"Merchant Navy" Class Pacific Modified

Photo] [*L. Elsey*

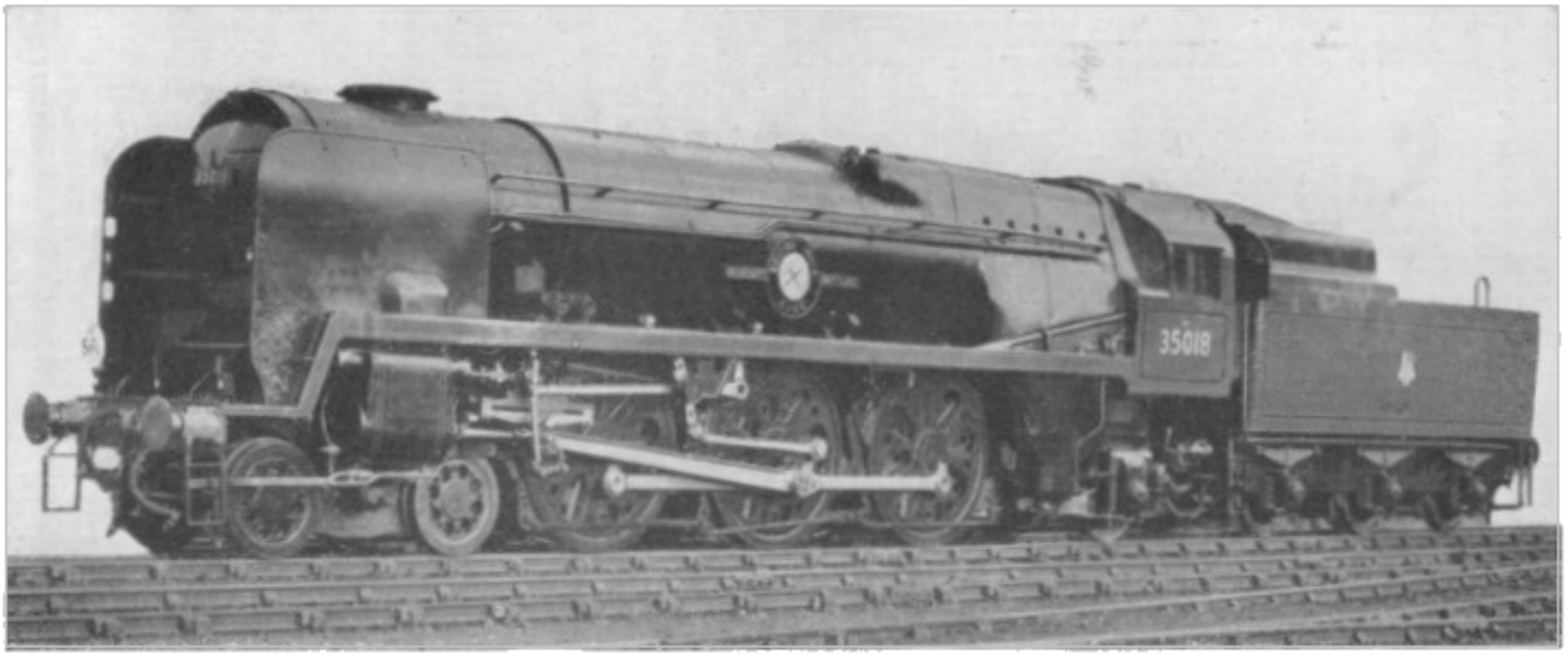
No. 35018, "British India Line," leaving Eastleigh with the 12.23 p.m. train to Southampton Central on February 17, the first passenger working after it was rebuilt

THE first of the Southern Region "Merchant Navy" class 4-6-2 locomotives to undergo extensive modification, No. 35018, *British India Line*, has emerged from Eastleigh Works. Initially, it is intended that a further 14 will be similarly rebuilt, followed by 15 of the smaller "West Country" Pacifics.

