1940

Locomotive Maintenance

Technical papers and addresses cover many phases of locomotive maintenance work in the back shop and enginehouse

F. B. Downey,
President

J. C. Miller,
First Vice-President

J. E. Goodwin,
Second Vice-President
and Secretary-Treasurer

F. J. Topping,
Third Vice-President

WITH a registration exceeding that of last year the annual meeting of the Locomotive Maintenance Officers' Association, held at the Hotel Sherman, Chicago, October 22 to 25 inclusive, will be remembered by those in attendance as marking a distinct step forward in the progress of the new association. The character of the attendance, including as it did a number of general mechanical officers and a comprehensive representation of the important supervisors in both the back shop and the enginehouse, is a definite indication that this association has succeeded in winning the support of the type of railroad man that will assure its future success. F. B. Downey, assistant shop superintendent, Chesapeake & Ohio, presided over the several sessions of the four-day meeting.

At the sessions the following papers and addresses were presented and discussed: What Members of the L. M. O. A. Can Do To Improve the Service on All Railroads, by C. B. Hitch, superintendent motive power, Chesapeake & Ohio; Design, Operation and Maintenance of Diesel-Electric Locomotives, by H. V. Gill, supervisor Diesel engines, Atchison, Topeka and Santa Fe; Future Locomotive Air Brake Maintenance, by J. P. Stewart, general supervisor of air brakes, Missouri Pacific Lines; Use of Modern Machinery and Tools in Locomotive Repairs, by D. J. Sheehan, superintendent motive power, Chicago & Eastern Illinois; Roundhouse Problems of the Present Day, by H. E. Hinds, assistant mechanical engineer, Burlington Lines, and Maintenance of Locomotive on Long Runs, by Lee Robinson, superintendent of equipment, Illinois Central.

D. S. Ellis,
Chief Mechanical Officer,
Chesapeake & Ohio

O. A. Garber,
Chief Mechanical Officer,
Missouri Pacific Lines

J. Roberts,
Chief of Motive Power and Car
Equipment, Canadian National

The members of the Association's 1940 Advisory Board

Roy V. Wright, editor, *Railway Mechanical Engineer,* who was called on during one of the sessions, paid tribute to the work that has been done by the association and its officers during the past two years and expressed the opinion that the time had now come to go out and sell the value of the association work to the mechanical officers and supervisors throughout the country with the object of increasing the membership. The present and potential members of the association, Mr. Wright said, are men who occupy important jobs in the railroad industry and they have every reason to look upon their work with the same feeling as professional men. Such an attitude will help to inspire the men who look to the officers and supervisors for leadership and training.

Over 500 members of the co-ordinated associations, supply representatives and guests attended a luncheon on October 24 given by this association in honor of the members of its Advisory Board, Messrs. Ellis, Garber and Roberts. The principal speaker at this luncheon was John M. Hall, director of the Bureau of Locomotive Inspection, Interstate Commerce Commission. Mr. Hall spoke on The Responsibility of the Locomotive Maintenance Officer and The Federal Inspector and in remarks preliminary to his address made an eloquent plea to railroad officers on behalf of the enginehouse foreman with respect to the long hours these men are required to be on duty. The text of Mr. Hall's address appears elsewhere in this issue.

Election of Officers

The following officers were elected for the ensuing year: President, J. C. Miller, general foreman, New York, Chicago & St. Louis (Nickel Plate), Conneaut, Ohio; first vice-president and secretary-treasurer, J. E. Goodwin, general foreman, Missouri Pacific, North Little Rock, Ark.; second vice-president, F. J. Topping, master mechanic, Chesapeake & Ohio, Hinton, W. Va.; third vice-president, S. O. Rentschler, general foreman, Missouri Pacific, Sedalia, Mo. Executive board members were elected as follows: For a one-year term: W. L. Rice, superintendent of shops, Reading Company, Reading, Pa.; F. W. Ekins, general foreman, Atchison, Topeka & Santa Fe, Chicago and J. P. Stewart, general supervisor of air brakes, Missouri Pacific, St. Louis, Mo.; for a two year term—E. J. Kueck, mechanical engineer, St. Louis-Southwestern, Pine Bluff, Ark.; W. P. Buckley, superintendent of shops, Chicago, St. Paul, Minneapolis & Omaha, St. Paul, Minn. and George Crowder, superintendent motive power, Georgia & Florida, Douglas, Ga.

Action was taken by the association to increase the membership of the Advisory Board to five members. G. C. Christy, general superintendent of equipment, Illinois Central, and D. J. Sheehan, superintendent motive power, Chicago & Eastern Illinois, were elected to that Board.

Improving Railroad Service

By C. B. Hitch

Superintendent Motive Power, Chesapeake & Ohio

The subject assigned to me—"What Members of the Locomotive Maintenance Officers Association Can Do to Improve the Service on All Railroads"—is indeed a broad one. There are many ways in which this Association and its members can be helpful. I will, however, mention what, in my opinion, is the most important thing, that is—qualifying ourselves to serve more efficiently, and I know of no better way of accomplishing this than to affiliate ourselves with an organization of this kind, where we are privileged to attend these conventions; take an active part in the meetings where problems of interest to the mechanical department of our railroads and to ourselves are discussed; and, where we are afforded an opportunity of mingling with men who are holding positions similar to our own. I am sure you will find men here who have successfully solved problems that are giving you much concern. Look them up; you may be able to help them, as they help you in solving the problems that are bothering you. Do not hesitate to use the floor of the convention, remembering that we are all representatives of the same department and our problems are pretty much the same.

The primary business of the railroads is to serve the public both safely and efficiently. Secondly, it is to sell transportation and, as in any other business, the difference between the actual cost of production and the price at which we can sell what we produce should enable us to pay taxes and other incidental expenses not included in the actual production cost and also afford a fair return on the money invested. The selling price of transportation, as furnished by the railroads, is more or less fixed. Therefore, it is perfectly obvious that if we are

themselves, and have been a great aid to locomotive maintenance officers in properly maintaining the equipment. It has been my experience that those who make a conscientious effort to maintain their equipment in safe and suitable condition for service will receive most hearty cooperation from these Bureaus.

As I mentioned in the beginning, the subject assigned to me for this discussion is a broad one and I have mentioned only a few of the points involved. This being a locomotive maintenance organization, I have confined my remarks principally to locomotives; however, they apply equally well to the maintenance of freight and passenger cars. It all leads up to the fact that the first duty of a locomotive maintenance officer is to do the best he can with what he has in the way of equipment, facilities and personnel. In order to accomplish this with the maximum benefit to his company, he must qualify himself thoroughly for his job. This can only be done by continual study of the problems involved, by keeping up with the latest developments in the field and by familiarizing himself with the latest information available. I know of no better way to accomplish this than by affiliation with an organization such as yours and taking part in its activities. I repeat that, in my opinion, the members of the Locomotive Maintenance Officers' Association can do more to improve service on all railroads by promoting the free interchange of ideas among its members than by other means.

Discussion

In the discussion of Mr. Hitch's paper one of the most important things mentioned was the value of stabilized operations. In reply to several questions the speaker told of the work that had been done on the C. & O. to plan all maintenance operations three and six months in advance so that the management could provide the necessary appropriations to assure that the program of work was carried along on a stabilized basis; so that material could be ordered from manufacturers far enough in advance to assure positive delivery at the time when it was needed. Mr. Hitch made the suggestion that carefully planned and stabilized operations were one of the most important factors in controlling the costs of maintenance.

Use of Machinery and Tools In Locomotive Repairs

By D. J. Sheehan

Superintendent Motive Power, Chicago & Eastern Illinois

The 1940 annual meeting of the Locomotive Maintenance Officers' Association is being held at a time when the entire world is in a chaotic condition. Our country is faced with a grave situation politically, economically, diplomatically and industrially. The transportation industry, and particularly the railroad industry, will again play a very important part in the industrial crisis in this country as well as in the military crisis, which it seems will soon be upon us.

We, who are identified with this Association, will play a very important part in the success of railroad operation which must be greatly accelerated to meet emergency demands. We must be prepared to put locomotives in service that will remain in service for the longest possible time. We must be prepared to maintain the condition of locomotives now in service in the shortest possible time. In order to do this, we must take advantage of every opportunity to do our particular work more efficiently, more economically and with utmost dispatch.

The locomotive maintenance officer has at his command three definite and essential organization components from which to secure successful and efficient maintenance. The first of these is a staff of well trained and efficient supervisors. A great deal has been said in past papers presented before this association on that very essential element for the successful operation of a locomotive shop. Thus, it may be assumed that we are all aware of the importance of providing and maintaining well trained and efficient supervisors.

The second is a corps of highly trained and efficient workmen. We have repeatedly heard in recent months that there is an acute shortage of trained and skilled manpower available for industry. Those of you who may have had recent occasion to augment your forces are well aware of this fact. The railroads will not be able to increase the manpower to expedite repairs to locomotives and to rolling stock without skilled men. Consequently, if we are to speed up maintenance programs so that we can maintain motive power in an efficient and economical manner and with the utmost dispatch, we must turn elsewhere for the solution to the problem.

The third and only remaining component is the efficient and economical use of machinery and tools.

Many locomotive shops are equipped with tools and machinery that are not modern. Some of this equipment, particularly the machines, has been permitted to lapse into a poor state of maintenance. Many machine tools in service today would cause the question to be raised as to whether or not the work obtained from them after an extensive overhauling would justify the cost of the overhauling. In some cases, it will be found that for very modest expenditures machine tools now in service can be put into condition to perform continued efficient and economic service. In other cases it will be found that after an intensive study and analysis a greater advantage would be derived by replacing these machines with new and more modern units.

In the case of those machines which are in a good state of repair and capable of performing a satisfactory job economically and efficiently, special studies should be made to develop the use of quick-change jigs and fixtures. The use of some of these ingenious devices will result in great advantage.

Under present conditions if it is decided to replace present machinery with new and more modern machinery it will not be possible to secure the new and modern machinery for a considerable period of time. Thus, it will be necessary to put the old equipment in the best possible conditions to do the job while waiting for the arrival of new equipment.

There are available a great many improved machine tools and other repair shop facilities which, if used to replace obsolete and inefficient equipment would greatly assist in producing results which are absolutely necessary to meet demands that are being placed on motive power.

The final approval for the selection of a machine or tool to replace obsolete equipment rests with the ranking mechanical officer. Too often such selection has been based only on the personal opinion of an individual who is a member of the mechanical staff.

The question of whether a planer should be replaced by a more modern planer, or an improved machine of the planer type, or a milling machine, can only be determined by a most careful analysis of all the factors involved in equipment replacement and experience and judgment must be augmented by thorough studies of the work to be performed by a new machine.

