LOCOMOTIVE PRACTICE and PERFORMANCE

The REMARKABLE BULLEID PACIFICS

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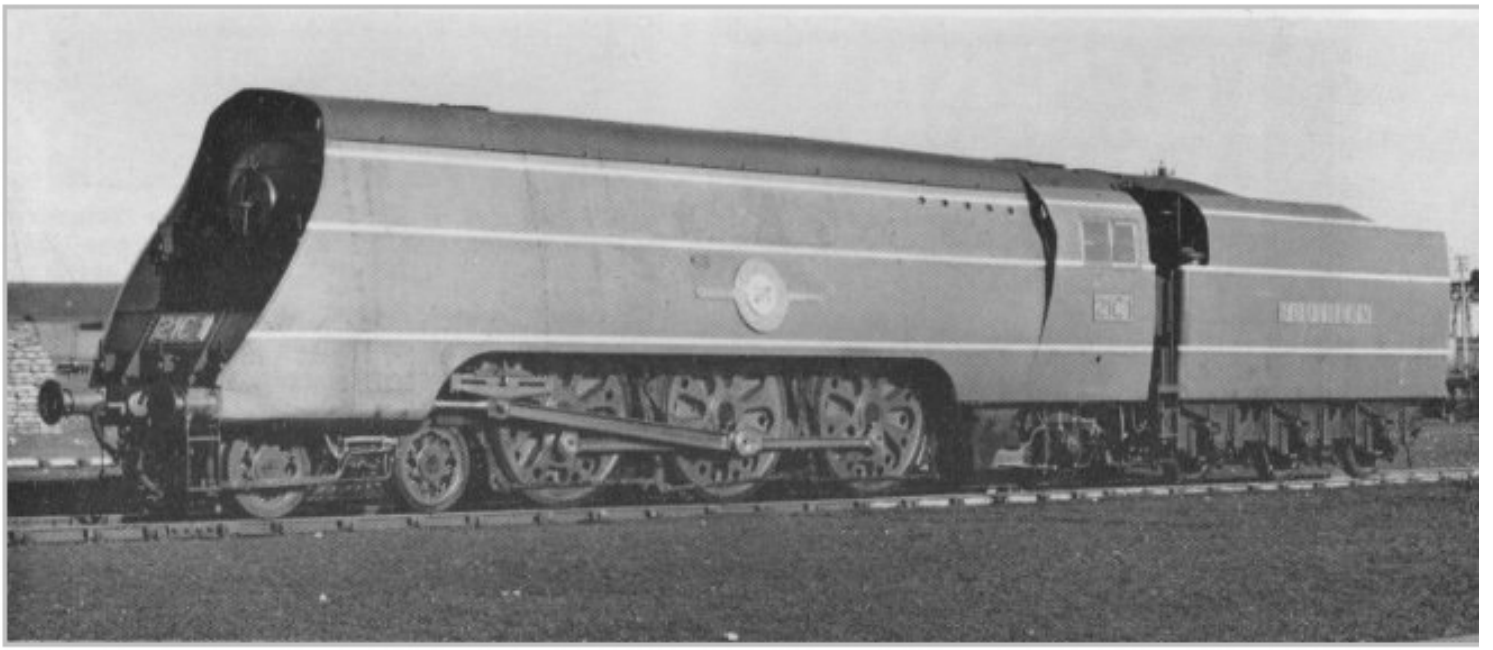
WITH the relegation of the West of England main line of the Southern Region to secondary status, and the approaching electrification of the Bournemouth lines, the last duties of the Bulleid Pacifics will soon come to an end, and thus also will end one of the most remarkable episodes in the history of the British steam railway locomotive. In years before the war, when it was clear that Maunsell's time as Chief Mechanical Engineer was drawing to a close, it might have seemed also that the sun was setting on steam locomotive operating all over the Southern Railway. Its sphere of activity was rapidly contracting as more and more lines were electrified, and the role of mechanical engineers on the Southern looked like becoming nothing more exciting than maintaining the existing stock in reasonably good order until successive lines were electrified, and still fewer steam locomotives were required.

