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G.W.R. Mechanics' Institution.

SWINDON ENGINEERING SOCIETY.

TRANSACTIONS, 1906-7

ORDINARY MEETING.– Tuesday, October 23rd, 1906.

Chairman —W. H. Waister, Esq., M.I.Mech.E. (Vice-President)

"THE WORK OF A RUNNING DEPARTMENT,"

BY

HENRY SIMPSON, Esq. (Vice-President).

In the early days of railways each Company had a small capital and only a few miles of line, but it was very soon found to be to the mutual advantage of small Companies to amalgamate. From these amalgamations have sprung such gigantic corporations as the Great Western, North Western, and Midland Railway Companies. With these changes have come modifications in the organization of the Locomotive, Carriage, and Wagon Departments. On a railway of from 50 to 200 miles of line the function of the Chief Locomotive Superintendent was essentially that of a Running Superintendent. He was responsible for the running and the repairing of the engines under his control. He would undertake general repairs ; but if he required a new boiler, crank shaft, or pair of cylinders he would order these from the engine builders. His responsibilities were, in short, about the same as a present day Divisional Superintendent. His engines were built by private firms, and most of you are aware that even now we have engines running on the Great Western which were originally built by such firms as England, Sharp, Stewart, Slaughter, Gruning & Co., Wilsons, Beyer, Peacock & Co., and others. Within the last few years some consternation was caused among the Locomotive Superintendents at a meeting of the Institute of Mechanical Engineers by the suggestion that the true function of a Locomotive Superintendent was to see to the running and repairing of Locomotives, but that the designing and building should be left to private firms. This suggestion was made by a representative of a

private firm, and was not endorsed by the Locomotive Superintendents present. No matter how clever the engineers of private firms may be, it would be impossible for them to build such engines as are at present running on the Great Western Railway unless they had actual experience in running, and were in a position to develop in directions which the working of the engines indicated. Now-a-days the Chief Locomotive Superintendent of a great railway is responsible for the designing, building, and running of all locomotives, as well as the designing and repairing of the carriages and wagons. One of his principal assistants is the Chief of the Running Department. The organization of this department is not the same on all railways. On the L. & N. W., for instance, there are two Superintendents—one is at the head of the Northern, and the other of the Southern Division—and these officers have foremen at the different sheds under their control. The Locomotive Running Department is altogether distinct from the Carriage and Wagon Department, and under a different set of officers. On our line the Chief of the Running Department has an assistant and seven Divisional Superintendents. The author does not propose to discuss the relative advantages and disadvantages of the different systems, but will content himself by saying that the Running Department of the Great Western is the most economical of the great trunk lines.

The Divisional System.—It is the work of a Divisional Superintendent that will be dealt with particularly in this. A sort of genealogical tree is shown on Fig. 1. From this will be seen the chain of responsibility from the Superintendent down to the call-boy, and we will consider the duties of each in detail.

It will simplify matters if we trace the operations of the staff from the time an engine approaches a running shed to its going out again to work a train.

Examination by Enginemen—Upon arrival outside the shed, the engineman, or engine-turner who relieves him, should make a careful examination of engine, and, before going off duty, book all the defects he discovers. The engine is then left at or near the coal stage in charge of the shed turner or, as he is sometimes called, pilotman, who sets it in the proper position for coaling.

Coaling.—The engineman or fireman has, before leaving his engine,

locked up his tools, and chalked on one of the boxes the quantity of coals he requires for his next trip.

Qualities of Coals.—As a rule, the best bituminous South Wales coal is used on engines intended for fast and heavy passenger trains, and a mixture of hard Yorkshire, North Wales, or Staffordshire, with second grade South Wales coal for trains of less importance. What is known in South Wales as smokeless steam coal is of no use whatever for locomotive purposes, on account of its dry character. It is very rich in carbon and its calorific value is exceedingly high. With a steady, continuous draught, such as is obtained in steamboats, it gives the best of results ; but in locomotives, where the draught is intermittent, the punching effect of the blast produces the same result as poking an anthracite fire. On the other hand, when a bituminous coal is used, the punching of the blast has the desired effect of keeping the fire open and turning the binding qualities of the coal to the best advantage. The Northern coals have different characteristics altogether. These are not so rich in carbon, but more so in hydrogen, and are therefore swifter burning. For light work, the hard coal makes an ideal fuel, and a mixture with a slower burning coal gives excellent results for heavy work. Instructions are given to the coalmen to put on suitable coal for particular trains, but, owing to the inadequate accommodation on the stage, or irregular supply of first and second grade coal, it sometimes, though fortunately not very often, happens that a shunting engine gets best coal, whilst an express engine gets such a quality as to render the lives of the engineman and fireman not exactly a bed of roses. This results in loss of time during journey, which involves much correspondence and explanation. The cost of coaling locomotives varies from $2\frac{1}{4}$d to $3\frac{1}{2}$d per ton. The lowest prices are paid at up-to-date tipping stages, where the wagon flaps can be dropped clear of the stage, and the tops of the tip wagons are no higher than the bottoms of the coal trucks. The coal can then be practically tumbled out of the trucks into the tip wagons, and labour is reduced to a minimum. The highest prices obtain at those stages where the coal is shovelled into tubs, the tops of which usually stand as high as the tops of the wagons, and the tubs have to be lifted by a hand crane before being tipped on to the tenders or bunkers. This is obviously a two-handed job and accounts for the high cost of

coaling. It will be seen, therefore, how necessary it is to have a well designed coal stage, both on account of the cost and expedition in dealing with the engines. A good, roomy platform is also necessary, as this enables the coalmen to fill a large number of tip wagons whilst there are no engines about, and facilitates the proper mixing of the coal. The cost of coal on the G.W.R. system amounts to more than half a million pounds per annum, hence it is an important part of the Chief Loco. Superintendent's duty to advise his Directors as to the making of contracts, and the Chief of the Running Department exercises an equally important duty in arranging for the proper distribution of the coal. It might be possible to find on the market a particular coal which would give very good all round results, but if a large Railway Company purchased that coal, and no other, the effect would be to enhance its price, and would put the Railway Company at the mercy of the market in the case of a strike or other dislocation of trade at the particular group of collieries from which the coal was drawn. It is, therefore, good policy to obtain the supply from as large a number of areas as possible. This, also, ensures getting the best possible value for money.

Cleaning Smokebox.—After the engine has been coaled, it is taken by the shed turner beyond the coal stage, where the turner's mate, or a boy appointed for the purpose, cleans out the smokebox, and, to prevent smothering the engine with dust, the ashes are plentifully sprinkled with water. In up-to-date sheds, hydrants are fixed for this purpose, and in some cases a shallow pit is provided, into which the ashes are dumped.

Fire Dropping.—The engine is then taken to the fire pit, where one fire dropper stands on the footplate and another in the pit. A couple of firebars are either pulled up by the former or knocked up by the latter, and the fire is pushed out into the ashpan, by means of a pricker, by the man on the footplate, whilst the one in the pit waters it from a hosepipe and rakes it out. At some sheds the practice is to " clean the fire "—that is, to shovel all (or as much as can be got at) of the clinker out through the firehole by means of a clinker shovel. This is really the better, though most costly, because the firebox is not cooled down

so suddenly as it is by " dropping ", consequently there is less liability to cause leakage of tubes, stays, and foundation rings. When the Author was in charge of Stourbridge shed most of the engines at that station had foundation rings of only $\frac{1}{2}$″in thickness, and, as they were constantly troubled with leaky corners, the practice of dropping was abandoned, and that of cleaning the fires adopted, with most excellent results as the leaky foundation rings were practically cured. At Stourbridge the engines did only a small mileage, consequently the amount of dirt and clinker in each firebox after a day's work was inconsiderable, and, as they only had about 25 engines steamed per day, there were no difficulties in the way of fire cleaning. The results justified the slight extra expenditure. When, however, the Author was appointed assistant to Mr. Read at Newport, he found the fireboxes at Pontypool Road, after a few days' work, so full of dirt and clinker that it was impracticable to clean the fires. As an experiment, he timed one of the shunting firemen, and found that, by working hard, this man cleaned a box in 20 minutes, and, even after that, a turner pulled out about six shovels full from the back corners. The conclusion the Author came to was that fire cleaning was advantageous, but not always practicable, more especially where there were 100 or more engines steamed every day.

A careful engineman always brings his engine to the shed with the fire as low as possible, and with very little unconsumed fuel in the firebox ; but the more clinker there is in the box at the end of a day's work the higher is the proportion of unconsumed fuel, and this constitutes an absolute waste. Unimportant as this fact appears, there is no doubt that it has some bearing on high consumption.

Tube Running.—After the fire has been dropped or cleaned, as the case may be, the engine is taken to the shed to be stabled. If the shed happens to be a straight one, it is necessary to have the tubes " run " at once, because, after it has been put into position, another engine may be put in front of it, and render the operation of tube cleaning impracticable. If, however, the shed is a round one, the operation may be performed at a convenient time to the tube cleaners. To run a set of tubes takes from 40 to 60 minutes. The tubes are cleaned by means of a long rod, about $\frac{3}{8}$″diameter, with an eye in the end of it through which is threaded a piece of canvas.

Cleaning tubes by means of a steam jet has been in vogue for some time at Paddington, and, it would appear, with good results ; although, when a blocked tube is encountered, steam and soot blow back into the cleaner's face. Steam cleaning in large sheds is more economical than rod cleaning, as it takes only 20 minutes or so to clean a set of tubes by this method, and the tubes are swept out very much better ; but the corks which form on the tube ends in the firebox are not so effectively removed as by a rod. Corked tubes prevent an engine steaming much more than do dirty tubes, and it is just a question whether a small amount of soot uniformly distributed in a tube does not rather assist the generation of steam, and maintains the tube at a more uniform temperature, thus reducing the risk of leakage.

On the whole, therefore, rod cleaning is more efficient, but steam cleaning is the cheaper. At Paddington a small vertical boiler supplies the steam, and this system is much better than having a cock on each engine, as all careful enginemen bring their engines to the shed low in fire and low in steam, so that by the time an engine is coaled and the fire cleaned there is not always enough steam left for tube cleaning.

Cleaning.—The cleaner or cleaners next take the engine in hand. The best system of cleaning is, in the Author's opinion, for each cleaner to follow his own engine. He then takes more interest in his work, and is alone responsible for the cleanliness of the particular engine he follows, and if the engineman finds he does his work well, every encouragement is given him.

Gang cleaning, on the other hand, affords no special inducement to a lad to exert himself. In fact, he takes about as much interest in his work as a man takes in a hired bicycle. The best *method* of cleaning is that inaugurated on the G.W.R. by Mr. Armstrong at Paddington, and adopted to a great extent in the Swindon Division. Mr. Armstrong has his engines cleaned with cleaning oil and water, and uses absolutely no tallow, as he considers that it has a detrimental effect on the varnish. In the Swindon Division, generally speaking, a little tallow is put on the cleading plates of the barrel and firebox only, these being the hot parts. The quantity of stores used varies according to the size of the engine cleaned. The following tabulated statement shews, approximately, the stores allowed :—

Class of Engine.	Sponge Cloths or each.	Cotton Waste. lbs.	Tallow. oz.	Cleaning Oil. pints.
0-6-0 T	8 to 12	1 to 1½	1¼	¼
0-6-0	12	1½	1¼	¼
2-4-0	16	1½	1¼	¼
4-4-0 T	16	2	1¼	¼
2-2-2	16	2	1¼	¼
2-4-0	16	2	1¼	¼
2-4-2 T	24	3	1¼	¼
4-4-2 T	24	3	1¼	¼
4-4-0	23	3	1¼	¼
2-6-0	24	2	1¼	¼
2-8-0	32	4	1¼	¼ *

* The same stores are allowed for the different types of " Atlantic " passenger engines.

Two galls. of petroleum are allowed per week to each chargeman to help with the cleaning oil on dirty engines.

Three Bath bricks allowed to each chargeman for each turn of duty, and 3 galls of cleaning oil which would average about ¼ pint per engine.

Bar Laying.—If it is not necessary to do any repairs to the firebox, the firebars, which were knocked out by the fire droppers, are laid generally about three hours before the cleaner has finished his work. This is done either with a long pair of tongs from the outside or a bar boy who goes inside, lays the bars, rakes off the accumulation of ashes from the top of the brick arch, and sweeps the corks off the tube plate. The lighter-up then throws a few shovels full of coal round the box, and afterwards one or two scoops of fire into the centre.

Sand Furnace.—Many sand furnaces are constructed on wrong principles. These have a firebrick lined furnace, above and below which ovens are fixed, into these the wet sand is thrown, and there lies sodden until all the moisture is eliminated. The sand furnaces used on the G.W.R. have a hot chamber between the furnace and the chimney, and above this chamber there is a receptacle for the wet sand. In the roof of the hot chamber one or more gratings are fixed, through which the sand falls gradually, and is dried thoroughly in detail by the hot gases passing through the chamber. These furnaces are automatic in action, and dry at least five times the quantity of sand as the old fashioned oven furnaces would with the same expenditure of fuel.

Lighting Up.—Lighting up is essentially a two-handed job, and in sheds too small to justify the employment of two lighters up on each shift it is usual for the cleaner to carry the fire. On an average, it

takes about three hours to make steam ; and it is, therefore, usual to light up about four hours before the booked time of train. When steam is up the engineman and fireman take charge of their engine ; but of their duties the Author will not now speak, as this branch of running work has already been fully dealt with by Mr. R. H. Smith in the excellent paper he read before this Society last session. But to complete the cycle of shed operations, it may be well to mention that the fireman rakes the ashpan out, fills the sand boxes, attends to glands, and takes water. As a rule, water is taken when the engine is coaling, or having the fire dropped ; but, in the case of a saddle tank engine, it is essential that water be taken when the engine is leaving the shed, and not before, because, after standing in a saddle tank for any length of time, the water becomes too hot to be picked up by the injectors.

The Ideal Shed.—Consideration of work performed in and about a Running Shed, as described in the foregoing, enables anyone to grasp the essential elementary requirements of a good shed and Locomotive Yard. In a paper read last Session on " Locomotive Engine Sheds," Mr. Arkell dealt fully with their construction, and gave illustrations of the several designs in vogue. Mr. Arkell advocates a straight-through shed as an ideal. There is much in his contention, and the particular form of straight shed he suggests is most convenient, but a round shed is, for many reasons, to be preferred to a straight one. On the ingoing road a pit of sufficient length should be provided to stand the engines waiting their turn to be coaled, and over which the enginemen or turners could make their examinations. Between this pit and the shed should be placed the coal stage, preferably on a loop, so that access might be had directly into the shed on the ingoing load for the convenience of those engines which did not require coaling, but required turning.

The platform of a coal stage should be high enough to allow of the cabs of engines clearing the tips when down, and should be of such an area as to accommodate as many tip wagons as would hold at least one twentieth of a day's consumption, and long enough to permit of proper mixing.

The elevated road should be high enough, as already mentioned, for the tops of the tip wagons to be level with the floors of the coal wagons. The length of this road to the dead end beyond the coal stage should be sufficient to hold wagons enough for one day's consumption.

The fire pit should be a fair distance from the stage, and between it and the shed, and at this pit, or at the coal stage, there should be a water crane. If the stage is on a loop, the crane should be put between the loop and ingoing road. The firepit should preferably be lined with fire bricks as the faces of Staffordshire blue bricks are quickly destroyed by the hot clinkers. This pit should be fitted with a number of hydrants, and these should be well set back in the brick work to protect them from injury. Adjacent to the fire pit, a short dead end siding should be provided, upon which the ash wagons could stand, and pavement should be laid down between the siding and the pit to provide a good bottom for the ash loaders to shovel on. The fire pit road should converge into the ingoing road outside the sheds, and the points should be as far from the pit as is practicable.

The ingoing road should lead direct to the turntable, and not converge into the outgoing road. The outgoing road should have two or three dead end sidings furnished with pits, over which men could get their engines ready without interference. A road should lead from the outgoing across the ingoing road to the coal stage loop. This should be compounded with the ingoing road, so that an engine requiring coal only could run directly under the tip, through the compound, taking the preference of those engines waiting their turn on the coal stage road, and immediately it was coaled it could run out again on to the outgoing road.

A water crane or cranes should, of course, be provided to serve the outgoing roads.

The sand furnace should be placed as near the preparing pits as possible.

The shed illustrated (Fig. 2.) would accommodate from 20 to 30 engines, and it will be seen that all shed operations can be done in proper sequence, and without necessitating a single back shunt, except in the case of engines leaving the shed having to set back on to the preparing pits ; but even here there is absolutely no risk of a broadside collision. All our latest sheds are designed more or less on these lines, but the ideal shed and yard occupies a large piece of land, which is, however, unfortunately hardly ever available in practice, and the accommodation provided has, therefore, to be modified according to circumstances.

WASHING OUT is a most important operation, and one which should be followed up very closely by the management. Two men comprise a " set " of washers-out, and a set can wash a boiler out in from two to five hours, according to its size. The washers-out first take out all plugs and hand-hole covers. They then very carefully swill out as much of the deposited sulphates, carbonates, etc., as is possible, this being assisted by a vigorous working with rods. After the scale has been removed, the boiler is examined by means of a light, preferably by a boilersmith, who certifies it as " clean and in good order." The plugs are then tallowed or greased with a heavy lubricating oil and replaced, as also are the hand-hole covers and any of the lead joints on the latter which may be defective are renewed. In most divisions the foremen

FORM No. 1.

GREAT WESTERN RAILWAY.

Return of Boilers Washed Out in.....District

W.E. Saturday..... .....190...

Date.	Station.	Engine.	By whom Washed out.	By whom Examined.	Remarks as to Dirt, &c.

are responsible for the washing out, but in the Swindon Division a return on the form shewn is sent to the Divisional Office weekly by each foreman. These lists give the numbers of all engines washed out, and a book is kept in the Divisional Office which shews at a glance how many days have elapsed since one wash out to another. It has been often found that when an engine fails owing to tubes leaking the failure has occurred after it has run over six trips, and this is due to the dirty condition of the boiler and the concentrated condition of the water, which cause over-heating of the plates. When, therefore, a tube failure occurs the wash-out book is examined, and if it is found that the boiler is fairly clean, the boiler card, to which reference will be made later, is examined, and if it is ascertained that according to the reports the firebox is in good condition, a special examination is made by the

chief boilersmith, or, in serious cases, by the Superintendent or one of his assistants, the idea being that no failure can take place without some cause, and the cause may be one or more of the following :—

1. Abuse of the engine in working.
2. Neglect in washing out.
3. Bad workmanship.
4. Indifferent examination.
5. The formation of dirt, generally between the tubes, which cannot be removed by the washers out.

The following up of these matters carefully has had a marked effect on the number of tube failures.

As a rule, each boiler is washed out after running for six working days, but at Reading, where the water is exceptionally hard, five, and, in some cases, only four, trips are allowed.

Repairs.—The engineman, before going off duty, books any repairs necessary, and in large sheds it is usual to book fitters' work in one book and boilersmiths' in another. The leading fitter and boilersmith then distribute the work among their staffs. These books are ruled as shewn :—

Form No. 2.

Date.	No. of Engine.	Work required on Engine.	Driver's Signature.	Date Finished.	Fitter's or Boilersmith's Name.	Remarks.	Foreman's Signature.

Generally speaking, one fitter and labourer can keep ten engines going, so far as small ordinary running repairs are concerned, but the number of boilersmiths and tubers depends not so much on the number of engines as upon the quality of the water used ; so that in South Wales, where the water is nearly all " surface " and comparatively free from impurities, one boilersmith can keep from 50 to 100 boilers going, whereas, in the Swindon Division, quite three times as many men are required. When, however, softening plants are in more general use, it will be possible to fix the number of engines per boilersmith as easily and accurately as for a fitter. At first sight, one would think that the running shed maintenance, so far as fitters' work is concerned, of our

very large goods engines would be more costly than that of the small ones, but this is found in practice not to be the case, because, in the first place, the adequate bearing surfaces, padded axleboxes, accessibility of parts for cleaning, oiling, etc., and the good design of details reduces the amount of fitting work. In the second place, the heavy duty of the big engine boilers very quickly reduces the stay heads and renders necessary heavy firebox repairs, which cannot be undertaken in a running shed under ordinary conditions. In other words, the running life of a big engine is dominated by the boiler, and engines of this sort have to be sent into the factory long before the engine itself is run down—that is, before it has reached that stage of its existence up to which it can be profitably maintained by ordinary running shed fitting. In the Author's opinion, every shed which stables a number of big engines should be furnished with a lift of such capacity that the boilers of these engines could be readily lifted out of the frames and the stays below the fire line renewed.

Although the engineman is responsible for the upkeep of his engine, examinations are made periodically by the fitters and boilersmiths.

Boiler Repairs.—The practice in the Swindon Division is for a boilersmith to make a thorough examination of each boiler once a month, generally when it is washed out. He can then examine the water

Form No. 3.

G.W.R. .....STATION.

Examination of Boilers, Week ending ....*190*...

Date.	Engine.	Report.

ways and is better able to test the stays, since the boiler is empty. In addition to the thorough monthly examination, the stays of each boiler which has a higher working pressure than 150 lbs. per square inch are hammer-tested once a week. A report of all boilers examined is made out weekly by the boilersmith on the form shewn. This is signed by the foreman and boilersmith.

The forms are sent to the Divisional Office, and are dealt with by the clerk as shown on the diagram. He enters the dates of the examinations in a book, which shows whether a longer period than that specified has elapsed between each examination. He then reads carefully over each report, and ticks off those which record " clean

Engine N° 2762.

Station Weymouth From Factory 4.3.03 To Factory 31.1.06
Boiler N° 2762 Boiler Pressure 150.

Date	Tube Plate	Back Plate	Crown	Sides	Tubes	Stays	Casing
13.1.04						∠S	
27.1.04						15	
19.4.04						∠	
12.5.04	R19 ; 5	⌒2				∠	
23.8.04	R21 ; 5½	⌒2			D	∠	M∠
30.8.04				SB	84		
11.4.05						12	
12.9.05	R21;7 L14;7	⌒2		B		∠	M ∠
17.10.05	R21;7 L14;7	⌒2		B	D	∠	M ∠

Key to Abbreviations.

Foundation Ring	M	Crack Vert! or Long! (1st thro')	⋮
Firebox Ring	H	do do do thro'	⊢
Flange	F	do Star	✳
do ⅞ reduced	F∠	do Mesh, or stay to stay	∞
Patch	P	do between tubes or stays	⁘
do Butterfly.	∽	do double between tubes	⊟
Flange Patch	P8R12	do rivet hole to seam	⊣
do Crack	8/12	do do to rivet hole	⊸
(1st Figure inches from bottom of foundation ring. 2nd Figure length of crack, or patch, in inches)		Top	⊤
		Holes corroded	○>
		Dirty (tubes ⅞)	D
Crown coming down	⌒3	Bulged	B
(Sketch shows where bulged and figure the crown stay)		do badly	BB
		Slightly	S
		Under observation	UO

Particulars of work done entered in red ink

Fig. 3.

and in good order." Once a week he reads the reports to the Superintendent, or, in his absence, to one of the Assistant Superintendents, who enter the condition of each boiler on a card (Fig. 3). It will be seen by the system of hieroglyphics a large amount of information is compressed into a very small space, and the whole history of a boiler is recorded from the time it leaves the factory up to the time it goes in

again. The specimen card shewn is that for engine No. 2762. This engine left the factory on the 4th March, 1903. Nothing of note occurred to the box during that year, but on the 13th January, 1904, the stay heads were slightly reduced. Fifteen new stays were put in on the 27th of January, 1904. The stays were reported reduced on the 19th April, and on the 12th May a crack had developed in the right-hand flange of the tube plate ; also, the top flange of back plate had dropped down near the second crown bars. On the 23rd August the tubes were dirty, and the casing plates were corroded near the foundation ring. It will be noticed there is a discrepancy in the sizes of the crack in the right-hand flange of tube plate, the May examination shewing this as 5″ long and 19″ from foundation, whilst that of August gives it as $5\frac{1}{4}$″ long and 21″ from foundation. These figures cannot be reconciled, but there is some excuse for the boilersmith, because it is most difficult to accurately determine the length and position of corner cracks without very carefully scraping the surface of the copper from the foundation ring upwards. On the 30th August, 1904, 84 new tubes were put in to replace those taken out to facilitate the removal of dirt, and this time, also, the sides were found to be slightly bulged. Twelve more stays were put in on the 11th April, 1905, and on the 12th September another crack had developed on the tube plate, this time in the left-hand flange, and the sides which had been previously reported as " slightly bulged " were reported as " bulged." On the 17th October the tubes were again reported dirty, and after the engine had been kept running as long as it consistently could be in this condition, it was sent to the factory for general repairs on the 31st January, 1906. This card gives a good idea of the wear and tear of a locomotive firebox in ordinary service.

