No. 1290 *e*

AMERICAN LOCOMOTIVE TERMINALS

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131 The most interesting example of American engine-house practice is that in the classification yards of the Pennsylvania Railroad at East Altoona, Pa. Here the traffic from three divisions of the road is concentrated, classified and despatched. The freight tonnage passing through this terminal is claimed to be the largest handled by any single system of freight yards in the world. The total capacity of the yards is 10,500 cars.

132 The eastbound traffic is composed largely of loaded coal and coke cars, and the number of cars handled per month in this direction is: loaded, 61,308; empty, 1306; total, 62,614. The westbound movement is composed largely of empty cars, with a total of 62,877 cars per month. In 1906 an average of 90 trains per day was received from the Pittsburg division and 60 from the Middle division, and the movement in one direction reached as high as one train every ten minutes for six hours. During the month of November 1909, the engine movement at this engine-house was as follows:

Average number of locomotives despatched east and west in 24 hours	243
Maximum number despatched in 24 hours	290
Maximum number despatched in one hour including switch engines	40

133 The trains are operated by consolidation locomotives, and on account of the grades on the eastern slope of the Allegheny mountains westbound trains require three engines, two in front and one as a pusher. Eastbound, the line follows a comparatively light gradient along the Juniata river, and here large trains can be handled by one consolidation engine. There are 35 switch engines, requiring 70 engine crews for day and night operation. During the month of

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November 1905, there were handled over the ashpit a total of 6479 engines. The number of men employed in the yards is 1830. The number of enginemen employed during the month averaged 1012 and the number of men employed about the engine-house, shops and coal wharf and on the motive power roll was 700.

134 Near the center of the length of the terminal (Fig. 22) is located a large engine-house, with ashpits, coal wharf, sand supply, a good-sized machine shop, storehouse and office, with bunk rooms overhead; also a power house, a fan house for heating, an oil house, and a toilet and locker house.

THE ENGINE-HOUSE

135 The engine-house is in diameter and cross-section the largest structure ever erected for this purpose. It has an exterior diameter of 395 ft. and a turntable of 100 ft. There are 52 stalls 90 ft. deep. The main portion of the house is 65 ft. wide and 30 ft. high. On the outer circle there is a lean-to 25 ft. wide and 18 ft. high. The engines head in toward this lean-to and the smokejack is located alongside the main columns at the outer portion of the main building. The main portion of the house was made 30 ft. high to accommodate a traveling crane, but columns for supporting the crane have not been erected, as jib cranes secured to the main columns were found more desirable. A cross-section of this engine-house is shown in Fig. 23.

136 The turntable is operated by an electric motor. There are four drop tables, also operated by electric motors, two of them for driving-wheels, one large table for all wheels except the engine trucks, and another for pony truck wheels.

137 The coal wharf is a large structure arranged with a trestle approach having a grade of 3.88 per cent. The coal is dropped from hopper cars directly into bins and no cover is provided for the cars, as they are emptied entirely by gravity and no men are employed in the unloading. The storage structure is 32 ft. wide and 216 ft. long. A special gate and hood are used for regulating the flow of coal from the pockets to the tender. A steel gate drops below the floor of the pocket and is operated by a compressed-air cylinder.

138 At one end of the coal wharf is a sand house, where sand is dried in large stoves and descends through a grating to a reservoir, from which it is elevated by compressed air to the sand bins overhead, and flows by gravity to the engines.

