KEY TO THE COLOR PLATES

RED		*Main-Reservoir Pressure*
PINK		*Brake-Cylinder Pressure*
GREEN		*Auxiliary-Reservoir Pressure*
BLUE GREEN		*Feed-Valve-Pipe Pressure*
LIGHT GREEN		*Equalizing-Reservoir Pressure*
ORANGE		*Atmospheric Pressure*
YELLOW		*Brake-Pipe Pressure*
BLUE		*Live Steam*
LIGHT BLUE		*Exhaust Steam*
PURPLE		*Application-Chamber Pressure* *Supplementary-Reservoir Pressure*
GRAY		*Feed-Valve-Pipe Pressure*
BROWN		*Low-Pressure Air-Cylinder Pressure*
LAVENDER		*Signal-Pipe Pressure*

NOTICE

The instruction matter in this Section relating to freight trains applies to trains of any length, the locomotive of which is equipped with the E T equipment and has a large air-pump and a large main-reservoir capacity.

TRAIN CONTROL

Serial 1294 Edition 1

HANDLING OF FREIGHT TRAINS

TRAINS EQUIPPED WITH H TRIPLES

MAKE-UP OF TRAINS

1. The smoothness and the freedom from injurious shocks with which a freight train may be stopped by means of the automatic air brake, either in a service or an emergency application of the brake, depends considerably on the condition of the air-brake apparatus; the manner in which the braking power is distributed throughout the train, especially with reference to mixed trains of loaded and of empty cars; the number of cars and the amount of free slack in the train; and the uniformity of the piston travel.

2. Distribution of Braking Power.—The length of modern freight trains as well as the great number of trains that are now handled over a division of road during a given period of time demand that careful attention be given to the manner in which the braking power of a train is distributed. To obtain the best results, trains should be so made up that the retarding power of the brakes will be as uniformly effective throughout the whole train as it can possibly be made, and that the retarding power of the rear brakes of the train will be slightly less if possible than that of the front brakes, so that the tendency during the progress of a stop shall be to keep the rear, to a slight degree only, pressing on the forward part, thus preventing any pulling-out tendency from the rear.

3. Effects of Free Slack.—During the time that the maximum number of cars hauled in a train did not exceed 50, it was possible to handle an all-air train with more freedom from shocks than a train made up of the same number of cars, part of which had air brakes coupled and operating and part of which had no air brakes. However, since the number of cars hauled in a single train has been increased to as high as 120, it is difficult to handle an all-air train smoothly. On account of the great length of such a train, a comparatively long interval of time elapses between the application of the forward brakes and that of the rear brakes. This causes the slack first to lurch quite heavily, and, later, when the force of the compressed draft-gear springs begins to be felt and the rear brakes take hold, to stretch out, often with sufficient force to part the train. The necessity, therefore, of having a proper make-up of train and of observing methods of brake handling that will permit the slack to adjust itself throughout the train in the easiest manner possible is very evident. The subject of slack control can best be understood by observing closely the effects of slack in the various classes of trains that are handled. In this way better provision can be made against damage and break-in-twos due to slack control.

4. Effects of Unevenly Distributed Load.—When a long freight train consists of both loaded and empty cars, its successful handling will in a great measure depend on the arrangement of these cars in the train. As a train may be started and kept in motion with greater ease if all the loads are assembled together and placed at the front of the train, it is the prevailing custom to do this, thus bringing all the empties at the rear of the loads. Although this arrangement in many ways is an advantage, yet it places the brake at a big disadvantage. There will be a much higher rate of brake retardation on the empty part of the train than on the loaded part, which will result in putting very heavy strains, sometimes quickly applied, on the drawbars and couplers, often causing them to part, and frequently resulting in considerable damage to the draft gear.

For example, in a mixed train made up of 25 loaded cars and 50 empty cars, the retarding force of the empties will be about *eight* times as great as that of the loads. This results in the empties holding the loads from the rear, and the tendency of the loads is to run away from the empties, resulting in a heavy drawbar *strain* that may result in the parting of the train. This tendency may be greatly overcome by placing not more than 10 empties next to the engine, ahead of the loads.