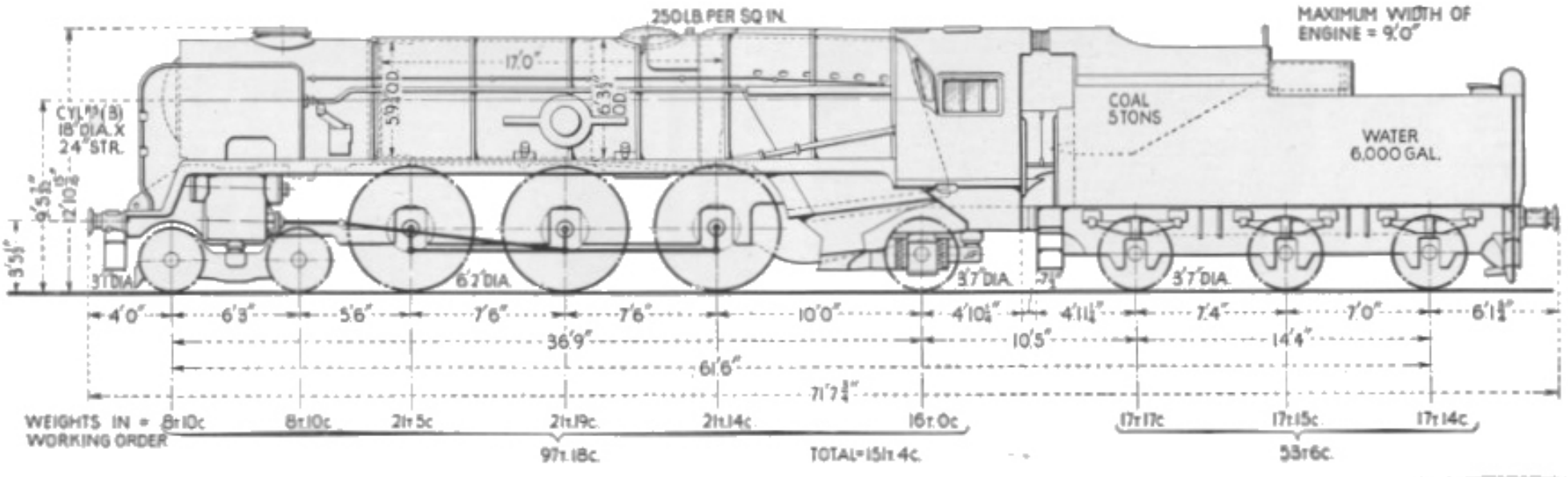
The "Merchant Navy" class locomotives were introduced on the Southern Railway in 1941, to the designs of Mr. O. V. S. Bulleid, then Chief Mechanical Engineer. Thirty in all were built at Eastleigh, in three batches, the last in 1949. When in good condition, they have displayed complete mastery of their work on principal expresses to Bournemouth and the West of England and on boat trains to the Channel Ports.

Although the locomotives follow the normal design tendencies for a Pacific type with three cylinders and a wide firebox, there are a number of features unusual in British locomotive practice, among which are : (*a*) A three-throw crank shaft, chain-driven from the driving axle, which operates valve gear for each of the three cylinders. Each gear is connected to its respective piston valve through a rocking lever arrangement having a 3 : 8 ratio ; (*b*) An oil-bath enclosing the three sets of special valve gear and the inside motion. This is intended to give continuous lubrication to the working parts ; (*c*) A smokebox of irregular shape ; and (*d*) Light plate casing over the whole of the upper part of the locomotive. Some of these features have proved troublesome, with the result that the locomotives have not been entirely satisfactory from the point of view of availability, maintenance and accessibility. In addition, their consumption of coal, oil and water is high in comparison with other modern locomotives.