Individually the "King Arthur" and the "Schools" class engines were doing magnificent work. Unfortunately, however, the same could not be said for the "Lord Nelsons", although from the viewpoint of maintenance costs and freedom from troubles on the road these locomotives also had an excellent reputation. With the "King Arthurs" able to work the heaviest trains the traffic department desired to run on the West of England service, and the "Schools" performing prodigies of weight haulage on the Bournemouth line, there seemed, down to the year 1937, no reason why these two types should not carry on until they were displaced by electrification.

Then ill health compelled the resignation of Mr. Maunsell and, by one of those coincidences of railway history, his retirement came to coincide with that of Sir Herbert Walker as General Manager. In the meantime, however, the management of the Southern Railway had been seeking a successor, and to the surprise of quite a number of onlookers the choice fell on O. V. S. Bulleid, who, since 1923, had been assistant to Sir Nigel Gresley on the L.N.E.R. The choice was surprising because Bulleid seemed to be about the last man to fit in with the passive, defensive role to which the Chief Mechanical Engineer's Department of the Southern Railway had gradually been committed. Although Bulleid's "light" had, outwardly at any rate, been very much hidden under the "bushel" of Sir Nigel Gresley, it was well known that he was an exceedingly dynamic character and a prolific inventor.

It is no exaggeration to say that, through his



First Bulleid Pacific, Southern Railway "Merchant Navy" class No. 21C1, "Channel Packet", as it appeared from Eastleigh Works in 1941

Photo: Derek Cross

Down "Golden Arrow" near Petts Wood on March 26, 1959, headed by unrebuilt "Merchant Navy" No. 35028, "Clan Line"

personal influence, drive, and enthusiasm, he completely transformed the position of his department within a very few months of taking office at Waterloo. His extensive rebuilding of the "Lord Nelson" class was extraordinarily successful; he immediately drew attention to the locomotives and carriages under his supervision by painting them in a new, gay, and even startling colour; but his most epoch-marking achievement was reserved for the war years.

One would have thought that with all the difficulties and hindrances of a great national emergency, and the responsibilities he had to shoulder in connection with the ordinary day-to-day work of his department, that there would be little time for the development of an entirely new locomotive design. But Bulleid not only did this, but packed into that design an extraordinary number of novel features, all calculated to react towards the utilisation of those locomotives in conditions that were only just developing on British railways in 1941, but which were to hit the railway network from end to end of the country with almost overwhelming effect several years later.

In its broad conception, the "Merchant Navy" class locomotive, the first of which appeared in 1941, represented a most imaginative excursion into future requirements; and although its ultimate use was to be wholly in express passenger service, the prototypes were definitely designated as "mixed traffic", with the twofold object of getting them fully tried out in both passenger and freight service during the war years, and of obtaining authority for them to be built at all, during a period of great national stringency in railway expenditure.