Dynamometer tests conducted by P. J. Langan, superintendent of air brakes for the Delaware, Lackawanna, & Western Railroad, to determine the best make-up for mixed trains so as to reduce shocks to a minimum, resulted in the adoption by that road of the following schedule for trains containing not more than 30 cars: If there are 10 or fewer than 10 empties, place all the empties behind the loads; if there are 11 to 20 empties, place half ahead of the loads and half behind them; if there are more than 20 empties, place not more than 10 empties ahead of the loads, and the rest behind them.

There should never be more than 10 empties next to the engine, because more would tend to induce buckling of the train. In case the train parts, the empties at the rear assist in preventing the rear part of the train from running in and colliding with the front part. In all cases, the car next to the engine should have a quick-action brake cut in and operative, and behind this not more than one brake should be cut out in succession. The law now requires that all air brakes in the train be cut in and operated, and the minimum number of brakes must be 85 per cent. of the number of cars in the train.

5. Effects of Unequal Piston Travel.—If a wide difference in piston travel exists on the cars that make up the train, the initial brake-pipe reduction of 10 pounds or less will make a great difference in the amount of brake power developed on the individual cars. For this reason, it is much better to adjust all piston travel (standing) at between 6 and 8 inches and to maintain it at this figure for the sake of the uniformity in braking power, the easier slack adjustment, and the more prompt and uniform release of brakes that may be effected.

CHARGING THE TRAIN

6. Before coupling an engine to the train, the brake system on the engine should be fully charged, so that time may be saved and, provided yard testing plants are employed, the necessary test of the brakes may be made without delay.

If the train has to be charged after coupling the engine to it—that is, after coupling the hose and opening all angle cocks except the rear one, which should be closed—the handle of the brake valve should be placed in release position and left there for at least 15 or 20 seconds. This will permit the main-reservoir and the brake-pipe pressure to equalize rapidly and thus hasten the work of charging. When the brake-pipe pressure increases *to nearly standard pressure*, the handle should be returned to the running position and the work of charging finished with it in this position.

INSPECTING AND TESTING THE TRAIN

7. Terminal-Yard Inspection and Test.—In air-brake and train operation it is very important that a thorough and systematic inspection and test be made at the terminal yard. The inspection of a train requires that every brake shoe, brake beam, brake-beam hanger, brake rod, lever, support, bolt, and nut comprising the foundation brake gear be carefully examined for defects. Missing cotter pins, broken rods, broken and missing brake shoes, brake shoes that are worn thin, etc., should be looked for, so that all these parts may be made good and the foundation brake gear be made reliable. It is on the foundation gear that the air-brake mechanism must act and through this gear that the power developed in the brake cylinder must be transmitted to the brake shoes and wheels in order to make the brakes effective. The air-brake mechanism should next be carefully examined for such defects as leaky hose-coupling gaskets; leaky, porous, and defective hose; angle cocks that leak and that have handles broken, bent, or missing; loose brake pipes; missing or loose pipe clamps; leaky pipe unions; loose retaining-valve pipes and pipe joints; loose supporting bolts for the auxiliary reservoir and brake cylinder—in a word, every part of the apparatus should be known to be properly secured to the car body and framing and to be in serviceable condition.

Then, after coupling up all hose and opening all angle cocks except the rear one, the train should be charged in the manner just explained, after which the brakes should be applied with a 20-pound service reduction. Inspection should then follow to locate all leaks and to determine the length of the piston travel, as well as to see whether or not each brake has applied and that none leaks off during the time occupied in inspecting.

Brake-pipe leakage is detrimental to safe and satisfactory brake operation, and for this reason it should be reduced to a minimum before the train is allowed to depart. Most brake-pipe leakage occurs at the hose couplings, through porous hose, and at the triple-valve unions. Leaks at the hose couplings and triple-valve unions may be detected by the sound, and those through porous hose can be easily detected by coating the hose with soapsuds, which should be done whenever practicable.

Leaks and improper piston travel that are found during the inspection should be marked, so as to identify them and to facilitate making the necessary repairs after the release has been made. After this inspection, the brakes should be released, and the train again inspected to see whether all brakes have properly released. If any brakes that have failed to apply or to release or that have leaked off during the time of inspection, are found, the cause should be ascertained and the proper remedy applied. Good results in air-brake operation depend greatly on intelligent terminal-yard inspection and testing and on the making of all repairs that this inspection shows to be necessary.