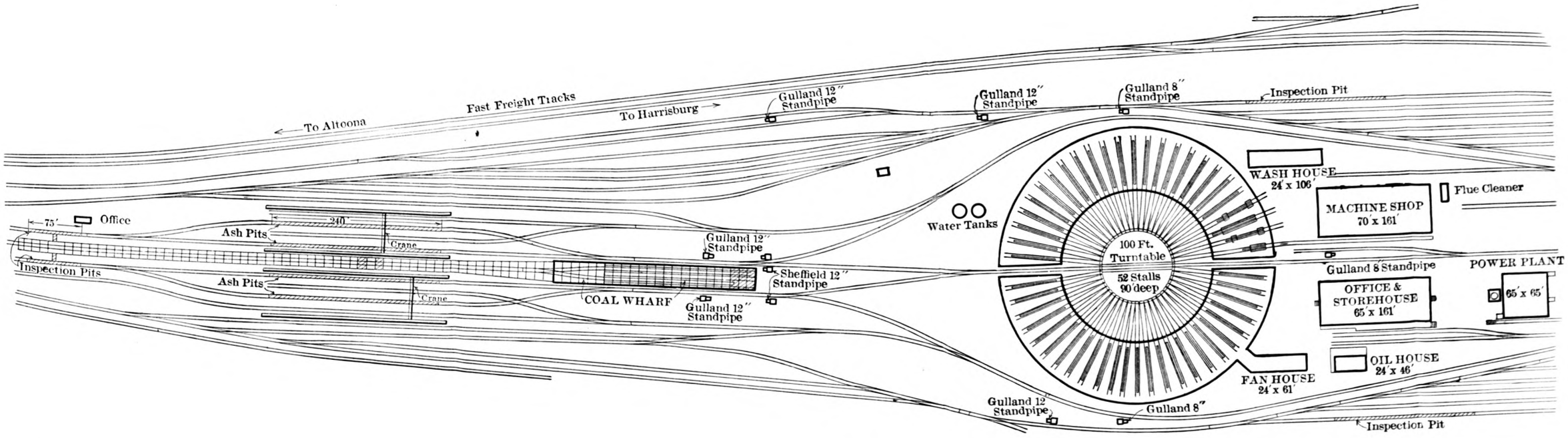

FIG. 22 GENERAL PLAN OF EAST ALTOONA ENGINE-HOUSE AND AUXILIARY STRUCTURES

139 Near the approach to the coal wharf are four ashpits, each 240 ft. long, two on each side of the wharf incline. Each pair is operated by an overhead 5-ton electric crane which spans four tracks, two of them over the ashpits for ash cars. Ashes are dumped from the engines into steel buckets which run on wheels on a track in the

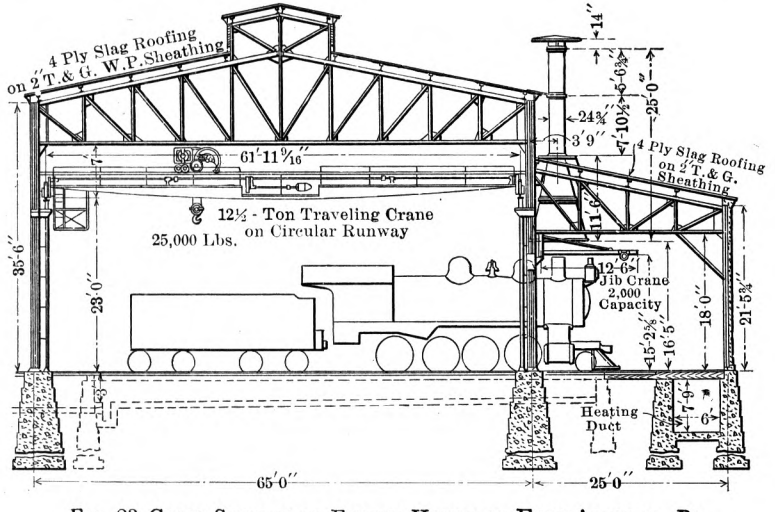

FIG. 23 CROSS-SECTION OF ENGINE-HOUSE AT EAST ALTOONA, PA.

ashpit. These buckets are elevated by the crane and transferred to the ash car, where they are dumped. Beyond the ashpits at the extreme end of the coal wharf are inspection pits, 80 ft. long and 3 ft. deep, and connected by an underground passage extending under the coal wharf track.

ENGINE-HOUSE ORGANIZATION

140 The work performed in an engine-house includes almos everything in connection with locomotive repairs that does not require the locomotive to be sent to the general repair shop. No attempt will be made to itemize these repairs. The work which must invariably be performed periodically consists of boiler testing every six months; boiler washing, from once a week to once a month as necessity arises; staybolt testing each week; examination of smoke-box, draft arrangements and ash pans, each week; testing steam and air gages each month; washing tenders each month;

gaging height of pilots each week; gaging tank water scoops each trip; testing air brakes each trip; draining main reservoirs each week.