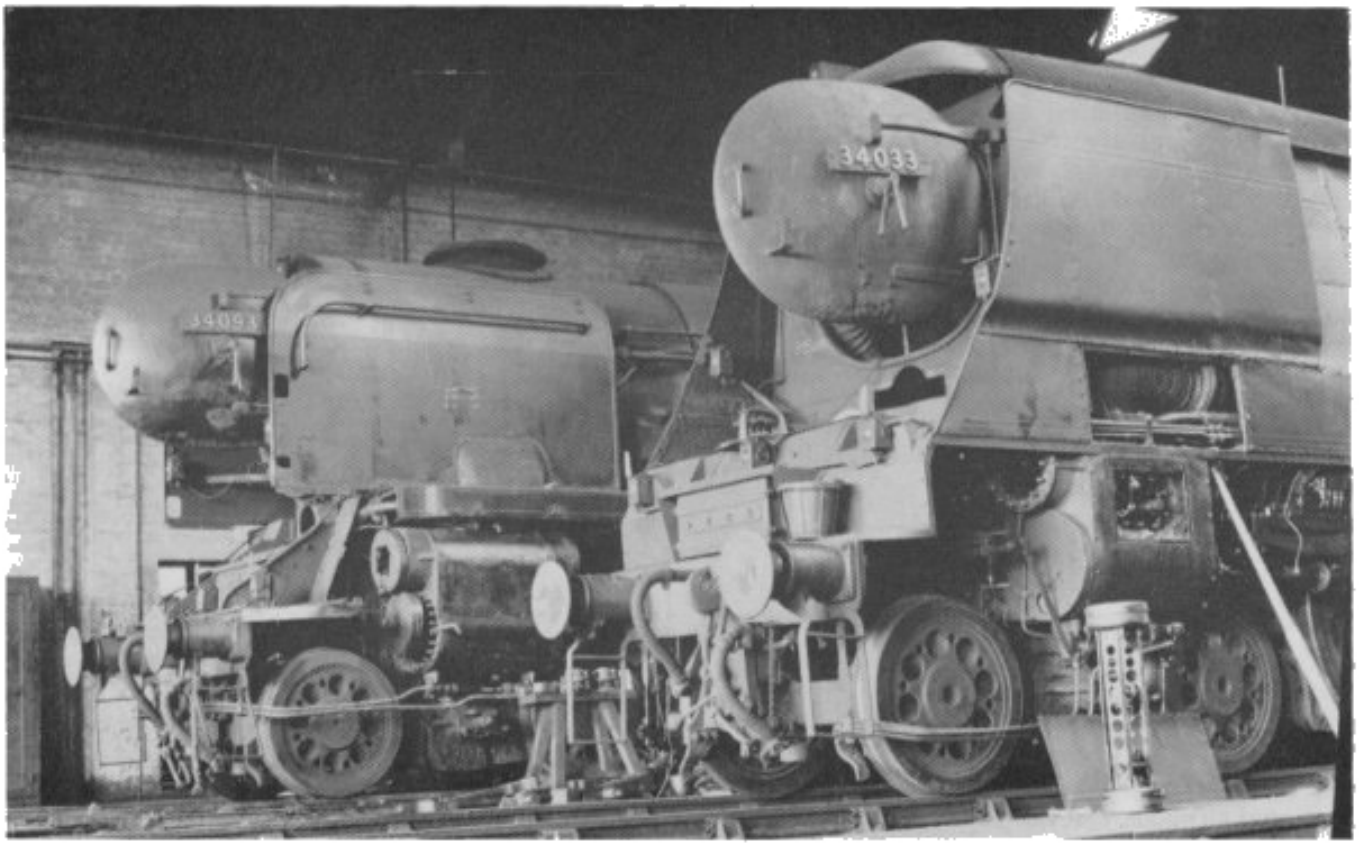
Bulleid envisaged in the immediate post-war years a prolonged use of inferior fuel, coupled with a shortage of labour, a shortage of the choicest engineering materials, and yet a demand for a quick return to pre-war standards of service on the British railways. His first concern was to have the largest possible boiler that could be accommodated within the limitations of length and weight imposed by civil engineering restrictions on the Southern. Whereas at the formation of the railway itself, after grouping, in 1923, the traffic department had desired a locomotive that would haul train loads of 500 tons at start-to-stop average speeds of 55 m.p.h., Bulleid designed the "Merchant Navy" class with the object of hauling train loads of 550 to 600 tons at average speeds of 60 m.p.h. between London and Dover, and at start-to-stop average speeds of 70 m.p.h. between Waterloo and the West of England.

The very large boiler and all-welded steel firebox fitted with two Nicholson thermic syphons proved the most prolific steam raiser; in fact, when one of the "Merchant Navy" class engines was subsequently tested on the stationary plant at Rugby the ultimate limit of evaporation was never finally established. Mechanical conditions both on the test plant and on the Settle & Carlisle line made it unwise to attempt to press the locomotive to its limit of steaming. Taken by and large, Bulleid succeeded, in the most striking manner, in producing a locomotive that would steam freely under the most adverse conditions, and by use of the five-nozzle multiple-jet blastpipe would steam while causing very little back pressure from the exhaust.