If the train is to be handled on grades that demand the use of the pressure retainers, this part of the equipment, together with its pipe connections, should be thoroughly examined and tested to make certain that it is in condition to render efficient service; that is, free from leakage and with both exhaust ports in the retainer open and free from dirt.

After the test, a report should be made to the engineer and conductor, showing the number of loaded and empty cars and their position in the train; the number of air cars in good order and the number cut out; the condition of the piston travel; the number of retainers, if they are to be used, that are working properly; and also the general condition of the train.

8. Terminal-Roundhouse Inspection and Test. Before the locomotive is allowed to leave the roundhouse, its brake equipment should be thoroughly inspected and tested, to make certain that it is in good operative condition. The inspection should be made after the main reservoir has been drained, the brake pipe blown out, and the pump has charged the system with pressure, and should consist in a close examination of all air pipes and pipe joints, so as to determine their physical condition and to detect any leakage.

The foundation brake gear should be carefully examined for thin, broken, or missing brake shoes; defective brake beams, brake levers, brake-beam hangers; missing bolts and cotters; etc. After having completed the external inspection and made such repairs as are found necessary, the automatic brake should be applied with a 15-pound service reduction and the action of the pump governor noted. It will be necessary to observe whether or not the governor permits the pump to accumulate maximum main-reservoir pressure, and at what pressure the pump governor throttles down the pump; also to note what cylinder pressure is obtained, as indicated by the brake-cylinder air gauge, and whether this pressure is maintained constant during the time that the brake is held applied. After the brake is fully charged, the number of pump exhausts should be noted, because they are a fair indication of the amount of the brake-cylinder leakage. The brake-piston travel should be noted to see whether or not it is too long. Next, the brake should be released by placing the automatic brake-valve handle in running position, and the time required to release, which should be about $3\frac{1}{2}$ seconds, noted. After this, the brake should be applied with the independent brake valve, leaving the handle in slow-application position and noting the

maximum brake-cylinder pressure obtained. This should be 45 pounds; any variation from this amount indicates that the reducing valve for the independent brake valve is either leaking, or is not properly adjusted, or that there is leakage into the application cylinder of the distributing valve from some other source. After this test, the brake should be released by placing the independent brake valve in release position, and the time required to exhaust the brake-cylinder pressure noted. The time should not vary materially from that given for the automatic brake, namely, about $3\frac{1}{2}$ seconds.

The adjustment and the operation of the safety valve should be tested by making a service reduction of 20 pounds, after which the handle of the automatic brake valve should be placed in emergency position. The pressure-maintaining port in the automatic brake valve will supply air to the application cylinder and increase the pressure therein up to the point at which the safety valve opens, which should be 68 pounds. During the application and release of the brakes, and the variations in brake-pipe and main-reservoir pressures that occur while making the tests, the action of the pump governors and of the feed-valve and reducing valve should be carefully noted, so as to determine the degree of sensitiveness and the accuracy with which they control the pump and regulate the pressure. If either is sluggish in its action, it should be replaced by one in good condition. A test gauge that is known to be correct should be applied to the brake pipe, and the pressure indicated by the engine air gauges carefully compared, first with the handle of the automatic brake valve in running position and then with it in release position.

After the test of the engine gauges, the accuracy of the brake-cylinder gauge may be determined with sufficient closeness by making a brake-pipe reduction and noting accurately the amount, since the gauge should indicate about $2\frac{1}{2}$ pounds of cylinder pressure for each pound of brake-pipe reduction.

The driver brake-piston travel should not exceed 4 inches, and that of the tender and engine truck brake, 6 inches. The pump should be observed during the time that it is working to see whether it operates smoothly; that is, without any unusual clicks or pounds. The air valves also should be tested by holding the hand near the air inlet to see whether the suction is strong and regular, without any back puff of air, on both the up and the down strokes.

