem-
bers 37 to 40 of the driving-longitudinal members 48 92
at each side of the locomotive, while the transverse 93
members 22, 23, 25 and 26 are located interme-
iate the two central longitudinal beams 19—19. 94
The arrangement of the lower portion of the 95
superstructure is, therefore, such as to provide 96
pockets for receiving the upper portions of the 97
several driving wheels.

The superstructure should of itself be suffi-
ciently rigid to house and support the various 98
elements of the boiler. It also preferably consti-
tutes rigid foundation structure for the locomo-
tive (either serving that purpose wholly, or in 99
connection with its interconnection with an un-
der-frame or bed structure 6, as already de-
scribed). To these ends, the main beam mem-
bers 17, 18, 19, the cross beams, and the plates 100
which define the passageway for the products of 101
combustion, are not only stiffened by various 102
angle bars and the like (as seen in Figure 4), but 103
also by the several contour-defining frames such 104
as 49 to 52, etc., which further serve to carry 105
insulating and/or streamlining sheathing. Vari-
os of these parts are also interbraced by the 106
drums 54 and by triangulated bracing plates a, b, 107
c, d, e, f and g (Figures 1, 2 and 4).

The boiler circulation need not be considered 108
in detail herein, although a few features thereof 109
are of importance to the present invention, as 110
follows:

In the arrangement illustrated, the boiler is 111
t of the forced circulation type, one or more pumps 112
51 being provided for this purpose. The outlet 113
53 of each pump delivers to a distributing conduit 114
59, one branch 60 of which is extended rearward-
ly for connection with inlet headers 61 for the 115
tubes lining the combustion chamber. The other 116
branch 62 of the distributing conduit 59 is con-
ected to headers 63 for the convection tubes 48. 117
The outlet headers 64 for the radiant heat 118
absorption tubes in the combustion chamber are 119
connected to headers 65 for the convection tubes 120
48. The outlet headers 66 of the convection tubes in the 121
forward portion of the boiler are connected to the 122
drums 54 as shown.

Return lines 57 run from the bottoms of the 123
drums back to the pumps, the two pump inlets 124
being cross connected by the pipe 67a (Figure 2). 125
The various headers also constitute cross con-
nections, so that the pumps operate in paral-
lel; and if one pump fails, the entire circulating 126
system will be maintained in operation by the 127
other pump.

The steam connections from the superheater 128
outlet pipes S (Figure 1) to the cylinder steam 129
inlet pipes S' (Figure 2) are not shown, but such 130
connections as well as numerous details of the 131
circulating system are fully disclosed in the said 132
copending application of Woodard and Frissler, 133
Serial No. 379,772, filed February 20, 1941, now 134
Patent 2,346,715.

Location of the boiler drums 54 with their ma-
135
or axes extended longitudinally of the locomotive 136
in positions vertically aligned with the driving 137
wheels also is important in effective utilization 138
of the available space, so as to provide a boiler of 139
high capacity and at the same time accommo-
date the very high driving wheels.

The type of superstructure above referred to 140
lends itself readily to the formation of pockets in 141
its lower portion to receive the upper edges of the 142
driving wheels, while at the same time retaining 143
simplicity in design and adequate strength and 144
bracing, transversely as well as longitudinally of 145
the locomotive.

The bundles of convection tubes may also read-
ily be withdrawn and inserted, notwithstanding 146
the fact that when in position portions of these 147
tubes are actually nested between the driving 148
wheels of the locomotive. This removal and in-
sertion of the tube bundles is further facilitated 149
by the arrangement of headers and connections 150
therefor, most of which are disposed at the top 151
of the locomotive and are, therefore, readily ac-
cessible. In addition to being accessible, the dis-
position of the headers at the top of the locomo-
tive also simplifies connection of the headers with 152
the boiler drums 54 which lie along the sides of 153
the central compartment in the superstructure 154
adjacent the said headers.

I claim:
1. A locomotive including main framing, axles 155
with relatively large-diameter driving wheels 156
journalled in the main framing, a superstructure 157
comprising a pressure-free boiler and firebox 158
housing and a skeletal framework supporting the 159
same of greater overall transverse dimension 160
than the gauge of said wheels, which housing and 161
framework together are interbraced with the 162
main framing at a plurality of points and con-
stitute a rigid foundation structure for the loco-
motive, said skeletal framework incorporating a 163
pair of longitudinal structural members on either 164
side of the locomotive, the members of each pair 165
being spaced apart to provide inverted longitudi-

nally-extending pockets for the upper portions 166
of the driving wheels, and a primary structural 167
element extending transversely of the locomo-
tive at an elevation below the tops of the driving 168
wheels and interconnecting longitudinal struc-
tural members between adjacent pairs of driv-
ing wheels.

2. A construction in accordance with claim 1, 169
and further incorporating boiler tubes mounted 170
and housed in the superstructure, with a portion 171
thereof in a central region nested between and 172
below the tops of the driving wheels, and boiler 173
drums mounted on the superstructure, said zones 174
located vertically above the driving wheels.

3. In a locomotive having a plurality of pairs 175
of driving wheels, a boiler and firebox super-
structure one end portion of which extends beyond 176
the pairs of driving wheels to enclose a firebox 177
combustion chamber which latter is of width great- 178
er than the transverse spacing between the driving 179
wheels, substantially parallel framing elements 180
in the adjacent portion of the superstructure po-
ositioned to define walls of a gas passage communic-
ating with the combustion chamber to receive 181
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, the central portion thereof being 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 said foundation 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 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.

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.

WILLIAM E. WOODARD.