Having designed this very large boiler and firebox he had to get the weight down in other respects,

"Battle of Britain" Pacific No. 34071, "601 Squadron", at Eastleigh motive power depot on June 11, 1965, and (below) "West Country" class Nos. 34093, "Saunton", and 34033, "Chard", in the shed on May 25

Photos: J. R. Carter



and one method was to support the outer casing for the boiler lagging on the frames rather than on the boiler itself. This gave rise, coupled with Mr. Bulleid's natural flair for publicity, to the outer "air smoothing" which bestowed on the engines so unusual and distinctive an appearance—and led to their being nick-named "Spam-cans". When the smaller "West Country" class engines were introduced in 1945 and were specially designated "lightweight", there were some who criticised the use of the so-called air-smoothing as being a contradiction in principles. It had been noted in the case of the "Duchess" class Pacifics on the L.M.S.R. that streamlining added several tons to the overall weight of the locomotive, and it was assumed that the "air-smoothing" on the Bulleid Pacifics did the same. On the contrary, the form of construction used actually resulted in a *reduction* of weight, as compared with conventional boiler-lagging practice.

Further advanced ideas

If Bulleid had been content with this magnificent boiler, and had proceeded rather more cautiously towards his further advanced ideas, one feels that the "Merchant Navy" class engines would have been a far greater success than they actually were. But with a view to reducing maintenance and the attention needed at running sheds in the course of ordinary day-to-day performance, he introduced the completely-enclosed valve motion, and he enclosed also the piston rod and connecting rod of the inside cylinder. It was a difficult task to design an oil bath which would be adequate for running conditions in ordinary locomotive practice; but this was achieved, though because of the confined space available an entirely novel arrangement of the valve gear had also to be designed, which was chain driven. Another novel feature was the driving of the piston valves themselves from a point midway along the valve rather than by a valve spindle in the conventional manner. It was this ingenious—almost daring—conception that led to a lot of trouble in service, and eventually led the nationalised British Railways to the drastic step of rebuilding the engines entirely with a conventional front-end and three sets of ordinary Walschaerts valve gear.

When the original Bulleid Pacifics were newly shopped and everything at the front end was tuned up to concert pitch, they could do remarkable work. The front end provided for a very free flow of steam into and out of the cylinders, and they were not only very fast, but very powerful engines. But deterioration with increasing mileage proved to be much more rapid than on normal types of locomotives, and not only did the coal consumption become heavy, but very considerable trouble used to develop because of leakage of oil. This made the engines particularly prone to slipping, and was the source of great anxiety to the test engineers at Rugby when one of these engines was being put through full-dress trials on the stationary plant.

It was the inherent characteristics of the front-end that prevented the enormous steam raising capacity of the boiler from being used to its full effect, and in consequence the locomotives were never able to attain in service a haulage capacity anything approaching that for which they were originally designed. Their rebuilding with conventional valve gear turned them into good reliable machines, but lacking that little "extra" which they possessed in their earlier days. Certain engines that were very well looked after could produce reasonably high outputs of power, even after running long mileages; an example of this is given later in this article. But many of the engines on which I rode, particularly the "West Country" class, appeared to be well off their beat at the front end and very heavy coal burners in relations to the actual work they were doing. At the time of their rebuilding the boiler pressure was reduced to 250 lb. per sq. in. to lessen the maintenance costs of the boiler.

In recent years I have received from correspondents more logs of runs with the Bulleid Pacifics than with any other type of locomotive—steam, diesel, or electric. The great majority of these include examples of smart and sometimes very fast running; but the loads are relatively light—very light indeed in comparison with the specified performance standards laid down by Mr. Bulleid when the locomotives were being designed. With the reduction in boiler pressure that accompanied their rebuilding, it is obvious that one could not expect the maximum efforts of the rebuilt engines to equal the best put up by the originals, and when the rebuilt engine No. 35020, *Bibby Line*, was put through a series of dynamometer car tests between Waterloo and Exeter, as I described in *The Railway Magazine* for February, 1960, the traffic authorities would not permit any excess over the regular loads of the trains concerned; to compensate for the inclusion of the dynamometer car there was one coach less in the ordinary passenger part of the train. Thus there was no opportunity to observe what the engine could have done if really opened out.