Various minor modifications have been made since the design was introduced, but to overcome these difficulties certain fundamental alterations were decided on, in accordance with designs prepared at Brighton under the direction of Mr. H. H. Swift, Chief Mechanical & Electrical Engineer, Southern Region, in consultation with Mr. R. C. Bond, Chief Mechanical



General view and diagram giving principal dimensions and axle loads of modified "Merchant Navy" class 4-6-2 locomotive



Engineer, British Railways Central Staff, British Transport Commission. The work of preparing the new details was carried out mainly at Eastleigh, with assistance from Ashford Works.

The three-cylinder arrangement is the same on the modified locomotive, with the cylinders in their former positions, driving on to the middle coupled axle. A new inside cylinder is provided, but the two existing outside cylinders have been retained. The diameter and stroke are unchanged at 18 and 24 in. respectively, and the piston valves remain at 11 in. dia. The inside cylinder has the steam chest offset to the right, and in common with normal modern practice has inside admission. A steel casting, having cast-iron liners to both the cylinder barrel and steam chests, has been used, to save weight.

The valves of the outside cylinders were formerly driven indirectly by a rocking shaft from the valve gear, passing into the exhaust chamber of the steam chest, an arrangement which permitted the use of outside admission. The steam chests, moreover, are placed on the same vertical centre line as the cylinders. To avoid replacement of the outside cylinders, it has been necessary to retain the latter feature and also outside admission. This has necessitated the use of a high-pressure gland for the valve spindle, and special measures to translate the actuation from the plane of the valve gear to the steam chest centre line.

Following the latest British Railways practice, the piston heads are attached to the piston rods by a parallel fastening. The piston rods are provided with a special type of cast-iron packing, and this packing is also used for the valve spindles of the outside cylinders. Cylinder cocks are of the steam-operated type.

The incorporation in the original design of continuous lubrication to the motion between the frames is an ideal principle, but in practice the oil-bath has been only partly successful and has brought troubles of its own. These were, broadly, excessive use of oil because of practical difficulties in keeping the bath oil-tight, the entry of water causing emulsification of the oil and corrosion of the steel motion details, and the inability to examine the various working parts except at infrequent intervals. As a result, it has been decided to dispense with the oil-bath and return to the orthodox arrangement in which the motion and valve gear of the inside cylinder are not completely enclosed, and require the normal attention as regards examination and lubrication.

Three independent sets of Walschaerts valve gear are provided, those for the outside cylinders being driven by return cranks placed on the driving crankpins, and by crosshead arms attached to the crossheads. The latter had to be redesigned for this reason and, as the original piston rod and crosshead had been manufactured from a single forging, the opportunity was taken with the new crosshead of making it separate from the piston rod, the normal cone and cotter attachment being used.

The outside valve gears, being arranged for outside admission, transmit the motion to the valve spindle from the top of the combination lever, but because of the offset between the centre line of the valve gear and the axis of the steam chest a suspension link is used, which carries the weight of the valve gear, thereby eliminating the need for the normal valve spindle crosshead guides. A short link connects the suspension link to the valve spindle crosshead. The piston valves have a maximum travel of nominally $6\frac{3}{4}$ in., and each head is fitted with four narrow rings. The return crank rod is attached to the return crank through a self-aligning ball bearing.

The inside valve gear is driven by an eccentric mounted on the right-hand crank-web of the driving axle. A spigotted attachment held by five studs is used, and the mounting for the eccentric is interchangeable with that of the chain-drive sprocket of the former valve gear when applied in its latest form. The new valve gear is of orthodox design, being arranged for inside admission. The lap-and-lead motion is driven in the normal way from an arm made integrally with the crosshead. The maximum travel is approximately $6\frac{5}{16}$ in.

The steam reversing gear has been dispensed with and in its place a screw gear has been provided. To suit the layout of the locomotive, the arrangement selected is one in which the cab contains only the handle, spur gearing, locking gear and cut-off indicator. The operation is transmitted by means of a shaft, with universal joints, to the screw located on a bracket attached to the outside of the

main frame, midway between the left-hand driving and trailing wheels. A short bridle rod connects the reversing screw nut the the reversing shaft. This arrangement, which is a compromise between that in which the screw is mounted in the cab, and that in which it is placed directly at the reversing shaft, was first used on the London, Midland & Scottish Railway.