It is possible for a piece of modern machinery to be absolutely essential, highly efficient, and very economical. At the same time this same piece of machinery may be absolutely unessential, highly inefficient and very uneconomical. Again, this same piece of machinery may have neither of these qualities—it may be purely ornamental.

If you were to purchase and place in your shop the most modern machine tool and place it in a glass case, it certainly would be neither absolutely essential nor absolutely unessential, it would be neither highly efficient nor highly inefficient, it would be neither very economical nor very uneconomical. It would merely be an ornament. On the other hand, if this same piece of modern machinery were purchased and put in your shop without careful study, planning and supervision, it might be absolutely unessential, highly inefficient and very uneconomical.

It would be possible to put a piece of modern machinery into a shop to do a wide variety of work requiring a great many changes in setting up and a consequent loss of time. It can be appreciated that such an installation might prove unessential, inefficient and very uneconomical.

Job Analysis Will Show the Way

However, if in the selection of a new machine to replace an obsolete one, a careful analysis of the work to be done on the new machine is made the desired results can easily be obtained.

It is often possible to find a new machine which will decrease the floor-to-floor time on a machine operation as much as 50 per cent. This fact alone does not necessarily justify the installation of new machinery. It may be found that this particular machine, with an apparent saving per unit of work can only be utilized a small portion of the working time. If modern machinery is put into a shop, it is of prime importance that it be kept busy. A machine that does an economical job one hour a day and an uneconomical job one hour a day and an uneconomical job 23 hours a day, does not contribute to any real saving nor is there any justification for its purchase.

"It is well to keep in mind that a unit of shop equipment, like a locomotive, can only justify its existence if it is kept busy. Therefore, it is obvious that if a special-purpose machine, designed to do one job and one only, is installed in a small shop with a limited volume of work it will probably prove to be an unsound investment whereas the same machine installed in a specialized department of a large shop may effect such savings as to pay for itself in two or three years.

"This is a good time to call attention to the fact that machine performance studies will often indicate that the actual machining time on locomotive parts may represent but a small part of an eight-hour day. The rest of the time is often consumed in setting up work on the machine and in handling the parts to and from the machine. In this, there is an important lesson for all of you who have the responsibility for selecting shop equipment. If adequate handling facilities are not provided for each machine, and if the proper jigs and fixtures are not available, it is quite probable that the greater part of the potential productive capacity and economy of a machine tool unit will be dissipated. Here again is the proof of the necessity for careful study and planning on the part of the officer in charge of a shop.

Many modern machines can be designed so that the work table will hold two or more sets of fixtures for holding various types of work. I am thinking particularly of some of the larger type millers which may be equipped, more or less permanently, with fixtures for holding crosshead shoes, shoes and wedges and driving boxes. When work of one class is being done, the fixture for the other class of work can remain on the work table, but located away from the milling cutters."

How to Get New Equipment

It is not uncommon to hear a locomotive maintenance officer make a statement to the effect that a new machine of a certain type would save a lot of money for his railroad if the machine were installed in his shop, but that the company does not have the money to purchase such a machine. This statement is usually made without proper thought and consideration. Railroad managements are always on the alert to replace tools and equipment that will result in a net saving. If the installation of a new machine will actually result in a net saving and, if the officer who recommends the installation makes a careful analysis of the potential savings he should have no difficulty in selling the idea to his management.

One of the greatest difficulties that a locomotive maintenance officer has in selling his management with the idea of a new installation is that he himself does not thoroughly analyze costs and conditions with existing machinery and tools and develop a sound comparison of the savings possible by the installation of more modern types of machinery. If he cannot conscientiously satisfy himself that there are very definite savings to be made, he should never attempt to convince his management that there may be some savings in new installations.

Too often the statement is made that if certain new machinery or tools were purchased more work could be produced in the shop, but when an analysis is made there is no normal need to increase output.

I believe there is another matter coming under the general heading of the use of modern machinery and tools which is often overlooked. In years gone by we sometimes felt that if we supplied our mechanics with tools they should be able to do the work properly. Many of the older type tools, particularly tools such as air motors, chipping hammers, riveting hammers and portable grinders were very heavy and awkward to handle. Many of us have overlooked the fact that the continual use of these heavy and awkward tools resulted in fatigue to the workman so that his efficiency and the ability to perform his work satisfactorily was greatly reduced as the work day wore on.

Modern developments in tools of this general character have produced efficient, lightweight, convenient tools and handling devices which will greatly assist in conserving the workman's energy for a greater number of hours.

In recent years a great deal of thought has been given to the development of so-called gadgets in railroad shops. In visiting various shops, it is not uncommon to see tools hanging from various types of supports, many being supported on spring balances. Practically no physical effort is required to put the tool into working position.

In one shop I recently observed a so-called gadget on which was suspended two large air hammers. By means of hand wheels and foot pedal throttles these air hammers were moved together and used very efficiently for double gunning rivets in a two-piece spider and bull ring. With this simple device, fatigue is practically eliminated from normally heavy jobs. Not all these so-called gadgets are home made. Many of them are avail-

able at low cost—a cost so low that it is not hard to justify their purchase and installation.

In closing, I want to say that, "in my opinion, there has never been a time in the history of American railroads when it is more important for officers and supervisors who are responsible for locomotive maintenance to study every job and the equipment with which the job is performed with the idea of determining whether or not obsolete facilities are depriving us of the output we need at a price we can afford to pay. As the volume of railroad traffic increases and the demand for motive power becomes more pressing, we are going to be up against a real problem to keep maintenance costs from getting out of line. Careful planning and the development of an intelligent program for the replacement of obsolete equipment offer the most logical solution of the problem of controlling costs."

Discussion

It was evident, from the remarks of several members, that shop officers and supervisors have considerable difficulty in getting the new equipment they need to replace old facilities. Mr. Sheehan took occasion to reiterate his remarks to the effect that the reason such difficulty is often encountered is that shop and enginehouse supervisors do not make a sufficiently thorough study of the problem at hand to build up a good case for the facilities they are trying to get. Management, he said, is always alert to the possibility of saving expense but that it is up to department heads to prove beyond any doubt that the facilities they are asking for will result in definite economies. Only by making a complete analysis of specific conditions can one decide whether or not a new tool should be purchased and he concluded with the statement that "if you can prove you need it, you can get it."

The Design, Operation and Maintenance of Diesel-Electric Locomotives

By H. V. Gill

Supervisor Diesel Engines, Atchison, Topeka & Santa Fe

The application of Diesel engines as the prime mover using an electric transmission for propulsion of locomotives on railroads of the United States has been used for a great many years. However, the intensified development of this type locomotive dates back only five and a half years to 1934. In that year the engineers of the Santa Fe and Electro-Motive Corporation collaborated on the design of a Diesel-electric locomotive capable of handling 14 cars on one per cent grades, and in November, 1935, the locomotive was delivered. The locomotive was powered with four 900 hp., 12-cylinder, V-type, two-cycle Diesel engines furnishing power for traction, and two 90 hp. four-cycle Diesel engines for auxiliary power.

Many difficulties were experienced with this locomotive such as camshaft breakage, crankshaft bearing failures, traction motor and generator failures, short wheel life, piston failures and cylinder heads cracking. These conditions have all been improved by the strengthening of the design and the application of more efficient air filters, oil filters and radiators.

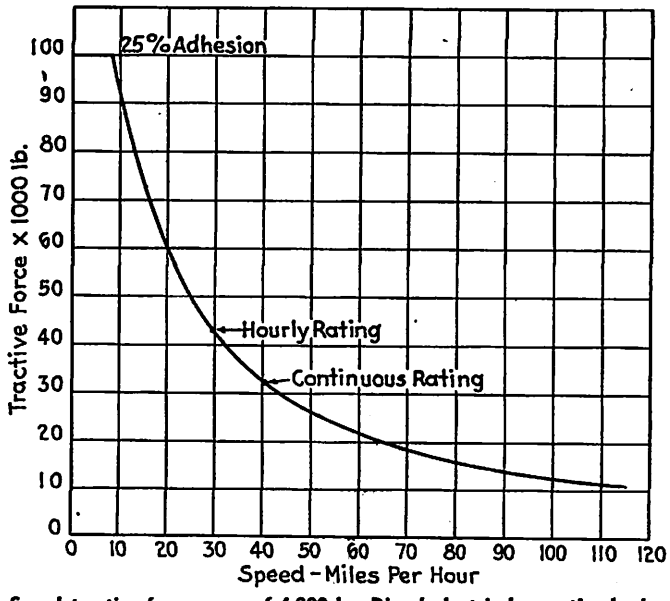
Also, in February, 1935, a 600 hp. Diesel-electric switching locomotive was placed in service. Since then an additional 40 switching locomotives and 17 high-speed road passenger units have been placed in service, making a total of 73,140 hp.

The high-speed road passenger locomotive units are all powered with two 12-cylinder, V-type, two-cycle Diesel engines per unit. The maximum speed is 117 m. p. h. The Diesel units have accumulated 7,684,111 miles of service to June 1, 1940, with an availability of 95.3 per cent.

Switching locomotives are powered with either the four-cycle or two-cycle Diesel engine and are at present time protecting 121 eight-hour switch tricks per day. They had an availability of 94.3 per cent during 1939.

The electric transmission is an important and expensive part of the equipment and at the present time is the major limiting factor in so far as continuous operation on heavy grades is concerned. This is due to the necessity of dissipating the thermal losses from the traction motors and generators. In selecting or assigning Diesel-electric locomotives for service, the thermal capacity of the electric transmission must be carefully considered to make sure that it is sufficient for the duty cycle.

Another limiting factor which interferes with continuous operation of the Diesel-electric locomotive on heavy grades during extremely hot weather is the dissipation of the tremendous amount of heat generated by the Diesel engines, and this is one of the most important problems encountered when designing Diesel locomotives. The difficulty is brought about by: Space limitations;



Speed-tractive force curve of 4,000 hp. Diesel-electric locomotive having two body units, each with two 1,000-hp. Diesel engines, two generators and four traction motors—36-in. truck wheels and 52:25 gear ratio

[Note: Mr. Gill presented a paper on this subject before the Society of Automotive Engineers at Los Angeles, Cal., February 9, 1940, a considerable portion of which was used in the paper presented at this meeting. The previous paper was published in the *Railway Mechanical Engineer*, April, 1940, page 131 and the reader is referred to that paper for additional details not included in this abstract. The inspection and repair forms, and maintenance record form, Nos. 1226-DS and 1226 D will be found on pages 133, 134 and 135 of that issue.—EDITOR]

weight per axle limitations; and, horsepower required to drive cooling apparatus.