9. Running Test.—The running test, which consists in making a light service application and noting the brake-pipe exhaust made while the train is in motion, is resorted to as a final check on the terminal testing. It should be made soon after departure from the terminal station, as an assurance against possible failure or oversight of the inspectors or crew to perform their full duty. It should also be made when approaching meeting points, railroad crossings at grade, junction points, drawbridges, and terminal stations, before commencing the descent of a heavy grade, and, in fact, at such places as will not permit of running by the designated spot without likelihood of disaster resulting. The running-test application should be made, without closing the throttle, at a point far enough back from the stopping or slow-down place to permit the crew to stop the train with the hand-brakes should the air brake fail to operate as expected. This test should also be made after a train has been parted and recoupled, or after it has stood for a long time in a place where there is opportunity for tampering with the hose or angle cocks. The running test is an important one, and just how and when it ought to be made should be thoroughly understood by an engineman before he is permitted to handle the brakes on the road.

When moving long, heavy freight trains out of yards or terminals the track of which is level or the grade is up, it is not always practical to make the running test; but when the grade is down, it can be made, in which case, of course, the brakes must soon be applied in the usual manner to control the train. With a freight train, the terminal standing test is very important; it should always be properly made, and on no account omitted.

HANDLING THE TRAIN

10. Running Precautions.—While running the train, the engineer should always know whether or not the pump is working properly and maintaining the desired pressure. He should watch the air gauge carefully to make certain that the correct pressures are being kept up. When double-heading, the second engineman should watch the brake-pipe air gauge of his locomotive to see that the engineer of the head engine is maintaining the pressure properly, as well as making the proper reductions to apply the brakes satisfactorily.

11. Service Stops.—When making a service stop with a modern freight train, the slack in it must always be considered. Formerly, when part-air trains were the rule rather than the exception, it was necessary after shutting off steam to allow sufficient time to elapse to permit the slack to adjust itself. However, with all-air trains, as is now generally the rule, the train, especially if it is long and if empty cars are at the rear, will stretch during the progress of the stop. For this reason, it is better to commence the brake application just before shutting off steam—while the train is stretched—and to make the initial service reduction no heavier than is required to apply the brakes lightly throughout the whole train.

With a very long train, a service reduction not exceeding 10 pounds will be sufficient to do this and at the same time reduce the speed very materially. If it is determined that a 10-pound reduction will stop the train, the brake-valve handle should be placed in service position and left there until the train stops, the idea being to keep the brake-valve exhaust blowing so that the brakes will be applying harder on the front end of the train than on the rear while the train is coming to a stop. For a train shorter than the preceding and running at a higher speed, the initial reduction may be between 6 and 8 pounds; and, after the slack has stretched out, a second reduction sufficiently heavy to stop the train may be made. In trains of 35 cars or fewer, the slack is not of so much importance. After the first reduction has taken full effect, the following reduction may be as heavy as speed and other circumstances require to make the desired stop. Before attempting to start a train that has been stopped, ample time should always be allowed for all brakes to release.

12. Quick Action During Service Application.—In making a service application, the brakes are liable to set quick action. This may be due to: (1) improper brake manipulation, (2) excessive brake-pipe leakage, or (3) a defective triple.

1. *Improper Brake Manipulation.*—The delay caused by moving the brake-valve handle from running to lap position and allowing it to remain in this position for 6 to 8 seconds before commencing the service reduction, often permits brake-pipe leakage to move one or more of the triples at the head end of the train to the position where the collar, or lug, on the piston stem engages the slide valve very gently. Thus, when the service reduction is begun at the brake valve, a somewhat greater differential between the auxiliary pressure and brake-pipe pressure must be made to move the triple piston and slide valve, with the result that this differential is sometimes great enough to cause some one of the triples to move to the emergency position and cause undesired quick action.

Failure to practice the kick-off movement after releasing brakes on long trains is often responsible for the occurrence of undesired quick action when the next service application is begun. The reason for this is that, as explained for the delay in lap position, the overcharged reservoirs cause their triple pistons to move back to a position where the piston lugs engage with the slide valve, in which position they will remain until a service reduction is begun.

2. *Excessive Brake-Pipe Leakage.*—Excessive brake-pipe leakage, which, as stated, is conducive to undesired quick action, is usually to be found at hose couplings and the triple-valve-union connections of the cross-over pipe. After a parting or a break-in-two occurs while the train is in motion, brake-pipe leakage will generally be found to have increased considerably at the points named. This leakage, in addition to the brake-pipe reduction at the brake valve, often causes

undesired quick action on account of the piston moving until the shoulder on the stem strikes the slide valve, as just explained, or on account of the leaks making the brake-pipe reduction quicker than ordinarily.

