construction. Among them is the distance between hubs of driving wheels, and because of this gauge limitation, 55 in. is probably the standard distance between driving wheel hubs at present. Therefore, with driving boxes of increased length in recent high powered locomotives, it has been necessary to decrease the distance between frame centres. This decrease, in combination with the wide cylinder centres, has caused the horizontal forces to increase in greater proportion than the load borne on the journals, so that while the vertical pressure per square inch of bearing surface, due to weight, has been maintained at a fairly constant figure by increasing the diameter and length of the present boxes, yet the bearing pressure due to the horizontal forces has increased in much greater proportion, so that the pressures per square inch due to thees horizontal forces have produced excessive wear on the driving boxes, permitting lost motion to accumulate very rapidly, causing a knock and pound which requires the renewal of the driving box bearings after much less mileage than heretofore.

In order that the driving boxes may wear uniformly, and the journals wear cylindrical and not conical, it is absolutely necessary that the vertical and horizontal forces be applied at the centre of the bearing. The frame centres, therefore, must be made of such spacing transversely so as to coincide with the centre of the boxes. This, however, has the disadvantage of largely increasing the pressures due to the horizontal forces of the driving box. The normal piston thust is very largely increased by the greater lever ratio produced on account of the narrow frame centres and wide cylinder centres, the ration being roughly 2 to 1. This force is still further increased at certain positions of cranks, because of the reaction of the opposite side increasing the normal piston thrust.

The wear of the driving boxes and the pedestal shoes and wedges, with the relatively small bearing surface usually obtained, has been very rapid, and for this reason some efforts have been made to increase this width and to provide more wearing surface by making the legs of the pedestals wider than the body of the frame. The disadvantage of this is that no increase in the length of the box is possible without resorting to lop-sided construction, which experience has shown results in uneven wear of the bearing and conical wear on the journal.

In the long main driving box, the normal width of the frame is increased by bolting on additional pieces for supplementary or auxiliary pedestals on the inside. These may be in the form of separate pieces or combined so as to form a cross brace and at the same time make the additional pedestal for the frame on the opposite side. They are preferably united together at the top and bottom by a cap secured with bolts. The shoes and wedges are increased in width equal to the amount the supplementary pedestals are wide. It is more convenient to retain the spring rigging in its normal central position in the middle of the frame, and for this reason a combination spring saddle has been devised, extending transversely across the engine, by which the spring load is transferred equally to the centre of the box. This arrangement of overhanging integral spring saddle for 2 boxes on one axle can be made in a variety of forms, but the basic principle consists in a rigid member, extending across the engine frames, provided with spring seats on its upper portion for the driving springs, and with means for transferring the load to the centre of the driving box, either by the use of an integral casting having the feet extending down, or by making this in two or more pieces and having the rigid overhanging beams separate and merely bearing on the portion forming the feet.

The idea in this application is the broad principle of a driving box of increased length (probably 50 to 66½%) unequally spaced in relation to the frame and spring rigging, but provided with means for transferring the spring supported load equally to all portions of the driving box and arranged with pedestals of increased width for the shoes and wedges, the frames being retained at about their normal transverse centres.

The increase in the size of locomotives during the past few years has introduced a number of new conditions and problems which the designer has been called upon to consider and for which it has been necessary for him to provide solution. These problems extend to almost all parts of the locomotive, and range from comparatively simple provisions to take care of the increased stresses and loads, to more complex problems resulting from the combination of new factors. One of these problems is the provision of suitable trucks. Many of the conditions of service have changed in the past few years. Limiting clearances have been increased in some extent and the permissible length over all has almost doubled. Very considerable increases in wheel loads have been allowed. Appliances have been devised to develop greatly increased horse power. But the degree of maximum curvature which the locomotive must be designed to pass has, except in rare instances, remained unchanged. Main line curvature has been decreased, but, for the most part, locomotives for all classes of service must be designed to pass certain maximum curves, such as turnouts and crossovers, and this at once imposes limitations and problems in the design of the trucks.

These conditions have led to the development of a lateral motion bolster device, known as the Woodard truck, which, it is claimed, will meet these exacting requirements more fully than the 3 point link suspension which heretofore has been almost universally used. In principle it provides a constant resistance, regardless of the lateral displacement of a bolster, instead of a low initial resistance increasing with the lateral displacement, as is obtained with the 3 point suspension links. Variations, such as high initial resistance, with a constant resistance following a predetermined bolster movement, can be obtained by slight modification of the surfaces in contact. The swing bolster bears directly on the heart shaped rockers, which are connected to it by links to ensure their remaining in the proper position. Service results with this truck are said to show a marked reduction in the flange wear on leading drivers, a steadying action while running on straight track, an absence of jerking motion on curves and withal a better riding locomotive under all track conditions.