In maintaining and operating Diesel locomotives, one of the major problems confronting all railroads was to train personnel to handle and maintain this type of power. New facilities, tools, etc., were required. That the railroads have met this problem is evidenced by the performance of the locomotives.

Maintenance Methods and Facilities

At Chicago, the Santa Fe has built a shop especially designed for handling Diesel locomotive repairs. With these new facilities, repairs should be expedited, resulting in greater availability for service and reduction in maintenance costs.

Special maintenance and inspection schedules in addition to the I. C. C. requirements have been found necessary to secure reliable economical service from the locomotives. These requirements are met by the schedule shown on Form 1226-DS, Santa Fe Standard, for Diesel-electric switch locomotives. This schedule is based on monthly service.

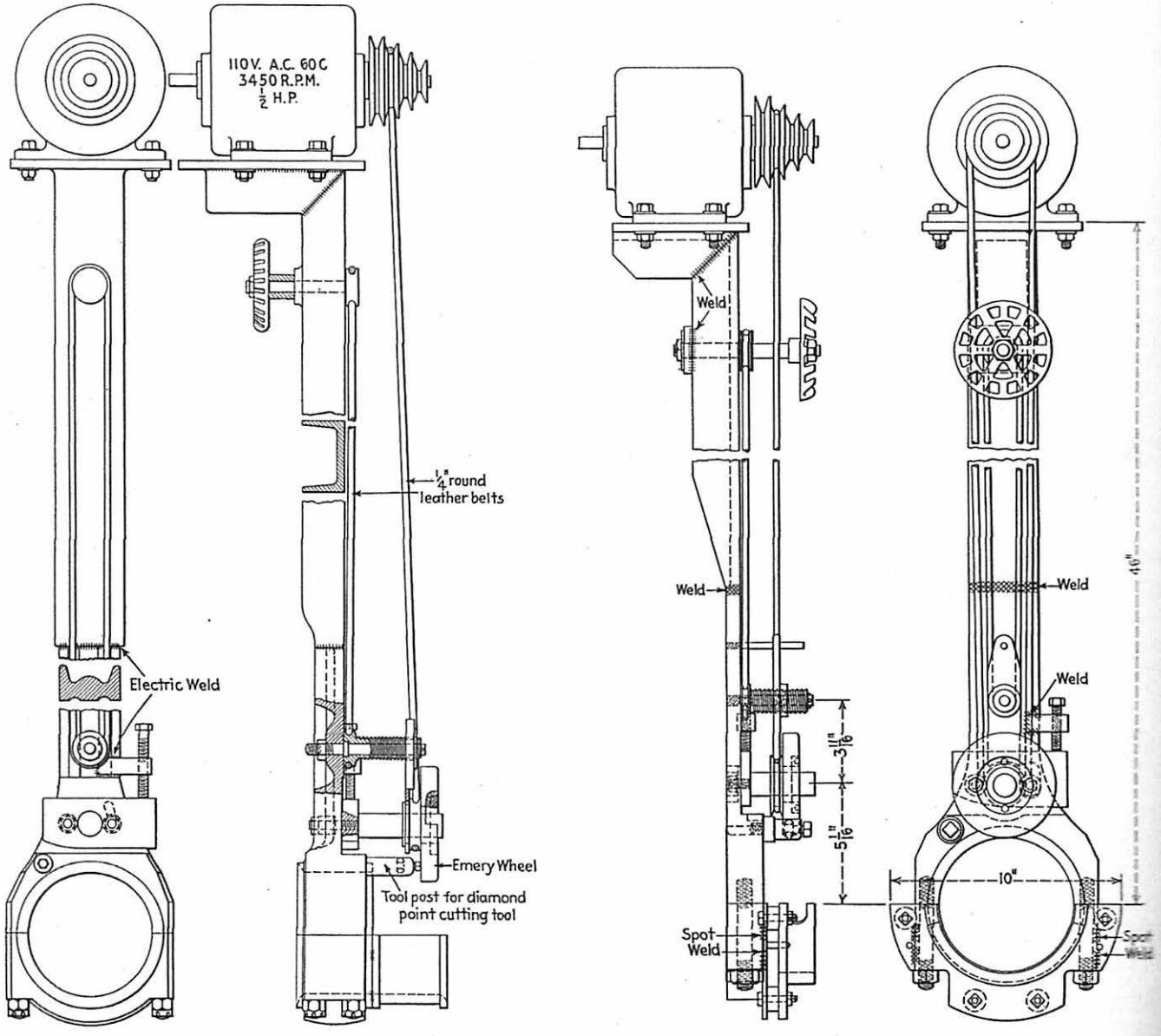
For road service, the schedule outlined on Form 1226-D*, Santa Fe Standard, is followed. Maintenance and inspections for road service are handled on a mileage basis. A copy of Form 1226-D is carried on each respective locomotive unit; therefore, the record of maintenance and inspection is always available to maintenance forces over the system.

A special instruction bulletin has been issued to cover in detail just what attention each item on Forms 1226-D and 1226-DS requires.*

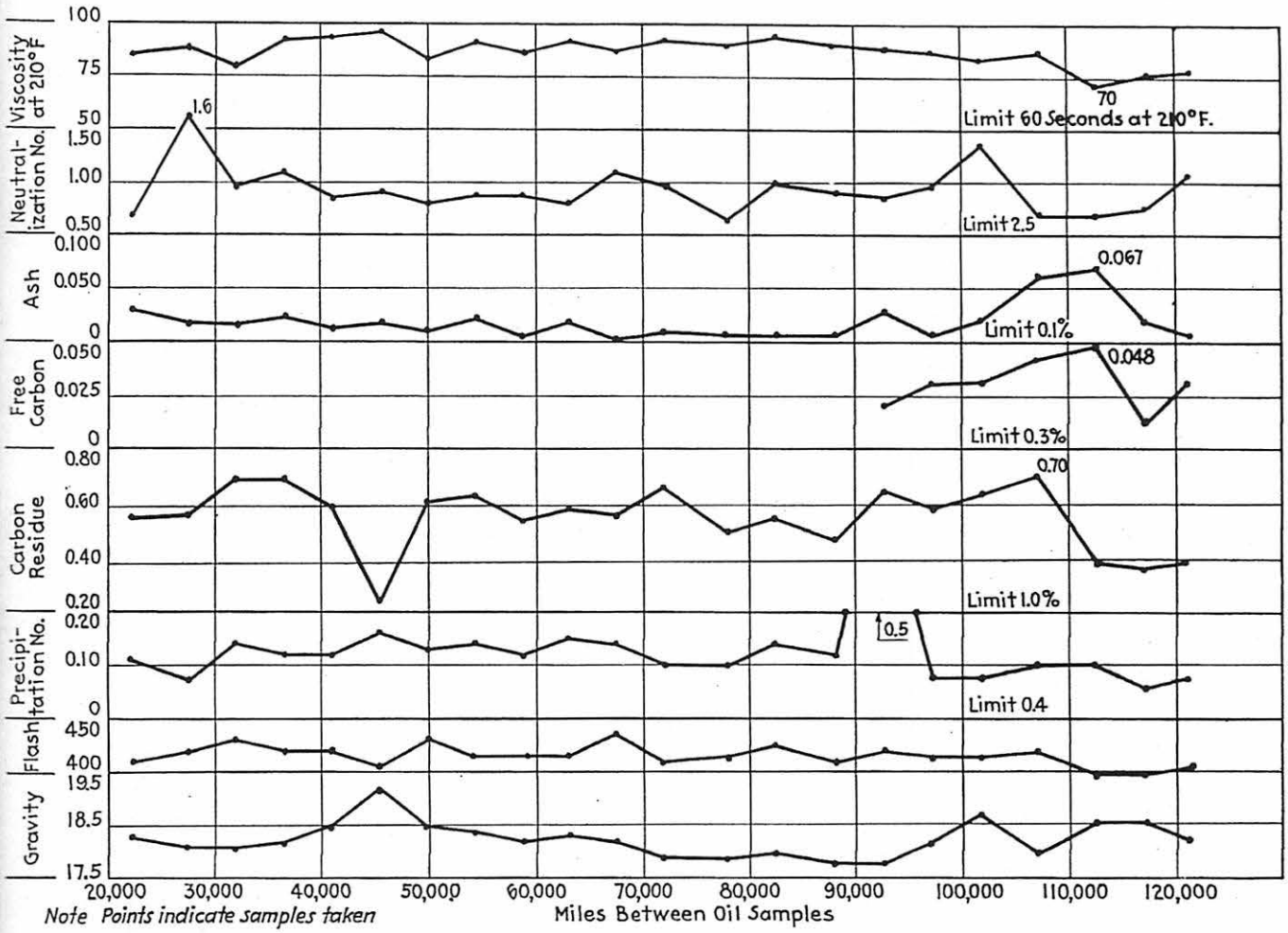
In road service a Diesel maintainer always rides the locomotive while it is in service. These maintainers are organized on a system basis. They make a complete log report of each trip, report to maintenance terminals all repairs and inspections required, and inspect their locomotives *sufficiently in advance of departure from terminal* to insure that necessary repairs have been properly performed.

A specially trained man has been assigned to follow the disposition of materials and he also keeps mileage records of locomotive performance and records of service

* Portions of the bulletin were published in the May and October, 1940, issues of *Railway Mechanical Engineer*. The forms mentioned appeared in the April, 1940, issue.



Two types of crankshaft, crank throw grinding machines designed and built by the Santa Fe. The type at the left is for grinding the pins on V-type Diesel engines where two connecting rods are side by side on the same throw; the machine at the right is for all types of Diesel engines which have only one connecting rod on each crank throw



Lubricating oil analysis chart showing condition of crankcase oil over 120,000 miles of service without oil change

received from cylinder heads, cylinder liners, pistons, traction motors, axles, wheels and other parts that are subject to frequent inspections or renewals.

Another specially trained Diesel man is assigned to follow switch locomotives over the system. He inspects the locomotives, checks the operation and instructs maintenance forces and operating crews in proper Santa Fe practices.

Lubrication and Mechanical Changes

Lubrication has played an important part in the operation of Diesel engines. By the use of effective oil filters the lubricating-oil drain periods in high-speed passenger service have been increased from 5,000 miles to 100,000 miles of service. In switchers, crankcase lubricating oil is changed every three to six months of service. The lubricating oil analysis chart shows the condition of crankcase lubricating oil covering 120,000 miles of service without changing oil.

It has been found desirable to conduct service tests in addition to laboratory tests before deciding upon the acceptability of fuel and lubricating oil.