MANNER OF REPORTING AND PERFORMING DAILY WORK

141 When a locomotive arrives the first information the organization receives as to work necessary is in the engineer's report which he delivers at the inspection pit when the locomotive is turned over to the inspectors. Five inspectors are here employed, as the work must be done thoroughly in a minimum time, so that the hostler can move the locomotive to the ashpit and make room in the inspection pit for other locomotives waiting. One inspector examines the under-part of the locomotive and tender; one on each side inspects the outside parts, such as driving wheels, rods, steam chests, guides, crossheads and Walschaerts valve gear; there are two air-brake inspectors, one to operate the brake valve and inspect the fittings in cab and air pump, and the other to inspect all other parts of the air and sanding equipment.

142 All defects found by the inspectors are entered upon regular blanks and transmitted, together with the engineer's report, to the gang leader in charge at the inspection pit, who decides whether it is necessary to send the engine to the house or whether the repairs are so slight that they can be made on the outside repair pits in connection with the outbound storage tracks. His decision is marked upon the report, and upon the steam chest of the locomotive, and the reports are forwarded to the work distributor's office by pneumatic tube in 45 seconds. This saving in time over the 10 minutes ordinarily required by messenger is a decided advantage to the work distributor, as he is able to assign the work to various gang leaders, and have the necessary material ordered, before the locomotive arrives in the house or on the engine track.

143 While the inspectors are at work the lamps and torches are filled and trimmed by two lamp fillers. There is no further necessity for the engine-house force to open the tool boxes, which are locked by the engineer, and the keys, together with his time card, delivered to the engine despatcher at the foreman's office. The engineer is then relieved of all responsibility and of the care of the locomotive.

144 The engine moves from the inspection pit to the ashpit, where the firebox, ash pan and smoke box are cleaned. It then moves to

the coal wharf, where the tender is filled with coal; and a little farther on reaches the sand house, where it receives a supply of sand and water. It then moves into the engine-house or to the outbound storage tracks, as necessity requires. If it goes to the engine-house the track number and the time of arrival are reported by the turntable motorman by telephone to the work distributor, who by this time has the work which was reported by the inspector and engineer subdivided and assigned to various gangs. After completing the work these gangs report the locomotive ready for service to the engine-house office, where arrangement is made for the movement of the locomotive to the storage siding to await assignment to a train. If the locomotive does not go to the engine-house it is moved directly from the sand house to the storage siding, and the necessary work is assigned to a gang located on the storage tracks to make light repairs, after which the locomotive is reported ready for service.

ENGINE TRACING

145 At East Altoona there are sometimes as many as 200 locomotives within the engine-house jurisdiction and it was found necessary to inaugurate some efficient method of locating them exactly at all times, so that men sent to make repairs will have no difficulty in finding any particular locomotive required. This is accomplished by telephone. Each time a locomotive moves to another locality the engine tracer in the foreman's office is advised as to where it came from and where it has been delivered, giving the number, the location on the track and the time in each case. When traffic at East Altoona is normal the engine-house must deliver ready for service one locomotive every five minutes during the whole 24 hours of the day, as the engines for three divisions are here concentrated. It is vitally important that everything should run in absolute harmony as any interruption in this rapid flow would quickly result in a congestion on the road.

ENGINE DESPATCHING

146 After the engine tracer has been advised that a locomotive is placed on the storage track for service, he informs the engine despatcher, to whom the crew callers report. The engine despatcher is also in touch with the yardmaster and is the middleman between

the engine-house foreman and the yardmaster. As soon as the yardmaster receives information that he needs a locomotive and crew for a certain train of a given class at a certain time, he advises the despatcher, who immediately calls out a crew, and when they arrive assigns to them the locomotive selected, which is standing on the outbound storage track. A telephone system has been installed whereby all crews may be called. The houses of the enginemen have been equipped with telephones connected with the engine-house office, an arrangement which dispenses with messengers and enables the crews to be called very promptly.