The most interesting trip I ever had with one of the original "Merchant Navy" class engines was with No. 35028, *Clan Line*, out and home on the "Golden Arrow" in the spring of 1954. The engine had then covered 100,000 miles since last general overhaul, and 35,000 miles since last intermediate. She was in reasonably good nick at the front end, but more important than that was we had a pair of thorough-going enthusiasts in charge, Driver J. Brewer and Fireman D. Ward of Stewarts Lane shed. It was a tonic to ride with them. The logs of these two journeys are set out in Tables I and II herewith. On the down journey I was interested to see the driver using wide openings of the regulator and relatively short cut-offs, and when linked up to 15 per cent the action of the engine was quite smooth at the front end. At the same time one cannot accept the readings of cut-off read from the reverser scale as precise, because the Bulleid Pacifics, above all engines, were subject to considerable variations in the actual cut-offs obtaining in their cylinders.

There was nothing special about the outward journey until we were heavily checked by adverse

signals at Headcorn. With the rails wet, and the engine slipping repeatedly, we took some time to get into speed again. The reverser indicated 20 per cent cut-off; but on the rising gradients from Pluckley a steam-chest pressure of 160 lb. per sq. in. was the maximum the engine would take without slipping, and we passed Ashford slightly behind time. The speed was then 72 m.p.h. and with all going well the driver then opened the regulator much wider to give 230 lb per sq. in. in the steam chest. The response was terrific. Up the rise to Smeeth, averaging 1 in 300, we accelerated to and *sustained* 75 m.p.h.; the brief easing of the grade past Smeeth Station raised the speed to 77½ m.p.h., and even though cut-off had to be reduced to 15 per cent we cleared the four miles at 1 in 266-286 to Westenhanger without falling below 72 m.p.h.—this with a load of 425 tons behind the tender. This very big effort would have brought us into Folkestone Junction Sidings well ahead of time; but the road was not clear, and we were stopped for 3/4 min. waiting to cross over from the main line.

The return trip was from Dover, and involved some magnificent running, with the same load. Cut-off was fixed at 20 per cent from the western end of Shakespeare's Cliff Tunnel, and with wide openings of the regulator we steadily accelerated up the long 1 in 266 gradient to 62½ m.p.h. at Westenhanger summit. Some fast work followed to Tonbridge, intercepted by a bad signal check at Pluckley; but it was after Tonbridge that the most extraordinary feat took place. With cut-off at 25 per cent and the regulator absolutely full open, we sustained 53 m.p.h. on the 1 in 122 gradient up to Sevenoaks Tunnel. This performance, involving an equivalent drawbar horsepower of between 1900 and 2000 was, of course, not up to the level of the maximum feats of the Stanier "Duchess" class Pacifics in climbing the Grayrigg and Shap inclines; but it was nevertheless a very thrilling affair to experience on the footplate.

TABLE I

S.R.: VICTORIA-FOLKESTONE JUNCTION
"The Golden Arrow"

Load: 9 Pullmans, 3 other vehicles; 406 tons tare, 420 tons full
Engine: "Merchant Navy" class 4-6-2 No. 35028, *Clan Line*
Driver J. Brewer, Fireman D. Ward (Stewarts Lane)