Normally with three or four cylinder locomotives which have independent sets of valve gear, it is necessary to use an auxiliary reversing shaft for the inside valve gear. In this case, however, it has been found possible to use a single shaft for all three gears, lifting of the radius rods being achieved by the arrangement in which a slide block works in a slot in the radius rod, the former being attached directly to the reversing shaft arm. The handle in the cab is "face-on" to the driver, and the cut-off indicator is of the drum type.

A new smokebox of the orthodox cylindrical shape is provided and this rests on a saddle, part of which is formed by the upper portion of the new inside cylinder and the remainder by a new fabricated saddle-stretcher. The latter is bolted to the front of the cylinder casting as well as to the frames, and, as it spans the space between the two outside cylinders, it gives a greater degree of rigidity to the front end of the locomotive. The saddle-stretcher is designed in such a way that it permits of ready access to the front cover of the inside cylinder and for the removal of the piston and rod. By removing a cover plate on the top of the stretcher, inside the smokebox, the inside valve spindle can be withdrawn.

The smokebox is surmounted by a cast-iron chimney of large diameter fitted with a petticoat and ejector exhaust ring. The multiple-jet blast-pipe is retained. A new superheater header has been fitted which has three flanges for individual steam pipes to each cylinder. The right-hand outside flange takes the steam pipe to the inside cylinder, while the inside and left-hand flanges feed the right-hand and left-hand outside cylinders respectively. All three steam pipes pass outside the smokebox through stuffing boxes on the smokebox wrapper. The existing smokebox door of elliptical shape has been retained.

The air-smoothed casing which formerly enveloped the boiler and smokebox has been dispensed with, and replaced by orthodox boiler clothing plates mounted on crinolines. The smokebox is unclothed. Footplating along the sides of the engine has been provided to assist in servicing and maintenance, following the pattern of the B.R. standard locomotives, except that is is carried principally by brackets from the main frame. A smoke deflector plate is provided at each side of the smokebox.

The boiler is unaltered, but, to bring the locomotive up to the latest standards, in the interests of good combustion and rapid turn-round, it is fitted with a rocking fire-grate of the standard type. The rocking sections are divided into two groups which can be rocked separately and are situated on each side of the longitudinal centre line. Both groups comprise six carrier bars, each mounting fifteen unit firebars. Two extents of rocking are provided for by locking devices incorporated in the operating gear on the footplate—a small angular movement for fire cleaning while running, and a large movement for dumping when the locomotive is over the ashpit. An entirely new ashpan is fitted; it has the standard type of butterfly doors for self-emptying. These are operated from the ground by a common linkage to a short lever which takes the same bar as that used for operating the rocking grate.

A feature of the previous ashpan which is retained is its division into three parts, there being a central section between the frames, and two outer sections. The former has two hoppers, each with bottom doors, the rear leg passing through the reins of the trailing truck. Two damper doors are provided in the central section, the forward door being hinged from the front leg and the trailing door from the rear leg. The outer sections of the ashpan have one hopper each, in line with the front leg of the central section, the rear portion of these pans being situated, inevitably, above the wheels of the trailing truck. To enable this portion to be cleaned out where it is not possible to provide sufficient slope to ensure that the ashes will slide down normally, side access doors are provided so that any accumulation of ash can be rodded down at disposal.