3. *Defective Triples.*—The defects in the triple that cause undesired quick action are improper lubrication, too much tension of the slide-valve spring, a weak or broken graduating spring on very short trains, a broken graduating pin, or a tight-fitting triple piston packing ring.

To locate the troublesome valve in long trains, it will be necessary first to place observers along the train and as far away from the side as practicable, so that when the brakes apply they can tell whether the undesired quick action starts from the front or from the rear. If it starts from the front, the rear portion of the train may be cut off, by closing an angle cock, while testing for the defective triple. After having ascertained the vicinity in which the triple that is causing trouble is located, it can be detected by making a service reduction of 5 pounds and noting which brake pistons do not move out. When these are found, the observers should be instructed to watch them closely while another reduction of 3 pounds is being made to bring the defective triple into action. The triple that is found to be at fault should be cut out, and then, with the whole train cut in, the system should be recharged and a 10-pound reduction made so as to be positive that the right triple has been found and that the brakes will apply in service without undesirable quick action.

Proper cleaning and lubricating and the use of proper lubricants, which are now known and may be easily procured, will eliminate all undesired quick action that may be charged to improper lubrication.

13. Slow-Downs.—If it is necessary to reduce the speed of a long freight train, an application of the locomotive brakes with the independent brake will often be sufficient, because the speed of such a train is seldom very high. Good judgment, however, must be exercised in applying the independent brake. If it is not used very cautiously, terrific shocks in the train will result; and if it is held applied too long, it will overheat the tires.

If the automatic brake has to be used to slow down the train, it is often better to come to a full stop before releasing than to attempt to release while under motion because of the danger of breaking in two. However, in a train consisting of 50 cars or fewer, the release should be made by placing the automatic brake-valve handle in release position for about 15 seconds and then returning it to holding position, taking care in the meantime to maintain sufficient brake-cylinder pressure with the independent brake valve to keep the slack together and to prevent a break-in-two.

14. Water-Tank and Coal-Chute Stops.—In making water-tank or coal-chute stops, the engineer should not attempt to spot the engine at the water spout or coal chute. The better plan is to stop short and cut off the engine to take coal and water, afterwards coupling up to the train and charging up and testing the brakes in the usual manner before proceeding.

15. Emergency Stops.—At times, emergency applications are necessary to avert accident and prevent the loss of life and property. There is but one thing to do in cases of actual emergency: Quickly place the handle of the automatic brake valve in emergency position and leave it there until the train stops or the danger is passed.

16. Trains on Grades.—Grade work is a very important branch of railway operation, because of the fact that it does not permit of any chance to be taken with the equipment, either with respect to its condition or with the method of its manipulation.

In order to realize the necessity for exercising great care in handling trains on grades, a clear understanding of the terms *force of gravity* and *per cent. of grade* is essential. By **gravity** is meant that force which the earth exerts on a body at all times, giving it weight and causing it, when unsupported, to fall. Gravity is constant in action, and whenever a body is to be lowered from one height to another, the force that gravity exerts must be neutralized by another force acting in opposition to it to the extent required to permit the body to reach the lower level without damage or injury. A train about to commence the descent of a grade is a body that is to be lowered from one height to another against the force of gravity, and the brake is the medium through which the necessary neutralizing force is applied that permits the train to be lowered at the required degree of rapidity to prevent damage, and to avoid the danger of a runaway.

The **per cent. of grade** should be clearly understood from the following: Assume that in 1 mile of railway the vertical rise is 52.8 feet. This 52.8 feet divided by 5,280, the number of feet in a mile, will give $\frac{1}{100}$, which is equal to 1 per cent.; that is, the vertical rise is $\frac{1}{100}$, or 1 per cent. of the length of the grade, and the grade would be called a *1-per-cent. grade.* If the vertical rise in 1 mile were 105.6 feet, or twice 52.8 feet, the grade would be called a *2-per-cent grade;* if three times 52.8 feet, or 158.4 feet, it would be a *3-per-cent. grade;* and so on.