147 The fireman usually arrives first, and after receiving his time card and keys he takes charge of the locomotive, relieving the engine watcher of any further responsibility, and immediately prepares a fire for road work. The engineer, upon arrival, after receiving his time card at the engine-house office and inspecting the bulletin board to read any new orders, goes to the locomotive and oils the machinery, and then waits until he is given the proper signal to move out of the storage yard. The crews are usually called in sufficient time to prepare the locomotive properly for road work prior to leaving the storage track.

ORGANIZATION OF STAFF

148 For the operation of this locomotive terminal an elaborate organization has been worked out, based upon the principle that none but the heads of sub-departments shall report to or receive instructions from the foreman, his assistant or the work distributor. The responsibility of supplying material and the supervision of the workmen are placed directly upon these gang leaders, who are foremen of their respective gangs. Certain questions of discipline must be handled by the foreman personally, but questions relating to rates of pay, transfers, discipline, etc., ought to originate with the gang leaders, and their duties not be confined to giving out work to the men after the distributor has assigned it. This results in successful operation, but it also gives some dignity to the position of gang leader, and at the same time relieves the foreman of petty details.

149 The foreman of a large engine-house should not be an ordinary shop man, but should have some outlook over and interest in the operating department. He should be a good disciplinarian, commanding the respect of his men, should display clear judgment and

form conclusions quickly. He should be a good all-round organizer and capable of taking care of business promptly during rush hours. He should know how to make brief and intelligent reports and possess mechanical ability. He should be broad-minded enough to recognize that there is a commercial side to transportation, and should not be overburdened with office work. His assistants should possess sufficient ability to decide what work may be slighted or not done at all, and a locomotive still be safe to make one or more round trips.

150 The engine-house foreman receives from the division master-mechanic instructions pertaining to such matters as the number of men required, rates of pay, discipline, maintenance of his entire plant, and standards. He receives from the division superintendent instructions relating to crews and despatching of locomotives, and carries out such discipline of the engine crews as may be imposed by the division superintendent through the road foreman of engines. He must coöperate with the road foreman of engines concerning the condition of power and its performance on the road, and the amount of coal and oil consumed. He must carry out orders issued by the road foreman of engines concerning the assignment of locomotives and crews. At East Altoona the engine-house operation is a continuous one throughout the day and night, and the night force is practically the same as the day force.

151 Reporting directly to the engine-house foreman are the *assistant day foreman and assistant night foreman.* Reporting to assistant foremen for office work are the *first clerk*, who takes all the foreman's and the assistant foremen's dictation, and the *second clerk*, who has charge of all messengers and ordinary clerks who may be engaged in computing the time and earnings of the men and in getting together all the information required by the master mechanic's shop clerk and for properly keeping the records. Next in order is the *engine despatcher*, to whom report the *engine tracer*, the *callers* and the *clerks* who keep the records of engineers and firemen and of locomotives arriving and departing. The engine despatcher marks up the crew board, issues time cards to engine crews going out, and accepts and approves them upon their return.

152 Next in order reporting to the assistant foreman are the various *gang leaders*. First is the gang leader in charge of the machine shop. The work of his men is confined to machine and vise work, and they are not called upon to leave the machine shop and make repairs in the locomotive shop or storage yard except in cases of emergency. Their work is chiefly preparing and fitting the repair parts which

the engine-house employees apply to the locomotives. The gang leader in charge of the blacksmith shop has charge of all smiths and helpers, as well as the forces of flue welders and laborers in the engine-house engaged in piecing flues and preparing them for locomotive boilers. The gang leader of the power plant has full charge of stationary engineers and firemen, electricians and wiremen. Another gang leader has charge of the ordinary helpers and sweepers in the engine-house, who keep the shop property clean.

153 The foreman in charge of all employees actually handling locomotives, from the time they arrive at the terminal until they are turned out, also of all workmen engaged in the engine house or storage yard, is called the *work distributor*. Clerks reporting to his two *assistants* receive the engineers' and inspectors' work reports and copy the work required on slips of paper numbered consecutively and properly dated. These slips are then delivered to the gang leaders of the men who perform the work.

154 The men composing the gangs working on a piece-work basis are divided into pools of three or four men, with leaders. The *pool leaders* are under the direction of gang leaders. When the earnings of three or four workmen are pooled it is found that each man is determined that the others should perform their fair share of work, and in case one man fails to do this the remainder insist that the lazy or careless workman be taken out of their pool.