All of the present road locomotives are powered with two-cycle Diesel engines. Since these locomotives are operated under a load factor of about 60 per cent, more trouble is experienced with the Diesel engines. In fact the Diesel-engine maintenance expense comprises about 50 per cent of the total locomotive-repair costs. Therefore, the two-cycle Diesel engine used in this service has been given a great deal of thought resulting in many improvements.

Pistons and cylinder heads are removed every 100,000 miles for inspection and servicing. Crankshaft bearings

Table I—Average Cost of Operation Per Service Hour for 1,000 HP Switch Locomotives—Year 1939

	1,000 hp., 4-cycle Diesel-elec. loco.	1,000 hp., 2-cycle Diesel-elec. loco.
Fuel	$0.282	$0.261
Locomotive repairs, labor and materials	0.119	0.336
Estimated cost general repairs	0.250	0.250
Enginehouse expense	0.026	0.028
Lubrication	0.022	0.045
Supplies	0.021	0.014
Total cost per service hour	$0.720	$0.934

Note—Figures do not include depreciation or wages of enginemen.

are inspected at this time and interior of engine thoroughly cleaned out.

Cylinder liners that were worn 50 to 60 thousandths

Table II—Cost of Operation per Mile—High-speed Passenger Service 4,000 HP—Year 1939

Fuel	$0.123
Locomotive repairs, labor and material	0.137
Lubrication	0.011
Supplies	0.007
Water	....
Total cost per mile	$0.278

Note—Figures do not include wages of enginemen or depreciation.

of an inch in about 60,000 miles are now removed when worn 20 thousandths of an inch after 325,000 miles of service and are re-conditioned for re-application.

Piston design has improved. At the present time, the drop-forged aluminum piston with greatly increased ring land width is giving the most dependable service. Piston

assemblies are removed for inspection every 100,000 miles and the service mileage received from pistons removed from road locomotives to date is 220,000 miles. This mileage feature will be greatly increased as new type pistons replace the older design.

Air for engine radiators is now carried through ducts eliminating dirt from this source getting in the engine rooms.

Wheels have been greatly improved. The service life of present wheels is about 250,000 miles with about 84,000 miles between machinings.

A crankshaft crank-throw grinding machine, designed and built on the Santa Fe, is now used at important terminals. By using this machine, we expect to run 1½ million miles in road service before removing crankshafts from the Diesel engines.

The Electro-Motive Corporation has built a 5,400 hp. freight locomotive powered with four 1,350 hp. Diesel engines. It has a starting tractive force of over 200,000 lb. and a maximum speed of 73 m. p. h. Extensive tests of this locomotive were very satisfactory, and two of these locomotives have been ordered. Two 44-ton switchers have also been ordered.

Discussion

In discussing the maintenance of Diesel locomotives one member from an eastern road raised a question as to the cause of the cracking of cylinder heads, mentioning the fact that on one recent trip six out of twelve heads on one engine were found to be cracked. Mr. Gill replied that when such a condition was found it could usually be traced to defective cooling and suggested that the engine cooling system be thoroughly checked for air locking, or binding, in some part of the cooling system.

Another member raised the question of comparative maintenance costs between Diesel and steam power. The speaker called attention to the fact that when costs are compared they must be compared on specific cases and conditions and said that a recent check of comparative costs between a steam passenger locomotive of 4,464 hp. and a Diesel of 4,000 hp., over a 30-day period, showed a cost of 19 cents a locomotive-mile for steam and 17 cents for Diesel. As to engine failures, it was brought out that on one road the average mileage between engine failures was 74,000 for steam and 144,000 for Diesels.

Future Locomotive Air-Brake Maintenance

By J. P. Stewart

General supervisor air brakes, Missouri Pacific

Train operation requirements have been and are constantly growing in magnitude and complexity. Faster schedules, higher speeds, longer trains, heavier tonnage per train, greater tonnage per car, new designs in motive power, high speed, light-weight trains, all are constantly calling for new appliances and improvements in existing standards.

As changes have been made in equipment, the application of new and special appliances have increased the responsibilities of the supervisor of locomotive equipment.

To meet this progress in transportation has not only increased the responsibility of supervision, but has brought about a change in the system of maintaining the equipment. Today, more than ever, it must always be first in mind to find the small, or the beginning of, defects. The elimination of a small defect is often the eventual elimination of an engine failure and a saving in man hours and expense. It is a big mistake to put off the elimination of a small defect until next trip because it is constantly becoming a major defect, and what today is a minor defect, if allowed to continue, will tomorrow be a major defect and perhaps an engine failure. Therefore, I wish to register with each of you that in the most perfect operating equipment, it is the elimination of the small defect that gives the efficient operation and keeps the cost of maintenance low. With the increased demands for speed put on the locomotive today, the locomotive must leave the terminal absolutely free of defects, either major or minor.

In this paper I am constantly bearing in mind the proper procedure to follow to bring about the results necessary for perfect train operation.

I know it is often difficult for the old timer to adopt new systems. There was a time when the air-brake inspector or air brake machinist was considered a specialist, and the real profession of the operation of the air-brake equipment was surrounded with a veil of mystery, and, when the apprentice started serving his time he was sworn never to reveal any of the arts of his profession unless it was to a bonafide student who was also serving his time. Today we are endeavoring to make all familiar not only with the maintenance and operation but with all the effects of the equipment and the manner in which to continue the operation regardless of defects.

Exit the Specialist

In my opinion, the day of the air-brake man as a specialist is coming to a close. To stay up in the ranks of up-to-date supervisors, a man has to be familiar with the operation and maintenance details of many different appliances and types of equipment. This is made possible by the manufacturers, associations, sales organizations and service engineers and by high class literature which makes it possible for any man to master any part of the equipment or any special appliance. Do not misunderstand me, that I am trying to advance the idea that all men working in the shop or roundhouse should be expert air-brake man, but the thought I wish to convey is that any man who so desires can, by applying a little time and study, familiarize himself with the operation and maintenance of all parts of the locomotive equipment, or any of the special devices, so that he will actually have a wider knowledge and a better understanding of the device or appliance than did the so-called expert of yesterday. Furthermore, it will not cost this seeker of information one penny for text books or lessons, but just for a few three-cent stamps he will have delivered right to his door, books, pamphlets, and literature furnished free by the manufacturers, which a few years ago could not be purchased at any price. Furthermore, the veil of mystery has been removed from the process of assembly and manufacturing so that today anyone who desires may visit any of the large manufacturing or processing plants, where he will be taken on an educational tour of instruction and inspection.

I wish to pay the greatest tribute to the locomotive manufacturers, and, when I say locomotive, I include all companies that manufacture special appliances for loco-

motives, for the educational advantages and the efforts they are putting forth to educate the railroad employes in the operation and maintenance of their equipment.

Not so long ago I had a forceful example of this. On two divisions we had large freight locomotives equipped with a special appliance with which most of you men are familiar. About every other day on the morning delay report there would appear a delay of 10, 15 or 20 minutes because of the failure of this appliance. We sent the air-brake instruction car to that territory and, as attendance for enginemen is compulsory, every engineman attended the car and received his card of attendance. In spite of all that the master mechanic, general foreman, road foreman of engines, my assistant or myself could do, these little annoying delays would show up. They were not real engine failures or appliance failures; they were man failures, so we asked the appliance company for several hundred instruction books. These books were gladly furnished and we gave one to each engineer and fireman. The result was that in two weeks, as far as the delays were concerned, you would not know we had such an appliance on our locomotives.

For our railroad to have printed such instruction books would have cost at least 50 cents per book, the compilation of the information would have cost considerably more, and as the distribution ran into hundreds, this educational drive would have been prohibitive without the entire cooperation and support of the manufacturing company. Therefore, I trust you appreciate the educational facilities we have gratis, and, by taking advantage of it, will greatly assist in reducing maintenance costs and also reduce the number of delays.

With the facilities of education we now have, let us now get to the real meat of this paper and see how we can get the best maintenance of the air-brake equipment at the most economical cost. I want to warn you that I will be unable to hold my thoughts directly on air-brake equipment alone. As we proceed, you will see that the methods of maintenance I outline will include air-brake equipment, as well as other important appliances.

Today the duties of locomotive maintenance supervisors, such as shop superintendents, master mechanics and general foremen, are so manifold that it is absolutely impossible for them to be in direct touch with most of the maintenance. Consider for a minute the time consumed in attending meetings, such as craft committee meetings, safety meetings, budget meetings, booster meetings, charity drives, etc. For this reason, he must have working under him men who are not only loyal to his interests but who know their jobs and have the ability to function without personal supervision. Therefore, I am going to build up a shop organization designed to get the best maintenance at the most economical rate for the back shop.

The Ideal Shop Organization

First, all special appliances should be together in one department or unit. By that I mean air-brake equipment, boosters, stokers, feedwater heaters, exhaust-steam injectors, injectors, force-feed and hydrostatic lubricators, reverse gears, gauges, air fire doors, bell ringers, and steam-heat equipment. Over these I am going to place a foreman, a monthly rated man. The general foreman is going to give this man absolute authority over the repairing and testing of this equipment. When a locomotive comes into the shop, this foreman will see that this class of equipment is removed, overhauled, tested and made ready for replacement on the locomotive.

The cost of overhauling is up to this man, and he alone can sign requisitions for new material. The only parts of the equipment he does not have the authority to supervise is the electrical equipment which coordinates with the air-brake equipment on some of the high-speed brake schedules. This equipment is sent by him after removal to the electric shop and, after being repaired, it is sent back to the special-appliance shop. It is up to the judgment of this foreman as to the amount of work necessary on the appliances; also, this foreman must be familiar with the operation and maintenance of the different appliances. He must be the direct representative of the general foreman, and, as the shop superintendent holds his general foreman responsible, so, in turn, the general foreman holds his foreman of appliance maintenance responsible, just as he holds his boiler foreman, machine foreman, blacksmith or pipe foreman responsible.

You will be surprised to see how the maintenance of the different appliances is naturally associated. As an illustration, the air-pump mechanic, with very little training, becomes an efficient feed-water-pump mechanic; the stoker mechanic grasps the maintenance of boosters; the fire doors, reverse gears and bell ringers group themselves together; while the gages, force-feed lubricator and speed indicator appear to come under the handling of one mechanic; and the feed valve, brake valve and distributing valve will come under the same mechanic. Thus, as these men become familiar with the same classes of equipment, they become more efficient.

On the railroad I represent, we have two main shops in which we have this system. In order to distinguish these men, they are given the title of air-brake foremen, which they still carry, but, in reality, they are foremen of special-appliance maintenance. Both of these foremen are students picked from the ranks because they were first-class mechanics, loyal to their superiors, pleasant to work with and below middle age.