The Foulder main rod back end deserves special mention. With this solid end, 4 bolts have been eliminated, the stub has been shortened, and a saving in weight was obtained which also saves in the counterbalance. Only one pattern is required for the bearings, as the same brass is used front and back of pin, the taper being on the two adjustable wedges. The heavy wedge, immediately in front of the bearing, extending to the full depth of the rod opening, and being of greater depth than the bearing itself, provides a fine support for the brass and prevents it from cocking or becoming distorted. Other features of this solid end are its simplicity and the time saved in taking it o ffthe engine, and there are no bolts to renew or holes to reream.

An interesting feature is the combination of the Gaines combustion chamber and the Security brick arch. With this arrangement it is claimed that a very complete deflection of the gases is secured, whereby better combustion is obtained and the back end of the firebox more fully utilized, with a resulting increase in the generation of steam. This arrangement, it is claimed, also gives an increased firebox volume and also tends to improve combustion. In addition, all the usual disadvantages of a shallow throat sheet are eliminated. This combustion chamber, it is claimed, also allows the added advantage of a short tube length and large diameter of boiler. A short tube length not only gives greater evaporative value per square foot of heating surface, but also reduces back pressure, and consequently increases the power of the engine. A large diameter, combined with short tube length, gives a large volume of water where the evaporative value is highest. This large volume of water is ready to flash into steam and therefore increases the reserve supply of steam.

These engines have a short distance from the rear wheel to the draw bar. This not only makes them ride easier on curves, but it also reduces the friction between flange of wheel and rail, which increases the draw bar pull.

These locomotives were built by the American Locomotive Co. at its Brooks works, Dunkirk, N.Y. Their general dimensions are as follows:

Cylinder, type, piston valve, diam. 26 in., stroke 32 in.

Tractive power, simple, 64500.

Factor of adhesion, simple, 3.96.

Wheel base, driving 20½ ft., rigid 15 ft., total 37 ft. 10 in.

Wheel base total, engine and tender, 70 ft. 2¾ in.

Weight in working order, 320,000 lb., on drivers, 256,000 lb.

Weight on trailer 31,000 lb., on engine truck 33,000 lb.

Weight engine and tender 512,200 lb.

Boiler type, extended wagon top, c.d. first ring 79-9/16 in.

Boiler, working pressure, 200 lb.

Firebox, type, wide; length, 144⅛ in., width 84¼ in.

Firebox, thickness of crown ⅜ in., tube ½ in., side ⅜ in., back ⅜ in.

Firebox, water space, front 5½ in., sides 5in., back 5 in.

Firebox, depth (top of grate to centre of lowest tube) 14 in.

Crown staying, radial.

Tubes, material, charcoal iron, no. 270, diam. 2 in.

Flues, material, cold drawn seamless steel, no. 42, diam. 5⅜ in.

Tube, length, 17 ft. spacing 13/16 in.

Heating surface, tubes and flues, 3,413 sq. ft.

Heating surface, firebox, 245 sq. ft.

Heating surface, arch tubes, 41 sq. ft.

Heating surface, total, 3,699 sq. ft.

Superheater surface, 850 sq. ft.

Grate area, 66.7 sq. ft.

Wheels, driv. diam., outside tire, 57 in., centre diam., 50 in.

Wheels, driv., material, cast steel.

Wheels, engine truck, diam., 31 in., kind, cast iron spoke.

Wheels, trailing truck, diam., 31 in., kind, cast iron spoke.

Wheels, tender truck, diam., 34 in., kind, cast iron spoke.

Axles, driv. journals, main, 11½ x 22 in., front 10 x 20 in., other, 10 x 12 in.

Axles, engine truck journals, 7 x 12 in.

Axles, trailing truck journals, 7 x 12 in.

Axles, tender truck journals, 6 x 11 in.

Boxes, driving, cast steel.

Brake, driver, American.

Brake, tender, Westinghouse, air signal, Westinghouse.

Brake, pump, 1 8½ in. C.C., reservoir, 1 18½ x 120 in., 1 22½ x 72 in., 1 26½ x 42 in.