Dist.		Sch.	Actual	Speeds
Miles		mins.	m. s.	m.p.h.
0.0	VICTORIA	0	0 00	—
0.7	*Grosvenor Road "D" Site*		1 56	—
2.3	Clapham		5 50	—
4.0	Herne Hill	8½	8 57	—
5.7	Sydenham Hill		12 15	30½
8.7	Beckenham Junc.	16	16 06	62/50
10.9	BROMLEY SOUTH		18 35	56
12.6	*Bickley Junc.*	22	20 58	30
14.9	Orpington	27	24 45	41
16.4	Chelsfield		26 54	43
17.7	Knockholt		28 40	41
21.7	Dunton Green		32 52	67½
			sigs.	15
23.2	SEVENOAKS	37	35 28	—
28.1	Hildenborough		41 33	72
30.6	TONBRIDGE	44½	44 15	—
32.1	*Milepost 31*		46 10	49½
35.9	Paddock Wood	50	49 42	75
40.5	Marden		53 22	77/75
43.0	Staplehurst		55 22	78
			sigs.	81 (max)
46.3	Headcorn		58 35	35
51.5	Pluckley		64 40	54½
				66½
55.0	*Chart Siding*		67 58	64½
57.2	ASHFORD	69½	69 57	72
			—	75
61.5	Smeeth		73 16	75
			—	77½
65.3	Westenhanger		76 20	72
66.5	*Sandling Junc.*		77 24	69
69.2	*Cheriton Junc.*		79 42	72
71.0	FOLKESTONE CENTRAL		81 13	—
			sigs.	—
72.0	Folkestone Junc. Sta.		82 18 }	Sig.
			83 02 }	stop
72.4	FOLKESTONE JUNC. SIDINGS	86	85 35	—

Net time: 78 min.

TABLE II

S.R.: DOVER MARINE-VICTORIA
"The Golden Arrow"

Load: 406 tons tare, 425 tons full
Engine: "Merchant Navy" 4-6-2 No. 35028 *Clan Line* (unrebuilt)

Dist.		Sch.	Actual	Speeds
Miles		mins.	m. s.	m.p.h.
0.0	DOVER MARINE	0	0 00	—
7.0	FOLKESTONE CENT.		12 44	55½
11.5	Sandling Junc.		17 18	61
12.7	Westenhanger		18 29	62½
16.5	Smeeth		21 35	80
20.8	ASHFORD	26½	24 47	84
			sigs.	15
26.5	Pluckley		30 10	—
31.7	Headcorn		37 35	68
35.0	Staplehurst		40 20	75
37.5	Marden		42 23	74
42.1	Paddock Wood	44½	45 54	82
45.9	*Milepost 31*		48 49	75
47.4	TONBRIDGE	49½	50 08	47 *
			—	53
49.9	Hildenborough		53 13	57½/53
			sigs.	10
51.8	*Weald Box*		56 35	—
54.8	SEVENOAKS	60½	62 51	—
56.3	Dunton Green		64 30	64½
60.3	Knockholt		68 40	51
63.1	Orpington	69	71 07	75
65.4	*Bickley Junc.*		73 43	30 *
69.3	Beckenham Junc.	78	79 55	—
72.3	Sydenham Hill		83 47	—
			sigs.	—
74.0	HERNE HILL	85	85 57	—
			sigs.	—
78.0	VICTORIA	92	92 07	—

Net time 83 min.
* Speed restrictions

Red-hot arrival at Victoria

Unfortunately we were badly checked by signal at Weald intermediate box, and our chances of making quite a record time from Tonbridge up to Knockholt spoiled. But despite further checks, and cautious running in the London suburban area, we reached Victoria on time. I said in my first reference to this day's running that the engine was not in her first bloom of youth. I can now tell also that we arrived in Victoria with all the metal out of one of the side-rod bushes, and a red-hot smokebox door! But No. 35028 had a strenuous programme to fulfil. The shed staff at Stewarts Lane rendered effective "first-aid" on the following day, and she was turned out, as immaculate as ever, for a V.I.P. Special the day after!