The Enginehouse Supervisor's Problem

The master mechanics and general foremen of the engine houses are up against a different proposition. Theirs is altogether a different line of operation than the back-shop supervisors. For the master mechanic and enginehouse foreman the whistle never blows; it does not blow to stop work, therefore, it cannot blow for them to start. It is not an eight-hour shop; their telephone is always ringing. Their one duty is to furnish engines when the despatcher needs them regardless of the amount of work necessary to be done on the engine. It must be ready when needed.

Each enginehouse foreman should have two good men in the positions of lead airman and engine director. In picking these two men, we should consider, first—that they should be young enough so that it is easy for them to study and learn and thus keep pace with the advance progress of new appliances and equipment, and second—that they should have sufficient seniority so they will not be displaced everytime there is a force reduction. It is very discouraging to go to a point and find a man inspecting engines who does not know the names of the different pipes on the distributing valves.

We might classify these two positions as the "finder" and the "fixer." To them the foreman looks for the analysis of the condition of the locomotive. Usually it is to the engine inspector's, or the "finder's" report that he looks before he tells the dispatcher how soon he can have the engine.

Now we are going to make a "finder" out of our engine inspector. In addition to just inspecting the engine for I. C. C. defects, we are going to make an air-brake test man of him.

Locomotive Equipment Has Changed

A few years ago, the locomotive air-brake equipment consisted of a 9½-in. pump, reservoir, brake cylinder, feed valve and brake rigging, G-6 brake valve and a Du-

plex air gage. At that time we had to have a special air-brake man to test out that brake equipment. I find in many places that we still cling to that system. Today we have large power, compound pumps, special appliances, H-6 and H-8 brake schedule, or HSC electro-pneumatic brake or HSC automatic brake schedule, but, in spite of all these increases, I say we should not have to have a specialist to test the air-brake equipment. This does not seem consistent, following a comparison of the present and past equipment. With the increased parts of the present equipment, I feel that, with the educational advantages I have so fully previously described and the superior quality of the present-day equipment, both in precision of construction and operation, the superior materials now used with the adoption of the composition gaskets and seats, more detail and greater attention to engineering and tests before being approved for service, there is no need for so much specialization in special appliances and air-brake equipment, as in the past. At the roundhouse, keep the air-brake mechanic as a fixer and use the engine inspector as a finder. That does not mean that the air-brake mechanic should not test out the equipment. Whenever any work is done on any appliance, he should test it out before he pronounces it OK. But to let the engine come in and not get the air-brake equipment tested until the air-brake mechanic gets to it, may result in unanticipated delay.

Now let's see how this works. In the first place, I believe strongly in inbound inspection and test. This gives the foreman assistance in distributing his force. Information developed in this manner, in addition to that shown on the engineman's or road foreman's work reports, enables the foreman to know what work has to be done on the engine and how long before the engine can be reported ready for service. So, as soon as possible after engine arrives on the incoming lead, the inspector will start his inspection and, as he looks for I. C. C. defects, he will also inspect the brake equipment. The locomotive should be left with brakes applied so the inspector will get his brake piston travel. As he passes the main reservoir, he will open the bleed cock on the main reservoir, which will cause the air compressor to start working, and he will listen for pounds and blows. When he gets up in the cab and checks, he will make the following tests:

1—Release brakes, adjust feed valves to standard pressure and note variation of feed valve which must not exceed 2 lb. per min. At the same time note adjustment of low-pressure governor.

2—Make a 10-lb. brake-pipe reduction with the automatic brake valve. Note that preliminary exhaust port is open and equalizing piston raises. Place automatic brake valve on lap position. Note brake-pipe leakage which should not exceed 3 lb. per min. Note adjustment of high-pressure governor. Release brakes.

3—Apply brakes with independent brake valve in slow-application position with 5-lb. brake-cylinder pressure. Move brake valve to running position. Brakes should release.

4—Apply independent brake valve fully in quick-service position. Brake-cylinder gage will show adjustment of reducing valve. Spring should return handle of independent brake valve to slow-service position. Move automatic brake valve to full-service position. Note adjustment of safety valve on distributing valve. Release brakes.

5—With automatic brake valve make a 5-lb. brake-pipe reduction. Brakes should apply. Move automatic brake valve to running position. Brakes should release.

6—With automatic brake valve in running position, brake-pipe hand and equalizing-reservoir hand on large and small duplex gages should correspond. Move automatic brake valve to full release position. Warning port should blow and brake pipe and equalizing-gage hands should register within 3 lb. of main-reservoir hand. Move brake valve to running position.

7—Move automatic brake valve to emergency position. Brake should apply in emergency. Return brake valve to lap position and note no increase in brake pipe pressure. Also note that brake-cylinder pressure does not decrease.

These tests can be made in a very short time, and will prove that brakes are operating and all operations meet the I. C. C. requirements as set forth in Rule No. 106.

Should the inspector find the brakes do not meet these tests, he will at once give a report to the air-brake mechanic or lead man whose duty it is to find the defect and make necessary repairs.

I. C. C. requirements are that an orifice test be made on the air compressor once each three months. I will recommend that the air-brake mechanic make an orifice test on compressors once each 30 days. He should keep a running record of each orifice test. When the orifice test shows that the strokes are nearing the limit, he can arrange to apply new rings or change compressors on a trip most convenient, and he can spread out his heavy compressor work so as not to have this work coming due when he is busy on monthly or quarterly inspections. I strongly advocate the application of a copper tag to each compressor showing shop initials and date pump received last general overhauling. This gives the foreman and air-brake man a line on the quality of work coming out of the shop and length of service before receiving necessary repairs.

It is necessary that the air-brake mechanic make tests for brake-cylinder leakage at frequent intervals. Brake cylinders should be given a first-class cleaning at time of general overhauling of locomotive. At that time new composition packing cups should be applied. Then it will not be necessary to clean brake cylinders again until brake-cylinder leakage is such that locomotive or tender brakes will not remain applied five minutes with communication to brake cylinders closed.

This is worthy consideration, as on the large modern locomotive it is a lengthy and costly job to clean and lubricate the brake cylinders. I find that if the brake cylinders are properly conditioned, lubricated and equipped with good composition packing cups the locomotive will run a long time before it becomes necessary to clean brake cylinders.

As to other tests necessary to maintain the equipment, the air-brake man can be governed by local conditions.

Enginehouse Maintenance Organization

Therefore, for the enginehouse we have two men, each of them with knowledge of air-brake and special appliances. First is an inspector who can make and check the seven simple tests I have previously outlined and who is familiar with the I. C. C. requirements.

Second is the air-brake leadman or air-brake mechanic who should be familiar with the purposes of each part of the equipment; operation of the equipment; defects and what results different defects will produce; method of making repairs and know when it is necessary to renew parts; short cuts to get results and be able to keep the equipment operating until place is reached where proper repairs can be made; testing the equipment, and I. C. C. requirements as to tests and cleaning periods.

There are two other men who are of great value to the master mechanic, general foreman and roundhouse foreman; they are the road foreman of engines and air-brake instructor or inspector. Those two men should be familiar with the working conditions of the locomotive and all special appliances. They should instruct the enginemen in the proper operation of all the equipment and especially in proper train handling. In the maintenance of air-brake equipment and all other appliances, they should instruct the enginemen in the proper method of handling; how to test for defects; as to manner of finding and reporting defects and impress on them the importance of making intelligent work reports, and how to make repairs on the line of road so as to avoid delays or engine failures.

One of the most valuable assets is to have a road foreman who can impress enginemen with the importance of making proper work reports. One way for the general

foreman, road foreman and air-brake instructor to have the full cooperation of the enginemen in making reports to assist in the maintenance is to give the enginemen credit when due. Pay heed to their reports and listen to their complaints and grievances. The enginemen will be encouraged to tell you their troubles and will go out of their way to avoid a delay or to bring to your attention some defect that, if neglected, may tie up a division.

New Type of Officer Needed

Today the job of a locomotive maintenance officer is a real, live, "he-man's" job. Never in history has transportation demanded such real major-league talent to stay in the game. The day of the hard-swearing, tobacco-chewing, rough-neck official is a thing of the past. The locomotive maintenance officer of today is a student. He has more duties and more responsibility than ever before, and as the changes and advancements continue to increase, so do his responsibilities increase, and more and more he realizes the importance of proper maintenance. Also does he realize that to get and keep this efficient state of maintenance in the future, he needs more and more the full and hearty cooperation of all those with whom he works and with all those who come in contact with those who represent his organization.

There are many ways and means of reaching our objective, which is a higher state of maintenance and efficiency at an economical rate. As the future will bring out new designs of equipment, and new and improved appliances, so will it bring out better and improved methods of maintenance.

I have no fear; I know the class of men we have as locomotive maintenance officers, and the men working under them will meet and conquer all emergencies and will always be on top of their jobs.

Discussion

Exception was taken, by one member, to the idea of doing any maintenance work on air-brake equipment at any enginehouse on the ground that it is not feasible to equip terminals with the necessary afcilities to do a good job. This type of equipment, said the member, should be maintained only in a special air-brake repair shop equipped with high-grade facilities such as will permit first-class work on precision parts. Only in this way can this important equipment be maintained so as to eliminate failures in service. Just as an example, he said, one road went through an entire year without an air-compressor failure and, on that road compressors are now running 3½ to 4 years between replacements. This kind of service, he said, is possible only where the work is done in a specialized shop. This member recommended the establishment of a committee in the association to develop a report on shop practices in connection with air-brake work. (This recommendation was acted upon by the association's executive board and such a committee will be appointed and instructed to report at the next annual meeting—EDITOR.)

Locomotive Maintenance for Long Runs

By Lee Robinson

Superintendent of Equipment, Illinois Central

What is a long run, and what is the standard of comparison regarding proper maintenance? It is more than likely that the so-called long run is now the common run and the short run is the rarity, but we still have locomotive runs with the consequent maintenance to take care of and I do not feel it is a great deal different from formerly, especially where we are dealing with the same equipment we had in former years.

Naturally, we have a somewhat different set of conditions to consider and handle today, but it makes me feel a little put out when we ascribe them to long runs. If it was just a matter of mileage to consider, it should not cause much concern, but there is another more important factor which has entered the picture and that is speed. When the distance between final or lay-over terminals is extended and then the rate of speed between these terminals is greatly increased, new problems are injected and new costs are created which were not necessary to deal with in past years.

We are dealing with equipment, which to a large extent was designed and built for service under the entirely different conditions of 15 to 20 years ago, so that a somewhat new job must be done with old tools not particularly designed for the purpose.

Improvements Have Been Made

Naturally, improvements have been made on the older equipment to meet present-day requirements. More attention has been given to the design and application of ash pans, grates, brick arches, front-end arrangements, nozzle and stack sizes, steam distribution, driving-wheel design and lubrication. Also where boiler construction permitted steam pressures have been increased.