In addition to the ordinary shed examinations others are made by the boiler inspector, who is directly under the Chief of the Running Department. He pays flying visits all over the line, and generally selects the worst boilers for inspection. He renders excellent service and, owing to his wide range of operations, he is often able to give good advice to the local boilersmiths.

Generally speaking, the stays give more cause for anxiety in a running shed than any other part of the boiler. Stay heads reduce very much more quickly when hard water is used, and this is due to the fact that

the temperature of the firebox plates is raised very much higher. Personally, the Author does not consider that a reduced stay head *per se* is in any way dangerous, the only useful function of the head being to protect the edge of the hole in the plate through which the stay is screwed. It is obvious that, with a firebox plate of reasonable thickness, the shearing strength of the thread is greater than the tensile strength of the stay. Consequently, if the stay is tight in the hole, it is perfectly safe, even without a head at all. Firebox plates, of course, reduce particularly below the fire line, but this reduction is much less marked in the immediate vicinity of the stays than it is between them, so that, even in an old firebox, there should be always plenty of thread. The real danger of reduced stay heads lays in the fact that when the head is gone, the hole corrodes, and the thread is ruined. And again, with long or heavy service, the plates bulge between the stays, and this tends to open the stay holes on the water side of the plate. These two evils render stays unsafe, so that it is always advisable whenever the plates are badly bulged or the holes badly corroded, to renew the stays immediately, or send the engine to the factory. If stays leak when the boiler is well up in steam, this indicates that they are loose in the holes, but mere leakage when the fire is out, and the steam going back, should cause no concern ; but if, when so leaking a stay be struck, and the water gushes out more freely, we may conclude it is loose, and therefore unsafe. Broken stays sometimes give trouble, and these are generally due, not to tensile strain, but to the bending moment set up by the expansion of the plates. In the old-fashioned boilers, broken stays are usually found in top front corners, but in modern boilers in the curved part of the side plates. With pressures varying from 150lbs. to 225lbs. per square inch, a broken stay is a source of considerable danger. Hence it is necessary to hammer test each stay in boilers working at these high pressures at least once a week. Up to within the last few years the Author had never seen a broken stay unless it had snapped off next the casing, and this is where one would naturally expect the breakages to occur, having regard to the nature of the strains put upon the stays ; but latterly several had come under his notice broken either next to, or actually inside, the firebox plate—clearly indicating that some causes have been operating which have seriously weakened the copper. This weakening

can only be attributed to the high temperatures to which the stays are subjected.

Leaky tubes provide more work for running shed boilersmiths than anything else. Leakage is brought on by one cause, and one cause only, *i.e.*, " high temperature." Most people would put this differently, and say, " sudden expansion and contraction," but, in the Author's opinion, this reason is not accurate. It is quite possible to have sudden expansion, or sudden contraction, or both, without leakage ; and it is possible for the tube plate to be raised slowly to a very high temperature, and lowered again slowly, when the tubes will leak because the plate has been distorted by the high temperature. If we take a plain piece of copper plate, or bar, make it red hot, and then cool it, either slowly or suddenly, it will contract, and resume its original shape and dimensions ; that is, of course, if it is of uniform structure. It does this, because its expansion has been in every way free and unrestricted. These conditions do not obtain in a locomotive firebox, for it is more or less rigidly tied to the casing, and the expansion is, in consequence, restricted. The copper has to " go " somewhere, and as it cannot " go " freely it becomes distorted. It never " comes back " quite to its initial condition, but in a clean boiler, well designed and constructed, the slight distortion of the plates will have very little detrimental effect except around those stay holes which are below the fire line. If the temperature has been excessive the distortion will be of such a serious character as to make it impossible for the copper to assume anything like its original condition when the plates cool down a little, and, consequently, the tubes, in particular, leak. It must be admitted that sudden cooling will aggravate matters, but the real origin of the mischief is the high temperature. The object, therefore, of both the designers of locomotive boilers and those responsible for running and maintaining them should be to so arrange matters that it would be impossible to attain excessive temperatures. Some few years ago it became the practice to crowd as many tubes as possible into the tube plate to obtain greater heating surface, and this involved a mesh of only $\frac{7}{16}$ths of an inch. The result was that the circulation was choked, and steam was generated so rapidly at the tube plate that the water was literally forced away from it. This caused the plate to become over-heated, and, consequently, leaky tubes and cracked meshes were an

everyday experience. It may be accepted as an axiom that a cracked mesh indicates too narrow a mesh, and a wider one would increase the efficiency of the boiler, although it decreased the heating surface. The meshes near the top corners of the tube plate should be wider than other meshes, because at three points the expansion of the plates meet with the more or less rigid resistance of the side and top flanges. In Mr. Churchward's large boilers the area of the firebox tube plate has been enlarged to the limit, and the true secret of efficiency has been exploited, that is, free circulation. If it were only possible to carry the sides of the firebox down straight instead of curving them inwards to clear the frames, we should have a boiler perfect in every respect as a steam generator. A boiler may be perfect in design, but even then trouble may arise if it does not receive proper and careful attention. Washing out must be done regularly and thoroughly. If any dirt forms between the tubes it should be at once removed, and this can only be done by taking a few tubes out. The stays must also receive careful attention, particularly those below the fire line, and any which are broken or defective at once renewed either by ordinary or steam-tight stays.

In the Swindon Division, dirt forms very quickly in the water spaces between the tubes owing to the hard water drawn from the chalk and Oolitic formations, so that it is necessary to take out and replace a large number of tubes annually. There are about 490 engines in the Division, and in 1903 14,871 tubes were renewed at an approximate cost of £3,718. In 1904 10,735 tubes were renewed at a cost of £2,684. In 1905 8309 tubes at a cost of £2,077. It will be seen that the cash saving on the transaction for 1905 as compared with 1903 was £1,641 ; and if Mr. Churchward continues his present policy of providing softening plants at the various watering stations the expenditure under this head will almost reach vanishing point. Since 1903 steel tubes exclusively have been used on the G.W.R., and have given excellent results except, in one respect, that is, many of the tubes corrode badly circumferentially, generally close up to the smokebox tube plate, and " pit " badly also. The same trouble with steel tubes was noticed about twelve years ago but, strange to say, the furrowing took place at the firebox end.

The practice of ferruling has been almost abandoned on the G.W.R.,

the tubes being rolled and beaded, our present method being rendered practicable by the use of mild steel tubes.

Corner patches are sometimes put on in Running Sheds. These should be studded on by countersunk fine threaded studs, and the stud holes should be tapped through both patch and plate. It is of no use putting a corner patch on unless it extends down to the foundation ring, because, if this is not done, the fire, continually impinging on the bottom seam of the patch, burns it and causes it to leak. Half tube plates were at one time put in on the G.W.R., and are even now on some railways, but there is no real economy in this, because the tubes never remain staunch, and the tube plate becomes distorted so badly in the seam as to become almost dangerous.

Engine Repairs.—Turning our attention now to the fitters' work, we find that the chief causes of failure on the road are hot boxes and hot big ends. Hot boxes may be due to any one or combination of the following circumstances :—

1. Shortness of oil.
2. Dirty trimmings or pads.
3. Bad fitting—*i.e.*, too tight on collars or not properly bedded down on the crown.
4. Bad adjustment of springs, throwing too much weight on a particular box.
5. Dirty white metal.
6. Box not made hot enough when the metal is run into the recesses, causing the metal to be laminated, and, therefore, easily " picked up " by the journal.
7. Boxes fitting too tightly in horns.
8. Dust, when boxes are not shielded and padded.
9. Water getting into boxes and preventing trimmings from syphoning.
10. Hot weather lowering the viscosity of oil.
11. Running tender first for long distances with ordinary soft journals.
12. Bad design of box.

It will be seen that hot boxes are preventable, and the remedies are in most cases obvious, although, once the metal has been disturbed, it is most difficult to assign the cause of heating.

No bearing surface should be in contact with its journal, but the two should be perfectly separated by a film of oil, and this can only be attained by using oil of sufficient viscosity. Consideration of the conditions under which this film is caused and maintained led Mr. Dewrance to design a box which took its oil from the sides instead of the crown. The universal practice has been to have a single groove in the crown, but Mr. Dewrance abandoned this, and substituted two grooves, one on either side of the crown, his idea being to have a perfect film instead of a broken one at the crown, where experiment has shewn that the highest fluid pressure is attained. This arrangement for a box, whose only function is to " carry," is fairly good, but in the case of driving boxes fitted to axles the wheels of which are coupled, the idea is, in the Author's opinion, wrong. In the case of an ordinary " carrying " axle, the weight supported by the journal acts vertically downwards, and to cut a groove in the crown would mean taking away the bearing surface from the very place where it is required. On the other hand, owing to the thrust and pull of the connecting rod in the case of a driving box, very much more pressure is thrown on the brass at the sides than at the crown, and, with side grooves, the brass is robbed of bearing surface just where it is most wanted. Hence, driving boxes should have one groove only, and that one in the crown. Even in " carrying " boxes it is usual to give only a small amount of bearing surface at the crown, and, if two grooves are provided, this surface lies between the inner edges of the grooves. Below the outer edges of the grooves the brass is eased, and, therefore, there is a great risk of losing the oil, owing to its running out of the groove, and between the eased part of the box and the journal. The practice of cutting oil ways to convey oil from the groove is to be deprecated, because they are not necessary, and certainly facilitate the blockage of the groove with metal if the box runs hot.

Hot Big Ends are caused by :—

1. Shortness of oil.
2. Plug trimmings too tight.
3. Plug trimmings too short, not reaching to the journal, and thus delivering the oil between the strap and brasses instead of on the journal.
4. Insufficient side play.

5. Little ends set up badly, causing spring on rod.
6. Dirty or laminated metal.
7. Increase of boiler pressure, causing too much pressure per square inch of bearing area.
8. Brasses not allowed sufficient bearing surface by fitter.
9. Collar radii of journal too large, thus robbing the bearing surface.

The importance of giving ample bearing surface to a big end will be realised when we consider that the pressure on a crank journal is, in many instances, much greater than the weight on an axlebox. There is no doubt but that the reciprocating character of the pressure is the great safeguard of big ends, because this gives time for the oil to form a proper film on each brass alternately before the pressure is applied. The correct method of fitting big and little end keys is worthy of note. These should on no account be allowed to bear in the straps, and if the key holes in the straps are cut well back there will never be trouble with loose keys or shouldered and broken bolts.

Injectors.—Injectors, clack boxes, and injector pipes require constant attention. Feed pipes drawing air frequently cause the failure of injectors, and although this is so obvious it is not by any means commonly known.

Examinations.—Periodical examinations are made of the valves and pistons, feeds and strums, steam and vacuum brake apparatus, and safety valves. A sharp eye is kept on the tyre flanges by foremen, enginemen, and leading fitters, and as soon as a leading flange becomes at all sharp or deep, it should be trimmed up on a ground lathe or by a tool which can be secured to the leading brake hanger or in some other suitable manner. Whenever a big end is taken down or an engine lifted, the axles are carefully examined, and a report of their condition is sent to the Chief Superintendent on the form No. 4.

General Repairs.—Attached to many of our large sheds is a small shop in which general repairs are undertaken, and on some railways they differentiate between light and heavy repairs, but the G.W.R. only differentiate between those engines which require more than, or less than, a fortnight's repair. The Author does not think that general repairs should be undertaken at an out-station unless there is sufficient accommodation to permit of at least four engines being on the stocks at

a time, as this is the lowest number which can be dealt with economically, and even then facilities should be provided for taking boilers out of frames when necessary. Old and worn out glands should never be bored out and bushed, because the difference in the cost of a gland so treated and a new one is so slight as not to justify the risk of a weakened gland breaking. If underhung axleboxes knock in the horns, these should not have brass liners pegged on, but should be scrapped, and new boxes fitted. When an engine is sent to the factory, a full report of repairs necessary is forwarded to the Chief of the Running

FORM No. 4.

GREAT WESTERN RAILWAY.

LOCO. DEPT.,..... ....STATION.

Report of Loco. Axles examined, Wheels changed, &c.,

Week ending.....190...

Date.	Engine or Tender.		Marks on Axle.			Material.	Dia. of wheels.		Thickness of Tyres.	Particulars of Condition of Axle, and Repairs to Wheels or Axles.
	Taken from	Put under	No.	Date.	Maker.		Ft.	In.		

Signature.....

Department, and sent by him to the Locomotive Works Manager. The following is a specimen report (Forms 5, 6 and 7). This is signed by the foreman and countersigned by the Divisional Superintendent. A report of work done (Forms 8 and 9), other than small running repairs, to each engine is sent in by the Works Manager or the Divisional Superintendent ; if the work has been done at an out-station, to the Chief Locomotive Superintendent, so that he may have a complete record of the repairs done to each engine.

FORM No. 5.

G.W.R.

.....190...

Report of Repairs to Boiler on No.....Engine,

from.....Station.

BOILERSMITHS' WORK.

PART OF ENGINE.	REPAIRS REQUIRED.
Boiler Barrel ..	Barrel of boiler requires cleaning and examining.
Outside Firebox ..	Casing plates grooved badly by foundation inside, waterways also eaten away by mud plug holes near foundation, all mud plugs to be re-tapped.
Inside Firebox ..	Mesh cracks showing in both top corners of tubeplate between the tubeholes, both flanges of backplate showing bad cracks, stayheads reduced all round firebox and require renewing.
Tubes	Tubes dirty in boiler, require renewing; several slightly reduced on ends in firebox; tubes slightly pitted.
Smokebox	Smokebox drawing air both sides, baffleplate burned away, requires renewing.
Ashpan, Dampers and Rods	Ashpan eaten away badly at bottom, requires renewing, sides very thin; dampers require setting in on bottom drawing air; rods want examining.
Framing and Cross Stays	Framingstay loose, requires rivet taken out and renewing; several loose rivets in framing require examining.
General Condition of Boiler	Tubeplate seam leaking badly at bottom of boiler; seams back of firebox leaking both sides; boiler will have to be taken out of framing to do repairs.
Miscellaneous ..	Please have all other necessary repairs done.

Signed,

FORM No. 6.

G.W.R.

.....190...

Report of Repairs required to No.....Engine,

from.....Station.

FITTERS' WORK.

PART OF ENGINE.	REPAIRS REQUIRED.
Wheels, Axles and Axleboxes	Wheels and axles examined, axle boxes re-lined and new bushes in outside rods.
Framing	Framing examined.
Springs	Springs examined and adjusted.
Cylinders	Slide valves and ports re-faced, new rings in both pistons and pistons examined; cylinder cocks ground in.
Motion	Big and little end brasses, eccentric straps, motion blocks, quadrant blocks, lifting links, weigh bar, shaft, bearings and reversing lever, lining up; motion bars closing.
Injectors, Clacks and Waterways	Both injectors and clacks changed and pipes cleaned out.
Brake Gear	All brake gear examined, new bush in vacuum pump, pumps cleaned out and clacks re-faced.
Draw Gear	Draw gear examined.
Sandboxes and Gear	Sandboxes cleaned out and gear examined.
Boiler Mountings ..	Both whistle valves ground in and steam valves and gauge frame changed.
Steam-heating Apparatus	
Regulator	Regulator valve and rod and steam pipe in boiler and smokebox examined.
Feed Valves, Strums and Connections	Feed valves, strums and connections examined.
Water Pick-up and Gear	
Safety Valves ..	Safety valves examined.
Ejectors, Pipes and Connections	Ejector box changed and pipes and connections cleaned out.
Miscellaneous ..	Leading guard irons, buffers and blower pipe in smokebox examined.

Signed,

FORM No. 7.

G.W.R.

.....190...

Report of Repairs required to No.....Tender,

from.....Station.

FITTERS' WORK.

PART OF TENDER.	REPAIRS REQUIRED.
Wheels, Axles and Axleboxes	Wheels turned, axles examined and axleboxes re-lined.
Framing	Framing examined.
Springs	Springs examined and adjusted.
Sandboxes and Gear	Sandboxes cleaned out and gear examined.
Brake Gear ..	Brake gear examined, and new bolts, brake blocks, and brake screw and nut wanted.
Vacuum Pipes and Connections	Vacuum pipes and connections examined and cleaned out.
Dragbars, Couplings and Screw Connections	Dragbars, couplings and screw connections examined.
Steam-heating Apparatus	
Tank	Tank examined.
Feed Valves, Strums and Connections	Feed valves, strums and connections cleaned out.
Water Scoop ..	
Miscellaneous ..	Intermediate and trailing buffers examined.

Signed,

G.W.R.

.....190...

Report of Repairs required to No..... .....Tender,

from.....Station.

BOILERSMITHS' WORK.

PART OF TENDER.	REPAIRS REQUIRED.
	Tank and shovel plates repaired.

Signed,

FORM No. 8.

G.W.R.

Report of Repairs done to No.....Engine at.....Station.

BOILER WORK.

Date came in Shop.....190...

Date finished ....190...

Name of Leading Man.....

Tubes	
Inside Firebox ..	
Outside Firebox ..	
Boiler Barrel ..	
Remarks	*Signature*.....

FORM No. 9.

G.W.R.

Report of Repairs done to No.....Engine at.....Station.

FITTERS' WORK, &C.

Date came in Shop.....190...

Date finished .....190...

Name of Leading Fitter .....

Wheels	
Springs	
Framing	
Cylinders	
Motion	
Miscellaneous ..	*Signature*.....

Breakdown Van.—At each Loco. Depot where a foreman is employed breakdown vans and, in most cases, a travelling crane are kept, and the district served is clearly laid down in the Appendix to the working time book. The following is a list of the tools and appliances in the Swindon vans :—

TOOLS AND APPLIANCES.

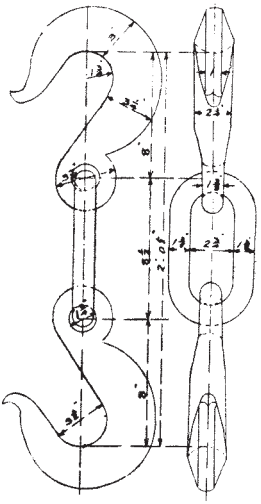
Jacks.

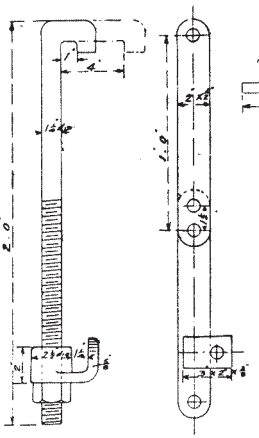
No.	Description.	Height in Inches.	Lift. Tons.	Traverse Inches.
2	Hydraulic Swivel	12	13	18
2	do. Non-swivel ...	12	13	18
2	do. do.	12	12	
2	do. do.	9	12	
2	do. do.	6	12	
5	Rack iron cased (spinning jennies)	13	6	
4	Bottles, ratchet	10	6	
12	Pump handles for hydraulic jacks			
7	Traversing do. do. do.			
6	Spinning jenny handles			
5	Bottle jack handles			
4	Hand lamps for officials			
9	Hand lamps cased			
13	Flare lamps, large, for petroleum			
3	Flare lamps, small, for petroleum			
2	Wells light lamps, No. 1 Class			
3	Oil fillers			
4	Gallon oil bottles			
4	Augers for wood $\frac{1}{2}''$ to $\frac{7}{8}''$			
1	Large axe			
1	Small do.			
6	Small circular buckets 7″ diameter by 5″ deep for carrying small iron packing			
2	Wheel gauges $4' 5\frac{5}{8}''$			
1	do. $4' 5\frac{1}{2}''$			
1	Road gauge for testing super elevation			
2	Red signal flags			
2	Green do.			

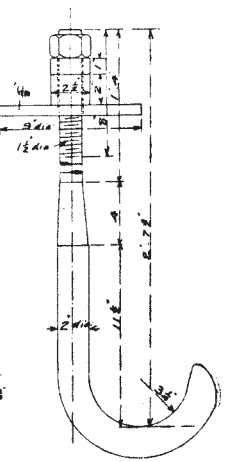
No.	
36	Detonators
5	Bushel baskets to carry small wood packing and wedges
2	Fire buckets
1	Hand saw
1	Cross cut, double
4	Vacuum pipe connections
2	Vacuum flexible pipes
1	Iron tank for petroleum—capacity 42 gallons
150	Bolts various from $\frac{3}{8}$″ to $1\frac{1}{2}$″
200	Split pins various from $\frac{1}{8}$″ to $\frac{3}{8}$″
60	Coach screws various from $\frac{3}{8}$″ to $\frac{7}{8}$″
220	Hexagon nuts various from $\frac{3}{8}$″ to $1\frac{1}{2}$″
36	Iron ferrules $1\frac{1}{2}$″ in hole. Lengths various from 1″ to 4″
2	Hooks for pony truck wheels and plates (see diagram)
2	Bogie frame lifting hooks.

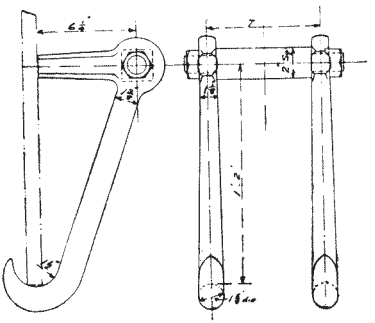
Spanners.

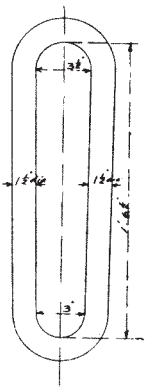
No.	Size. Inches.	Description.
21	$\frac{3}{8}$ to $1\frac{1}{4}$	Single ended (various).
2	$\frac{3}{8}$ & $\frac{1}{2}$	Double ended.
2	$\frac{1}{2}$ & $\frac{5}{8}$	do.
3	$\frac{5}{8}$ & $\frac{3}{4}$	do.
3	$\frac{7}{8}$ & 1	do.
2	$\frac{7}{8}$	Long single ended.
2	1	do.
2	$1\frac{1}{8}$	do.
2	$1\frac{1}{4}$	do.
2	$1\frac{3}{8}$	do.
2	$1\frac{1}{2}$	do.
2	$1\frac{3}{4}$	do.
2	2	do.
3	$2\frac{1}{8}$	do.
2	$1\frac{1}{8}$ & $1\frac{1}{4}$	Double ended.
1	$1\frac{3}{8}$ & $1\frac{1}{2}$	do.
1	$1\frac{3}{4}$ & 2	do.
1	2 & $2\frac{1}{8}$	do.

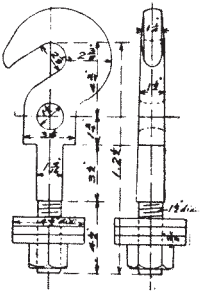


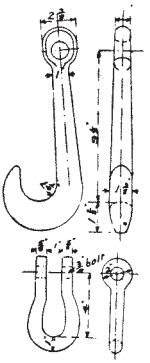


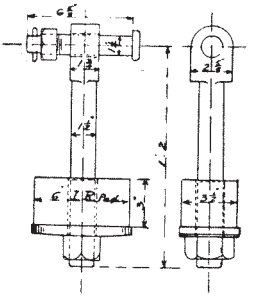












Steel Wedges.