155 The gang leaders at the inspection pits are in charge of *inspectors, lamp fitters and engine preparers*, who handle the locomotives between the inspection and ashpits.

156 There are three *assistant gang leaders* in charge of the *engine preparers*. Assistant No. 1 has charge of all work in cleaning fires and placing the locomotives in the engine house or storage yard and of *the ashpit men and crane operators* who load cinders. Assistant No. 2 has charge of the *coal gagers and sand house men, turntable operators* and men engaged in handling locomotives from the engine house to the storage yard. Assistant No. 3 has charge of the men handling locomotives in the storage yard and despatching them when ordered for service, including *engine watchers, switchmen and engine timers*.

157 Next reporting to the work distributor is the *gang leader of boiler washers*, whose men wash out the tenders, blow out, wash, fill and fire all boilers, and watch locomotives until they are removed from the engine house. Next is the *gang leader of staybolt inspectors*, whose men test staybolts and examine fireboxes and tubes. There

is a *gang leader of boiler makers*, engaged in renewing tubes and staybolts, patching, testing and calking tubes, and general boiler work. A *gang leader of engine cleaners* has charge of men cleaning locomotives and tenders. There is a regular schedule for doing this work, and it is so arranged that the work is performed when the locomotives are receiving staybolt repairs or boiler washing. A *gang leader of spongers* is in charge of packing journal boxes and other work relating to lubrication. In the engine-house there is a *gang leader of machinists*, who are engaged in setting valves, renewing packing and all other general machinist work on the locomotive proper. The *gang leader of tank repairs* is in charge of repairs to tenders, frames, tanks and couplers, of renewing truck wheels, and other tender repairs. The *gang leader of air-brake repair men* keeps in order the air brakes and sanding equipment.

158 The gang leaders of men on piece work should have not more than ten or twelve men under them, with the exception of the gang on boiler work, which may require from one to four days to complete.

POOLING LOCOMOTIVES

159 Improved engine-house facilities, more system and better organization are favorable to the pooling of locomotives, and this practice has become more general for freight engines in the United States. As recently as in 1905 the reports on pooling presented at the International Railway Congress indicated that pooling was not used on the majority of railways in the United States under normal conditions of traffic. The large increase in traffic in proportion to the number of locomotives in 1906 and subsequent years has compelled most of the roads to resort to the pooling of freight engines and the double-crewing of passenger engines, and these methods are now well established on the majority of American railways. By improved methods the operations of cooling down, washing, and filling with hot water may be performed in less than two hours without injury to firebox and tubes, and this alone has contributed in a large measure to the success of pooling. The reduction in boiler pressure from 225 lb. to 160 and 180 lb. has also reduced the number of boiler failures and permitted the more continuous use of locomotives which results from the pooling system.

160 The amount of work which the engineers and firemen do at the engine-houses is now so small that it is almost confined to lubrication of machinery and inspection of tools and supplies on engines,

and no dependence is placed on them for repair work. The engineer is required to report any defects or needed repairs which he observes while running the locomotive or by casual inspection on the outside. The machinery underneath is inspected by men regularly employed for that purpose, and inspection pits in the tracks approaching the engine house are now regarded as an essential of a modern locomotive terminal. With the changes in practice above indicated, the pooling of freight engines is rendered more successful and satisfactory and its effect on the cost of locomotive repairs is not so pronounced as formerly.

161 On some railways where shop facilities are limited, locomotives are required to make a large mileage before they go in for general repairs. The principal items which send engines frequently to the shop are worn tires, defective tubes, and, perhaps, worn driving boxes. At some engine-houses all these repairs are made, the worn tires being replaced by new ones or by others which have been turned at the shop. In this way such machinery as rods, crossheads, guides and link motion, is kept in service, so that passenger locomotives make as high as 127,000 miles, and freight locomotives, 100,000 miles between general repairs, one passenger locomotive making 256,000 miles between shoppings. Passenger locomotives average 120,000 miles and freight locomotives, 95,000 miles.