I have not left myself very much space for the tabulation of recent runs, and must conclude with reference to a very fine performance with one of the

Rebuilt "West Country" No. 34098, "Templecombe", at Southampton Central on August 5, 1964, with a Bournemouth to Waterloo express

Photo: G. R. Hounsell

TABLE III

S.R.: 8.40 BOURNEMOUTH CENTRAL TO WATERLOO

Load: 13 coaches; 450 tons tare, 485 tons gross
Engine: Rebuilt "West Country" 4-6-2 No. 34004, *Yeovil*

Dist.		Sch.	Actual	Speed
Miles		mins.	m. s.	m.p.h.
0.0	BOURNEMOUTH CENT.	0	0 00	—
1.2	Boscombe		3 47	40
3.7	Christchurch		6 37	62 *
7.0	Hinton Admiral		10 05	56½/51
9.5	New Milton		12 55	56½/68
12.5	Sway		15 47	67½
15.2	BROCKENHURST ...		18 24	62/77
20.0	Beaulieu Road		22 31	74
22.6	Lyndhurst Road		24 43	62 */73½
26.2	Redbridge	28	28 12	47/56
28.8	SOUTHAMPTON CENT.	33	32 18	—
1.0	*Northam Junc.*	3½	3 22	16 *
1.9	St. Denys		5 24	39½
3.4	Swaythling		7 25	47½
5.6	EASTLEIGH	10	9 59	60
10.2	*Shawford Junc.*		14 31	63
12.6	WINCHESTER CITY ...	20	17 12	—
2.1	*Winchester Junc.*	5½	5 03	43
8.5	Micheldever		12 21	58½
10.4	*Roundwood*		14 16	60
14.0	*Wootton*		17 43	68/70
16.3	*Worting Junction*	23	19 47	61 *
18.8	BASINGSTOKE		22 05	70/75
24.4	Hook		26 48	72½
26.6	Winchfield		28 45	76½
30.1	Fleet		31 31	71½
33.4	Farnborough		34 13	76
35.6	*Milepost 31*		36 00	74/82½
38.6	Brookwood		38 20	80½
42.3	WOKING		41 17	71½/66
46.2	Byfleet		44 43	77½
47.5	Weybridge		45 43	76½/74
49.5	Walton-on-Thames ...		47 18	81½
52.2	Esher		49 19	83
53.3	*Hampton Court Junc.* ...	55½	50 05	82
			sigs.	50
54.6	SURBITON		51 30	53½
56.8	New Malden		53 55	60½
			sigs.	5
59.4	Wimbledon		58 33	22
61.0	Earlsfield		61 21	50
62.7	CLAPHAM JUNC. ...	65	63 38	39 *
66.6	WATERLOO	72	70 25	—

Net time from Winchester: 65¾ min.
* Speed restrictions

rebuilt "West Country" class on the up "Royal Wessex", for details of which I am indebted to Mr. B. C. Smith. The log is set out in Table III. The load was a heavy one of 485 tons gross behind the tender, and the departure from Bournemouth 2¾ min. late. The initial booking of 33min. start to stop for the run to Southampton is tight, in view of the four intermediate speed restrictions, at Christchurch, Lymington Junction, Lyndhurst Road and over Redbridge Viaduct and curve. But by dint of an excellent climb of Hinton Admiral bank, with a minimum speed of 51 m.p.h. on the 1 in 111 gradient, and some fine bursts of speed on the section through the New Forest, nearly ¾ min. was gained, and the train left Southampton a shade under 2 min. late. Splendid work followed with an acceleration to 60 m.p.h. at Eastleigh and a further increase to 63 m.p.h. in the 1 in 250 that begins shortly after that station. Thus Winchester was left on time.

On the continuous 1 in 250 gradient that extends from the start to Roundwood Box speed was gradually worked up to 60 m.p.h. and, with a brief maximum of 70 m.p.h. beyond, Worting Junction was passed more than 3 min. early, at a reduced speed of 61 m.p.h. Then, on the generally favourable gradients that extend to the outskirts of London, some fast running was made with an average speed of 73 m.p.h. between Worting Junction and Hampton Court Junction. At the latter point the train was 5½ min. early, and paid the penalty by getting involved in signal checks. But although some 4½ min. were lost in running there was sufficient time in hand to offset the effects of this delay, and Waterloo was reached 1½ min. early. This was a really splendid example of the work of the rebuilt "West Country" Pacifics, and the net time of 65¾ min. from Winchester showed an average speed of 60.8 m.p.h. with this heavy train of 485 tons.