No.	Thickness.		Length.	Width.
	At Butt.	At Point.		
	Inches.	Inches.	Inches.	Inches.
1	1	Fine	24	2
2	1	Fine	14	2
3	2	Fine	14	$2\frac{1}{2}$
2	$1\frac{1}{2}$	Fine	14	2
7	$\frac{5}{8}$	Fine	6	$1\frac{1}{2}$

No.	
18	Split cotters, 1″ wide, $1\frac{1}{8}$″ thick for drawbar connections
1	Ratchet brace
3	Large monkey spanners
7	Drills, $\frac{1}{2}$″, $\frac{5}{8}$″, $\frac{3}{4}$″
2	Screw drivers
1	Measured square
1	Set 1″ pulley blocks
3	Ropes, 120ft. by $\frac{3}{4}$″
12	do. 18ft. by $\frac{3}{4}$″
2	Pairs rope pulley blocks, $\frac{3}{4}$″ pulleys, 3 in top block, 2 in bottom
2	Rope slings for lifting hyd jacks
1	Iron sling do. do.
7	Hand hammers
2	Metal hammers
11	Large hammers
8	Shovels
2	Picks
3	Oil gas wrenches
24	Shoes from $\frac{3}{8}$″ to $2\frac{1}{8}$″ to pack on axlebox ferrules
3	Drifts various 30″ by $1\frac{1}{8}$″
4	Drifts various
1	Drift 72″ by $1\frac{1}{4}$″ for drawbar connection
2	Slips or slides for wheels 48″ by 3″ angle iron
2	Ramps, large type for one side of rail only
2	Do. for between points and crossings
6	Pinch bars, and 6 prizing bars
2	$1\frac{1}{2}$″ tie rods for broken crank axle
4	$1\frac{1}{4}$″ do. do.
18	Tie rod plates for securing wheels
1	Carriage connection opener

No.	
28	Lbs. nails, cut and wrought, $1\frac{1}{2}$″ to 9″ long
18	Iron blocks for axlebox packing, 8″ by 4″ by $2\frac{1}{2}$″
150	Pieces iron packing, various, from $\frac{1}{8}$″ to $1\frac{1}{4}$″ thick and 2″ to 7″ long
3	Carriage bogie frame clips $1\frac{1}{4}$″ diameter (see diagram)
12	Strap plates for wagon axleguards, $1\frac{1}{4}$″ by $\frac{1}{2}$″ (see diagram)
6	Plates for holding do., 4″ by 3″ by $\frac{3}{8}$″ (see diagram)
14	Chisel rods
19	do. spare
6	Chisel bars, 36″ long
10	Hand flat chisels
13	Hand cross cut chisels
22	Rod punches
13	do. spare
16	Pin punches from $\frac{3}{16}$″ to $\frac{5}{16}$″
2	do. $\frac{1}{4}$″ on point by 18″ long
2	Screw connections for engines
2	Three link couplings for wagons
1	Two do. with shackle for wagons
1	Hook and small shackle (see diagram)
4	Intermediate drawbar connections
2	Spare drawbar hooks for engine or tender
6	Spare connections for wagons (see diagram)
2	Drawbar hooks for wagons
4	Pads and plates for do.
12	Leathers for hyd. jack pumps
6	do. rams
2	Side lamps
1	Tail lamp
4	Lengths of ladder, 6′9″ fitted with sockets for lengthening purposes
3	Two gallon water cans
1	Three gallon water bucket
1	Two quart kettle
1	Two gallon urn
1	Four gallon urn
12	One pint enamel cups
1	Enamel bowl

Packing Wood.

No. of Pieces.	Thickness. Inches.	Length. Inches.	Widths Inches.
48	1	30	15
33	2	30	15
50	3	50	15
39	4	30	15
12	6	30	15
12	3	16	12
12	4	16	12
6	3	30	9
4	4	30	9
3	2	30	7
22	$\frac{3}{8}$	24	5
18	$\frac{3}{8}$	24	12
2	4	72	6
10	$4\frac{1}{2}$	$10\frac{1}{2}$	10
3	7	90	14
1	7	66	14
50	Various		
50	Blocks do.		
15	2	6	3

Wedges.

No. of Pieces.	Thickness. At Butt. Inches.	Thickness. At Point.	Length. Inches.	Width. Inches.
100	Various for wheels			
2	$1\frac{1}{2}$	Fine	96	$6\frac{1}{2}$
50	3	Fine	6	4
26	$2\frac{1}{2}$	Fine	6	$3\frac{1}{2}$
6	7	1″	30	6
6	4	1″	30	6
6	2	1″	30	6
6	1	Fine	30	6
12	4	Fine	20	14
12	3	Fine	21	14

Iron Plates.

No.	Thickness. Inches.	Length. Inches.	Width. Inches.
3	$\frac{3}{4}$	30	20
1	$\frac{5}{8}$	31	20
1	$\frac{3}{4}$	36	14
1	$\frac{1}{2}$	33	20
5	$\frac{3}{4}$	24	14
2	$\frac{3}{4}$	21	14
2	$\frac{3}{4}$	18	9
3	$\frac{3}{4}$	18	12
2	$\frac{3}{4}$	24	8 & 4″ taper.

Chains.

Description.	Length. ft.	Length. in.	Working Load. Tons.
Tow	37	6	6
Tow	23	0	4½
Tow	24	8	3
Tow	21	8	8
Tow	10	6	8
Tow	122	0	3¾
Sling	6	1½	1½
Sling	12	0	3
Sling	6	6	4½
Sling	19	0	4½
Sling	20	6	3
Sling	12	0	3
Sling	6	0	4½
Sling	20	0	3
Sling	6	0	1
For strapping damaged sides of wagons	12	6	2
Do. do. do.	24	6	1
Do. do. do.	10	0	2
Do. do. do.	10	0	2

2 Snatch Blocks.
1 Link Anchor, iron, 1½″diameter, 19″ long.
1 Link and 2 Hooks (see diagram).

The Traffic Officers have instructions, in case of a breakdown, to wire the number of coaches or wagons off road, loaded or empty. If an engine, number of wheels, and whether the main line is blocked, or not. If these instructions are carried out, the Locomotive Foreman is well able to judge how many men he should call out for the service. Very rarely indeed are we called upon to deal with accidents to passenger trains. The usual mishaps are those connected with derailments of engines or wagons at catch or other points, and these are generally simple matters ; but, occasionally, wild runs, ending in collisions, or broadside collisions at converging points occur, and these tax the resources of the department, sometimes even necessitating the provision of relief gangs. The officer in charge of a breakdown gang should always see that he has a thoroughly competent labourer in charge of the vans, who remains in the tool van during the whole time the operations are in progress. He hands out the tools, appliances,

and packing, as these are sent for. This simple arrangement saves much time and worry, as a man unused to the business, if he be sent for a piece of 3″ packing would probably bring an inch piece, or even a wedge, whereas, with a competent man in charge, whatever a man is sent for, and asks for, he will get.

Upon arrival at the scene of accident, the officer in charge should at once arrange with the traffic officer for a suitable place where the vans can be allowed to stand. If single line working is in operation, the blocked line should be made use of for this purpose, if practicable. He should next take a careful view of the situation, and then divide his men into suitable and independent gangs, taking care, if possible, to have a competent fitter or carriage man in charge of the gang. If absolutely necessary, he should take charge of a gang himself, but if it is practicable, he should hold himself free, and exercise general supervision. Locomotive men make the best all-round breakdown men, but carriage men, when it comes to wagon work pure and simple, cannot be beaten, and it is astonishing to see the rare judgment some of these men exhibit when " throwing " wagons on the road. An ordinary " spinning jenny " is used for this purpose, and it is sometimes set vertically and sometimes slopes in the direction of the fall. When the end of a wagon is lifted, all hands push, and it falls, as does also the jack, towards the rail it is intended to put it on. Pieces of packing are placed on the ballast where the wheels and jack are expected to drop, so as to save some lifting for the next throw, and to save also the jack being damaged.

The end of a wagon can easily be thrown a yard at a time, and as most traversing jacks only travel 18″, the time and labour saved is considerable. When both ends of the wagon are so near to the rail as to render only one more throw at each end necessary, the jack is set very carefully, sloping considerably in the direction of fall. It is screwed up, and when the wheels drop just the other side of the rail, instead of on it, the discomfited operator comes to the conclusion that the laws of nature have been suddenly modified for his confusion. The Author is not ashamed to say that he would not attempt a last throw unless stops were put on the rails to prevent the wheels going over, but would use a traverser. With practice, however, it is wonderful what can be done and how accurately a throw can be judged. Next to

the jacks, the most useful appliance at a breakdown is the snatch block. With this, by attaching one end of a chain to the rail and threading the other end through the block, which is hung on the drawbar hook or other part of a wagon, wreckage can very easily be pulled apart, because the block gives double purchase, and the one engine which is usually available at breakdowns is practically equal to two. When several wagons are derailed, they are generally tied together in such a way as to render it impossible to get at them for lifting or throwing, and so tightly are they bound that a single engine without a snatch block could not pull them apart. The list of tools give a good idea of the character of breakdowns, but is almost impossible to describe the many and varied operations of a gang. The most important things to bear in mind are :—

1. To carry out the Rules and Regulations.
2. Never foul a single line unless the pilotman is present.
3. Clear the main line as quickly as possible, even if this involves either damaging stock or taking more time over the job.
4. Ascertain the cause of accident if possible.

DISCUSSION.

The Chairman, in opening the discussion, referred to the Author's remarks respecting the bushing of glands, and said this was a matter which caused him a good deal of trouble when he first came to Swindon. Failures were very numerous, and were getting so bad that he issued instructions forbidding the bushing of glands of any kind. Failures were of rare occurrence now, and, even when they did occur, were generally caused by improper attention in the matter of packing and lubrication.

Mr. Waister also referred to the question of leaky stays in fireboxes and stated he found that in the large fireboxes, when the boilers were cooling down or were being started up, the stays began to leak, but the leaks took up when the pressure had been increased, and the stays remained tight under working conditions. Could Mr. Simpson give them any reason for this action ?

Mr. Russell referred to the fact that he (Mr. Russell) was a pupil of Mr. Simpson's, as a superintendent, and had worked with that gentle-

man for two years. He regarded Mr. Simpson's remarks with reference to the system of engine cleaning in vogue at Paddington as conferring a great honour upon Mr. Armstrong and himself, although he thought their cleaning was done in a way which Mr. Simpson did not quite agree with—*i.e.*, the working of gangs. There was a day gang and several piecework gangs. All new hands were taken into the day gang, and brought on so that they might take piecework at any time. When a cleaner was called away to take the place of a fireman, he was replaced by the best man that could be produced from the day gang, so that the piecework gangs were not weakened by the introduction of inefficient men. At Paddington the cloths were cleaned with paraffin and water, but it was found in cleaning that the whole of the paraffin did not dry out. The cloths were, therefore, given to the lads with a certain amount of paraffin in, which cleaned off a good deal of the grease. Oil was not issued to the cleaners, but sponge cloths soaked in oil were given out.

With regard to tube cleaning, Mr. Simpson had said he thought the steam tube cleaning process was not good. Mr. Russell said it had been used at Paddington for a long time—six years—and he understood that a Company had now taken it up, and were bringing out steam cleaners provided with a spinning nozzle, which they claimed to be an improvement. He mentioned that the tubes were so effectively cleaned and scoured by this steam cleaner that they became quite polished. Mr. Simpson had referred to the difficulty of cleaning a blocked tube by this process. Mr. Russell said that if a plate were not placed on the tube cleaner, as was done now, there certainly was a rush back of the steam, but the plate now used prevented this happening. A rod was generally pushed down a blocked tube to clear it out while blowing. This was found to give the best results.

With reference to the washing out of boilers, Mr. Russell said they were handicapped at Paddington owing to their not having a very high tank from which a good pressure of water could be obtained. An injector was employed, using the steam from a small tank engine which had finished shunting in the yard, and two boilers were cleaned out, one on either side, by the aid of the steam remaining in the engine. The water passing through the injector was made warm and higher in pressure, and, of course, was better for the tubes and stays, as there

was no sudden alteration in the temperature of the plates, such as results from squirting cold water on to them, and the scale and dirt were removed very much easier ; in fact, the arrangement was found to be a very good one. Cold water was, however, used when a side tank engine could not be obtained.

On the subject of taking out bars, Mr. Russell said that Mr. Churchward had provided most of the large boilers with a dumping grate at the front end of the box. He believed this was not very often used, for what reason he did not know, unless it was because the removal of these grates allowed a rush of cold air up to the tube plate and caused the tubes to leak.

Mr. W. R. Bird said, with regard to oil holes in axle boxes, he believed it was better to have the hole at the top, especially in the case of the brasses which carried the weight and did not receive the side thrust, and was of opinion that the principal advantage of putting the oil holes at the side was that a continuous film was obtained. He thought the principle was that just at that point there was a very great pressure on the oil, tending to squeeze it out in every direction. When a journal was running, if the oil was at the side, the film was greatly reduced in thickness, as it was carried round by the journal, and the position something like a curved wedge, but if the oil was taken at the top, the wedge end was just at the top where the pressure is greatest, and it was impossible to find a sufficiently stiff film of oil to keep the surfaces apart.

Mr. E. G. Wainwright, in referring to coal stages and the mixing of coal, said the adequate mixing of coal was a very difficult matter in a division which was supplied with only a very small quantity of South Wales coal, and stated that at most stations there was not sufficient coal stage accommodation to mix the coal with advantage, and as a consequence very serious delays occurred. With regard to boiler repairs, Mr. Wainwright said this was a subject of the greatest interest to him. When he was in the Swindon division, the boiler repairs were carried out very thoroughly by Mr. Simpson, and the percentage of tube failures was reduced from 52 per cent to 15 or 16 per cent.

Repairs to Big Engines.—This was a very big question and a growing one. The appliances in the Wolverhampton division were sufficient for anything from a " small tank engine to a standard

goods," but they could not manage anything beyond this. He thought the question of big lifts was a rather pressing matter. Mr. Wainwright also spoke of the efficacy of providing a number of spare boilers, by the interchange of which more mileage could be obtained. Of course it was a large item of expense, but he thought it would pay for itself.

Examination of Boilers.—Mr. Wainwright said they carried out the same system at Wolverhampton as that mentioned by the Author. An annual examination by an Inspector was made of every boiler in addition to the ordinary examinations made by the shed boilersmiths, who were expert men. Mr. Wainwright said they had a little trouble with the fine threads on studs and stays used in patching, particularly when used on three quarter side plates, and was very doubtful whether the coarse threads would not give better results. In some places, such as Stourbridge or Reading, it was questionable if the deeper thread would not prevent the plates and stays getting thread-bare so quickly. Mr. Wainwright also asked whether the factory were adopting the practice of metalling the axle boxes on the front.

Mr. Collett said he would like to know whether the trouble of the water heating in the saddle tanks was still experienced now that the boilers were covered with magnesia composition, as far better results under test were given with this material than with that formerly used. With reference to the excellent forms showing the dates between which the engines were washed out, he would like to know whether any record of the mileage run between the trips was taken, also whether the frequency of washing out was based on a time period or on the amount of work done by the engine. With regard to the maintenance of boilers, was this increased or reduced by the adoption of the higher pressures now in use ? It would naturally be expected that the maintenance would at least increase in proportion to the extra work got out of the boiler, but it would be interesting to know whether it had increased beyond this. Referring to stays, if hammer testing was satisfactory for pressures above 150 lbs. per square inch, why was it not adopted for pressures of 150 and under ? The heads of stays were, in his opinion, of great importance, more especially when the plates had become bulged or thin. Were the broken stays referred to next to the copper plate isolated cases or were they found generally in the higher pressed boilers ? Adverting to the question of tubes, at present they

were taken out for the purpose of removing the scale. With the use of softened water, did the tubes last much longer or did they suffer excessively from pitting ? Experiments with zinc to prevent this had been made many times, but with little effect, as the zinc always disappeared, being more readily affected than the steel tube. With regard to axle boxes, Mr. Collett could not agree that the oil was best applied through the top groove. There was no doubt, but for the trouble of starting away with a dry box, that it would be better to have no groove at all but in order to lubricate the journal quickly and to break the oil film as little as possible, the best place to put the grooves, was one on either side. He thought this, in conjunction with the underfed pad, produced the best type of box, and of those recently fitted there had hardly been a failure. He was afraid that the oiling of the permanent way was due to the old types of boxes which had not yet been entirely superseded. In reply to Mr. Wainwright's question, the fronts of axle boxes were now white metalled. The method of fitting keys suggested by Mr. Simpson was now standard practice in the works. With regard to fine and coarse threads for stays and studs, the matter had received great attention in the factory, and the conclusion arrived at was that the 11 threads were the best for stays and 8 threads were more suitable for screwed studs, as they were less liable to be stripped of their threads when drawing plates together.

Mr. Dumas, with regard to the axle boxes, said that Mr. Collett had pointed out that the top would be the worst place to put the oil hole. Did Mr. Collett refer to a carrying axle ? In the case of a driving axle, there would be pressure downwards, also the thrust, and the resultant would be a diagonal pressure alternating on each side. He thought, therefore, the position for the oil hole suggested by Messrs. Dewrance would be the worst. He noticed that the Author said they had to send big engines to the factory often for boiler repairs before the engine was completely run down. He had recollections of riding on some big engines, and wondered what sort of condition they would be in if they were properly run down. He thought it would be interesting if the Author could give them his views on American methods of " pooling " locomotives. He thought they got more work out of their engines by this method. He understood also that they had a special plant for washing out with hot water, thus saving the time lost in

waiting for the engines to cool down. It seemed to him that one of the troubles of the Running Department was the shortage of engines, and if more work could be got out of them, the advantages thus gained might be sufficient to overcome the disadvantages of the system.

Mr. W. A. Stanier, referring to the question of washing out boilers at Paddington by means of an injector, as the tank was not sufficiently high, said he thought the tank was about the same height as in other sheds, but at Westbourne Park they were accustomed to a much higher pressure, as they were able to use the water from the Electric Light Station condensers, which was pumped against a dead weight valve. He said Mr. Armstrong, the Divisional Loco. Superintendent at Paddington, was very keen on hot water for washing out big boilers, because of the excellent results obtained at Westbourne Park, where this hot water was available. Mr. Armstrong suggested the scheme for using an ordinary injector coupled to a tank engine, and he (Mr. Stanier) believed it was working very satisfactorily.

Cleaning of Engines.—With regard to the one cleaner per engine method, he (Mr. Stanier) knew that at a number of sheds this method was employed, but thought that at a large station like Paddington it would be exceedingly difficult, with the number of cleaners kept to do the work, to clean the engines as well as they were being cleaned. The gangs were on piecework, and with strict supervision good results were obtained. Mr. Stanier also asked if the Author found the hammer test for the stays sufficient now that the stays were drilled. He knew expert boilersmiths could detect a broken stay by hammering, but if a stay were cracked half way through it seemed to him that the drilled stay was much more reliable, and the hammer test might be dispensed with. There was no doubt that the improved water spaces were doing an immense amount of good in the matter of leaky stays and tubes. When No. 2 boilers were first built with the straight barrels this was a great source of trouble, owing to the narrow waterway at throat plate and between the tubes. When the cone plate, with the throat plate practically straight was made, an immense amount of space for circulation was obtained and at the same time the space between the tubes increased, which gave a very satisfactory boiler so far as circulation was concerned.

When he was in London, considerable trouble was experienced with

the driving and trailing axle boxes of the Metro. class engines. These engines had very hard work to do, and were timed on some of the Slough and Paddington trains 18½ miles in 24 minutes, with 10 eights load, and these boxes continually ran hot about the horizontal centre line. The boxes were fitted as supplied from Swindon, fairly close to the journal to below the horizontal centre line. With underhung boxes the tendency was to pull the sides of the box in, and if they started fretting a little, they had a tendency to close in, and ran hot very quickly. The practice now was to put a clearance for about half inch above the centre, and to scrape away on each side, so that the slight expansion of the box and axle owing to ordinary running was compensated by the clearance, and there was no tendency to pinch the journals. Very good results were obtained from the practice. He would like to know Mr. Simpson's practice in dealing with the balance valves on the " Bulldog " and " City " classes of engines. These valves were balanced with strips which slide on the bottom of the steam chest cover. In a very short time these covers were so grooved on account of the strips that the balance was almost destroyed, and the valves blew badly. In the running shed they were frequently plugged up as a temporary expedient to save stopping the engine, but this practice must put a big strain on the valve gear, and it would be interesting to hear if the Running Department had found anything to overcome this difficulty. So far as he could see, piston valves if maintained efficiently, were the only remedy for valve troubles, and indeed a necessity for modern express work.

The Author, replying to the Chairman's question with regard to stays leaking when pressure was going back, said he thought this was really due to the effect of the determination of the metal round the stay heads when the box had become highly heated. The metal round the stay became less dense when the pressure was going back, and the plate came away from the stay and caused leakage. When the box was heated again, the metal expanded and the stays were held tight. He thought this was a matter of no great concern so far as safety was concerned.

The Author said he could not agree with what Messrs. Russell and Stanier had said concerning the cleaning of engines. He thought, however, that the idea of soaking the sponge cloths in oil was a good one. That was really what was done at Swindon, but, instead of

soaked cloths, oil and cloths were supplied to the men. The Author also quite agreed that the system of washing out with hot water was a good one, and wished it could be carried out at Swindon.

With regard to Messrs. Collett and Bird's respective statements on axleboxes, the Author pointed out that for an ordinary carrying axlebox, where all the pressure was on the top, he thought the two grooves were fairly good, but with these boxes there was not a complete bearing. He thought that the oil bath was a very good idea, but considered that, on the whole, the proper place for the oil groove was on the top for carrying or driving axleboxes.

The Author also thought Mr. Wainwright's suggestion with regard to spare boilers was a good one, but spare boilers were no good to them in the Swindon Division until they had a lift capable of dealing with them. He said the examination of boilers annually was a good thing, more particularly when they could be sent to the factory.

Referring to the remarks on fine and coarse threads and studding three-quarter plates, the Author said he was a great believer in fine threads for studs and stays, but some people had been converted from fine threads to the use of coarse threads for studs. He did not think the true function of the studs was to pull the plates together, but merely to hold them together. He pointed out that with the coarse thread the countersink was nicked into very considerably.

In regard to metalling axleboxes on the faces, which Mr. Collett said they were still doing in the factory, the Author said that the same thing was being done in Gloucester, but the practice was most objectionable, and the evil effects of it could be seen in South Wales. The filings or wearings from the brake blocks got in between the white metal and the wheel-boxes and cut the faces. He thought that the white metal on the faces of the axle-boxes really acted the same as a lead lap.

Concerning the work on large boilers, the Author said the running life of a large boiler was very much less than that of a low pressed boiler. With soft water they get less trouble with both sorts of boilers. Speaking generally, high pressed boilers gave very little more trouble than the others so far as running repairs were concerned. With regard to stay heads, he thought the only useful purpose they served was to protect the edge of the hole in the plate, but had, however, seen plates so badly bulged that they were only being held together by the stay head, and about one or, at most, two threads.

In reply to a question on the shortage of engines, Mr. Simpson said that in America there were two ways of dealing with engines, " pooling " and "chain ganging." With the " pooling " method, certain men took charge of certain engines, and perhaps two or three sets worked one engine. In " chain ganging " any man took any engine. " Pooling " is certainly preferable to " chain ganging," but both systems should be avoided if possible.

Referring to the question of balance slide valves, he was sorry to say that in many sheds he had been acquainted with the fitters had plugged up the hole, but he had the plugs drilled out again. These valve were not a success, and he thought that salvation was to be found in the piston valve.

With regard to those axleboxes which were not padded, Mr. Simpson said it was almost impracticable to find accommodation in the keep for the pad. He wished it to be remembered that in the axlebox he referred to there was a pad underneath, and the pad fed oil to the axle.

Mr. C. B. Collett said that when bearings were made partly of white metal and partly of bronze, that the part of the axle in contact with the bronze was found to wear most, from which he concluded that the white metal only acted as a lap when grit was allowed to get in. To avoid this the axleboxes were now being fitted with a grummet of worsted bearing on the axle.

He was very glad to hear that Mr. Simpson had been converted to piston valves, although at the outset there was general opposition to them, and no doubt the troubles at first were considerable, but he believed the latest type was very satisfactory.

Mr. R. H. Smith, with regard to the axlebox question, said if there was no hole at the top, they had to depend upon the oil being taken up from the well through the pad by the slight heat set up due to friction until the pad became wet enough to oil the journal. During this time the journal became overheated and the lubrication insufficient to cool the bearing. With the top hole type of feed, the driver would feed the axlebox before the engine left the shed, the oil reaching the journal and filling the groove at once. The moment the engine moved, the oil would go round the journal and satisfactorily lubricate it. If a pad were provided underneath, so much the better. He should like to point out that a hard coating was found on the pad after running about 1,000 miles.

SWINDON ENGINEERING SOCIETY.

SECOND ORDINARY MEETING.– Tuesday, Nov. 6th, 1906.
Chairman —W. H. Waister, Esq., M.I.Mech.E. (Vice-President)

" THE WORK OF A RUNNING DEPARTMENT, "

(*CONTINUED*).

BY

HENRY SIMPSON, Esq. (Vice-President).

With Discussion.

Working of Trains.—So far as goods trains are concerned, the working arrangements are made by the Traffic Officers. The existing service has grown up to meet the requirements of the traffic, and from time to time meetings are called by each Divisional Traffic Superintendent to discuss the working and loading of the goods trains in his Division. The Superintendents of adjacent Divisions are invited to these meetings and a representative from the Chief of the Loco. Running Department, together with the Divisional Loco. Superintendent, also attend. Various suggestions are made for improving the train service. The loading of each train is carefully considered, and in some cases new trains are proposed. The Locomotive Officers are in a position to say whether or not the suggested alterations are practicable from a locomotive point of view, and sometimes they themselves make suggestions with the object of saving power, and these are considered by the meeting. Minutes are drawn up by the Divisional Traffic Superintendent at whose office the meeting is held, and these are sent to the Superintendent of the line, who, if he approves, recommends the General Manager to put on any new trains which may have been recommended, and the necessary alterations are made in the service books. The through goods trains are worked by second class enginemen, and, generally, they have tender engines. Most of these trains are " double home." For example, a train from Swindon to Exeter is worked through to its destination, and the men take rest at Exeter, returning to Swindon the next day or night, as the case may be, with the balancing train. On

alternate days Exeter men work to Swindon, where they take rest, and return to Exeter working their balancing train. The effect of this arrangement is that at every Loco. Depot Mondays, Wednesdays, and Fridays are looked upon as " our " days, and Tuesdays, Thursdays, and Saturdays are looked upon as " foreigners " days.