The general "pepping up" of this equipment to meet the increased service demands has necessitated closer inspection and working to closer tolerances than was considered necessary in the past, but if these features are not continually followed up to see that both the inspectors and the mechanics fulfill these requirements, then the desired effort is lost and troubles appear rapidly. Locomotives have a habit of showing the lack of proper attention at the most inopportune times, requiring studied explanations and much extra correspondence concerning the cause of the ensuing failure or delay resulting from some remiss action on the part of the inspection or maintenance forces. The monotony of daily routine is a factor we must all fight to prevent workmen from getting into a rut, resulting in perfunctory handling of their work, and it is more important than ever that supervisors be on the alert to overcome and remedy such a condition.

A frequent notation on an inspector's work report is "tighten bolts." This is too often taken literally by merely tightening nuts instead of investigating the cause and making the proper repairs. Wherever the use of bolts can be eliminated by redesigning, the present parts should be replaced by new parts as rapidly as possible. A loose part here and there throws an added strain on some other part which usually results in the failure of the latter. This emphasizes the necessity of making lasting repairs when such repairs are performed.

The increased vibration due to high speed causes looseness throughout the locomotive to a much greater degree than was the case in the past, and it is absolutely necessary that closer inspection and the best workmanship be obtained in making repairs, particularly to those

parts which may have a tendency to work loose in service.

Influence of Fuel and Water on Maintenance

The quality of the fuel and water available for use naturally plays an important part in the maintenance expense of locomotives, and while mechanical supervisors do not have the final decision as to the source of supply of these items, those concerned in the fuel and water supply should constantly be reminded of the importance of uniform grades of fuel and boiler water. When treated water is used systematically—controlled blowing off of the boiler on the road and at terminals will naturally reduce flue and boiler maintenance costs, as well as boiler-washing expense.

What I have said is nothing new to any of you, but I feel that constant reiteration of the right things has a tendency to make them second nature.

Naturally, "the objective of long runs is to obtain increased utilization of locomotives, but the economics of the situation existing on each railroad will eventually determine the length of locomotive runs on the various properties in the country.

Mechanical-department officers and supervisors should familiarize themselves with the operating conditions on the various divisions over which the locomotives under their jurisdiction operate, in order fully to understand the work these engines are expected to do between final terminals and handle the power to meet satisfactorily the existing conditions peculiar to those runs."

Discussion

One member made the statement that today, when locomotives were required to make runs in many cases five times as long as was formerly the case that locomotive parts had to stay tight five times as long; that it was no longer a job of going around tightening up nuts but that no effort should be spared to find out why parts came loose and eliminate the cause, by changes in the design of parts, if necessary.

A master mechanic suggested that one of the most important things today is to make sure that a locomotive is properly aligned and that a considerable improvement in condition of power had been effected on his road by checking locomotive alignment at enginehouses.

A shop foreman with previous enginehouse experience suggested that many roads were not entirely fair to apprentices in training them exclusively in back shops for service in the enginehouse at the completion of their time; that the apprentice should be given a chance by training him at an enginehouse under the conditions where he must ultimately work. By doing this the standard of enginehouse repair work can be raised.

Mr. Robinson summed up the discussion with the remark that there is still too much buck passing between enginehouse foremen and that all outlying terminal foremen should do their own work and do just as good a job as the home terminal. He also stated that one of our greatest problems is that of lubrication and that every effort should be made to improve lubrication methods.

The Responsibility of the Locomotive Maintenance Officer and the Federal Inspector

By John M. Hall

Director, Bureau of Locomotive Inspection, I. C. C.

If we use your meeting last year and your program this year as measuring sticks of what to expect in the future I can say with confidence that you will be an exceedingly valuable asset to the railroads at present and during the years to come. Railroads spend more money for locomotive repairs than for any other single item of operating expense. There is need for reduction of costs of maintenance accompanied by continuous improvement in locomotive performance and your association is one of the most effective agencies through which these twin accomplishments may be effected.

I promised to talk on the responsibility of the locomotive maintenance officer and the federal inspector. It may be unnecessary to remark that the proper carrying out of the respective responsibilities is essential if the maximum degree of usefulness of locomotives and freedom from failures and accidents is to be obtained.

The purpose of the law is to promote the safety of employees and travelers upon railroads by making it unlawful for any common carrier by railroad to use or permit to be used on its line any locomotive that is not in proper condition and safe to operate without unnecessary peril to life or limb.

Responsibility of Maintenance Officers and the Federal Inspector

Rule 102 specifies that the mechanical officer in charge, at each point where repairs are made, will be held responsible for the inspection and repair of all parts of locomotives and tenders under his jurisdiction. He must know that inspections are made as required and that the defects are properly repaired before the locomotive is returned to service.

Section 6 of the law, specifies, among other things, that the first duty of the federal inspector shall be to see that the carriers make inspections in accordance with the rules and regulations established or approved by the Interstate Commerce Commission, that carriers repair the defects which such inspections disclose before the locomotives are again put in service, and if the inspector finds a locomotive not conforming to the requirements of the law and rules, he shall notify the carrier in writing that the locomotive is not in serviceable condition and thereafter the locomotive shall not be used until proper repairs are made.

Purpose and Necessity of Daily and Periodic Inspections

It is the purpose of the daily, monthly, quarterly, and annual inspections required to be made by the railroads to disclose wear and deterioration that inevitably develops in service and to detect weaknesses that may have been unintentionally or thoughtlessly incorporated in construction or when making repairs. Vigilance should be exercised on the part of the railroads so that all defects and conditions that indicate a defect is in the process of development will be found at the inspections. If this procedure is carried out thoroughly and conscientiously and proper and timely repairs are made, engine failures, which are a waste of money, and their accompanying personal injuries, which are a waste of human resources, will be practically eliminated. If engine failures or train delays must be had the proper place to have them is at the terminal where safe and economical repairs can be made.

The responsibility for thorough inspection and proper

repairs in all the various phases constitute a rather large subject running all the way from the trip or daily inspection, the monthly inspection, quarterly inspection, to the annual inspection which also includes the final inspection after the locomotive is turned out of the back shop newly overhauled and ready for another term of service.

The time is too short on this occasion to go into all the essentials of each inspection and the necessity of turning the locomotive out after each kind of inspection in such shape that it can be safely used without liability of failure for a maximum possible period of service; therefore, other than to say that maintenance officers must approve or certify to each inspection report, my remarks in this connection will be confined to the trip or daily inspection required by Rule 104 of the steam locomotive rules and Rule 203 of the rules for locomotives propelled by power other than steam. These rules are alike and read as follows:

> Each locomotive and tender shall be inspected after each trip, or day's work, and the defects found reported on an approved form to the proper representative of the company. This form shall show the name of the railroad, the initials and number of the locomotive, the place, date, and time of the inspection, the defects found, and the signature of the employee making the inspection. The report shall be approved by the foreman, with proper written explanation made thereon for defects reported which were not repaired before the locomotive is returned to service. The report shall then be filed in the office of the railroad company at the place where the inspection is made.

This trip or daily inspection, and report thereof, enables those in charge of running repairs to keep informed of the current condition of each locomotive. The value of the inspection reports in the elimination or reduction of defects depends upon the thoroughness of the inspections made, the integrity and clarity of the reports, and the amount of interest displayed by the maintenance officers having jurisdiction over repairs. It is not the purpose of the rule to permit locomotives to be returned to service with any defects in violation of the law or any rule or regulation made thereunder or with any condition that would likely develop into any violation during the succeeding trip.

We have now reached the point at which decision must be made as to what reported defects shall be made and what repairs, if any, may be deferred. It might seem to some unnecessary to say that the decision should not be based on expediency, but unfortunately we too often find that this is the case. We also sometimes find that the report is approved without any attempt to make repairs to reported defects and without any written explanation on the report as to why repairs were not made. Approval of an inspection report under these circumstances puts the maintenance officer whose signature appears thereon in a rather untenable position as he has evaded a plain requirement of the law and rules and has made his railroad company liable for the penalty provided in the law for violations of the requirements.

It is not uncommon to find the same defects repeatedly reported, together with indications that at least some attempts had been made at repairs each time reported. We have had some instances, and these seem to be increasing, where the same defects were reported time after time and notations made on the reports each time that would indicate that repairs had been made, but if made they were ineffectual and culminated in failure of the reported parts, resulting in injuries or death. Repeated reporting of any item should be ample warning that the methods of repair were not effective, that progress was not being made, and that time and money were being wasted and human life endangered. Many maintenance officers do not take full advantage of the opportunity afforded by the trip or daily inspection reports to keep informed of the sufficiency and durability of repairs. Comparisons of the items reported on individual locomotives from trip to trip will point out ineffective repair methods and can be recommended to you as a procedure that will, if properly followed up and suitable action taken, pay big dividends in reduction of defects, greater security of those who work on or about locomotives, and reduced maintenance costs. If a defective condition is repeatedly reported it is evidence that there is something wrong, therefore the cause should be found and an effective repair applied.

As an example of repeated failures most of which could have been avoided I will cite a succession of failures, on a comparatively small but important railroad which I shall not name, that I am sure none of you would like to encounter on your road. In a 12 month period, April 1, 1939, to March 31, 1940, a total of 54 stoker failures occurred; 34, or 63 per cent, resulted from failure of mechanical parts of the stokers; 10, or 18.5 per cent, were ascribed by the railroad to miscellaneous causes, worn parts, maladjustments, etc.; and another 10, or 18.5 per cent were attributed to foreign substance in the coal. By far the greater number of these failures could have been avoided by thorough inspection, proper attention to the inspection reports, and timely application of needed repairs.

It is essential that systematic procedure be adopted in routing a locomotive through the various steps after arrival and that due weight be placed on the necessity for thorough and complete inspection. Upon arrival of a locomotive at a roundhouse or shop terminal, or as soon thereafter as possible, tests should be made for blows, pounds and steam leaks before the boiler pressure is allowed to drop appreciably and all visible parts of the boiler, machinery and tender, should be thoroughly inspected and all defects found reported on the required form in an intelligible manner. In addition to the inbound inspection, parts that have been reported as needing repairs, together with all parts upon which work has been done during the lay over, should be thoroughly inspected before departure to make sure that all work has been properly completed.

Injectors, feed water heater equipment, water-level indicating devices, low water alarms, brake and signal equipment, lighting equipment, train control equipment, and other special devices should be tested and known to be in proper condition before starting each trip.

The carriers enjoying the greatest success in eliminating defects are those having a systematic outbound as well as a systematic inbound inspection.

