at such intervals as will permit of satisfactory brake maintenance, those with ineffective brakes in trains must be located and set out for repairs with the minimum possible interference with transportation. For this we depend on the train brake test. The defect card can be made to help a little, but not much. Some claim that the train yard test plant is needed and useful for this. I believe it is not, in other than the very exceptional yard, as in special service, such as ore, where there is unusual dead time with no switching to be done. Repairs cannot be made safely while switching is going on, and when a train is made up it should start with the least delay thereafter.

The outgoing freight brake test is, or should be, merely a check against error. To then set out defective brakes for repairs is to disorganize dispatching and switching, thus delaying cars ready to proceed, and greatly augmenting expenses, hence, is as unthinkable as a means of maintenance as it would be to depend on an inspection of locomotives and reports of work needed alone when they were being got out for departure.

Immediately on arrival each train must have a general inspection under blue signals. Assuming that the proper brake application was made by the incoming engineer, a thorough brake inspection can now be given, minor repairs made, and cars with inoperative brakes marked for repair tracks, all during the time and protection afforded by the general inspection. As the air brake inspection must be begun as soon as the brakes are applied, and must be completed quickly (not over 20 minutes and preferably less, so as to avoid an unduly severe test and the setting out of cars with reasonably efficient brakes), it cannot be performed by the men making the general inspection. Under the above plan, the yard master is informed, before switching, just what cars are ready to proceed. Thus brake delays to departing trains are avoided, brakes are maintained, and incident expense is kept at the minimum.

But these desirable ends all depend on the correct performance of a simple duty by the incoming crew. The locomotive man must leave the brakes applied by a 20 lb. reduction, merely adding to any reduction needed for stopping the amount necessary to total 20 lb. It is preferable to have this made as one reduction, and some locomotive men do so by carefully making the stop with the locomotive brakes only, but the other method will have to answer in many cases to avoid the delay of releasing and recharging. Where time will permit of releasing, stretching the slack (hand brakes set at rear), recharging and then applying, a better inspection of draft gear will be possible. If less than 20 lb. is drawn off, some brakes in condition to proceed will be found unapplied. On being sent to the repair tracks these will be found operative, and the inspector may be criticized for the unnecessary work and delay. Thereafter he will fear to bad order brakes found unapplied, especially if there are several in a train. Thus there will be either useless expense and delay or brake maintenance will depreciate, with its resultant dangers and ultimate greater expenses, all due to even a few improperly-made incoming brake test applications. The errors are due either to the locomotive man failing to make the proper reduction (even after drawing off 20 lb. he will generally need to add more to have 20 lb. off when the brake valve exhaust ceases), or to the brakeman closing the angle cocks (to cut off) before the reduction is completed. Yet the delay, if any, to make the test application right will not exceed 15 seconds. For this reason, the simplicity of the test, and especially because of the value of the inspection depends primarily on the application being made properly, it is reasonable and necessary to require 100% efficiency in this.

War time merely emphasizes the need for making the incoming brake test invariably and correctly. We must depend mainly on road foremen and trainmasters to, while on other duties on the locomotive or in the caboose, instruct and check against errors and delinquencies. They cannot do so if they get off when entering yards. Carmen cannot check this. An attempt to do so under existing conditions would result only in more trouble for them. Instructions to govern the method of making the incoming freight brake test, arranged so that they may be issued conveniently in bulletin form, are given at the end of this paper. These are the result of several years' experience with this test on one large road, being a recent revision. Where, as in some instances at mountain terminals, trains arrive with 90 lb., this should be reduced to 70 lb., by suitable application and release, before making the test application. Tests from 90 lb. are less severe, because the high pressure left in the auxiliary reservoir after the reduction of 20 lb. will supply brake cylinder leakage longer than where the application is made from 70 lb.