The local goods trains are worked by third class men, and are almost invariably " single home " jobs—that is, the men take rest at their home stations. Shunting engines are worked by the lowest grade of Enginemen, known as turners or pilotmen. In addition to shunting, this grade does most of the relief work, although at some stations, where the relief men have to frequently do long distance work, third-class men are employed. Relief work is most irregular, and is, of course, provided for the purpose of keeping the hours of the train men within reasonable limits when trains are running late, owing to fog, congested state of the line, or other causes.

Engine Diagrams.—The provision of power for working the passenger service is dealt with solely by the Chief of the Running Department, with the exception of the Birmingham local service, which is arranged by the Divisional Superintendent at Wolverhampton, and also the whole of the Severn and Wye service, both goods and passenger, which is dealt with by the traffic Manager and the Divisional Superintendent at Swindon. Mr. Waister has in his office an expert who schemes out the most economical arrangement of engine power by means of diagrams. Generally there are three sets of these diagrams issued annually to meet with the changes in the train service, and, in addition, small diagrams shewing the excursion and special workings are issued at holiday times. If these diagrams are not drawn out, a lot of light mileage would be caused, and this would involve the Company in unnecessary expense. Many years ago the late Mr Joseph Armstrong was Locomotive Superintendent of the Shrewsbury and Chester Railway, and when that line amalgamated with the Shrewsbury and Birmingham there was naturally one Superintendent too many, and the Directors decided that the one who could make the best and most economical working arrangement for the amalgamated lines should be retained. Mr. Armstrong, who was essentially a splendid " Running " man, was selected. He continued in that office until the amalgamated lines were taken over by the G.W.R., when he was appointed Divisional

Superintendent at Wolverhampton, and shortly afterwards became the Chief Locomotive Superintendent of this line. This little historical fact is mentioned to shew the importance of being able to make good and cheap working arrangements. The diagram shewn (Fig. 4) gives the engine working, both goods and passenger, on the Severn & Wye joint Line. A map is also given (Fig. 5) of the Severn & Wye

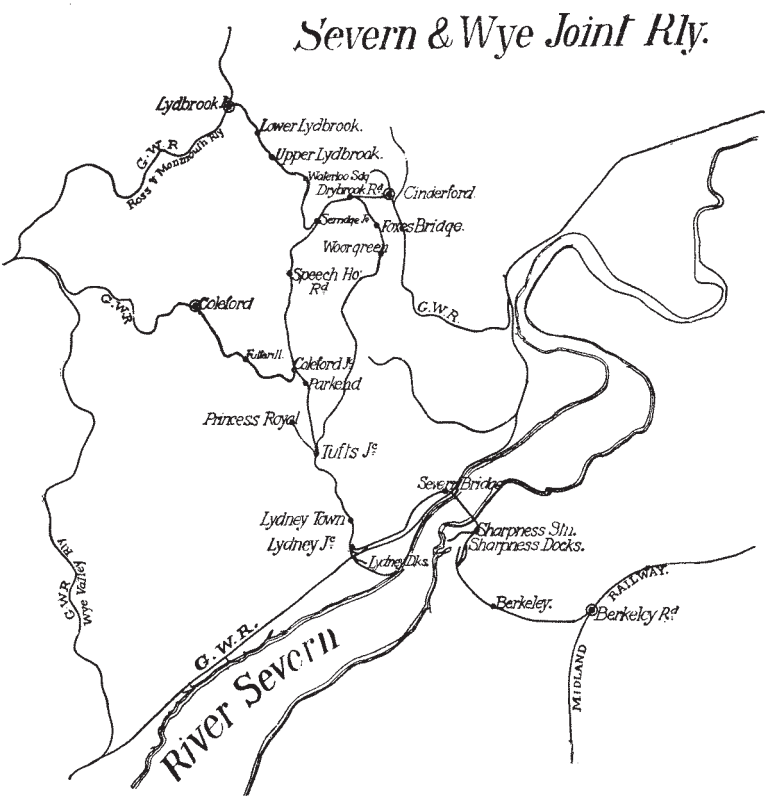


Fig. 5.

Joint Line to shew the routes covered by the trains. The engine working of the S. & W. Line is arranged at a meeting called by the Traffic Manager and attended by the Divisional Loco. Superintendent, the Chief Clerk to the Traffic Manager, and the Chief Traffic Inspector.

The method of constructing the diagram is as follows :—First, the

timetables are gone carefully through, and the names of all those stations at which trains terminate are noted down. A number of vertical lines are drawn to represent railway stations, and those stations which appear to be likely to have many engines running to and from during the day will require two lines each. In the diagram under consideration, only Lydney Junction and Coleford Junction are so treated. Each of the other stations is represented by one vertical line only. When two lines are used, the arrival times are always shewn between them and the departure times outside them. The arrival times of all trains from stations to the left of a two line station are entered adjacent to the left-hand line, whilst the arrival times of all trains from stations on the right are entered adjacent to the right-hand line. The departure times are dealt with in a similar manner, and a mere inspection of the diagram, therefore, indicates the direction in which a train is going, irrespective of the times. When a single vertical line represents a station, the arrival and departure times can be shewn on whichever side of the line suits the convenience of the diagram maker.

Having drawn the vertical lines, and entered at the top of them the names of all the stations which have been noted, the next thing to do is to enter all the trains in order as these appear in the timetables, and represent them by horizontal lines, which should at first be drawn in pencil. The next operation is most important—viz., the coupling up of the horizontal lines with the vertical or diagonal lines to represent the working of the engines. It is obvious that an engine must start from a Locomotive Depôt and finish at one. In the particular case under consideration there is only one Locomotive Depôt—viz., Lydney Junction. The starting of an engine is represented by a square above the horizontal line representing the train, and the finishing up of it is indicated by an arrow. If the men are relieved, this is shewn by a circle. It must not be supposed that the way in which the lines have been joined up is the only or best one, and it should be borne in mind that the specimen diagram is only intended to indicate the elementary principles of diagram making. As mentioned before, this is expert work, and there are all sorts of conditions to be taken into consideration, such as short margins, suitability of engines for particular work, etc., which complicate matters considerably.

FORM No. 10. G.W.R.—LOCO. DEPT. ..... DISTRICT.

Working of ..... *Engines* ..... 190...

Class of Engines ..... Class of Men { Engineman ..... Fireman .....

No. of Train.	Reference to Service Books. bk.	page.	col.	Time of dep.	arr.	TRAIN. From	To	Time Booked out. H.	M.	Miles.	Days booked to run marked "R." S.	M.	Tu.	W.	Th.	F.	S.	Time Paid. Hours.

LINK SYSTEM.—The turns of duty of the men are arranged by the loco. foreman. He knows from the diagram what trains he has to run, and, for convenience of reference, the working of all trains, goods and passenger, is shewn on Form No. 10. He arranges his enginemen, according to then grades, in suitable "links." Take, for example, the second class engineman at Swindon. The second class trains starting from this station run to Wolverhampton, London, Aberdare, Llantrissant, Neath, Cardiff, Weymouth, Taunton, Yeovil, Hereford, and Exeter. There are 22 sets of second-class men employed, and if they were all of the same character, these men would form one big link, and work all the trains round in turn. This would be the fairest to the men, because they would each make practically the same time, taking all the year round, and would be treated with absolute impartiality. However, the Aberdare and Cardiff trains have to be worked by big engines, whereas the Wolverhampton, Exeter, London, etc., are worked by small tender engines, and the Yeovil and Hereford trains by tank engines. Hence, the 22 sets of second-class men are divided into four links—one link, comprising 13 sets of men, working the Wolverhampton, Exeter, Taunton, Paddington, Weymouth,

and Neath trains ; one link, comprising four sets of men, working the Aberdare and Cardiff trains, one link, comprising three sets, working the Hereford and Yeovil trains ; and one link, comprising two sets, working the Llantrissant trains. To ensure each man getting his proper turn, the foreman has either a foreman's day book or he makes a diagram for each link in the form shewn on Fig. 6.

Link Diagram.—The specimen diagram represents the method adopted for working the men in the Wolverhampton link. The lower part shews the daily turns of each of the 13 men. Taking for example turn No. 1, it will be seen that on Sunday the men work " up " that is, they are returning home from Exeter, after working the 7-55 a.m. from Swindon to Exeter on the Saturday in the previous week, when they were doing No. 13 turn. On Monday they are off duty, and on Tuesday work the 2-20 a.m. to Wolverhampton, coming " up " home again on Wednesday. They work the 2-20 a.m. to Wolverhampton again on Thursday, back Friday, and to Wolverhampton again on Saturday, " up " on Sunday, and they then take the 9-55 p.m. on Monday to Neath, because they are then off turn No. 1, and on to No. 2. Each man should, in his proper turn, work each of the 13 trains, and to ensure this being done, the foreman makes use of the top portion of the diagram. Here the letters A, B, C, etc., represent the names of the enginemen. In the actual diagram the names are of course entered, and not letters. I have substituted letters for names to make the diagram clearer. The horizontal row of figures represents the numbers of turns, whilst the vertical row represents the weeks. A pin, or drawing pin, is placed in the number which indicates the current week's working. Supposing it is in No. 6 week, the foreman then allots the first turn to engineman (I), the second to engineman (J), and so on. On Saturday, when the duty sheet is made out for the following Sunday and Monday, the foreman puts the pin in No. 7 week, and then Turn No. 1 is allotted to engineman (H), Turn No. 2 engineman (I), and so on. It will be seen that so far as the regular trains are concerned, there is no difficulty in dividing the work out fairly among the men, but in the case of special and conditional trains, the foreman finds it most difficult to do this. As a class, enginemen and firemen know less of the amenities of life than any other section of the community. Their hours of duty and rest are irregular, and they never know what it

Diagram showing working of men in 2nd Class Link Swindon, Wolverhampton, Exeter, Taunton, Paddn, Weymouth & Neath Trains

— Weekly Turn Number —

Order of working for 13 weeks.

Weeks	1	2	3	4	5	6	7	8	9	10	11	12	13
1	Eman A	Eman B	Eman C	Eman D	Eman E	Eman F	Eman G	Eman H	Eman I	Eman J	Eman K	Eman L	Eman M
2	M	A	B	C	D	E	F	G	H	I	J	K	L
3	L	M	A	B	C	D	E	F	G	H	I	J	K
4	K	L	M	A	B	C	D	E	F	G	H	I	J
5	J	K	L	M	A	B	C	D	E	F	G	H	I
6	I	J	K	L	M	A	B	C	D	E	F	G	H
7	H	I	J	K	L	M	A	B	C	D	E	F	G
8	G	H	I	J	K	L	M	A	B	C	D	E	F
9	F	G	H	I	J	K	L	M	A	B	C	D	E
10	E	F	G	H	I	J	K	L	M	A	B	C	D
11	D	E	F	G	H	I	J	K	L	M	A	B	C
12	C	D	E	F	G	H	I	J	K	L	M	A	B
13	B	C	D	E	F	G	H	I	J	K	L	M	A

— Daily Turns of Men —

	1	2	3	4	5	6	7	8	9	10	11	12	13
Sunday	Up	Up	Down				p.m. 5:30 London						a.m. 7.40 Reading
Monday	Off	p.m. 9:55 Neath	p.m. 11:30 for a.m. 1:0 Whpton	a.m. 5:15 Exeter	p.m. 11:45 Taunton	a.m. 11:45 Weymo.	Down	a.m. 10:15 Whpton	p.m. 5:5 Exeter	p.m. 9:40 Whpton	p.m. 7:45 London	a.m. 5:55 Whpton	off
Tuesday	a.m. 2:20 Whpton	Up	Up	Up	Up	Up	noon 12:0 London	Up	Up	Up	Down	Up	a.m. 7:55 Exeter
Wednesday	Up	p.m. 11:30 for a.m. 1:0 Whpton	p.m. 7:45 London	a.m. 7:50 Exeter	p.m. 9:40 Whpton	a.m. 11:45 Weymo.	Down	a.m. 10:15 Whpton	p.m. 5:5 Exeter	p.m. 11:45 Taunton	p.m. 9:55 Neath	a.m. 5:55 Whpton	Up
Thursday	a.m. 2:20 Whpton	Up	Down	Up	Up	Up	noon 12:0 London	Up	Up	Up	Up	Up	a.m. 7:55 Exeter
Friday	Up	p.m. 7:45 London	p.m. 11:45 Taunton	a.m. 7:50 Exeter	p.m. 9:55 Neath	a.m. 11:45 Weymo.	Down	a.m. 10:15 Whpton	p.m. 5:5 Exeter	p.m. 9:40 Whpton	p.m. 11:30 for a.m. 1:0 Whpton	a.m. 5:55 Whpton	Up
Saturday	a.m. 2:20 Whpton	Off	Up	Up	Up	Up	Off	Up	Up	Up	Up	Up	a.m. 7:55 Exeter

FIG. 6.

is to have a decent square meal whilst they are at work. They sometimes come on duty, expecting to arrive at a certain destination, but owing to fogs or other causes they never reach it, having to put in for rest at some station out of course, and possibly do not return to their home station again for some days. If a man books off say at 7 p.m., he may be called for duty again at 4-0 a.m. the next day, and he is prepared for this, but he may not be required until much later. If however a foreman keeps in touch with the traffic inspectors, and exercises good judgment, he can, and mostly does, make such arrangements as put the men to the least possible inconvenience, and on the other hand, generally speaking, the men pull together well with the management, and do all they possibly can to meet the exigencies of the traffic.

Duty Sheet.—Each day the foreman makes out and exhibits the duty sheet, Form No. 11 (see Appendix), shewing the working for the following day. The information on this sheet is not only necessary for the enginemen and firemen, but it is useful to the lighters up, washers out, fitters, and boilersmiths, and these men have to keep in touch with the sheet, noting any alterations which have been made ; and if a fitter or boilersmith finds that he cannot complete the work which he may be doing on a particular engine before the time at which it is marked to go out, he at once notifies the foreman, so that arrangements can be made for another engine to replace it.

Exhibition and Distribution of Notices.—A very important part of a foreman's duty is to exhibit and distribute the notices appertaining to reduction of speed, no water, single line working, special trains, etc. All notices which involve the safe working of the line are signed for by the enginemen affected. This not only impresses on the men the importance of the notice, but it forms a record, and shews that each man concerned has been supplied with a copy.

Statistical Information.—There is, perhaps, more statistical information prepared in the Running Department than in any other. This is due to the fact that the men employed in the Running Department are, unlike those employed in factories, spread over a large area of country, and are not under the immediate eye of the management. And again, in a factory the cost of making or repairing an article can be laid down very definitely—so much for labour, so much for material, and

so much for factory expenses—but in the Running Department the cost of working is a much more complicated matter, and unless a Divisional Superintendent had a mass of statistical information provided for him, it would be impossible to keep any check on the working expenses. In the Swindon Division there are 270 forms used, many of them relating to working expenses. Many of these, together with a description, will be found in the appendix. Each engineman, in addition to making out a daily ticket, which gives full particulars of the times and loads of the trains he has worked, makes out a weekly mileage ticket, upon which he enters the number of trips, shunting, empty mileage, ballasting, piloting, and train mileage, and the starting and finishing times of each turn of duty. These tickets furnish the necessary data for compiling the mileage and engineman and fireman's times. The coalmen record the quantity of coal in cwts. put on each engine, and this is usually signed for by the engineman. A complete record is also kept of the quantity of coal used for other purposes.

Stores.—Nothing whatever is given out from the Stores unless a requisition, duly signed by an authorised person, is handed in. This requisition states clearly for what purpose the article or articles are required, that is for locomotive or rail motor car, running oil and tallow, running tools and sundries, boilerwashing, cleaning, coaling, shed tube running, fire dropping, smoke boxes, lighting up, shed labouring (such as sweeping up and ash loading), offices and stores, water pumping, repairs to water appliances, repairs to locomotives and tenders, rail motor cars, buildings and turntables, coal expenses (such as coal stacking), sundries, credits (such as materials supplied to other departments).

Timekeeping.—The time of the mechanical, cleaning, and shed staffs is recorded in practically the same manner as similar work is done in the factory, but all men are rated at 10 hours per day, except the mechanics and their labourers. The time of each man is charged properly to the section of work upon which he is engaged. For instance, a cleaner may be engaged tube running, and his time would be charged, not to Cleaning, which is his usual work, but to shed attendance on engines, or a shed labourer may be employed stacking coal, and his time would be charged to coal expenses. Again, a fitter may examine a locomotive belonging to a trader to ascertain whether it is fit to travel on its own wheels over the main line. His time would be

debited against the Goods Department through credits. A return of engines cleaned and lighted up is compiled once every four weeks. It will thus be seen that the cost of all labour and material can be appropriated to the proper charges, and the necessary work of compilation is done partly in the divisional offices and partly in the general offices of the department. The Divisional Superintendent is furnished once every four weeks with a statement of the miles run, coal and oil consumed, and the number of pounds of coal per mile and pints of oil per 100 miles for each engine in his division. The corresponding figures for the previous four weeks are also given. On this statement the engines are grouped together in links, and the average consumption of coal per mile and oil per 100 miles is given, so that it can be readily seen which men are above and which below the average. Each half year a statement of a similar character is supplied, and it is upon economical working, as shewn by this sheet, that the first and second class enginemen are paid their premiums. Each first and second class engineman is recommended by the Divisional Superintendent once every six months for a premium, provided that his general conduct has been good, and he has not had it deferred for misconduct. The chief of the Running Department will grant a premium to each man so recommended, who is either below or next above the average in his link, but if his cost of working is higher than that of the man who is next above the average he is called upon for an explanation, and if this is unsatisfactory his premium is deferred for one, two, three or more months, according to circumstances. If, however, his engine has been rough, as compared with others in the link, or his conditions of work have been exceptional, the chief of the Running Department grants it. These premiums are well worth having, being £5 for six months, and if one is deferred only for one month it means a loss of rather more than 16s.

Abstract Book.—Once a month, what is known as the abstract of working expenses book, is entered up in the General Offices. In this the total mileage run, passenger, goods, trains for other companies, ballasting, rail motor cars, light miles (these include banking, traffic shunting, and empty), number of locomotives in district, number in working order, and number under repair, similar information being given for motor cars, number of engines, and motor cars in steam,

average number of miles per engine in steam, and per motor car in steam, quantity of coal consumed by engines, motor cars, sand furnaces, offices, etc., pumping engines, smiths' fires, etc., and hydraulics, consumption of coal in lbs. per mile for both engines and motor cars. The whole of the wages paid are also abstracted, and appropriated to the several charges, and the average wages paid to each class of men, together with the cost per mile of each class of work, is entered, for comparative purposes. The cost of all the Stores consumed is likewise appropriated to the several charges. It will be seen that this book forms a complete record of the work done in a Division, and the cost of doing it, and a Divisional Superintendent can

FIG. 7 (*see* p. 54).

WORKING EXPENSES.

CONSUMPTION OF FUEL PER MILE AND OIL PER 100 MILES.

Didcot Main Line Goods Link. Goods Engines.

Abbreviation.	Year.	Jan. 10th.		Feb. 7th.		March 7th.		April 4th.		May 2nd.	
		Coal.	Oil.	Coal.	Oil.	Coal.	Oil.	Coal.	Oil.	Coal.	Oil.
D2	1902	53·9	4·73	50·8	5·00	53·5	5·05	50·5	5·34	52·3	5·07
	1903	56·7	4·86	57·8	5·01	53·0	5·00	54·9	5·48	51·3	4·95
	1904	50·9	3·94	52·4	3·85	49·5	3·34	49·9	3·60	50·3	3·83
	1905	50·4	3·79	54·9	4·05	51·9	3·88	52·1	4·08	52·4	3·88
	1906	48·1	3·69	48·0	3·67	47·3	3·57	47·1	3·59	44·4	3·58

see at a glance whether his Division is being worked, as a whole, more or less economically than previously, and it is an important part of his duty to watch the fluctuations in this book, and take every precaution against extravagance.

DISSECTION OF EXPENDITURE.—The abstract book does not, however, reveal the particular part of the Division where serious fluctuations in expenditure take place. It is therefore necessary to obtain information of a more local character. To show what can be done in this direction, consideration will be given to coal and oil, the cost of which is such a serious item. The fact has already been mentioned that the monthly consumption statements shew the engines

and men grouped together in links, and that the consumption is shewn for both the current and previous months. This is done for comparative purposes, but it is found from experience that the only true comparison is that made with the corresponding period of the previous year. A special book is used in the Swindon Division, which is framed in such a way as to show at a glance the average consumption, month by month, and year by year, of each link in the Divisions (Fig. 7.) All the links which show increases over the previous year are noted, and the monthly consumption statement is then examined to ascertain which men in these links are above the averages, and they are asked for an explanation of their high consumption. The foremen are also asked to express an opinion as to the increase in the average of the link. When the statements of the men are received in the Divisional Office they are examined, and in the case of an unsatisfactory explanation a record is made on a card against the uneconomical man. This method of dissecting the accounts can be carried to any length, and applies to both wages and stores as well as coal, but it is unnecessary to point out that the more refined the accounts the greater the cost of keeping them. The reason why coal in particular was selected for dealing with in this way was that coal is, next to the wage of enginemen and firemen, the heaviest item of expenditure, and indeed in some divisions it is the heaviest. The consumption in pounds per mile in the Swindon division is about 36·2, and at the low estimated cost of ·06d. per lb., a difference in consumption of only 1 lb. per mile would represent a cash gain or loss of at least £170 per month.

Of late years the number of engine miles and train miles per hour per man have been abstracted, and these figures are most interesting. In the Swindon Division for month ending August 15th, 1906, the number of engine miles per hour per man equals 7·28, whilst the train miles per hour per man equals 6·07. The great difference between these figures arises from the fact that the engine miles include light miles, banking, and traffic shunting at four miles per hour. This mileage ranks as " empty," and the percentage of empty to total engine miles is about 17%. One would imagine that a much greater average speed than 7·28 miles per hour would be attained, but this figure compares most favourably with other divisions, more especially those in which the percentage of passenger mileage to goods is low, because a high

percentage of goods miles means a slower average speed of running, and also a largely increased empty mileage. Useful as is this miles per hour figure, practically the same information is given in another form, and in greater detail in the abstract book, as " cost of enginemen and firemen in pence per mile " for both passenger and goods. It is obvious that as the cost per mile goes up the miles per hour go down, and *vice versa*, and the cost per train mile is really a more valuable figure than the " miles per hour " ; but to demonstrate to any officer outside the Loco. Department that a particular section of the line is badly congested, or to impress upon them the importance of improving the methods of dealing with the traffic, the " miles per hour " is much more useful, and would appeal with much greater force than any other figures.

A few particulars of the mileage and cost of operating the Swindon Division for month ending the 15th September, 1906, may prove interesting. There were 431 engines in the division, of which 412 were in working order and 19 under repair, and there were also nine motor cars. The total mileage run was 857,978. The total quantity of coal consumed was 299,504 cwts., and of this 268,385 cwts. were used by locomotives and 4,134 cwts. by cars. The consumption of coal by passenger engines per train mile equals 31·34, and that of goods 40·00. The average consumption per engine mile equals 36·20.

Fig. 8 gives the divisional expenditure under all heads, the cost of coal being assumed as 10/- per ton. The grand total of nearly £20,000 per month is made up of numerous items, which require the watchful care of the Divisional Superintendent and his staff ; and it is obvious that with such an enormous expenditure the commercial part of the Superintendent's duties are quite as important as the engineering part.

Clerical Staff.—Turning now from statistics to the members of the staff who do their share—that is the divisional share—in preparing them. On the genealogical tree (Fig. 1) the chief clerk comes first. He should have had considerable experience of Running work. He knows the duties of all the clerks under his control, and divides the work amongst them as equitably as he possibly can, taking care to have men employed as far as practicable on work for which they have a special aptitude. He deals with a large amount of the correspondence himself, and generally takes up some speciality such as, for instance, Carriage and

FIG. 8 (*see* p. 55).

LOCOMOTIVE DEPARTMENT.

DIVISIONAL SUMMARY OF MONTHLY EXPENDITURE.