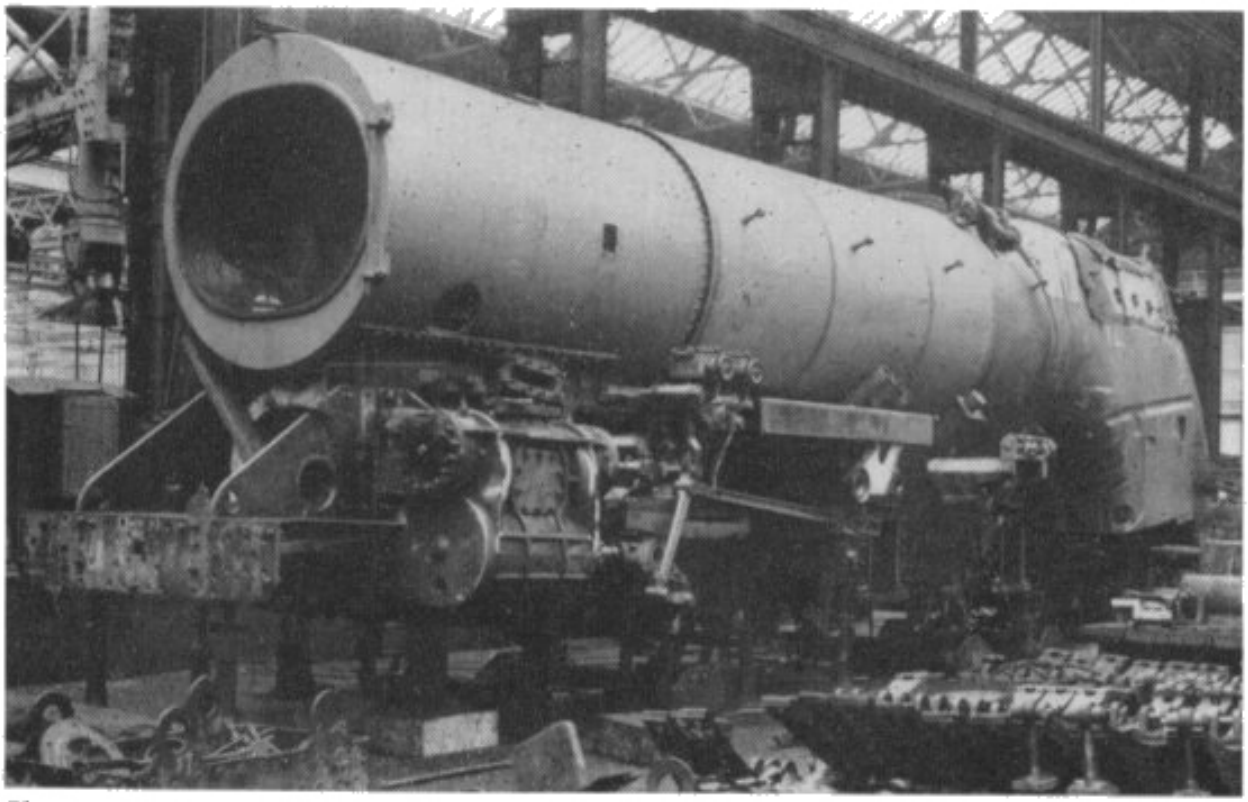
Two damper doors are provided on each of the outer sections of the ashpan so that, in all, there are three damper doors facing forwards and three facing

rearwards; this provides adequate combustion air to support the highest steaming rate of which the boiler is capable. The damper doors are operated in two groups by screw control on the footplate. The transverse shaft which operates the three forward doors, which are in line, is provided with a simple form of universal joint so that any slight deformation of the ashpan will not cause tightness.

The structure of the cab is unaltered except that, for accessibility and to conform with the altered external appearance of the locomotives, the lower portion of the curved side sheeting is cut away. The new cab roof ventilator provided is of a type supported on links, so as to be easy to operate and positively held.

The majority of the driving controls remain the same, the principal exception being the provision of the reversing screw handle and gearbox in place of the controls to the steam reversing gear. This alteration has made it necessary to adjust the driver's seat to a position slightly further back. The same type of firehole door is retained, but as the steam operating gear is very little used this has been removed. The firehole is fitted with a deflector plate to improve the combustion of the volatile content of the coal, by directing the secondary air into head-on collision with the gases leaving the fire-bed.