Car brake repair instructions.—It is generally understood that triple valves cannot be well maintained, unless at each periodical cleaning they are cared for in a suitable room, having among its facilities a standard test rack. At two points where experienced cleaners cared for good order triple valves without removing them, but where instructions were to get a good order valve from the near by repair room to replace each found defective, the change was made to sending all valves to the repair room. The effect was shown by one shop repair foreman complaining of the additional work required on triple valves, other than cleaning, while the other and more far seeing foreman expressed surprise that they had, considering the additional serious defects found and repaired, got along as well as they had. Both repair rooms had standard test racks.

The manufacturer's instruction book for use of the standard test rack gives much of the information needed to care for the triple valve repairs fairly well, but the men who maintain the rest of the brake equipment on the car have generally had to depend upon verbal instructions. To aid such men the Westinghouse Air Brake Co. has had certain of its men, who are closely in touch with such work, prepare instructions for the brake work to be done on the car. They represent in concrete form a large part of the remedies proposed for unsatisfactory freight brake maintenance.

Piston travel and brake pipe leakage. Short piston travel (less than 6 in.) and brake pipe leakage render good braking far more difficult. A piston travel of 9 in. is actually less objectionable than one of 6 in. The former, by giving a much less increase for ordinary braking reductions, lessens slack action and consequent shocks, yet is almost as efficient in a full application as the 6 in. travel.

Regarding the caution in the appended instructions against altering piston travel until it has been determined, by ascertaining if a brake beam can be moved, whether the brake has partially leaked off, it will be of interest to know that tests made a number of freight cars, starting with 50 to 60 lb. in the brake cylinder, gradually reducing the pressure, and noting the amount remaining after each ¼ in. recession or loss in piston travel, gave an average amount left of 30 lb. after ¼ in. recession, 20 lb. after ½ in., 10 lb. after ¾ in. and 5 lb. after 1 in. This explains the statement elsewhere that 1 in. loss in piston travel means the loss of all effective holding power.

The bad results from brake pipe leakage are much greater with long trains and increase more rapidly than the train length. That is, a rate of leakage that would not be particularly detrimental with 40 cars would prevent good handling with 80. But as any leakage is detrimental and wasteful, and as the many moderate leaks, while harder to find and remedy in a train, make a large total leakage, it is very important that all such be located and stopped substantially when cars are on repair tracks. The needed results cannot be obtained without the soap suds test. A loose pipe means a future leak, as also does a rigid pipe where the need of some flexibility is plainly indicated. One illustration of the latter is a branch pipe connection (from main pipe to triple valve) consisting of two straight pieces and one ell. Another that destroys the pipe fit in the triple valve and breaks the pipe is a retaining valve pipe connection running close to the auxiliary reservoir and horizontal or nearly so.

Brake head spacing.—In these days, when conservation of material is of the greatest importance, attention may well be given to the waste of shoe metal and brake efficiency resulting from the brake shoes that overlap the wheel treads. This is due to the old head spacing of 60½ in., magnified by manufacturing errors and the spreading action of the overlapping shoes. In addition to insuring that all new beams have the 60 in. spacing, the errors should be rectified in repairing old beams.

Efficient train inspection.—Is not considerable of the unsatisfactory maintenance, and which extends beyond the brakes, due to lack of system, insufficient or untrained inspectors, and undue haste in train inspecting and repairing? Where a specified time is allotted for this work is it based on tests with a certain number of reasonably competent men, modern inspection requirement, and certain car limits per train? Is the number of men apportioned for this work generally adequate for the time allotted? Do the switchmen, in an effort to meet the requirements of their superiors, as to when trains must be ready to depart, prevent the inspectors from doing the work properly, as by emptying the brake pipe of air, bleeding uninspected brakes, and by commencing to switch the train before the inspector's work can possibly be completed properly? These questions do not necessarily suggest the belief that the most thorough inspection required should be made of each freight train at every locomotive terminal, but if the rules require it and gross deviations occur regularly, due either to insufficient time or men, how can any really good inspection be expected? If the circumstances will not permit of or justify a thorough inspection at each locomotive terminal, why not outline a less complete one for, say, through trains at alternate terminals, specifying for particular attention only the most important details? Of course, the term inspection includes the making of needed repairs, either on cars while in the train yard or by sending them to repair tracks. Unfortunately, the tendency