	CHARGE.	WAGES. Cost.	WAGES. Cost per Train Mile.	STORES.	COAL.	TOTAL.
LOCOMOTIVES.	Enginemen and Firemen—Passenger	£ s. d. 2228 12 10	d. 1·59	£ s. d. 494 12 2	£ s. d. 6814 8 6	£ s. d. 14037 17 8
	Ditto Goods	4500 4 2	3·08			
	Boilerwashers	174 17 10	·06	5 19 4	—	180 17 2
	Foremen and Inspectors ...	192 18 6	·06	—	—	192 18 6
	TOTAL ...	7096 13 4	2·49	500 11 6	6814 8 6	14411 13 4
	Cleaning	791 7 10	·27	147 14 2	—	939 2 0
	Coaling	161 3 4	·05	1 3 6	—	162 6 10
	Shed	594 3 9	·20	15 19 5	10 10 6	620 13 8
	Shunting	3 9 9	—	—	—	3 9 9
	TOTAL ...	8646 18 0	3·03	665 8 7	6824 19 0	16137 5 7
RAIL MOTOR CARS.	Enginemen and Firemen ...	133 17 10	1·14	14 7 4	103 8 6	251 13 8
	Boilerwashers	4 10 7	·03	0 10 2	—	5 0 9
	Foremen and Inspectors ...	4 0 0	·03	—	—	4 0 0
	TOTAL ...	142 8 5	1·21	14 17 6	103 8 6	260 14 5
	Cleaning	9 16 0	·08	3 9 8	—	13 5 8
	Coaling	4 17 7	·04	1 2 9	—	6 0 4
	Shed	4 1 11	·03	—	—	4 1 11
	TOTAL ...	161 3 11	1·37	19 9 11	103 8 6	288 2 4
Time and Storekeeping ...		168 3 1	·05	3 18 9	—	172 1 10
Water Pumping		113 19 1	·03	18 9 10	106 3 6	238 12 5
Water Repairs		98 5 4	·03	9 5 7	—	107 10 11
TOTAL WORKING EXPENSES		9188 9 5	3·09	716 12 8	7034 11 10	16939 13 1
Repair to Engines and Tenders ...		970 10 6	—	509 3 6	19 0 6	1499 4 6
Do. Rail Motors ...		16 15 9	—	9 13 1	—	26 8 10
Do. Buildings, Locomotive ...		63 11 2	—	10 18 7	—	74 9 9
Do. Buildings, Rail Motors ...		—	—	—	—	—
Coal Expenses		5 11 3	—	0 3 4	—	5 14 7
Factory Expenses		384 7 1	—	—	—	384 7 1
Sundries		102 18 8	—	23 5 11	—	125 14 7
Credits		342 7 11	—	41 19 0	162 17 6	547 4 5
TOTAL ...		11074 11 9	—	1311 16 1	7216 9 0	19602 16 10

Wagon work. He follows up the routine work, and generally gets everything cleared up day by day. He scorns " repeats," and only gets one when there is some good cause for delay in replying to a letter. In short, he saves his Superintendent from a lot of worry over routine matters and details.

The second clerk keeps in touch with the work of the chief clerk, so that he can at any time take his place. He deals with some of the correspondence, and takes up some particular section or sections of the work according to circumstances. In the Swindon Division, he deals with engine failures and special train working. All the other clerks work either single-handed or in couples. When in couples, there is always one in charge. Immediately on the right of the second clerk will be seen " special and working expenses." This man dissects the consumption statements in the manner already described, and he also gets out all special statistical information which the divisional superintendent or the chief officers may require. His duties are onerous and varied. The next clerk to the right keeps the boiler records (which were described in the last paper), and makes out all the accident reports. Still again to the right will be found a single-handed job, that of examining the eyesight of cleaners and dealing with the promotion of men, advanced rates of wages, premiums, etc. Next are three correspondence clerks. They deal with general correspondence, and are experts at shorthand and typewriting. The senior of the three goes through the more important letters with the superintendent daily. He also attends some of the more important joint enquiries, and types seven copies at once of the evidence of the men concerned as fast as it can be dictated. The next job is the coal account, which is single-handed, and involves the preparation of numerous returns. Two men are employed on Carriage and Wagon accounts, and these also deal with the advances of carriage examiners, etc. One man deals with notices of special trains, also the accounts which are rendered by or against the Locomotive Department. Stores trials, etc., is a single-handed job performed by a man who makes a speciality of storekeeping. Frequently as many as fifty articles are on trial at a time ; it will be seen, therefore, that keeping a proper record of these forms an important part of his duties. The cashier in the Swindon Division deals also with the applications for passes, and by means of a card system he can

at once see whether or not an applicant for a pass is entitled to it. Letter registration is an important duty, though for some reason or another most people look upon it as simple routine work, calling for no special use of brains and judgment, but the way letters referring to the same subject sometimes get registered under two or three different references leads the Author to think that none but experienced clerks should be employed on this work. The six spare men, shewn on diagram, are not waiting round for a job, the word " spare " merely indicating that they are not told off for any specific work.

Accidents.—All accidents, especially those involving personal injury, are carefully enquired into, and reports are made to the Chief Loco. Superintendent and the Chief of the Running Department. The Company is under obligation to report to the Board of Trade :

(a) Any accident attended with loss of life to any person whomsoever, whether to a passenger, a servant of the Company, trespasser, or any other person.

(b) Non fatal accidents to servants of the Company, whenever they are such as to prevent the servant injured, on any one of the three working days next after the occurrence of the accident from being employed for five hours on his ordinary work.

(c) Non fatal accident to persons other than servants of the Company to be in all cases reported.

(d) Any collision when one of the trains is a passenger train.

(e) Any passenger train, or part of a passenger train accidentally leaving the rails.

(f) Accidents not comprised in the foregoing, which have been ordered by the Board of Trade to be reported (not necessarily for enquiry in all cases, but for information and record), viz. :

The bursting of a boiler.
The failure of a wheel or tyre.
The failure of an axle.
The failure of a horn plate of an engine.
The failure of the axleguard of any vehicle in a passenger train.

The failure of any other part of locomotive engines, tenders or vehicles not included in above, which leads to an accident to a passenger train.

The failure of brakes used in passenger trains.

And other failures which do not effect the Locomotive, Carriage and Wagon Department.

Unless the cause of an accident which does not involve personal injury to a servant of the Company is obvious, a joint enquiry is held by the divisional officers or their representatives, and a report is drawn up and sent, together with the statements of the witnesses, to the Superintendent of the Line, Chief of the Running Department, Chief Goods Manager, Chief Engineer, and the Signal Engineer, or to those of them whose departments are concerned.

In the case of a fatal accident to a Company's servant, a joint enquiry is always held, at which the principal local officers themselves attend, if possible, but if they are unable to do so, they have to be represented by a leading and responsible member of their staff. Similar enquiries are of course held in connection with non-fatal accidents. The object of a joint enquiry is to ascertain whether anyone is to blame for the accident, and also whether anything can be done to prevent a similar thing occurring again. The greatest care is always exercised at these enquiries, with a view of carrying out the spirit of the Workmen's Compensation Act, which was no doubt framed for the purpose of safeguarding the lives and limbs of employees.

Foremen.—Each division is sub-divided into districts, over each of which a foreman has charge. On the G.W.R. these are usually promoted from the grade of enginemen. On the L. & N.W. Railway and some other lines they are usually men who have been pupils or apprentices. The Author considers the G.W. system the better, because the most important part of a foreman's duty is arranging the working of the engines, and his training as an engineman renders him more competent to do this work than a man who has spent his time in a factory and drawing office. An assistant foreman, however, should be appointed at all large sheds who has been either a pupil or an apprentice. Such a man could follow up thoroughly the shed work and repairs, and thus leave the head foreman free to do the arranging. Sometimes, when the line is very congested and the demand for engines and relief

excessive, it is impossible for a foreman to follow up the mere routine work as closely as it should be followed up, so that if he had a competent assistant it would relieve him considerably. The assistant could pick up the work of the head foreman, and his detail knowledge of running work would make him well fitted to become an Assistant Superintendent, and finally a Superintendent.

Examiners and Lifters.—In addition to the shed work, each foreman controls all the pumping stations in his district ; also the carriage and wagon examiners and lifters. The Loco. Department is responsible for the maintenance and working of engines, but the Carriage and Wagon Department is responsible for the maintenance only of carriages and wagons, the working of the stock being under the control of the Traffic Department. There are examiners and lifters at each of the large stations, and they pay particular attention to the passenger trains which stable there, making the necessary adjustment of the brake gear, and changing brake blocks, oil pads, etc. They also examine each vehicle in all passenger and goods trains which stop, and if they discover any defects which render the running of the vehicle unsafe, they affix a red " not to go " card to one or both of the solebars, and the vehicle is at once cut out of the train and put in the cripple siding for the necessary repairs to be executed. In some cases, defects are discovered which do not render vehicles unfit to travel, and these are " green carded "—that is, they are allowed to proceed to their destination, where the necessary work is done. Sometimes it happens that a wagon carrying a heavy consignment has a hot box. It is stopped, lifted, and then " green carded " to travel in stopping trains. This is done to lessen the risk of the box running hot again.

At junctions where there is an exchange of traffic between one Company and another it is usual for the examiner of the receiving Company to examine all wagons before they are accepted, and he draws the attention of the examiner of the other Company to all defects he discovers, and defective wagons are invariably refused. This is done because once the wagons are accepted by the receiving Company they are responsible for making good any damage which might have been caused in shunting, etc.

Nearly all the coal carried by the G.W.R. is conveyed in private owners' wagons, and if any of these are damaged in shunting, etc., the

Company repair free of cost. If, however, defects are due to " wear and tear," the owners or their agents repair them at their own cost, or give an order to the Company to do so, and the owner is then debited. The private ownership of wagons gives rise sometimes to some curious cases of equity. Suppose a train consists of 40 wagons, 10 of which belong to an owner whom we will call A, 10 to B, 10 to C, and 10 to D, and an axle breaks on one of A's wagons. The chances are that several of A's wagons are damaged, and also several of B, C, and D's. Up to last year the Company would repair at their own cost all the wagons damaged except A's, because they would hold that A was responsible for all the damage, whilst B, C, and D were in no way responsible. Attempts have been made from time to time by owners in the same position as A to compel companies to repair even their wagons, because they argued that the Company kept examiners, and if these, their servants, allowed a defective wagon to pass they were responsible. The Company, however, always resisted such claims, because they kept examiners for their own protection, and not for the protection of private owners, who, of course, paid nothing for the service. In December, 1904, however, an accident happened on the Pontypridd and Caerphilly Railway, owned by the Alexandra Docks, Newport, Company, which upset all the preconceived ideas of both Companies and owners. A train of empties was being conveyed from the docks to the colliery districts when a defective coupling on a wagon belonging to Messrs. G. Watkinson & Son broke and allowed all the wagons in the rear to run back down an incline, and off the road at a pair of catch points, damaging a number of wagons belonging to the Powell Duffryn Company to the extent of £378. This Company claimed damages against the Alexandra Dock, because they alleged the defective coupling might have been detected by the latter Company's examiner at Newport. The case was tried in December, 1905, before Mr. Justice Lawrence, who held that the examination was perfunctory, but he could not persuade himself that the flaw was discoverable. He gave a verdict for the defendants, with costs. This case placed matters on altogether a different footing from that which had been previously recognised.

In the first place, it appears to be established that the examination of wagons is quite as much for the protection of the private owner as for

that of the Railway Company. In the second place, it is very properly recognised that the usual examination can only be perfunctory. In the third place, a Railway Company cannot be held responsible for defects which cannot be discovered by a perfunctory examination. The natural inference is that owners in the position of B, C, and D have no claim upon the Company unless the accident arose from a defect which could be discovered by a perfunctory examination, and then, apparently, A would have quite as good a claim as B, C and D.

Carriage Cleaning.—Carriage Cleaning was formerly undertaken by the Traffic Department, and, except at Paddington, Cheltenham, and a few other places, the practice was apparently to put any porters who had nothing else to do on to this work. Now the cleaning comes under the Running Department, and the results of the change have been most satisfactory ; but the cost has naturally increased. Generally speaking, the coaches are cleaned with oil and water, care being taken to wipe off all the oil. The chief assistant of the Running Department, Mr. Williams, has given careful attention to this branch, and the system adopted is about the best possible considering the limit of expenditure imposed. In each division is a Sub-Inspector under the Divisional Superintendent, and he is responsible for the work. There are 95 carriage cleaners in the Swindon Division, and they deal with about 480 coaches per day.

Reverting to locomotive work, the duties of Inspectors claim attention. The Chief Inspector should be, and is usually, a first-class Engineman. The others may be of lower grade. In the Swindon Division there is one chief and two sub-inspectors. Their duties are numerous and varied. If an engine is reported as steaming badly, an Inspector is sent to ride on it and report as to its condition, and suggest any remedy he may consider desirable. Sometimes heavy traffic arises in some part of the division, such as would be the case at a race meeting, agricultural show, Volunteer encampments, etc., and an Inspector is always present to regulate the engine working, and make the best provisions for conditions which may not have been foreseen. Inspectors have also to look into many questions in connection with the loading and speed of trains, high consumption of fuel and oil, engine working, banking, defects, or alleged defects in engines, relief, release of engines at the end of a day's work, signal alterations, etc., etc. These

men relieve the superintendent of a large amount of detail work, and conduce to economical administration. On the genealogical tree will be noticed the " District Foreman," under whom work the men who maintain the buildings, turntables, and water appliances.

Assistant Superintendents.—An Assistant Superintendent is, from the nature of his position, the right hand of his chief, and it is necessary for him to keep in touch with all the current work, so that at any moment he may be able to take it up in the absence of the Divisional Superintendent. It is essential that the superintendent should keep his assistant posted up in everything that is going on, and the assistant should, in his turn, be " eyes and ears " for his chief. It is clearly the duty of a superintendent to let his assistant know all he himself knows about running work ; and if this is done it is to the mutual advantage of both. In the natural order of things, an assistant ultimately becomes a superintendent, and if he should turn out a failure this would reflect quite as much on the superintendent under whom he worked as on himself.

An assistant should have as much work and responsibility as possible given him, because in the first place it lightens the labours of the superintendent, and in the second it is seldom found that if a man is put on his mettle he fails in anything he has to do. There is one great disadvantage an assistant is generally put under, and that is, he is usually promoted straight from the Drawing Office, or material inspection staff, and in consequence he does not know even the rudiments of running work. He is therefore put over men who know more about his business than he does himself, and in many instances draws a less salary than those who are under him. Of course, as time goes on, his superior education and engineering training brings him to the fore, but his path would be made very much easier, and it would also be to the advantage of his employers, if he were taken out of the Drawing Office and put first as an assistant foreman at a running shed, as suggested earlier in this paper. As to the sort of men who are likely to make the best officers in the Running Department, the Author thinks there is no scope for men of great academical knowledge, but scope enough for those possessed of that particular kind of genius which Carlyle defines as " an infinite capacity for taking pains." Experimental research is a fine thing in its way, and scientific

"knowledge has its uses, but the Author has not yet heard of, say, the " differential calculus " being put to any practical use in the Running Department. The men really wanted are those who make a study of economy, know the rules and regulations, know how to treat men with fairness and justice, and have a good practical knowledge of engines, sheds, coal, and water. In this connection it may be mentioned that Mr. Read, one of the best Divisional Superintendents on the G.W.R., commenced his career as a cleaner at Newport High Street 50 years ago, and is just about severing his connection with the Company, after having raised himself to the position of Divisional Superintendent at the very station where he had first started as a cleaner. It is of course impossible for an officer to treat men fairly and justly unless he knows their duties, and the difficulties they have to contend with.

In conclusion, the Author expresses his thanks to Messrs. Barker, Clinch, Nutman, Noble, and others for their valuable assistance in preparing this paper. The subject affords scope for a treatise, and although only touching on some of the chief features of running work, it is hoped this paper may be, at some time, of practical value to a few, at least, of the members of this Society.

DISCUSSION.

Mr. Collett, speaking with reference to Mr. Smith's remarks upon the axlebox question, said the point which he had referred to in the last discussion and upon which he wished to be clearly understood, was that the pressure on top of the journal was really a fact. Had a cork been placed in the hole, no doubt the pressure would have accumulated sufficiently in a short time to force it out—the result of hydrostatic pressure between the two surfaces. The pressure accumulated as soon as the oil film was formed, but it could not form as long as the groove was there to relieve it.

He congratulated Mr. Simpson on his excellent paper and his methods of tabulation, and said he had never come across anything in his (Mr. Simpson's) department which was not tabulated. He noticed, however, that only one statement had been done graphically. He thought that

statements in graphical form were much more easy to understand, and said he had seen particulars of some foreign methods, notably the Swiss, which were very good.

Mr. Collett, by the aid of blackboard sketches, described at some length the working timetable on a Swiss Railway. The description included :—Mileage, turntable size, engine sheds, water tanks and coal stages, and gradient diagram.

He noticed that the lecturer said that when wagons or vehicles were marked off to be repaired or stopped they had green or red labels attached on one or both sides. He had seen some unpleasant things happen in the works through wagons being labelled on one side only, and thought that it was most important that the green or red labels should be fixed on both sides.

Mr. Bird, with regard to the axlebox question, said he understood that it was the driving axle which required most attention. The result of the two forces on the axle, thrust, etc., would be to remove the pressure from the hole immediately over the top of the axle, which would alter the conditions and allow the oil in that part of the axle to run away properly. He thought that this was probably why the oil ran away. For a time, at any rate, the pressure was not directly on the top of the axlebox. With a trailing box, it would probably be found that the oil would not run away.

With regard to the working expenses statement, he pointed out the rather large difference between the figures for the year 1905-6, and asked whether lighter trains had been run in the latter year or better coal used, or was it due to greater efficiency in working ; and, if so, in what direction ?

Mr. Russell, speaking on the question of enginemen's duties, said this was one which had given them a lot of trouble. The Author had told them a few of the enginemen's duties and also referred to the way in which the notices were supplied to the men. In addition to these, a great number of notices were posted in the sheds, such as whistling at certain points, alterations to signals, and alterations to the working in general. Complaints were frequently made because enginemen had failed to fulfil these duties. Perhaps sometimes there was an excuse, but he should like to have Mr. Simpson's views as to whether a board could not be fixed at these points on the line, where

whistling, etc., was needed, for a time, and taken down and put in other positions when required. He thought it would not be expensive. For instance, for the slackening of speed, certain boards or signals were used. He thought if similar boards were used they would be a great help to the enginemen in some cases, because the men had a lot to remember if they had to bear in mind all the notices they read in the shed.

With regard to attending inquiries to look into the cause of accidents, he could not agree entirely with Mr. Simpson upon this point. When he was at Swindon and an accident occurred there was always someone to blame. The Author had mentioned that these enquiries were to find out whether *anyone* had been to blame. The rule book was full of rules on all points, and if an accident occurred some one must be to blame.

With regard to the damage caused to trucks by a break-away, he should like to ask Mr. Simpson who would pay for the repairs if a break-away occurred on a long train with an extra heavy load on with the large engines. The couplings in some cases were practically the same as those which had been used for years on smaller trains.

Mr. R. H. Smith thought that the gradient diagram shewn them by Mr. Collett would be very useful to enginemen. Referring to Mr. Collett's remarks on the axlebox question, he thought the pressure would be pneumatic rather than hydrostatic, as after a time the air would become warm and thus expand, and the cork would be blown out. He mentioned that for fifty years the edges had been taken off the oil grooves. The film could not be broken by the groove, as the groove was always full of oil. As fast as the oil was taken from the groove the trimmings kept up the supply.

The Author said he had noticed a short time ago an engine which had the grooves in the axle-boxes, not so low as Mr. Collett had suggested, and saw the oil running away. The box could not be kept cool because instead of oiling the journal, the oil was dropping on to the ballast. The engine was sent to the factory and two grooves were provided much nearer the crown, so that the construction of the box more nearly approximated to that of one with a single groove. He thought the single top groove would ensure excellent results. It is wrong to assume that in the case of a single groove there is a broken

film. There are really two films, one of which is fed by the pad and the other by the trimmings. In the case of a two-grooved box, there is only one film at the crown, not because the crown is the natural place for it, but because of the two grooves. The oil supplied to one only of the grooves lubricates, that supplied to the other is nearly all wasted.

With regard to the excellent diagrams shewn them by Mr. Collett, the Author said they, in England, were not so far behind the Swiss people, because, on the North-Western Railway, the same style of diagram had been in use for many years. He thought it was not so useful for Loco. working as it would be to the Traffic Department, although for complete train working it was very good.

With reference to Mr. Bird's question *re* difference of working expenses for the years 1905-6, there were sometimes differences due, not to good or bad management, but to unusual circumstances in the working. They were probably using heavier trains ; but that might not be the cause of the difference in that particular case. It might have been that in that particular link a good many passenger trains had been worked or engines might have been lent to some other stations.

Mr. Bird said he did not know whether the water softening had done any appreciable good, to which Mr. Simpson replied that the water softening had effected a saving at Reading.

With regard to the question raised by Mr. Russell, about whistling boards, the Author said there were a number of these about the line, especially on the Berks and Hants line, wherever there was a crossing, cattle crossing, or perhaps a curve in the line. It was desirable to notify the engineman in addition to erecting a board.

In regard to the subject of joint inquiries, the Author said that some accidents happened for which it could not be found that anyone was reasonably to blame.

Adverting to Mr. Collett's question *re* washing out of boilers, Mr. Simpson said the " trip " basis was worked upon. To do it according to the number of miles run would entail some rather elaborate calculations. However, they really worked indirectly on the lines which Mr. Collett had indicated.

The Chairman pointed out that the axleboxes with the hole in the top had been running for many years.

With regard to this, Mr. Collett said no one seemed to have gone

into the question of the quantity of oil used, and remarked that in the old days the journals had not such heavy loads on them, and the journals themselves were not so massive, and there was less friction, etc. He thought the essence of the whole business was to get a film of oil, and said that the viscosity of the oil had a great deal to do with the results.

Mr. Stanier, with regard to the graphic illustration of statistics, said Mr. Collett was unaware, perhaps, that in most divisions they illustrated graphically the coal expenses and working expenses. He thought they also followed this practice with regard to gas and water consumption at Running Sheds, which made it very easy for the shed foreman to follow the consumptions.

With regard to axleboxes, he thought that the difficulty which had arisen with the grooves low down was due to the fact that, when fitting boxes, no allowance was made for the expansion of the axleboxes, which sometimes caused fretting on the sides. With the engine oil, the slightest rise of temperature made the oil as a lubricant very much worse than it was formerly. He had had a little experience with the bogie boxes of the big engines, and when they first came out they gave a lot of trouble. One was fitted up in accordance with Mr. Collett's idea, and there had been no tendency for the box to become hot during the whole of last summer.

Mr. Collett then gave some particulars of weights that could be carried on an axlebox running with grooves cut in different positions, showing by sketches how the oil film was broken by the grooves and its thickness reduced, and demonstrating that the plain surface was best and carried most weight, but that oil pockets were necessary in order to quickly produce the film over the whole surface when starting from rest.

Mr. Bird thought that the relative pressures would vary with the oil used ; oils having different viscosities would probably make the difference.

Mr. Dumas asked why was it possible to run carriages and tenders without any axlebox trouble, and why was it not possible to run an engine axlebox without heating.

With regard to notice boards, he certainly thought it was essential, whether a notice board was exhibited on the line or not, to give a notice to the enginemen beforehand. In some cases the driver saw

that he had the signal given at one point and took it for granted it was right to run to the next signal. Perhaps his lubricator might require attention, and if a notice board was put up and the driver not warned, he would probably have his whole attention on the lubricator, and would not see the board.

Mr. Nash said he would like to know what was now in use for carriage cleaning, to which Mr. Simpson replied that ordinary mineral oil mixed with water was used, and remarked that there was an advantage in cleaning carriages in sheds, and moreover he thought that when left in the open the carriages were damaged more while standing than when running. He thought they did not spend enough money on carriage cleaning in England.

The Chairman said it was a very interesting paper, and there had been a good discussion. In proposing a hearty vote of thanks to Mr. Simpson, he hoped that what had been said would be of permanent good to all present.

Mr. Collett seconded the proposition, and wished the Author success in the work he was about to take up in a larger sphere, although they were sorry to lose him from Swindon.

Mr. Simpson thanked those present for the hearty vote of thanks accorded him, and said that the information given them by Mr. Collett was most valuable. He was extremely obliged to Mr. Collett for bringing the matter before them.

On the proposition of Mr. Burrows, seconded by Mr. Bird, a vote of thanks to Mr. Waister was heartily accorded, for his kindness in presiding.

APPENDIX.

Description of various Forms used in Loco. Running Department, in addition to those given in paper.

METHOD OF TIMEKEEPING, ENGINEMEN AND FIREMEN.—The foreman arranges terms of duty and exhibits a duty sheet, Form No 11, in shed for guidance of men. Each man upon coming on duty is booked on by timekeeper in book framed to shew train he is working, engine number, and actual times on and off duty ; at the same time he is handed any notices or instructions necessary, and his signature taken for anything of importance in book provided, *e.g.*, reduction of speed, alteration of signals, etc. Upon completion of turn of duty, he makes any reports of detects on engine in report book, Form 2 (*see* p. 13), same

FORM NO. 11.

GREAT WESTERN RAILWAY.

Shed Notice of Duty to be performed by Enginemen.