It is a well recognized principle of all successful production methods that thorough inspection of each component part, and of the assembled unit, is essential in the control of quality and I have therefore emphasized inspection, before and after applying repairs, as a prime requisite in the process of preventing engine failures and their accompanying casualties.

I may here remind you that the requirements of the law and rules covering the construction, inspection and repair of locomotives and tenders are the rules and regulations recommended and established by the best known authorities on mechanical matters, such as the Mechanical Division of the American Railway Association and its successor, the Mechanical Division of the Association of American Railroads, locomotive builders, and standard practices adopted by the railroads prior to and subsequent to the enactment of the Locomotive Inspection Law. The requirements of the law and the rules and regulations established thereunder are not new and untried theories, but are based on well known and established practices. It is therefore essential that the officer charged with the duty of passing upon inspection reports

and necessary repairs have thorough knowledge of the requirements and be endowed with sound judgment in order that all repairs may be made in proper time and place and, in order to keep on the good side of those over you, without unnecessarily withholding the locomotive from service.

If we are to be successful in eliminating locomotive failures and their accompanying casualties we must not allow a locomotive to leave a terminal with any defect, or condition that is at all likely to cause failure while enroute. It is generally conceded that the best results are obtained if we do not permit ourselves to fall into the error of considering small defects as of minor importance. The only safe policy is the full recognition of the fact that a potential accident lurks in the shadow of many apparently insignificant defects. The mere omission of a cotter key, or failure to spread the key when applied, has too often resulted in serious failures.

We should not neglect the personal element because success in any undertaking depends largely upon human relations. Good will and mutual confidence are paramount. We all do our best work under the stimulus of encouragement and approval of the people for whom we are working. Sincere efforts to advance the legitimate interests and happiness of those whom we supervise, are more essential to success than elaborate organization or modern shop facilities, desirable as these may be.

Results from Enforcement of the Locomotive Inspection Law

In the first fiscal year of our work, which ended June 30, 1912, at which time the law was applicable to boilers and boiler appurtenances only, 65.7 per cent of the locomotives inspected by our inspectors were found to be defective and in that year 3,377 locomotives were withheld from service by our inspectors because of conditions which rendered the boilers or their appurtenances unsafe for use; in addition to these, 3,591 boilers of locomotives were either held out of service for necessary repairs or changed or strengthened to conform to the requirements of the law or permanently removed from service. This is to be compared with the fiscal year ended June 30, 1940, in which year the percentage of locomotives found defective by our inspectors was 8, and 487 locomotives were withheld from service by our inspectors because of unsafe condition of the boilers or machinery, or both.

Complete statistics of accidents and casualties for the fiscal year ended June 30, 1940, are not yet available for publication, but these will compare very favorably with results in the year 1939. Table I shows the results with respect to boilers and appurtenances only in that year compared with the first fiscal year in which the law was effective.

Table I

Boiler and its appurtenances only	Year ended June 30 — 1939		1912
Number of accidents	52		856
Per cent decrease from 1912		94	
Number of persons killed	15		91
Per cent decrease from 1912		84	
Number of persons injured	55		1,005
Per cent decrease from 1912		95	

Table II shows a comparison of the machinery accidents, the number of persons killed, and the number of persons injured as a result of failures of parts other than the boiler and appurtenances for the fiscal years 1923 and 1939.

Table II

Machinery accidents (exclusive of boiler and boiler appurtenance accidents	Year ended June 30 — 1939		1923
Number of accidents	100		839
Per cent decrease from 1923		88	
Number of persons killed	0		25
Per cent decrease from 1923		100	
Number of persons injured	109		966
Per cent decrease from 1923		88	

All of you have participated in the work of bringing about these improvements and I wish to express my sincere appreciation for the help that has been so willingly given. I feel, even without any assurance on your part, that I can depend upon you for continued cooperation.

Enginehouse Problems of the Present Day

By H. E. Hinds

Assistant Mechanical Engineer, Burlington Lines

Running an enginehouse has always presented unexpected problems and no doubt always will, as any enginehouse foreman can tell you. To get a picture of the foreman's problems, I might suggest that you pick up a copy of any recent issue of the *Railway Mechanical Engineer* and read the stories by Walt Wyre in which fact, fiction and humor are happily blended in depicting the troubles of Jim Evans, foreman of the Plainsville enginehouse of the S. P. & W. R. R.

While at first glance the picture may seem overdrawn, yet a careful perusal will show that the stories contain more truth than poetry. Whether the problems of today are more exacting than those of the past is open to argument. No doubt the Old Timer will insist that his was the harder job because of lack of modern facilities, but I doubt very much if he can get the foreman of any modern enginehouse to agree with him. Everyone at times feels that his job is much harder than the other fellow's, so perhaps by comparison we may arrive at a fair appreciation of their respective problems and a determination as to who had the harder job.

Naturally the problems both as to magnitude and frequency divide themselves into two parts, viz., main and intermediate terminals, and while the first may have better facilities, yet the difference in magnitude and frequency of problems arising at the main terminal may more than offset this difference in facilities.

The business of the enginehouse and the enginehouse foreman is to furnish suitable power to meet the demands of the traffic, and while the intermediate terminal is called on to serve but one line the main terminal may have to serve several. Therefore the latter, based on number of locomotives despatched, is plainly handicapped at the start. In addition to this, the main terminal often has problems to contend with that are not common to the other terminals.

Prior to the present high-speed age, locomotives were designed to pull tonnage regardless of speed. The result was a certain number of large heavy powerful but slow-speed locomotives. However, all traffic was not drag rating stuff. There were always a few fast freight or manifest trains mixed in, and at certain seasons of the year the high-speed stuff predominated. Naturally the large heavy slow-speed locomotives could not be used in this service, therefore where the number of locomotives adapted to fast service was limited, the enginehouse had a real problem in furnishing power to meet requirements. It was this periodical shortage of suitable power that initiated the so-called extended runs.

Happily the mechanical department immediately sensed the change in operating methods and realized that the change was here to stay. This resulted in the development of what are termed "all-service locomotives" and the modernization or conversion of existing low-speed locomotives to suit that service. This gradually eliminated one enginehouse problem, but in the interim introduced another, viz., rapid despatch through terminals.

Where the facilities are inadequate or the force limited, this introduces another problem, viz., the interruption of routine through drawing men away from their regular work to service and inspect rapid despatch locomotives. Of course, where such servicing is of sufficient frequency a regular force can be assigned to this work, but where it is only occasional, it tends to interrupt the regular routine, especially if some minor repairs are to be made on the inspection pit.

Inspection of Power

When the Federal Inspection order first went into effect a howl went up that could have been heard to the high Heaven. Time has demonstrated that it was a blessing in disguise. Had it not been for the rigid enforcement of that order, it is doubtful if the present extended locomotive runs could have been inaugurated and carried to a successful conclusion. In fact, the enforcement of this order has been so helpful that I am satisfied if a vote were taken today for and against it, the vote would be 100 per cent "for".

Under the head of inspection, we should include locomotive accessories such as air pump, stoker, superheater, lubricator, feedwater heater, booster, running and carrying gear, valve gear, power reverse gear, etc., parts which under the general order must be maintained in operative condition. Some of these introduce problems not common to the older types of locomotives and of course, items that the old timer did not have to contend with. The addition of these items to modern power affects the time element, i. e., time to make inspections and repairs and this is one of the major problems of the present-day enginehouse. In other words, "Time is the essence" of the present-day problem that causes the foreman to scratch his head and wonder how he can have one man in two places at once or do in 30 minutes a job that usually takes one hour. But somehow he generally gets away with it, much to his credit.

Many of the modern locomotives today are equipped with roller bearings on the drivers, engine truck, trailer truck or tender trucks, and some on valve gears and power reverse gears. Roller bearings on the drivers and other journal bearings have been a boon to the enginehouse forces as time savers in the quick turning of the locomotives, thereby increasing their availability.

The cast-steel locomotive bed with integral cylinders also plays an important part in the modern locomotive.

The pronounced success of specific types of mechanical lubrication, as applied in the automobile field, gave rise to their adoption on the steam locomotive. With the advent of Alemite lubrication to all valve-motion parts, together with positive lubrication of hub liners, shoes and wedges, and driving-box, trailer- and engine-truck journals and mechanical lubrication to valves and cylinders, as an absolute necessity for longer valve-ring and cylinder-packing life, enginehouse foremen were faced with the problem of reducing lubrication costs. The matter of properly applying lubrication had now been overcome, and by the regular assignment of men on each shift to handle this work, failures from this source have been materially reduced. However, there has developed the tendency to waste grease and oil. The result is that, unless a close check is maintained, the net cost of lubrication increases and the capital investment in mechanical equipment has not brought adequate return. By a proper policy of education for the man handling this equipment, and by keeping it in repair, waste can be eliminated.

As motive power assignments now include longer runs, more experienced judgment is required on the part of the enginehouse supervision, to know that all work reported has been properly performed, and the locomotive is in safe and suitable condition for the assignment. It is necessary to maintain a closer check on driving boxes, and running gear, as a number of intermediate enginehouses have been eliminated, and conditions which would enable locomotives to run 50 miles successfully, will not permit them to operate 500 miles, or more, successfully. Therefore closer attention must be paid to knocks and pounds, which are ever present, and lost motion eliminated from such important points as reverse gears, throttles, main driving boxes, etc. At monthly form periods, all items whether only of minor importance must be repaired, as locomotives despatched to outlying points invariably remain there for 30 days. No extensive repairs are anticipated at these points, as the majority of this force has been transferred to the larger engine terminals, where all repairs are concentrated, and can be more consistently handled. As extensive investments have been made in water-treatment facilities to improve boiler performance, and repair, it is necessary for the supervision assigned to boiler work to see that blowing-down is properly performed at all engine terminals, and daily checks made on the boiler water situation to prevent foaming and accumulation of solids and suspended matter.

As the turning time of power has been reduced, enabling a smaller number of units to be maintained in service, the forces assigned to engine handling and servicing must be so balanced, as to move the locomotives from the inspection pit, ash pit, coal dock and washing spot without delay. This feature of engine house operation can be definitely controlled through proper planning. Improved grate installations have reduced fire-cleaning time. Modern coal docks have expedited refueling, and improved engine washing facilities have corrected delays which were formerly occasioned from these sources.