The cylinders and steamchests are fed by three six-feed mechanical lubricators, which were formerly mounted on the platform in front of the smokebox. The new position is on the side footplating immediately above the slidebar brackets. Two of the lubricators are located on the left-hand side and the third, together with a new ten-feed lubricator for engine oil, is on the right-hand side. They are driven in the normal manner from small levers attached to the outside expansion links.



Photo] [*L. Elsey*

No. 35018 undergoing modification in Eastleigh Works on January 21

Lubrication to the steam chests of the outside cylinders is atomised, but atomised feeds to the inside valve are introduced into the steampipe, because of the position of the steam chest under the smokebox. The cylinder barrels are lubricated by non-atomised feeds introduced at top and bottom. The remaining non-atomised feeds are to the piston rod packing and the valve spindle rear bush.

The coupled axleboxes are fed at the crown by feeds from the engine oil mechanical lubricator, and this eliminates the large multi-feed oilboxes previously fitted in the cab. The remaining feeds from the lubricator supply the slidebars

and the inside valve spindle crosshead guides. Small auxiliary oilboxes with trimming feeds supply the axlebox guides and also the piston rod swab-boxes. The connecting and coupling rods are, as previously, oil lubricated, but the majority of the valve gear is lubricated by grease.

As built, the locomotives had steam sanding for forward running applied to each coupled wheel. For backward running, two sandboxes were fitted to the front of the tender to give dry sanding on the rail between engine and tender. The sandboxes for the leading coupled wheels formed a part of the smokebox, while those for the driving and trailing coupled wheels were disposed under the casing, along the side of the boiler. The leading sanding gear gave rise to difficulties and was subsequently removed.

In the modified locomotive, the leading sanding gear is restored and the sand-pipes which formerly led to the trailing coupled wheels are reversed to provide sanding behind the driving wheels for rearward running. The sandboxes on the tender have been dispensed with. Because of the re-design of the smokebox and the removal of the casing, it has been necessary to provide entirely new sand-boxes. The leading boxes are placed on the platform adjacent to the rear of the smokebox. The boxes for the driving pair of wheels are placed between the frames—a twin box ahead of the crank axle for the forward, and a similar box behind the crank axle for the rearward sanding gear. These boxes have extensions to the foot-plating on each side of the engine for filling purposes.

The engine and tender drawbar is pin-jointed at the tender end to a plunger which slides in guides and is controlled by the drawbar rubber spring in such a way that the tractive force is cushioned by the spring. In the static position the engine and tender are held positively at their correct distance by curved rubbing blocks on the engine and tender drag-beams. The curves are struck from the centre lines of the corresponding drawbar pins, so that any movement between engine and tender is accomplished without additional loading of the drawbar and spring. The rubbing blocks are faced with manganese steel to reduce wear.

The superstructure of the tender is modified by the removal of the side raves, and compartments for the fire-irons are formed on each side of the coal bunker. A casing is placed over the vacuum reservoirs to prevent their becoming enveloped in coal. The rear portion of the tender top is flat and open so as to facilitate the manipulation of the water crane. The tank is provided with external feed sumps with shut-off valves to enable the sieve contained in them to be removed and cleaned without the necessity for emptying the tank. A float type of water level indicator is provided.

Principal particulars of No. 35018 are as follows :—

Cylinders (3), dia and stroke	18 x 24 in.
Wheels :	
Coupled, dia.	6 ft. 2 in.
Bogie, dia.	3 ft. 1 in.
Trailing, dia.	3 ft. 7 in.
Heating Surface :	
Tubes	2,176 sq. ft.
Firebox (incl. syphons)	275 sq. ft.
Total evaporative	2,451 sq. ft.
Superheater	612 sq. ft.
Grate area	48.5 sq. ft.
Boiler pressure	250 lb./sq. in.
Tractive effort	33,495 lb.
Adhesion factor	4.34
Weight of engine in working order	97 tons 18 cwt.
Weight of engine and tender in working order	151 tons 4 cwt.