....Station.....day,.....190 ..

ENGINE.	ENGINEMAN.	FIREMAN. N.B.—The blanks show that the Firemen work with same Engineman as on previous days.	TRAIN.				Remarks and Special Instructions.
			Time of Departure.	a.m. or p.m.	From	To	

form being used for fitters and boilersmiths, and is booked off duty by timekeeper.

Before leaving the premises he must make out his daily trainbill, Form 12, for passenger work. Forms of a similar nature, but adapted to suit, are used for motor car, goods, and relief work. He carries with him a memorandum book, which is framed on similar lines to trainbill, for recording times at stations, delays, loads, etc., during trip, and trainbills are compiled from this.

The trainbills are then taken charge of by timekeeper, who abstracts particulars necessary for compiling time and duty book, Form 13, with the exception of times of arrival and leaving shed, which are taken from

book, Form 13a, and booked times of departure and arrival of train from service book, and time book time, with one hour allowance calculated from these figures. Similar information is also given so far as firemen are concerned. Trainbills are afterwards sent to Running Superintendent.

Weekly Mileage Tickets, Passenger and Goods, Form 14.—Made out by engineman at end of each week. These forms are a record of all miles ran and time worked. The man must show number of engine daily, and if more than one it must be clearly shown by which engine any particular work is done, so that miles may be credited to engine which performs the work, stations between which he runs, also number of trips between each place, passenger and goods train mileage separated, number of hours piloting (*i.e.* standing prepared to take on any train, the engine of which may fail) shown, and miles at the rate of two per hour entered.

Empty miles, or miles for which the Company receive no revenue, entered, and shunting at four miles per hour ; but before charging this the engineman is required to obtain and attach to ticket a voucher from the Traffic Department certifying that the work was actually done. Ballasting miles, *i.e.*, work for Engineering Department, entered at eight miles per hour, but should actual mileage exceed this figure the actual would be charged. In this case also the engineman is required to obtain a voucher, but it is on a different form, and is usually furnished by the guard, and gives particulars, of starting and finishing times and work performed.

The fireman's name must be plainly entered, also train starting and arrival times, hours worked, and lodging allowance, if entitled to any.

In " remarks " column must be entered particulars of special working or any explanation necessary.

Orders for special trains run must, together with vouchers, be attached to ticket. If special is run on authority of a notice the number of the notice to be quoted in remarks column.

A ticket printed in red, as a means of distinction, is provided foremen employed on rail motor car work.

Report of Engines—Four-weekly return furnished to Chief Locomotive Engineer of all engines in the division, grouped in depôt and in numerical order. First portion of return showing engines in

working order. Engines under repairs are shown in two sections—viz., engines requiring more than two weeks' repairs and engines requiring less than two weeks' repairs. There is also provision made for showing the numbers of the engines set to work during the period after having undergone more than two weeks' repairs.

Each foreman in division furnishes a return for his section. These are checked in the Divisional Office, and a complete return compiled. A list of all changes made during the month is also included.

FORM No. 15.

G.W.R.....*District.* *Four Weeks ended*.....*190*...

RETURN OF ENGINES IN STEAM AND CLEANED.

Station at which Engines Cleaned, &c.	Stations to which Engines belong.	No. OF ENGINES.							
		IN STEAM.						CLEANED.	
		Sundays.		Week Days.		TOTAL.			
		Pass.	Goods.	Pass.	Goods.	Pass.	Goods.	Goods.	Pass.

N.B.—This Return to be sent to the Chief Office on Wednesday following the close of each four-weekly period. All Engines cleaned and lighted up within the District to be included. Each Station to be shown separately, the Engines belonging to the Station to be first given, and on the following lines the Engines belonging to other Stations.

Good Friday and Christmas Day to be treated as Sunday.

At foot of return a summary is made showing totals as above, also same information for tenders.

Should an engine be stopped for more than two weeks, or have 50 or more tubes renewed, a report of actual work done has to accompany return, on Form 8 for boilersmiths' work and Form 9 for fitters' work.

REGISTER OF ENGINES.—Book framed to suit requirements, giving number of engine, class, date received, engine it replaces, date reported for factory, and date sent in.

Before an engine is sent to factory for repairs, a report of work required to be done to it must be sent by the foreman to Divisional

Superintendent on Forms 5, 6, and 7 (*see* pp. 24-5), who forwards it to running Superintendent. It is afterwards sent to Factory Manager for guidance of repairing staff. (Forms illustrated previously.)

Engines in Steam and Cleaned (Form 15).—Engines in steam taken from Enginemen's Duty Sheet.

Engines Cleaned.—At Swindon, where a system of piecework cleaning is in operation, particulars are taken from piecework cards, but at other stations the chargeman over cleaners supplies the information.

Coal Account.—Amount required at each depôt arrived at from actual experience, and a distribution list compiled in Chief Running Superintendent's Office for guidance of Coal Distribution Inspector in coal district.

Form 16.—Daily advice of coal invoiced to each depôt, station, and

Form No. 16. G.W.R—Locomotive Department.

To Mr..... .....Station.

Advice of Coal forwarded to Locomotive Department Stations.

No. of Wagon	Net Weight.		Daily Total.		Colliery.	Description of Coal.	Consigned to	Date Invoiced.	Received at	
									Station.	Date.
	T.	cwt	T.	cwt						

.....Signature.

.....Station.

.....Date.

date inserted in Divisional Office as wagons are received. Details transferred to Form 17, and completed Form 16 then forwarded to Chief Running Superintendent.

A daily telegraphic advice is sent to Chief Coal Inspector at Pontypool Road from large depots, but at the smaller places a printed form is sent at each week end, shewing number of wagons sent away during week, colliery to which they were sent, and number on hand. This acts as a further guide to distribution in addition to list previously mentioned.

Form 18.—Daily return of wagons on hand, received and forwarded. Only guide to stock on hand other than that in stack. Details of

wagons received transferred to book. Form 19 ; forms then passed forward to Running Superintendent.

A book shewing " wagons received " is kept, columns being provided for date, station, wagon number, and contents. Particulars abstracted from Form 18 ; station and date entered on Form 16. From this book a ready and valuable means is obtained of tracing wagons which may get out of course.

Form 17.—Four-weekly statement compiled and retained in Divisional Office. Dates received, number of wagons, and weight of contents entered in column on left-hand side of form. A column is provided for each station, where the weight of coal in wagons sent to different stations is recorded.

Numbers and weights of wagons advised as despatched to division each day entered together, and a daily total of quantity made. The weight of coal in each wagon is shewn in station column to which it is sent. Quantity of coal despatched to division, also each depôt in the

Form No. 19.

WAGONS RECEIVED.

Date Received.	Station.	Wagon No.	Contents.	Remarks.

division, either daily or monthly, can then be readily arrived at. At each coaling place a book is provided, framed with spaces for wagon number, quantity of coal put on, number of engine, and engineman's signature. This book is in duplicate, one portion being sent to Divisional Office, the other being retained at the station for reference.

All coal received at each depôt has to be accounted for on this form, enginemen signing for that used on engines daily, and a weekly form sent in, certified by foreman, for any used for other purposes. Coal put to stack is also shewn daily. A daily total is made of that used on running engines, which is transferred to book framed to suit. Daily totals are cast at end of week, and figure obtained is used for calculating wages of coalmen paid at piecework rate, etc.

Particulars of coal used for purposes other than running—*e.g.*, pump-

ing engines, cabins, offices, etc., transferred to a manuscript form (Sundry Coal Account). Details of coal put to or taken from coal stack entered in coal stack book. Forms then passed over to Accounts Office.

Coal Stack Book.—Printed book giving date coal put to stack, name of colliery, wagon number, and weight of coal. The details are abstracted from daily coal return. Totals cast and stock arrived at at end of each four-weekly period. Books kept at each foreman's office and at Divisional Office, one acting as a check on the other. Separate account kept for each stack.

Form 20.—Monthly return of all coal used in division, giving

Form No. 23. G.W.R.—Locomotive Department.

COAL ACCOUNT.

.....*District.* *Four Weeks ended*.....*190*...

Station.	Stock. 19... .. (a)	Receipts during 4 weeks. (b)	Total. (a + b)	Stock 19..... (d)	Consumption. Total. (c − d)	Consumption. Charged as per Coalmen's Returns. (f)	Under-charge. (g)	Over-charge. (h)
cwts.	cwts.	cwts.	cwts.	cwts.	cwts.	cwts.	cwts.	cwts.

particulars of charges, sent to Accounts Office. Compiled from returns previously mentioned.

Coal Supply : Stock on Hand.—Required for statements for Board entries made for each Loco. Depôt, giving estimated weekly consumption, stock in hand 6 p.m. on the Saturday on ground and in wagons, also quantity put to or taken from stock during week. Supplied to Running Superintendent weekly.

Form 21 Book.—Furnished from each depot weekly. Last-mentioned return stock on hand weekly compiled from this. At the end of four-week period it is passed forward to Accounts Office with Form 22, in which it is incorporated.

Form 22.—Compiled from forms mentioned. Forwarded at end of four-weekly period to Accounts Office.

Form 23.—Compiled in Accounts Office and sent to Divisional Office, but it is usual to compile a trial statement in Divisional Office and look into any serious differences before rendering monthly returns. The undercharge or overcharge is due very largely to the fact that it is impossible to retail coal out to measure which has previously been advised by actual weight in bulk.

Note.—Quantities are, unless otherwise stated in forms shewn, in cwts.

Compilation of Paybills.—All time books and returns for the week must be sent to Divisional Office by 9.0 a.m. on Monday morning following close of week. Two clerks are engaged on each set of paybills. One man takes mileage tickets, Form 14, and makes a summary of all time and charges at foot of each, the second man totalling hours entered in time and duty book, Form 13, particulars are then transferred in detail to pay bill book, Form 24 ; these entries in total are compared with totals previously made in time and duty book, Form 13, and all discrepancies adjusted.

With regard to Shed Staff, all charges are abstracted from time returns and details entered in paybill book, total afterwards being checked with time book.

Time and lodging allowances are now transferred to paybill, which is a form framed on almost identical lines to paybill book, excepting that no particulars of charges are shown, time being simply entered in total. Book and paybill are now " monied out " by separate men in order to form an adequate check, amounts are compared and cast for each grade of men, and a summary of the whole made at the end of paybill.

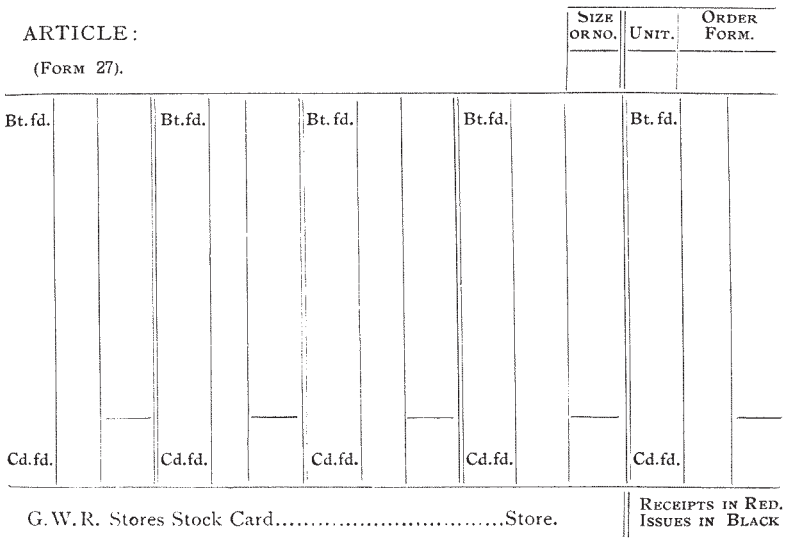
Money is now appropriated to the various charges on paybill abstract, Form 25, for each station.

The various items in appropriation columns speak for themselves, with the exception of credits, *i.e.*, charges for work done other than that in connection with Locomotive Running Department. This is entered in total and a detailed list subsequently sent forward to Accounts Office, giving description of work done, name, class and rate per day of workmen, number of hours engaged on job, and amount.

Full particulars of cost for each station of pumping water, repairing water appliances, and buildings, is also rendered, together with details of charges for rail motor work.

The whole of the paybill abstracts are afterwards summarised on two forms, the amount of money paid to each class of workman at each station, as per list on side of paybill abstract being shown on one summary and a divisional total made, and on the other total amount of money appropriated to each class of work, as per heading, is shown, a divisional total being also arrived at.

Method of Keeping Stores Accounts.—All stores to be taken into stock are ordered from Stores Department, and are charged out by stores people to the division, but articles required for immediate use on any particular work may be ordered from Factory, it being clearly stated



on requisition for what purpose they are wanted. The factory people then charge direct to the job, and material is not taken into divisional stock.

As a general rule, stores must be ordered monthly, a schedule being furnished by Stores Department, giving particulars of dates each station should order ; a catalogue of goods stocked in each warehouse is also supplied and separate requisitions made out for stores if stocked in different warehouses.

Orders in use as under :—

Oil.—Giving particulars of quantity on hand, approximate fortnightly consumption and quantity required.

TIMBER.—With spaces for full dimensions. All other stores on a plain order. These orders are all made out in triplicate, one part being retained by storekeeper and the other two passed forward to stores. As articles are despatched from stores warehouses in advice note in duplicate is sent, one portion is signed and returned to Stores Department, the other being retained for reference.

When articles are required from a Running Department Stores, a small printed requisition has first to be presented to storekeeper, signed by an authorised person, usually foreman, chargeman fitter and charge-

(FORM 28)

G. W. R.

STORES ORDER FILE CARD.

Article :

Store

Date 4 W.E.

A/c.	Quantity.	A/c.	Quantity.

(FORM 29)

Eng. No. .....

Station .....

4 W.E. .....

Oil for Running.	1st Fort.	2nd Fort.	Total.
Cylinder ..			
Engine ..			
Rape ..			

man boilersmith in case of ordinary stores, and engineman in case of oil, but as there is an allowance per trip, the engineman cannot draw an unlimited supply.

A separate requisition has to be made out for each article, or articles of same description, if more than one is required for the same job, and the charge entered in space provided.

Following required in connection with card system of keeping stores accounts.

Stores Stock Card, Form 27.—Separate card for each class of article stocked. Receipts shewn in red, with number and date of advice note. Issues in black.

Stores Order File Card, Form 28.—A card being framed for each class of article issued during month.

Oil and Tallow Order File Card, Form 29.—A card required for each engine for which oil is issued at the station during the month.

Table of Stores Charges Abbreviations.—Table framed to save Labor. Charges and stations bearing distinctive letter or number, *e.g.*, B2 would be Banbury Buildings. W.P. 44 Witney Water Pumping. Each requisition, with exception of those for oil and tallow used on pumping engines, now has Stores charge abbreviation entered on it, and it is placed in file card allotted to that article. At the end of four-weekly period, the storekeeper has to total issues of each class of article for each charge, and enter particulars on front of file card in spaces provided, total issues for month then entered on stock card.

Oil and tallow requisitions are sorted into engine number order and placed in file card framed for that engine, and total of quantity made at end of four-weekly period. This is transferred to return of oil and tallow. This return is a list of engines for which oil has been drawn during the month. A separate store requisition is made out for total quantity of oil used on running engines, and is placed in proper position in store order file card.

Oil and tallow return is passed forward to Accounts Office, and is used in connection with consumption of fuel and oil statement.

Sheets are framed at the commencement of each half-yearly period, the names of articles being entered in column on left side and monthly periods shown at head. Quantity of each article used on any particular work is entered in space allotted to it for the month. Sheets are then sent to Accounts Office, where rate or price is entered and cost calculated. Official stocktakers from Stores Department visit each depot half-yearly and take stock of the stores. This is done as a check on storekeepers ; further, it invariably happens that in retailing stores which have previously been received in bulk, a difference is bound to arise between the actual and book stock. The storekeeper is required to explain any differences found, the stock being then either debited or credited, as the case may be, with the difference.

Appropriation of Gas or Water Charges.—It frequently happens that the company purchase either gas or water from a private company, who fix a meter showing total consumed. The gas or water may, however, be used by more than one department, in which case additional meters would be fixed by the G.W.R. or an arrangement made as to charging, and upon receipt of account the proportion chargeable to each department would be shown on this sheet.

Great Western Railway.

Locomotive Department ....Station.

Return of Services rendered and accommodation afforded to and work done for other Departments and Railways, Persons, and Joint Lines and Stations.

Four Weeks ending.....190

STATION.	Chargeable Against.	No. of Engine.	Water Supplied. No. of Tenders.	Washed Out.	Stabling. No. of Days.	Lighted Up.	Turning. No of Times.	Sand Supplied.

N.B.—If any Piloting Foreign Engines is done it should be stated. A separate return should be sent here when any Specials are worked for Foreign Companies, other than those for which there is a standing arrangement, and for working or repairing Engines belonging to other Departments, Railways, or Persons.

Return of Services Rendered and Accommodation Afforded, etc.—Monthly return to Accounts Office. This is more in the nature of a statement of services rendered to other departments, or companies, for which a set charge is arranged, such as turning engines, and must not be confused with details of credits, on which any particulars of time are entered other than for work in connection with set charges which appear on above.

Abstract of Working Expenses Book. Forms 25, 26 and 30.—Compiled in Accounts Office and sent to Divisional Superintendent's Office monthly. It forms a record of all miles run and expenditure in the division. The particulars are based on information abstracted from the various returns and statements previously enumerated.

Mileage.—Miles run by either passenger engines, goods engines, or rail motor cars on each class of work shown in detail, and total ; further the train, or actual revenue earning mileage is shown as distinct from engine mileage.

Locomotives and Rail Motor Cars in District.—See report of engines.

Locomotives and Rail Motor Cars in Steam.—Taken from " Engines cleaned and in steam," Form 15. From this figure and mileage previously mentioned, the average miles per locomotive, or rail motor car in steam can readily be arrived at.

Coal.—Compiled from information furnished in connection with coal account.

Coal Consumption as per Mileage Returns.—This figure represents the total quantity of coal put on the engines, or cars, stationed in the division, in all sections. It is taken in conjunction with mileage, and the average consumption per mile computed.

Abstract of Paybills and Appropriation of Wages.—Taken from information contained in summaries of paybill abstracts, with the additional information shown in last column, viz., average wage per man per week, and average cost per mile for each class of charge.

Locomotives Cleaned.—Taken from " Engines cleaned and in steam," Form 15. By taking number of engines cleaned, and amount of money appropriated to cleaning, cost per engine cleaned is arrived at.

Coal Put on Locomotives.—Information contained in daily coal return is collected for the month, and the consumption per mile of passenger locomotives, goods locomotives, and rail motor cars, in detail, and total is arrived at.

Stores.—Value of stores used in division on the various charges as per Stores Issued Sheets, is calculated in Accounts Office, and cost per 100 miles shown in column provided ; also similar information for corresponding period previous year entered. So far as the charges

commencing with offices and stores are concerned, corresponding period only is entered.

Four-Weekly Statement of Miles Run and Coal and Oil Consumed.—Statement compiled in Accounts Office, showing engine number, driver's names (who have worked engine during period), passenger train, goods train, and total engine miles, coal consumed and average per mile, oil used and average per 100 miles. Also pounds of coal per mile each engine is in excess of lowest average in link.

Names of men who have worked engine and miles run being obtained from mileage tickets, coal from coal returns, and oil from oil and tallow consumed return.

Working Expenses System of Checking Consumption of Fuel and Oil.—On monthly statement of consumption of fuel and oil, the men at each station with the same class of engine, and on same class of work are as nearly as possible grouped together, and they should if all exercise equal care, and their engines are in fair condition, use nearly the same quantity of fuel per mile and oil per 100 miles ; further the average of link as a whole should in ordinary circumstances correspond with that for the same period in previous year, when conditions would be about the same.

The average consumption of each link is arrived at, and a record made in a specially prepared book, corresponding months in each year appearing under each other, the consumption of the link is then compared with the previous year to arrive at an idea of the general working. The Enginemen who are in excess of link average are then asked to explain their position, and the foreman at the depot is requested to report, as to whether, in his opinion, the explanation is of any value or not.

In asking for explanations, the position of the link compared with corresponding period is taken into account and statements asked for accordingly. If there has been a general increase in the work of a link the foreman should so report.

Upon receipt of enginemen's statements in Divisional Office, they are examined, and in the case of unsatisfactory explanations a record is made on card against engineman responsible. When statements are abnormally or systematically high an Inspector is sent to ride with the men, and if they are considered to blame they are suitably dealt with.

Enginemen's Half-Yearly Consumption Statements.—A statement is furnished each half-year from Accounts Office, showing position each engineman occupies in regard to consumption of coal and oil, giving man's registered number, name, depot stationed at, engine or engines he has had during period, miles run, and coal in pounds per mile.

A statement has to be prepared in Divisional Office showing particulars of working of men, but the other details are obtained from returns mentioned in other places.

Sheets are ruled with columns for engineman's name, registered number, and each week in period spaces are set apart for the various links, and the names of men working in these links entered, sufficient room being left to admit of the entry of names of men working there temporarily. Each week the mileage tickets are gone through and a mark placed in column for that week, against the man's name, in link in which he is working.

At the close of the half year the particulars are transferred to classification of enginemen for comparative statement return in a condensed form, *e.g.*, if an engineman worked only one week in a link it would appear in column as a quarter of a month, two-week half, &c., &c.

The return is then passed forward for guidance of persons who compile the half-yearly statement.

Each engineman's premium is allowed or deferred according to his position on this statement and his general conduct during the period. He is, however, given an opportunity to explain his position by means of his report, which is invariably asked for before the premium is deferred for high consumption.

Distribution of Notices.—A supply of all notices issued is sent direct to each foreman by the Traffic Superintendent responsible for its publication, the quantity being regulated by a list furnished by Divisional Superintendent, based on the working of the men at the station over the various sections of line. The notices, immediately on receipt, are distributed, and an acknowledgment sent to sender on form provided. All men affected by the contents of notices are handed a copy, and in all cases in which the safe working of trains is concerned in any way, such as engineering work,

reduction of speed, alteration of signals, also notices dealing with the personal safety of the men or any important matter, their signatures are taken as having received same. In some instances it is impossible to supply each man with a copy of the notice, in which case one notice would be posted in a recognised and prominent position, and the attention of the men specially drawn to it, and they would have to sign as having read same.

The matter is an exceedingly important one, and as a safeguard against any oversight a supply is also sent direct to the Divisional Superintendent's Office, where a clerk who is conversant with the train working throughout the division, carefully scrutinizes each notice, and

FORM No. 31. GREAT WESTERN RAILWAY.

Reference to this letter.

LOCOMOTIVE & CARRIAGE DEPARTMENT.

.....*Station*,

.....*190*

Dear Sir,

A supply of notice No. as above has been sent you.

Please hand a copy to each of your Enginemen likely to work over the portion of line referreed to, and take signatures for same.

Kindly acknowledge on receipt form below at once.

Yours truly,

Mr.....

.....

RECEIVED Circular as to NOTICE No.

DATED

.....

in those cases in which it is necessary to take signatures he sends a reminder to the foreman on Form 31. If the matter has been dealt with, the foreman detaches acknowledgment at foot, signs and returns it to Divisional Superintendents Office, where it is filed with a copy of notice for reference should any question arise. If foreman has not received a supply, he would immediately on receipt of Form 31, reply to that effect, and steps would at once be taken to put the matter right.

In addition to foregoing, the Running Superintendent also sends a copy of each notice to the Divisional Superintendent, which has to be acknowledged if it has been dealt with. This is taken as a certificate that the notice has received attention.

A register is kept in Divisonal Superintendent's Office, giving date and actual time each notice is received, number it bears, description, such as special and excursion trains, engineering department work, etc., and name of person issuing it.

Particulars of Shed and other Accommodation for Running Engines.—Full details of all buildings entered on form as per sheet. Further, a sketch of shed and other buildings has been attached. One copy sent to Chief Engineer's Office, and another retained in Divisional Office for reference. At intervals these forms are checked and certified as being correct.

Particulars of Water Supply.—Similar course pursued with this sheet, with the exception that it is not usual to furnish a sketch.

Examination of Water Appliances.—A man is appointed in each section who has to make an examination monthly of all water appliances, and execute any necessary repairs. He has to render a return certifying that he has examined the water appliances, giving date of examination and defects found, and repairs executed. The dates of the examination are recorded in a book, suitably ruled, together with particulars of repairs executed. Serious defects are reported to district foreman to look into.

Return of Slide Valves Fitted.—Weekly return of all slide valves changed for use in connection with registers in Engineer's Office, giving engine number, where stationed, particulars of old valves taken out, and new ones put in.

Examination of Safety Valves, etc. : Manuscript Form. Monthly return or certificate of condition of safety valve and water gauge frames in the Section sent to the Divisional Superintendent, who has a record of particulars made for future reference. It is simply a return giving number of engine, date of examination, and signature of examiner.