At the present time, on most roads, Diesel-electric locomotives are handled at the same terminals as steam power. Experience gained previously with gasoline-electric power has revealed the necssity for close and detailed inspection and repair work on any type of internal combustion engine. Diesel-electric locomotives have demonstrated the absolute necessity of cleanliness in handling all work. Details of inspection must be followed closely at monthly form periods, and no items reported by inspectors or crews left unfinished, when the locomotive is dispatched. There is no such thing as deferred maintenance on Diesel-electric power, and a greater degree of foresightedness is required to anticipate certain repairs, rather than wait until excessive wear requires such repairs to be made. The supervision must be alive to special equipment necessary to handle this type of

motive power, and provide the proper tools for the mechanics assigned to this class of work. Mechanics must not be transferred periodically from steam to Diesel work and vice-versa, but must be kept on Diesel maintenance and properly trained to follow through all jobs assigned. This practice of course, also applies to those engaged in electrical maintenance on Diesel power.

Solving the Problems

Your present co-ordinated associations well point the way by which an answer can be found, viz., through co-ordination and co-operation. While the following may be common practice with most of you, nevertheless the suggestions offered may be helpful to others, and for that reason only are offered for your consideration.

A railroad is just one big organization, the sole business of which is the expeditious handling of traffic. In this organization are many departments. Naturally the closer these departments work with one another, the better the final result. Of course the enginehouse is quite remote from the executive, legal and financial departments, but it is tied in closely with the operating department. The action of either intimately or materally affects the work of the other, therefore I will confine my remarks to cooperation between these two.

The despatcher knows through his connections with other lines when and what traffic will be delivered to his line. This information is transmitted to the yard master, who in turn notifies the despatcher when he expects to have a train assembled. If now the despatcher will advise the enginehouse foreman when and what type of locomotive he will require to move such trains, giving him all the advance notice possible, it will help in the solution of the power problem. A good plan practiced at many terminals is a notification on the part of the despatcher of his requirements during the next 8 or 10 hours; this notification to be repeated at least three times every 24 hours. Where such a system does not obtain the foreman, not to be "caught with his pants down," so to speak, may fire up a number of locomotives as fast as he gets them ready, only to have them stand under steam for hours at the expense of the coal pile. Money is not so plentiful on the average railroad today as to warrant any waste in this manner.

Influence of Stores Department

A perusal of the Jim Evans stories in the *Railway Mechanical Engineer* indicates, at least by inference, that most of his troubles are due to failure on the part of the storehouse to carry an adequate supply of repair parts. This criticism may and may not be deserved. In my opinion, an examination into the facts will reveal that there are two sides to this as to any other story.

We must recognize the fact that the storekeeper also has his problems. One is always to carry an adequate supply of repair parts and yet maintain a low inventory and avoid the danger of obsolescence. The enginehouse and the storehouse have a mutual interest and by close co-operation can each help to solve the other's problems.

With the present rigid inspection and more efficient methods of repairs—welding instead of patching—the possibility of failure of any major part of the present-day locomotive is rather remote, and therefore the necessity of carrying a stock of such parts for protection at a sub-store house is hardly warranted because in case of such a failure the locomotive is usually definitely tied up long enough to get repair parts from the main source of supply. However, this does not apply to locomotive accessories where in case of failure of any part, repairs can usually be made in a few hours if proper repair parts are available. It is in this connection where close co-operation between the enginehouse and the storehouse is so helpful.

Interior parts of locomotive accessories such as air pumps, feedwater pumps, superheater units, stoker conveyor screw, etc., are not so open to inspection as are the major parts of the locomotive proper, and for that reason they may be subject to unexpected failure. True, such failures may not result in a complete engine failure, but it may result in a train delay and, if repair parts are not available when the locomotive reaches the terminal, will of course result in tying up the locomotive until the parts are repaired or new parts are sent from the main storehouse.

It is self-evident that it would take longer to remove, repair, and replace a failed part than simply to make replacement; therefore, it should also be self-evident that it is economy and will expedite out-shopping of the locomotive if substitution of the failed part can be made at once, and the failed part repaired, if possible, and returned to storehouse stock as opportunity permits. It is here that close co-operation between the enginehouse and the storehouse pays big dividends. The storekeeper has no way of knowing except from his records, just how heavily he should stock up on accessory parts, as he has no way of knowing just how many locomotives equipped with any particular accessory are working out that terminal, as the number is subject to change at any time due to transfer of power, etc. But the enginehouse foreman does know, and if he will keep the storekeeper informed, the latter can arrange for protection. It is a good idea for the two to get together, say once a week, go over the store stock jointly, agree on what should be carried on hand and what should be transferred to another storehouse when there has been a transfer of power.

Probably the greatest single change in enginehouse operation has been the training of supervision to become foreman-managers. This has been a necessity, in order to handle repair work on a basis similar to that which would apply if that foreman were handling or managing a job-shop, where all work must be turned out at a sufficient profit to make the business a "going concern." Material and labor costs are now a definite part of the knowledge of every foreman. With this knowledge it has been possible to reduce the cost per engine dispatched.

On the Burlington Lines a method is in practice for controlling locomotive costs, whereby each master mechanic is furnished each month a budget, based on anticipated locomotive miles. This budget is strictly followed, and should the actual mileage during a month be less than anticipated, adjustment in labor is made to meet the budget estimate of direct labor per mile. A follow up is made to make sure that the labor budget is not exceeded.

On account of individual locomotive cost records, it is possible to pick out the engine out-of-line in cost and make the necessary repairs.

The cost of material is checked monthly by divisions and if out of line corrective measures are taken.

Total amounts expended for running repairs are furnished by the auditor each month by divisions; material, labor and overhead are shown separately.

The master mechanic with the budget method can check the monthly expenditure with previous months record and make corrections if necessary.

This system of accounting has developed a healthy competition among our supervisory forces at the enginehouses and shops.

Improved engine terminal facilities, both in machine tools and equipment for servicing power, have entailed a responsibility upon the supervision to see that all work

is performed safely. This feature is not an enginehouse problem, it is a duty that supervision insist upon work being performed properly and safely. It is of course definitely known that the caliber of work turned out is governed by the safe and efficient manner in which it is performed. An enginehouse foreman can no longer see that work is properly assigned to the various members of his working personnel, but he must know that cranes, hoists, scaffolding, hammer handles, chisels, ladders, slings, etc., are all in good condition, so as to avoid accidents. Today, the necessity of having trained mechanics who can work their regular assignments is too important, and the cost of their having a lost time accident too expensive to allow supervision to neglect the safe performance of work under his direction.

The advent of Social Security, and the Railroad Retirement Act, have given older employees their well earned security, at the pension age, with the result that a large majority have taken advantage of this asset. This has placed a definite responsibility upon supervision to aid in the training of the younger employees.

The enginehouse foreman, compared to back-shop supervision, has an even greater problem, because he is dealing with "live" motive power, and all weather conditions. The younger men who have finished their apprenticeship, and are working in enginehouses, must be placed with experienced enginehouse mechanics, in order to learn the methods peculiar to roundhouse work. It is not merely sufficient that one know how to do a mechanical job, but he must know that the locomotive he is working on is properly blocked and set to do the necessary work.

This is a major enginehouse problem today—the careful training of the younger men, so that they may become safe and efficient employees, and develop into future material for foreman-managers.

The Smoke Problem

The main terminal is usually located in or near a city having a strict smoke ordinance. Therefore, means must be adopted whereby locomotives may be fired up without being charged with smoke violations.

Smoke did not trouble the old timer. Quite the contrary, the presence of smoke was considered an indication of industry.

Another important problem is the one of safety. The supervisors must be safety minded in order that the men working for them be made safety conscious.

I think you will admit that the fellow near the Canadian border working under sub-zero temperatures has an entirely different problem from the fellow in Georgia whose enginehouse consists of a bunch of tracks radiating from a turntable with the blue sky for a roof. Therefore, no definite method of procedure can be laid down to suit all conditions. On the contrary, each problem must be composed as it arises, and right here let me pay tribute to that master composer—the night enginehouse foreman. The day man can consult with the general foreman or the master mechanic if faced with a tough or unusual proposition, but the night man is usually on his own. He must work out his own salvation. More power to him.

I have tried to lay down a few simple suggestions. Boiled down they spell "Co-ordination and Co-operation," but I want to add another thought. If someone has established what might be called a fence around your department, break it down. Get acquainted with the trainmaster and superintendent. You will find them good fellows who will be only too glad to help if you get up against it. After all, we are working for the same railroad and there should be no fences between us.

As R. H. Aishton once said, "If by spending an extra dollar, one department of a railroad can save a dollar and ten cents for another department, it is money well spent."

Discussion

The member who opened the discussion of the paper made the statement that the steam locomotive is on trial; that it is being challenged by the Diesel. He followed by saying that "without becoming involved in any discussion of relative costs of operation the score card after considering such items as fuel, lubrication, maintenance and enginehouse expense indicates that the Diesel may only be slightly out in front. So, what is it that stands out? It is high availability. Therefore, to find ways and means of increasing the availability of steam power would most certainly put the steam locomotive in a much more favorable position to meet the challenge of the Diesel. One of the most remarkable things about the steam locomotive is the fact that individual studies show that entire classes of locomotives on certain roads show an availability of over 90 per cent while they are actually used less than 50 per cent of the time. Lack of traffic may be part of the answer but the time spent at terminals may be the important factor. A locomotive must go through the routine of inspection, firecleaning and ashpit work, terminal movement to the house, running repairs, lubrication, service and final inspection. To increase steam-locomotive availability for service rests, to a large extent, upon our ability to reduce the time required to perform these tasks." The member then proposed several specific questions, the answers to which might serve to develop the means of increasing availability. Some of these questions were: How can inspection methods be improved; by the better training of inspectors and by the installation of improved facilities? How important is engine terminal and track layout in expediting the movement of locomotives within a terminal area? What are the most important improvements that could be made to speed up running repair work? How about lubrication; is it an important factor in the time locomotives must spend at a terminal? In answering some of these questions it was brought out that firecleaning time is often dependent on the type of grates and coal; that roller bearings have a most important influence on the time needed for repairs; that good shop tools and time-saving devices are vitally important and that force-feed lubrication on steam locomotives is of outstanding value in cutting down repairs and the consequent time spent at terminals.

A chief mechanical officer stated emphatically that regardless of any I. C. C. requirements the railroad company's requirements should be to make sure that each and every locomotive should be completely and thoroughly inspected every trip and that all necessary repairs be thoroughly made and that, regardless of destination, it is the duty of every supervisor to make sure that the locomotive is in perfect shape to go through to that destination without failure or delay.

Several members brought up the tendency for certain enginehouse foremen to pass up minor jobs and take a chance that the man at the other end of the run would do the work. This should not be tolerated, one master mechanic said, and each terminal foreman should develop the spirit of working with the other fellow to produce as nearly perfect locomotive condition as possible.

Another master mechanic said that an inspector is the kind of a fellow who likes to feel that his work is important and that if the work he reports is not done it is not fair to the inspector. If you want good inspection, he said, it is up to the enginehouse foreman to see that the reported work is done.