162 On the Chicago, Burlington & Quincy for the last six months of 1909, pooled freight engines made on one division as high as 4167 miles per month and 110 engines on three divisions averaged 3777 miles per month. On other roads passenger engines double-crewed make an average of 6500 to 7500 miles per month, one road reporting for engines in express service 418 miles per day and 12,780 miles per month.

No. 1290*f*

HANDLING ENGINES

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162 The desirability of pooling engines in place of operating them by regularly assigned crews depends, in the writer's opinion, on whether the engines are engaged in passenger or freight-service, and in the latter case, on the conditions which exist.

PASSENGER SERVICE

163 Where traffic conditions admit of the engine making greater mileage than can properly be run by one crew, two crews assigned to one engine, or three crews to two engines, will enable the engine to make as great a mileage as is desirable. On account of the comparatively short time occupied from terminal to terminal, the crews can usually make a round trip without holding the engine longer than is required to handle it and prepare it for the return trip or to await its train. By using more than one crew to the engine, it is theoretically available on its return just as soon as though it were pooled. In practice, unless pooling is carried to the extent of sending out any engine on any train, certain engines are regularly used on certain trains or groups of trains, and it is comparatively easy to arrange the crews and engines so that a reasonable time may be allowed for repairs and yet ample service be obtained from the engine. When working with assigned crews it is of course usual to employ some extra passenger men to take the place of the regular men, who are also available in case an extra trip is required from an engine on account of specials or extra sections of regular trains. Where regular scheduled trains have to be provided for, this system is as flexible and convenient

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as pooling and has the additional advantage in passenger service that the men run certain trains regularly, and will consequently give better service than when handling a number of trains indiscriminately.

164 Pooling in passenger service probably does not require much discussion. The system is not in extensive use and will presumably have few advocates. The writer would, however, state as a result of his experience with both pooled and assigned engines in passenger service, that he is most strongly opposed to pooling in this service and considers that far better results can be obtained from assigned crews.

FREIGHT SERVICE

165 Here conditions are very different. The time is slow and a long time is occupied from terminal to terminal, so that crews may require a full allowance of rest on arrival, or may even have to be relieved on the road. Few, if any, of the trains run at regular hours, and in place of following a defined schedule, the demand for engines varies with the traffic. When business is heavy, engines are wanted as soon as they are repaired and ready for service, making it difficult, if not impossible, to select the engines in any particular order. By pooling, such difficulties may be more easily met, especially at large terminals. When engines are assigned the practice usually required by the agreement with the men is that engines shall be prepared and despatched in the order in which they arrive, but if the engine is ready its use may be retarded by the time required by the crew for rest. In pooling, both these objectionable conditions vanish. An engine may be turned at once if fit for service and thus rendered immediately available, and the movement of the men being entirely independent of that of the engines, the detention of engines at a terminal can be regulated by simply increasing or decreasing the number in the pool.

166 Under such conditions, if pooling is not carried on in name, it will be in fact, simply because business can not be handled unless engines are used without reference to the order of their arrival. Granted therefore that pooling is advantageous under these conditions, it should be done properly. All the features necessary to a successful pooling system must be employed, such as thorough terminal inspection independent of the engine crews, and arrangements for handling tools and engine supplies, and caring for headlights, oil cups, etc. If pooling is resorted to when business is especially heavy, or

when traffic is disturbed by storms or by other causes, without proper arrangements being made, the results are most objectionable. Under these circumstances, the condition of the power will depreciate rapidly and the service rendered will be exceedingly inefficient. The maxim is frequently stated, "If you pool, pool," and its wisdom has been demonstrated by experience. The real question about pooling is therefore whether there are conditions under which it is preferable to adopt the alternative practice, that of running engines with assigned crews. This depends on the results obtained from the two systems, which are in the writer's experience as follows:

167 *Mileage.* It is possible to obtain a somewhat greater average mileage per engine under the pooling system, but the increase does not exceed ten per cent when traffic is being handled smoothly and without excessive congestion and delays.

168 *Repairs.* When running successfully under the assigned engine system, repairs are less than when similar conditions exist with pooled engines. A man running an engine regularly keeps up the smaller details and knows what work is required at once, and what must be looked after in due time. His inspection reports are more reliable than those of a man who has had an engine for one trip only. As he has to run the engine next trip as well, he will handle it with greater care and avoid any action that will cause him trouble in the future. Men who have been accustomed to running pooled engines will not do all this at once, but they most certainly will if assigned to an engine for any length of time, and the difference is noticeable in engine-houses where some engines are assigned and some are pooled.