Report of Broken or Defective Wheel, Axle, or Tyre : Form 32.—This report is made out in duplicate, one copy being sent to Chief Loco. Engineer, the other to Chief Running Superintendent.

Water in Continuous Brakepipes on Engines.—An examination of all vacuum brake apparatus on engines has to be made monthly by fitter appointed, who has to render a weekly return shewing conditions of appliances on engines examined during the week. The returns are filed in Divisional Office for reference.

FORM 10 (*see p.* 47) : WORKING OF ENGINES.—Compiled at each important alteration of train service. It is a detailed list of working of all engines in this division, giving service book number, page and column, booked times of train starting and finishing, stations worked between, hours out, miles run, days on which train runs, and time paid to men.

The working is as nearly as possible shewn in service book section.

A copy is furnished to Running Superintendent, and one or more retained in Divisional Office for reference. A supplementary return has to be rendered each month giving any alterations that occur.

FORM No. 33.

G.W.R.—*Return of**.....*Trains worked by the Engines at*

.....*Station, during the Week ending*.....*190*

Date.	No. of Order.		From	To	ENGINE	Miles.	By whom Ordered.	Remarks.
	Forward.	Backward.						

INSTRUCTIONS.

1.—This Return to be sent in with the Mileage Tickets.

2.—It must be made up from the Mileage Tickets, after the Special, Excursion, and Conditional Trains entered thereon have been examined with the vouchers for the same, and the vouchers relating to each Ticket must be attached.

* State whether "Special Passenger," "Special Goods," "Excursion," or "Conditional."

RETURN OF TRAINS NOT RUN.—Weekly return giving details of trains not run for use in Accounts Office.

RETURN OF SPECIAL CONDITIONAL OR EXCURSION TRAINS : FORM 33.—A record is made of all special trains by timekeepers from daily train bills, giving date, number of engine order as authority for train run, stations from and to, number of engine, miles run, name of person ordering special, and remarks giving description of train, etc.

This is sent to Divisional Office with mileage tickets, where it is checked. Return compiled from it and passed forward to Accounts Office.

Report of Operations of Break-down Gang : Form 34.—Immediately a foreman is advised of an accident blocking a main line a telegram is sent to Divisional Superintendent, giving a brief description and time break-down vans are leaving. If the mishap should be of a

Form No. 34.

GREAT WESTERN RAILWAY.

Locomotive and Carriage Department.

.....*Station.* .....190...

REPORT OF OPERATIONS OF BREAK-DOWN GANG.

Date of Accident .....190.....
Time ,, ,, ...
Site ,, ,, ...
Time Message received at Shed .....
,, Vans left Shed.....
,, ,, ,, Station .....
,, ,, arrived at site .....
,, Break-down Gang commenced work .....
,, ,, ,, finished ,, ...
,, Vans left site of Accident .....
,, ,, arrived at Shed.....
Description of Lines blocked.....
.....
Time Lines cleared .....
.....
Single Line working from (time) .....to (time).....
No. of Men in Break-down Gang .....
Description of B.D. Crane .....
Work done with Crane .....

REMARKS.—Give particulars, if Crane available, but not used—probable cause of Accident, &c.

Note.—This Report must be sent to the Divisional Loco. Superintendent's Office immediately on return of the vans, and to be followed at the earliest possible moment by a complete report giving full details of damage to stock and cost of clearing the line.

serious nature a similar message is also sent to Running Superintendent. After lines have been cleared a further telegram is sent.

Upon vans again reaching depot, it is the duty of the person in charge to immediately furnish information required to make out this return, which has to be dispatched to Divisional Superintendent by first train as an advice in advance of detailed report. The Divisional Superintendent has to render a similar report to Running Superintendent.

Accidents Causing Personal Injury.—In order to conform to Board of Trade requirements, all accidents which may occur to servants of the Company have to be immediately reported to the head of department, and Form No. 35 is used in this department. Particulars required are shown on return. In the event of an accident occurring to a servant of the Company *inside* an engine shed of such a serious nature as to prevent him performing five hours work on any one of the next three working days, an advice of the occurrence has to be sent to the factory inspector for the district on Form No. 36. If the accident causes loss of life, or is caused by machinery moved by steam, water or other mechanical power, notice must also be sent to district certifying surgeon. A register is kept at all stations coming under the Factory Act, and particulars of accidents occurring inside shed must be entered therein within seven days of the occurrence, for use of factory inspector and certifying surgeon of the district. Should it be probable that an accident will incapacitate a man from work for more than a fortnight, a statement of his earnings for the past twelve months must be sent to head of department, in order that the amount due under the Workmen's Compensation Act may be calculated. In cases of fatal accidents a statement of earnings for past three years has to be given. This is furnished on a printed form giving rate per day and amount earned each week.

Carriage Department.—Time returns are made out weekly by workmen, giving men's names, number and class of vehicle repaired, and description of work, also time occupied, and handed in at the foreman's office, where time is checked with timebook, which has previously had time entered up as worked. The returns are then certified by foreman as being correct, and passed forward to divisional office for paybill purposes. Upon reaching there, a summary of charges is made at foot of each return. It is not considered necessary for each man to make out a return in every case, as it frequently happens that two or more men work together, and their time is spent on the same charges. In such cases the leading man makes out one return, including on it his assistants' time also. The total time is transferred to paybill, which has previously been framed so far as men's names and rates per day are concerned ; it is then monied out and checked and a summary made ; this being simply a statement showing total number of men and wages

earned at each station, also total for the division, further particulars of any stoppages, such as house rents, sick fund, etc, are shown, and total amount of money, men at each station and in whole division, will receive, entered. The paybills and summary being then sent to chief Carriage Office to be checked.

The majority of Carriage Department charges being rendered four-weekly from Divisional Office, it is necessary to collect the weekly items together, and the wages appropriation book is supplied for the purpose. Charges are printed at head of form, and four lines left between each man's name, thus allowing one framing to be utilized for a month. A four-weekly total is made and the information transferred to wages abstract, Form 37, and forwarded to Carriage Accounts Office.

Stores accounts are kept on slightly different lines to Loco. Department Orders used are similar to Loco. Department, except that a special form is provided for grease, giving stock on hand, monthly consumption and quantity required.

A stores book is kept in each section of the division, framed half-yearly, showing stores brought forward at commencement of half year monthly and half-yearly totals received and issued, and quantity carried forward at end of period. This book is sent to Carriage Accounts Office at end of each four weeks.

A requisition has to be handed in for each article or set of articles required on same job. These requisitions have the arranged stores abbreviations entered on them, and they are then placed in file cards. At the end of the four weekly period details are transferred to front of card.

Details of stores issued are compiled monthly in a similar manner to Loco. Department, separate sheets being framed for each charge. This framing lasts a half year, the sheets passing between out-stations, Divisional Office, and Carriage Accounts Office as required.

At the end of each half year stock is taken of all stores on hand and a list complied, the actual stock compared with book stock, and store-keeper called upon to explain any discrepancies, after which the excess or deficiency is entered in store book as a receipt or issue, as the case may be, in a column marked " verification," a list of differences being made out on manuscript form, headed " Verification of stock." The spare stores sheet and verification return are sent to Carriage Accounts Office.

Details of wages and stores in connection with each departmental charge are made out monthly, and passed forward to Carriage Accounts Office ; a sheet being framed for each charge, giving particulars of station, description of work done and wages, also materials used, price and cost being entered in carriage accounts office.

With regard to repairs to freighters' wagons, a special charge note, Form 38, has to be passed to Accounts Office fortnightly. Particulars of time and stores being entered in details.

FORM NO. 38.

No.

M _____ } *Dr.*
_____ }

N B.—Full postal address to be given.

To GREAT WESTERN RAILWAY CO.....Dept.

.....190

Station where work done, and No. and description of Vehicle.	Date stopped	Date set to Work.	Description of Work.	WAGES.				MATERIAL supplied by G.W.R.		
				Name and Trade of Workman	Time H'urs	Rate	Amount	Description.	Rate	Amount

A summary is also attached, giving number of charge note, name of freighter and amount of charge.

OIL AND GREASE RETURN (Unnumbered Form).—Monthly return rendered to Loco. and Carriage Superintendent, information being first supplied from out-stations on Form 39. The finished return showing particulars for all stations on one form.

ROLLING STOCK UNDER REPAIRS (Form 40).—Weekly return of vehicles under repair or set to work, with analysis showing number

standing in shops, under repairs, in sidings under repairs, and waiting in sidings for repairs. Return sent to Chief Carriage Office.

Wagons and Cranes Repaired.—A four-weekly return of wagons and cranes belonging to other departments repaired in the division to be sent to Chief Carriage Office, giving number of vehicle stopped, station and dates stopped and set to work.

Return of Oil Axle Boxes Running Hot.—Weekly return of all vehicles fitted with oil axle boxes running hot, both G.W. and freighters, giving particulars of train, class of vehicle, where heating discovered, how dealt with, delay to train, last lifting mark and result of

Form No. 39.

Great Western Railway Carriage Department.

OIL AND GREASE RETURN.

....Station, 4 W.E..... 190

	Denom.	Stock, B.F.	Receipts.	Total.	Actual Consumption.	Issues to other Stations.	Total.	Stock on hand.
Oil ..	gallons							
Grease	lbs.							

Note.—No fractions of gallons or lbs. to be entered, the quantity given being the nearest whole number. This return to be sent to Divisional Superintendent on the Monday following the close of each four-weekly period.

Signature..... ....

examination of pad.

Return of Scrap Material.—All scrap material which accumulates at various depots is returned to Stores Department, a delivery note being sent with it. Each depot sends in a return, and the whole is collected and passed forward to Carriage Accounts Office as a divisional return.

Return of Repairs to Carriages and Wagons (Form 41).—Weekly return of repairs executed to all G.W. carriages and wagons in division, giving date stopped and set to work, and number and class of vehicle. A tick is placed in the column showing description of repairs done, name of workman executing work. If any structural alteration

is made, particulars of lifting have to be furnished as per heading of form.

Carriages Cleaned.—A daily return of all carriages cleaned is made out by chargeman cleaner, who gives particulars of class of cleaning performed by means of a tick in columns provided, on a form similar to No. 42, except that a return is sent in from each cleaning station daily, and provision is made for inserting number and class of each vehicle dealt with, also time of train starting in which it works out. A summary of number of coaches cleaned daily sent to Running Superintendent at end of each four-weekly period on Form 42.

GREAT WESTERN RAILWAY.—LOCO. DEPARTMENT.

ENGINEMAN'S TRAIN BILL _____ **Passenger Train from** _____ **to** _____

_____ **day, the** _____ **day of** _____ **190**

ENGINEMAN.	ENGINE	STATIONS	Actual Time of Arrival.	Actual Time of Departure.	Vehicles left with *				Detentions due to		EXPLANATION OF DELAYS.
					12 Wh.	8 Wh.	6 Wh	4 Wh.	Traffic Dept. Mts.	Engine. Mts.	

SPECIAL REMARKS:—

Engineman's Signature _____

Name of Fireman _____

Engineman on duty at _____ *Station at* _____ *Off duty at* _____

Fireman on duty at _____ *Station at* _____ *Off duty at* _____

INSTRUCTIONS AS TO FILLING UP THIS TICKET.

Detentions due to Traffic Dept.—In this column must be entered Overtime at Stations, *i.e.*, the number of minutes the Train is delayed at the Station *beyond* the time allowed in the Service Books, Delays by Signals, Trains ahead, Waiting Line Clear, &c.

NOTE.—No time to be entered as Over-Detention at intermediate Stations, where the times of Departure only are shown in the Service Book, until it exceeds Two Minutes at Second Class, and One Minute at Third Class Stations, or Three Minutes when Tickets are collected.

Detentions due to Engines.—Overtime at Stations caused by the Engine, Time lost in Running, and delays through failures, or any other cause connected with the Engine to be shown in this column.

Explanation of Delays.—Explanations to be given of all Time Lost, whether due to Traffic or Engines.

Extra Stops.—The time of arrival at and departure from all Stations at which the Train is ordered to stop where not booked, must be shown, and a remark made "Extra Stop."

Stops Withdrawn.—In all cases where Instructions are given to Drivers not to stop at any Station where booked to stop, a remark must be made.

Trains Assisted.—Enginemen must always shew when they are assisted by another Engine, and give the number of the assisting Engine, the places between which they are assisted, and cause of assistance being required.

Loads.—The Load must be distinctly shown from each Station entered, and the number of each class of Vehicle correctly given.

When an Engineman gives up his Train to another man owing to the failure of his Engine, he must always state the number of Engine by which the Train is taken on, on his Ticket. Special Remarks of any other circumstance to be made in the space provided for the purpose.

Continuous Brakes.—If from any cause the Continuous Brakes are not used, or fail to act when required, a special remark should be made, and the Train Bill should be accompanied by a report giving particulars.

FORM No. 13.

GREAT WESTERN RAILWAY.—ENGINEMAN.....

Date.	Engine.	Engineman's Name or Description of Work.	Time of Arrival at Shed.	Proper Time of Starting of Train.	Proper Time of Arrival of Train.	Actual Time of Arrival of Train.	Time of Leaving Shed.	Time at 10 hours per day.					Lodgings.		Remarks.
								Time Book Time with 1 hour allowance.	Late Arrivals.	Special Allowances.	Total Hours.		At 1/6.	At 2/6.	
											At Registered Rate.	At Advanced Rate.			

FORM No. 13A.

GREAT WESTERN RAILWAY.—LOCOMOTIVE DEPARTMENT.

ENGINEMEN AND FIREMEN'S TIME BOOK,

.....Station,.....day.....190.....

Train Starting Time.	From	To	No. of Engine.	ENGINEMAN.			FIREMAN.		
				Name.	On Duty.	Off Duty.	Name.	On Duty.	Off Duty.

Form No. 17.

Great Western Railway.—Locomotive Department.
COAL RECEIVED.—SWINDON DISTRICT.

Coal Advices.					Date Received.	Weights (cwts.) Received at each Station.																													
Date.	Colliery	Wagon No.	Weight T. C	Daily Total. T. C.		Reading.	Basingstoke.	Wallingford.	Didcot.	Abingdon.	Winchester.	Oxford.	C. Norton Jnc.	C. Norton.	Woodstock.	Banbury.	Faringdon.	Swindon.	Chippenham.	Malmesbury.	Box.	Colchester.	Tetbury.	Brimscombe.	Gloucester.	Cheltenham.	Bullo Pill.	Lydney.	Trowbridge.	Frome.	Marlborough.	Salisbury.	Yeovil.	Bridport.	Weymouth.
	Brought forward.																																		
	Carried forward..																																		

Form No. 24.

G.W.R.—Locomotive Dept. *Pay Bill................................Station.*

Name.	Week ending 190									Week ending 190													
	Charge	Time.		Rate.	Wages.		Payments or Deductions.	To Receive		Charge	Time.		Rate.	Wages.		Deductions.			Payments.			To Receive
		Days.	Hours.		Amount	Total.					Days.	Hours.		Amount	Total.	s. d.	s. d.	s. d.	Mutual Assurance. s. d.	s. d.	s. d.	

FORM No. 18. G.W.R.....*Station*,.....*190...*

LOCOMOTIVE WAGON RETURN.

N.B.—All Loco. Wagons to be entered (whether used for Coal or other purposes), including those under Repairs.

WAGONS RECEIVED.			WAGONS FORWARDED.			WAGONS ON HAND THIS DAY.					
Number.	Contents.	Labelled from	Number.	Contents.	Labelled to	Number.	Contents.	Number.	Contents.	Number.	Contents.

NOTE.—This Return is to be carefully made out and sent to Swindon daily. .....*Signature.*

FORM No. 20.

GREAT WESTERN RAILWAY.—LOCOMOTIVE DEPARTMENT.

Coal Consumption Account.....*Division.* *Four Weeks ended*.....*190...*

Coaling Station.	Running.		Lighting-up Furnaces.		Offices and E'men's Rooms.	Factory Expenses.	Shop Stationary Engine.	Smiths' Fires.	Pumping Engine and Water A/c.				Carriage and Wagon Dept.	Gas Works.		Traffic Dept.			Total Cwts.
	Engines.	Rail Motors	Engines.	Motors.										Coal.	Oil.	Hydraulics, Hoists, &c.	Steam Cranes.	Steam Boats.	

FORM No. 21.

GREAT WESTERN RAILWAY.

LOCOMOTIVE DEPARTMENT.

.....Station,

.....190

Monthly Return of ACTUAL Stock of UNCHARGED Coal and Coke on hand at Midnight on Saturday.. .....190 .

	COAL.		COKE.		REMARKS.
	Tons	Cwt	Tons	Cwt	
Stacked (*Coal* 40, *Coke* 80, *cubic feet per ton*).. ..					
On Coal Stage, and in Tube or Baskets, *not charged* ...					
Standing in Tenders, *not charged*					
Ditto in Wagons :—					

No.	Tons	Cwts	No.	Tons	Cwts
			Brought forward		
Carried forward ...			Total Uncharged } Actual Stock }		

.....Coalman.

Mr.....

Loco. Superintendent.

.....Foreman.

....Station.

To be sent to Swindon on Thursday, after the close of each four-weekly period.

FORM No. 22.

G.W.R.—LOCO. DEPT.

....*District.* *Four Weeks ending*.....*190*...

COAL RETURN.

ADVICES.		STATION.	RECEIPTS.	STOCKS (Cwts.) Saturday, 6 p.m.			
Date.	Cwts.		Cwts.	Stacks.	On Stage and Tenders (uncharged).	In Wagons.	TOTAL.
M.							
Tu.							
W.							
Th.							
F.							
S.							
M.							
Tu.							
W.							
Th.							
F.							
S.							
M.							
Tu.							
W.							
Th.							
F.							
S.		Total Received					
M.		*Add*—					
Tu.		*Wagons advised, but not received					
W.		*Detailed List to accompany Return.					
Th.							
F.		*Less*—					
S.		Wagons advised, but not received, previous Return..					

TAKEN FROM STACK.		ADDED TO STOCK.	
Station.	Cwts.	Station.	Cwts.

FORM No. 32.

GREAT WESTERN RAILWAY.

.....*Station*,.....*190*

REPORT OF BROKEN OR DEFECTIVE WHEEL, AXLE OR TYRE.

Date discovered ..	..	..
By whom discovered	..	..
Station where discovered	..	..
Train	.. ..	..
Delay to Train ..	..	..
Engine, Tender, or other Vehicle.		
	No. or Name	..
	Description ..	..
	Loaded or Empty	..
	Owner ..	..
	Builder ..	..
Wheels.	Diameter ..	..
	Description of Skeleton	
	Maker ..	..
Axle.	No. ..	..
	Maker ..	..
	Material ..	..
	Date ..	..
Tyres.	Maker ..	..
	Material ..	
	Date put on	..
	Where put on	..
	Thickness on tread	..
	Fastening ..	..
	No. of transverse fractures	
	Did Tyre, or any portion of it, leave Wheel?	..
Description of flaws and fractures, &c., stating whether in Wheels, Axle or Tyres, also whether they are of old standing, or if they have a brittle or crystallized appearance ..		..
Remarks as to disposal of Wheels		..

Signed,..... .....

Every case of a Tyre breaking across, or splitting, or the Failure in any way of a Wheel or Tyre, whether under Great Western Railway, Foreign or Private Stock, must be reported upon this form, whether such failure is discovered while the vehicle is in traffic or while in shop or sidings,

The Report must be sent to Swindon by first available Train after the discovery of a defect.

FORM No. 35.

GREAT WESTERN RAILWAY.

LOCOMOTIVE AND CARRIAGE DEPARTMENT.

.....Station,

.....190

REPORT OF ACCIDENT CAUSING DEATH OR PERSONAL INJURY.

(To be sent to the District Superintendent immediately after an Accident causing death or personal injury has occurred).

Date and time of Occurrence ... ...

Locality of Accident (if between Stations give nearest mile post) ... ...

Nature and cause of Accident ... ... (full particulars to be given)

Can Accident be said to be due to the serious and wilful misconduct of injured person ...

Christian and Surname of person killed or injured ... ...

Age and Occupation ... ...

Where Stationed .. ..

Nature of Injury ... ...

Will injuries prevent the person from performing five hours work on any one of the next three working days... ... Are the injuries of such a nature as to disable him for more than a fortnight

Married or Single ... ...

*If married, give particulars of family with ages and sexes of children, if any... *If single, whether any dependents (either wholly or partially) and their relationship

Actual Time of booking on and off duty ... on ____ off ____

Turn of duty ... ... from ____ to ____

No. of hours on duty when accident happened

Length of service ... ...

Was engine in motion at the time of accident ...

Damage to Stock or Works ... ...

REMARKS ... ...

Signed ____

To ____

N.B.—In all cases of fatal accident a short report by telegram must be despatched to the Chief Locomotive Superintendent immediately after the occurrence. A report on this form must be sent to the District Superintendent as soon as particulars can be obtained. If more than one person be injured a separate form must be sent for each.

* This information to be given only in fatal cases.

FORM No. 36.

FACTORY AND WORKSHOP ACT, 1901.

NOTICE OF ACCIDENT.

To be sent to the Inspector of Factories and to the Certifying Factory Surgeon.

WORKS

1. Name of Occupier _____
2. Address of Works _____
3. Nature of Industry _____
   State also whether Factory, Workshop, Laundry, Warehouse, Dock, etc. ... _____

INJURED PERSON

4. Name _____
5. Sex, and age last birthday _____
   If between 13 and 14 state whether employed as a child or young person _____
6. Occupation _____

ACCIDENT

7. Date and hour of accident _____
8. How caused—By what part of machinery or in what other way .. .. _____
   If by machinery, state whether in motion by mechanical power at time of accident .. _____
9. How injured person was employed at the time of the accident .. .. _____
10. Hour at which he began work on the day of the accident _____
11. Injuries received and their results .. .. _____
    State whether fatal, severe or slight, and describe briefly their nature and extent, *e.g.*, loss of finger, fracture of leg, scald, etc. _____
12. Residence of injured person _____
13. Place to which injured person has been removed _____

Signature of Occupier, Manager or Agent _____

Date _____

FORM No. 37.

G.W.R.—Carriage Department..... .....District.

WAGES ABSTRACT.

4 W.E.....190

	Amount.	Total.
Carriage Repairs		
Wagon Repairs		
Rail Motor Car Service		
Cartage Repairs—London Parcels ..		
,, ,, ,, Goods ..		
,, ,, General Parcels ..		
,, ,, ,, Goods ..		
Workmen's Compensation		
Retiring Allowances		
Unclaimed Wages re-entered		
Shop Expenses—Foremen		
Storekeepers, &c. ..		
Laborers		
Repairs to Buildings ..		
Repairs to Tools ..		
Dept. and Personal Accounts—		
Freighters' Wagon Repairs ..		
Traffic Dept.—Greasing Passr. Trains..		
,, ,, ,, Goods Trains..		
,, ,, Carriage Cleaning ..		
,, ,, Sundries		
Loco. Dept,—Wagon Repairs ..		
,, ,, Sundries		
Stores Dept.—Sundries		
,, ,, C. Z. 2		
,, ,, Standard Ironwork ..		
Engineering Dept. Wagon Repairs ..		
,, ,, Crane Repairs ..		
,, ,, Sundries ..		

FORM No. 40.

G.W.R.—RETURN OF ROLLING STOCK UNDER REPAIRS.

Station..... *Week ending*.....*190*...

This Return should Reach Swindon not later than Wednesday following its date.

DESCRIPTION OF STOCK.	On hand for Repairs as per last Return.	Taken off for Repair during the week.	Total off for Repair.	Repaired and set to work during the week.	ON HAND FOR REPAIRS.				REMARKS.
					TOTAL.	ANALYSIS.			
						In Shops under Repair.	On Sidings under Repair.	On Sidings waiting Repair.	
Carriages—First Class (including 1st Class Saloons)									
Composites ..									
Second-Class ..									
Third-Class (including 3rd Class Saloons)									
Motors									
Motor Trailers ..									
Vans—Guards and Luggage ..									
Mail, Milk, Fish, &c. ..									
Horse Boxes									
Carriage Trucks									
Wagons—Traffic (including Fish and Meat Vans, &c.)									
Vans—Goods, Brake ..									
Wagons—Loco.									
Engineering Stock									

FORM No. 41.

G.W.R.—CARRIAGE DEPARTMENT.

Return of Repairs to Carriages and Wagons,..... ..Stations, Week ending.....190...

Date stopped	Date set to work	No. of Vehicle	Class of Vehicle	DESCRIPTION OF REPAIRS														Repaired by	If any structural alteration is made, or any alteration of Class, carrying capacity or Tare, full particulars to be given in this column	PARTICULARS OF LIFTING											
				Body	Underframe	Buffers	Draw Gear	Brake	Side Springs	Axle Boxes	Wheels	Painting	Trimming	Gasfittings	Steamfittings					Description of Axle Boxes		Brasses			Dia. Wheel Seat	Size Journal	Dia. Wheels	Axles		Lifter	Why Lifted
																				Old	New put on	New	Eased	Clean'd				No. out	No. in		

FORM No. 42.

GREAT WESTERN RAILWAY.

CARRIAGES CLEANED BY LOCO. AND CARRIAGE DEPARTMENT.

Station..... ..... Four Weeks ended..... .....190...

DATE.	CLEANED WITH KLEENMRITE.			CLEANED WITH OIL.			WASHED.			DRY-WIPED			THOROUGHLY CLEANED INSIDE.			SWEPT OUT.		
	8 wh.	6 wh.	4 wh.	8 wh.	6 wh.	4 wh.	8 wh.	6 wh.	4 wh.	8 wh.	6 wh.	4 wh.	8 wh.	6 wh.	4 wh.	8 wh.	6 wh.	4 wh.

FORM No. 43. GREAT WESTERN RAILWAY.—LOCOMOTIVE DEPARTMENT.

Particulars of Shed and other Accommodation for Running Engines at.....Station.

ENGINE SHED (*Sketch Plan to be attached*).

How built (Stone, Brick or Wood) ...

Inside dimensions:
- Length ... ...
- Breadth ... ...
- Height to top of roof ridge ...
- Do. do. wall plate ...
- Cubical Contents ... ...

Style of Roof (Gable, Hip Gable or Saw-tooth) ... ...

Roof Principals (Material) ...

If fitted with Smoke Troughs ..

Date built, or date Shed was first used

Length of each line used for running Engines ... ...

Do. do. do. Repairs

Engine Pits—length of each used for running Engines ... ...

Do do. do. Repairs

SHOPS OR OFFICES OUTSIDE THE SHED.

How built (Stone, Brick or Wood) ...

Inside dimensions:
- Length ... ...
- Breadth ... ...
- Height to top of roof ridge ...
- Do. do. wall plate ... ...
- Cubical Contents ... ...

Style of Roof (Gable, Hip Gable or Saw-tooth) ... ...

Roof Principals (Material) ... ...

Date built, or date opened ... ...

Length of Line used for repairs ...

Do. Engine Pit used for repairs

OUTSIDE SHED.

Lines available for standing Engines

Engine Pits—length of each ...

Do. at Station ...

ENGINE TURNTABLES. ...

Diameter ... ...

Length of Rail ... ...

Girders (Material) ... ...

How turned ... ...

Where fixed ... ..

Date fixed ... ...

Maker ... ...

COAL STAGE.

Sktch and size ... ...

Number of Cranes or Tips ...

How built (Stone, Brick or Wood) ...

Date built ... ...

SAND FURNACE.

Outside dimensions length, breadth, height,

Brief Description and Sketch ...

Date built ... ...

Where situated ... ...

Date Certified..... ..... Superintendent's Signature.

,, ... ,, ,,

,, ... ,, ,,

,, ... ,, ,,

,, ... ,, ,,

,, ... ,, ,,

FORM No. 44.

GREAT WESTERN RAILWAY.

PARTICULARS OF WATER SUPPLY..... .....STATION.

Source and Position of Supply

From whom obtained

How obtained

If pumped, give particulars of Pump

,, ,, Engine

,, ,, Boiler

,, Average Number of hours pumping

Description of Tanks :—

Where situated.	Material.	Dimensions.	Capacity (gallons).	How fixed.	Date fixed.

Description of Water Cranes or Stand Pipes :—

Where situated.	Maker, and Date.	Description.	Size (inches)	Date. fixed.

OTHER CONNECTIONS FOR LOCO. PURPOSES :—

Hydrants

Miscellaneous

Description of Water Meters :—

Owner.	Maker.	Size (inches).	Registering Supply.	
			To	From

Particulars of Connections with Loco. Mains (otherwise than for Loco. Purposes) with inside diameter of pipes

TRAFFIC DEPT. :—

Station (including Refreshment Rooms).

Down Platform. Up Platform.

Hydrants

Average No. of Carriages washed per week

GOODS DEPT. :—

Cattle Pens, No. of Stalls

Hydrants

Taps for Troughs

Average No. of Trucks washed per week

OTHER DEPTS. OR PERSONS :—

....*Divisional Superintendent.*

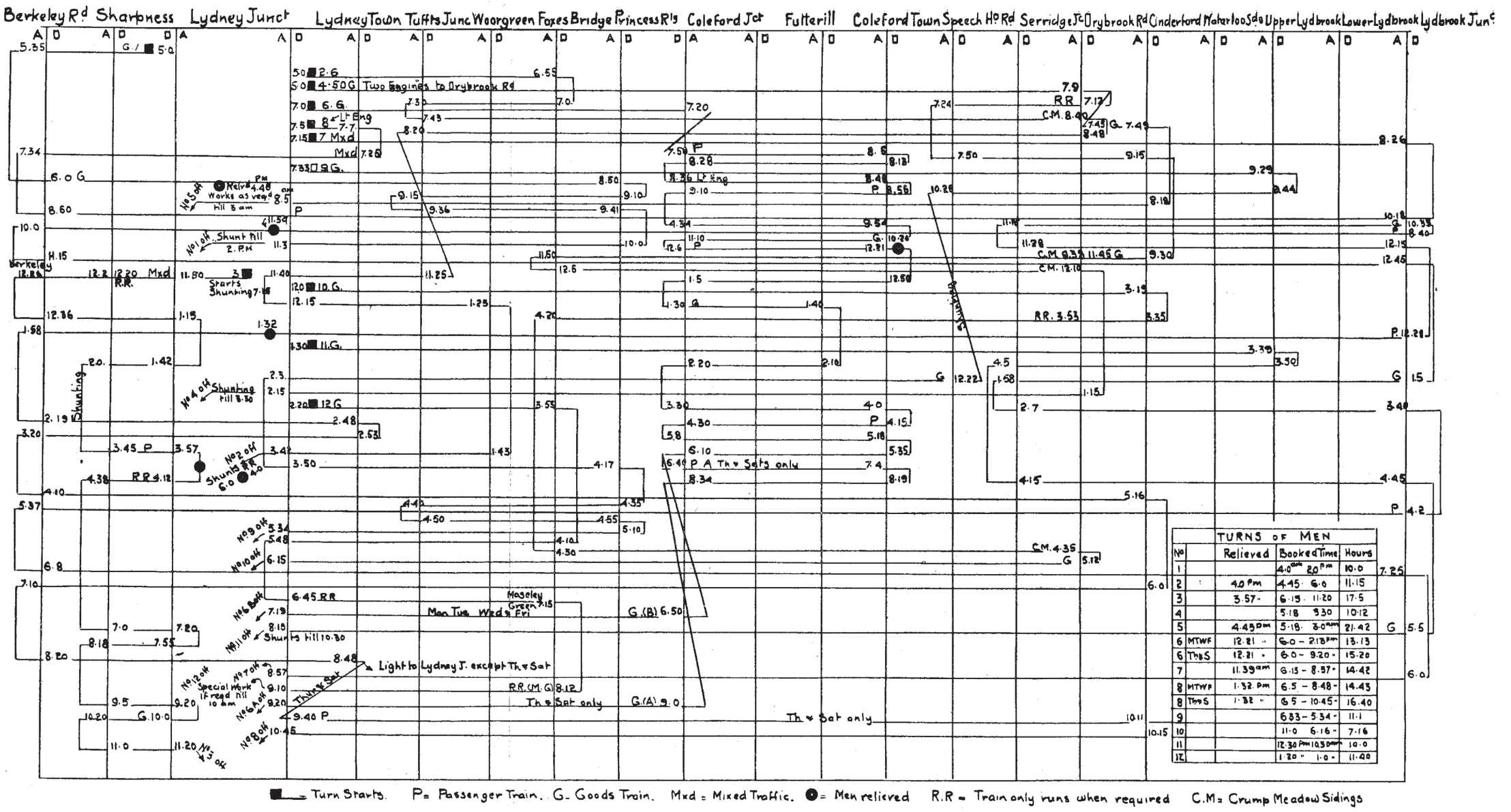


Fig. 4.—Severn and Wye and Severn Bridge Joint Railway.—Diagram of Engine Working, Winter Service, 1906.

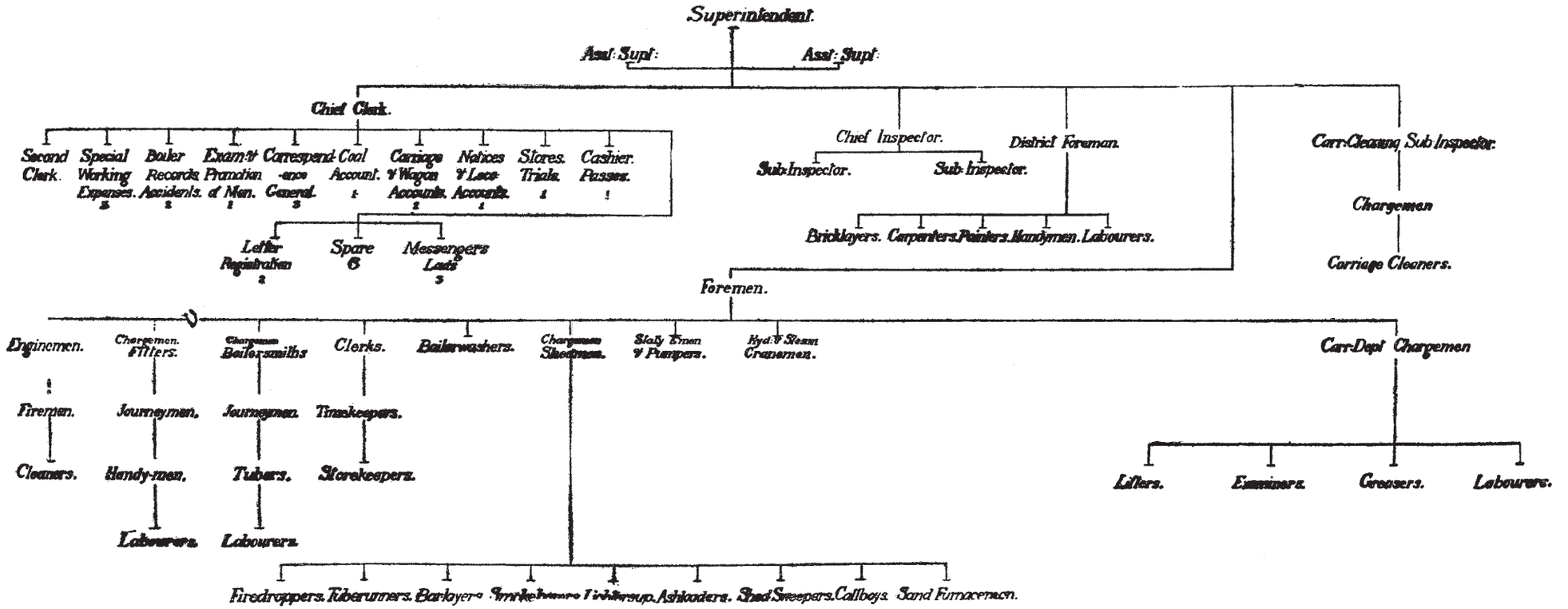


Fig. 1.—Table showing all Grades of Men employed in a Locomotive Division.

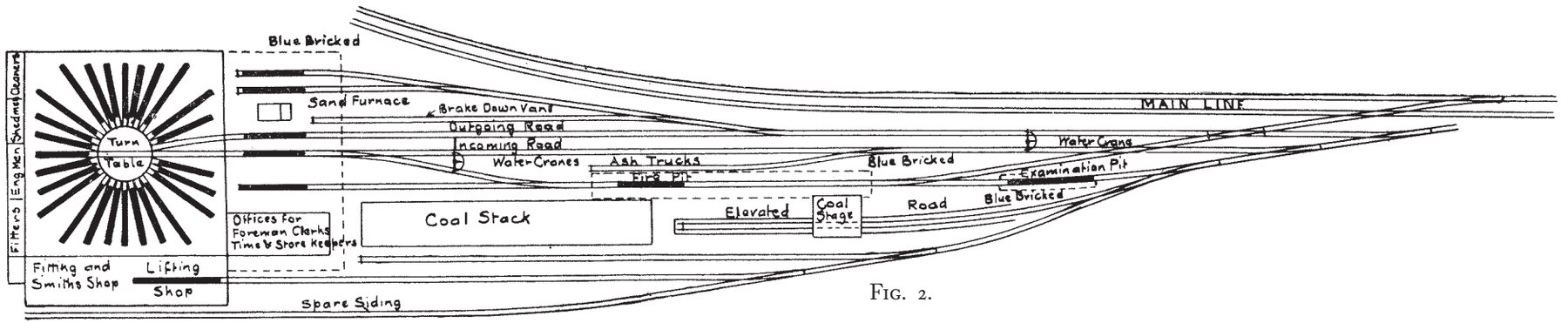


Fig. 2.

G.W.R. Engineman's Mileage Ticket.

W.E. ____________ 190__ Station ____________ Engineman ____________

Day of Week.	Engine.	Between	And	No. of Trips.	Train Miles. Passenger.	Train Miles. Goods.	Piloting. No. of Hours.	Empty Miles. (Including Piloting at 2 Miles per Hour.) Passen-ger.	Empty Miles. Goods.	Shunting at 4 Miles per hour. Station.	Passenger. Hrs.	Passenger. Miles.	Goods. Hrs.	Goods. Miles.	Ballasting, &c. Hrs.	Ballasting, &c. Miles.	Fireman's Name	Booked Time of Starting of Train.	Actual Time of Arrival of Train.	Time in Hours. (Train Time with allowance for getting ready, &c.) Engine-man.	Time in Hours. Fire-man.	Lodging Money. Engine-man.	Lodging Money. Fire-man.	REMARKS. N.B.—If a Passenger Train is run without Continuous Brakes, a note must be made in this column.
Sun.																								
Mon.																								
Tues.																								
Wed.																								
Thur.																								
Fri.																								
Sat.																								

SUMMARY OF TIME AND LODGING MONEY.

NAME.	Hours.	Rate.	Lodgings Amount.
Engineman			
P			
G			
Firemen			
P			
G			
P			
G			
P			
G			
P			
G			
P			
G			

Divisional Superintendent.

W.E.	Station	Engineman

Engine.	Train Miles. Pass.	Train Miles. Goods.	Empty. Pass.	Empty. Goods.	Shunting. Pass.	Shunting. Goods.	Total.

W.E	Station	Engineman

Engine.	Train Miles. Pass	Train Miles. Goods.	Empty. Pass.	Empty. Goods.	Shunting. Pass.	Shunting. Goods.	Total.

W.E.	Station.	Engineman.

Engine.	Train Miles. Pass.	Train Miles. Goods.	Empty. Pass.	Empty. Goods.	Shunting. Pass.	Shunting. Goods.	Total.

W.E.	Station.	Engineman

Engine	Train Miles. Pass.	Train Miles. Goods.	Empty Pass.	Empty Goods.	Shunting. Pass.	Shunting. Goods.	Total.

W.E.	Station.	Engineman.

Engine	Train Miles. Pass.	Train Miles. Goods.	Empty Pass.	Empty Goods.	Shunting. Pass.	Shunting. Goods.	Total.

W.E.	Station.	Engineman.

Engine.	Train Miles. Pass.	Train Miles. Goods.	Empty. Pass.	Empty. Goods.	Shunting. Pass.	Shunting. Goods.	Total.

Form. 14.

G.W.R. ..... Division. SUMMARY OF WAGES.

NOTE.—The number on Register is taken as on the closing date of the period.

ABSTRACT OF PAY-BILLS.

	No. of Men on Register.	Wages paid.	Average per Man per Week.	No. of Men on Register.	Wages paid.	Average per Man per Week.	No. of Men on Register.	Wages paid.	Average per Man per Week.	No. of Men on Register.	Wages paid.	Average per Man per Week.	No. of Men on Register.	Wages paid.	Average per Man per Week.	No. of Men on Register.	Wages paid.	Average per Man per Week.	No. of Men on Register.	Wages paid.	Average per Man per Week.	No. of Men on Register.	Wages paid.	Average per Man per Week.	No. of Men on Register.	Wages paid.	Average per Man per Week.
Enginemen and Firemen																										
Boilerwashers																										
Cleaners																										
Coalmen																										
Shedmen																										
Loco. Shunters																										
Mechanics and Labourers																										
Stationary Enginemen and Pumpers																										
Hydraulic and Steam Cranemen																										
Gasmen																										
Coal Inspectors																										
Time and Storekeepers																										
Foremen and Inspectors																										
Total ..																										
Retiring Allowances, Gratuities, &c.																										
M. A. S. Allowances																										
Workmen's Compensation Act																										
Pay-Bill Total																										

APPROPRIATION OF WAGES.

	Cost.	Average Cost per Train Mile.	Cost	Average Cost per Train Mile.	Cost.	Average Cost per Train Mile.	Cost.	Average Cost per Train Mile.	Cost.	Average Cost per Train Mile.	Cost.	Average Cost per Train Mile.	Cost	Average Cost per Train Mile.	Cost	Average Cost per Train Mile.	Cost	Average Cost per Train Mile.
Locomotives. Enginemen and Firemen—Passenger																		
Do. do. —Goods																		
Boilerwashers																		
Foremen and Inspectors																		
Total ...																		
Cleaning																		
Coaling																		
Shed—Attendance on Engines																		
General Labouring																		
Total ...																		
Rail Motor Cars. Enginemen and Firemen																		
Boilerwashers																		
Foremen and Inspectors																		
Total ...																		
Cleaning																		
Coaling																		
Shed—Attendance on Engines																		
General Labouring																		
Total ...																		
Time and Storekeeping																		
Water—Pumping																		
Do. Repairs																		
Total Working Expenses ..																		
Repairs to Locomotives and Tenders																		
Do. Rail Motor Cars																		
Do. Buildings and Turntables																		
Do do. Rail Motor Car																		
Coal Expenses																		
Factory Expenses																		
Sundries																		
Retiring Allowances, Gratuities, &c . .																		
Workmen's Compensation Act																		
Credits																		
Pay-Bill Total .																		

	Corres. Period.	Corres. Period.	Corres. Period.	Corres. Period.	Corres. Period.	Corres. Period.	Corres. Period.	Corres. Period.	Corres. Period.
Locomotives Cleaned, Total number									
Cleaner's Wages, per Locomotive ..									
Rail Motor Cars Cleaned, Total number									
Cleaner's Wages, per Rail Motor Car ..									
Coal put on Locomotives . . .									
Coalmen's Wages, per ton . .									
Coal put on Rail Motor Cars . .									
Coalmen's Wages, per ton									

Form. 25.

No. 71.—The Work of a Running Department.

G.W.R. ..... Cost of Stores used for Running, Cleaning and Repairs of Engines, &c.

	Amount	Average cost 190 / 190	Amount	Average cost 190 / 190	Amount	Average cost 190 / 190	Amount	Average cost 190 / 190	Amount	Average cost 190 / 190	Amount	Average cost 190 / 190	Amount	Average cost 190 / 190	Amount	Average cost 190 / 190	Amount	Average cost 190 / 190	Amount	Average cost 190 / 190
Locomotives. Running :—Oil and Tallow		per 100 miles		per 100 miles		per 100 miles		per 100 miles		per 100 miles		per 100 miles		per 100 miles		per 100 miles		per 100 miles		per 100 miles
Tools and Sundries ...																				
Boilerwashing		per Engine		per Engine		per Engine		per Engine		per Engine		per Engine		per Engine		per Engine		per Engine		per Engine
Cleaning																				
Coaling																				
Shed :—Attendance on Engines ...																				
General Labouring ...																				
Total ...																				
Rail Motor Cars. Running :—Oil and Tallow		per 100 miles		per 100 miles		per 100 miles		per 100 miles		per 100 miles		per 100 miles		per 100 miles		per 100 miles		per 100 miles		per 100 miles
Tools and Sundries ...																				
Boilerwashing		per Car		per Car		per Car		per Car		per Car		per Car		per Car		per Car		per Car		per Car
Cleaning																				
Coaling																				
Shed :—Attendance on Car																				
General Labouring ...																				
Total ...																				
	190	190	190	190	190	190	190	190	190	190	190	190	190	190	190	190	190	190	190	190
Office and Stores																				
Water :—Pumping																				
Repairs																				
Repairs to :—																				
Locomotives and Tenders ...																				
Rail Motor Cars																				
Buildings and Turntables ...																				
Do Rail Motor Cars ...																				
Coal Expenses																				
Factory Expenses																				
Sundries																				
Credits																				

Form. 26.

G.W.R. ____________ Division. *SUMMARY OF MILEAGE, LOCOMOTIVES, RAIL MOTOR CARS AND COAL ACCOUNT.*

	Passenger Locomotives and Rail Motor Cars.	Goods Locomotives.	TOTAL.	Passenger Locomotives and Rail Motor Cars.	Goods Locomotives.	TOTAL.	Passenger Locomotives and Rail Motor Cars.	Goods Locomotives.	TOTAL.	Passenger Locomotives and Rail Motor Cars.	Goods Locomotives.	TOTAL.	Passenger Locomotives and Rail Motor Cars.	Goods Locomotives.	TOTAL.	Passenger Locomotives and Rail Motor Cars.	Goods Locomotives.	TOTAL.	Passenger Locomotives and Rail Motor Cars.	Goods Locomotives.	TOTAL.	Passenger Locomotives and Rail Motor Cars.	Goods Locomotives.	TOTAL.	Passenger Locomotives and Rail Motor Cars.	Goods Locomotives.	TOTAL.
MILEAGE.																											
TRAIN MILES:																											
LOCOMOTIVES—																											
Passengers (Traffic)																											
Goods „																											
Trains run for other Cos. ..																											
Ballasting																											
Total Locomotives ..																											
RAIL MOTOR CARS																											
Total Locomotive & Motor Train Miles																											
Light Mileage: Banking																											
Light Mileage: Traffic Shunting																											
Light Mileage: Empty																											
Grand Total, Locomotive & Motor Miles																											
LOCOMOTIVES AND RAIL MOTOR CARS.																											
LOCOMOTIVES IN DISTRICT as on last day of period																											
Number in working order																											
Do. under Repair																											
Do. in working order in Factory																											
Do. under Repair in Factory...																											
Total Locomotives ...																											
RAIL MOTOR CARS IN DISTRICT.																											
Number in working order																											
Do. under Repair																											
Do. in working order in Factory																											
Do. under Repair in Factory ...																											
Total Rail Motor Cars ..																											
LOCOMOTIVES IN STEAM: Week Days																											
Sundays ...																											
Total ...																											
RAIL MOTOR CARS IN STEAM: Week Days																											
Sundays ...																											
Total ...																											
Locomotives in Steam, average per week day																											
Rail Motor Cars in Steam do																											
Average Miles per Locomotive in Steam																											
Do. per Rail Motor Car in Steam																											

COAL.	Cwts.	Corresponding period.	Cwts.	Corresponding period.	Cwts.	Corresponding period.	Cwts.	Corresponding period.	Cwts.	Corresponding period.	Cwts.	Corresponding period.	Cwts.	Corresponding period.	Cwts.	Corresponding period.	Cwts.	Corresponding period.
COAL PUT ON LOCOMOTIVES AND RAIL MOTOR CARS as per Coalmen's Returns																		
Overcharge deducted																		
Undercharge added																		
Total ...																		
Lighting-up Furnaces																		
Offices, Enginemen's Rooms, &c. ...																		
Total Running ...																		
Water, Pumping Engines, &c. ..																		
Repairs, Shop Engines, Smiths, &c. ...																		
Hydraulics and other Departments ...																		
Total ...																		

	Passenger Locomotives and Rail Motor Cars.	Goods Locomotives.	TOTAL.	Passenger Locomotives and Rail Motor Cars.	Goods Locomotives.	TOTAL.	Passenger Locomotives and Rail Motor Cars.	Goods Locomotives.	TOTAL.	Passenger Locomotives and Rail Motor Cars.	Goods Locomotives.	TOTAL.	Passenger Locomotives and Rail Motor Cars.	Goods Locomotives.	TOTAL.	Passenger Locomotives and Rail Motor Cars.	Goods Locomotives.	TOTAL.	Passenger Locomotives and Rail Motor Cars.	Goods Locomotives.	TOTAL.	Passenger Locomotives and Rail Motor Cars.	Goods Locomotives.	TOTAL.	Passenger Locomotives and Rail Motor Cars.	Goods Locomotives.	TOTAL.
COAL CONSUMPTION as per Mileage Returns																											
By Locomotives in District																											
„ Rail Motor Cars in District ...																											
By Locomotives, lbs. per mile ...																											
Corresponding period																											
By Rail Motor Cars, lbs. per mile...																											
Corresponding period																											

Form. 30.