169 Engines are sometimes taken care of by the headquarter station system, the work required to maintain the engine in proper condition being done at the terminal designated as the home station, while at the other terminal the only work done is that necessary for the return trip. With this arrangement, even with pooled engines, the same crew will, if possible, make the round trip; but when they are changed, practically as much work is required at the away station as at the home station. The result is a considerable increase in the cost of repairs, for there is not as a rule very much difference in the cost at the home station.

170 When the assigned engine system proves inadequate for traffic demands, the results change. Men will endeavor to book enough work against the engine to hold it until they have rested, and on the other hand engines are liable to be wanted before repairs that are actually required are completed. Under these conditions engines may be bet-

ter and more cheaply maintained when pooled; but under normal conditions the writer's experience would show that with assigned crews the cost of running repairs may be reduced five to ten per cent and better mileage obtained from the engines between shoppings.

171 *Fuel.* It is almost impossible to determine the fuel consumed by an engine on an individual trip, and consequently difficult when pooling to keep any record of the amount of coal used by different men. A record may be kept by engines, but it is then impossible to locate the responsibility for any excessive consumption. The practical result is that on pooled engines, individual fuel records are of comparatively little use. With assigned engines, while trip records may not be individually accurate, the average of several consecutive trips soon becomes so, as the variation of the amount of coal left on the tender, while important on one, is of comparatively small importance on a number of trips. There is no doubt in the writer's mind that individual coal records, whether by trip or by period, are an important factor in obtaining economical results in fuel consumption, both from men and from engines, and he ascribes the good results that have been obtained on the Canadian Pacific Railway largely to the careful way in which the records have been watched.

172 Apart from the records, the familiarity of the men with the engines has an important bearing on fuel consumption. Most engines vary slightly in the way they burn the coal, in the nature and intensity of the draft, and in the best position for the throttle and reversing lever. Crews knowing an engine thoroughly learn about these peculiarities, while they do not when running a different engine each trip. One crew will obtain from an engine results that are impossible for another crew, and thus the result with assigned crews is a tendency to higher efficiency than when every engine has to be drafted and adapted to do the work with the poorest crew on the division. It is only necessary to watch the difference in the way an engine is handled by a regular crew and by a pooled crew, to realize the advantage of the former, and important results have been clearly shown with the same men and engines, on divisions where the two systems have been in effect.

173 *Service.* The remarks that have been made in connection with repairs and fuel apply with almost equal force to the class of service obtained from the engines, with reference to failures, breakdowns and ability to make the time required. A crew that knows the engine will get more out of it than one that does not. They will notice any difference in its working and will take more interest in getting

any defect rectified. They will keep their equipment in better condition and will pay more attention to bearings which show signs of heating, etc. All these conditions lead to better and more efficient service.

174 *Engine-House Expenses.* Inspection, the care of tools, the filling of lubricators, headlights and cab lamps, are commonly looked after on assigned engines by the crews. When engines are pooled this work has to be done by the engine-house force. At a large terminal this expense is not large, but when the number of engines handled is small, it is difficult to arrange the duties of the men doing this work to prevent its becoming a serious item. Conditions vary on different roads in this respect, but the fact remains that this work is not in any way burdensome to men having a regular engine, while it is burdensome if they are required to prepare a different engine each trip, and consequently they object to it very strongly. In the majority of cases this work constitutes an additional charge on engines that are pooled.

CONCLUSION

175 In conclusion, the writer considers that in passenger service pooling is objectionable under any conditions and should be avoided if possible.

176 In freight service, pooling is advisable if conditions are such that engines cannot be run with assigned crews, and probably on divisions where business is so heavy that sixty engines per day or over are despatched from the terminal; but the writer's experience is that where assigned crews can be used on engines, the cost of repairs, the amount of fuel consumed, and the class of service obtained, will all be more satisfactory.

177 He therefore regards pooling as a practice that may be necessary under certain conditions, but that is certainly not desirable if the alternative system can be satisfactorily carried out.