As was said before, gravity is a force that acts continuously and it is just equal to the weight of a body. Hence, on a body free to fall vertically downwards, gravity exerts a force equal to 100 per cent., or the full weight of the body, in accelerating its motion. On the other hand, if in dropping vertically downwards a distance of 52.8 feet the body must move along an inclined plane a distance of 5,280 feet, then only $\frac{1}{100}$, or 1 per cent., of the force of gravity will be exerted toward accelerating the motion of the body. In other words, $\frac{1}{100}$ of the weight of the body is the constant accelerating force that produces motion along the inclined plane, and when the grade becomes level, gravity of course does not exert any force on the body to produce motion along the level. In ascending a grade, a locomotive not only moves the train along an inclined plane, but also lifts the whole train through a distance equal to the vertical height of the grade.

17. From what has just been said, it will be seen that on down grades there is absolute necessity for having at each instant not only sufficient braking force to offset the force of gravity but an additional braking force for stopping the train.

Therefore, before commencing the descent of a grade it is important to be sure that the auxiliaries are fully charged and that the brakes are in such operative condition that they will respond when wanted with the requisite holding power. This can best be determined by testing the brakes according to the prescribed rules in force on the road, then recharging the brake system to the pressure prescribed as standard for that grade, and, finally, turning up the number of retainers that experience has indicated are necessary for the grade. Another thing, of great importance is, never to let the speed of the train increase over that prescribed by the rules.

18. After a train on a down grade has attained sufficient speed to withstand a service application without stalling, a reduction of not less than 12 pounds should be made. With this reduction the train should, provided the brakes were held applied, come to a stop. If it will not bring the train to a stop, a reduction sufficiently heavy to stop it should be made, and the brakes should then be inspected to ascertain the cause of failure to hold as they should. If it is seen that the 12-pound reduction will control the train, the recharge of the auxiliaries may be commenced by placing the brake-valve handle in release position for 20 or 30 seconds and then in running position until it is desired to increase the brake-cylinder pressure, when a reduction of from 6 to 8 pounds will usually suffice to reduce the speed to the rate it is desired to maintain.

In grade work, good judgment should be used in handling the brakes, so as to maintain as uniform a rate of speed as possible. In the exercise of this judgment, advantage should be taken of the curves and the let-ups in the grade for recharging the reservoirs. However, just how this should be done is something that cannot be explained here, because no two grades nor no two trains are just alike; it must be acquired by experience.

As modern engines are heavy, overheating of tires is very likely to result if the driver brakes are not used with discretion. This is especially the case with the E T locomotive equipment if the grade is very steep and long. Nevertheless, there need be no difficulty in regulating the amount of brake

work the driver brakes should do, because they may be released at any and all times with the independent brake valve without disturbing the automatic brakes on the train. Locomotives that operate on long and heavy grades are usually provided with special driver-brake cut-out cocks. These are located in the cab and are to be used by the engineer for the purpose of preventing tire heating.

19. As some very long all-air trains have to be handled on grades, there is a demand for the skilful use of the straight air or an independent brake on the engine. For example, if the speed of the head part of a train that is being pulled on to a grade commences to increase over the speed of the rear part so rapidly that there is a possibility of breaking the train in two, the independent brake should be used to keep the slack from running out too hard and until the rear comes over the summit. Again, when on the grade, and the automatic brake-valve handle is placed in release position, the independent brake should be applied to prevent the slack from running out rapidly, and to assist the retainers in its gradual adjustment.

20. In all grade work, it should be the aim to make certain that the brakes are sufficiently powerful to prevent the train from getting away and to put them into operation before the speed of the train exceeds the maximum allowable. Many runaways have occurred simply because the speed of the train was allowed to get too high before the brakes were applied on the initial application, or because, through carelessness or ignorance, or both, the air was frittered away by frequent small and ineffective reductions. It should be remembered that the holding power of a brake shoe reduces as the speed increases.

If sufficient pressure retainers are used and the brake cylinders are once charged with pressure, the aim should be to control the speed by frequent comparatively light reductions and recharges. This method will maintain a more uniform rate of speed while descending the grade, and at the same time give a higher average brake-pipe and auxiliary-reservoir pressure, which will always be available in case an emergency arises and a quick stop is imperative. Close watch should be kept of the air gauge in descending grades, so as to know that the pump is maintaining the required pressure.

21. In starting a train that has been stopped on a grade, care should be taken to see that all wheels commence to rotate. As the pressure retainers hold pressure in the brake cylinders, there is always danger that some of the wheels may not start to rotate, in which case they would be skidded along a sufficient distance to flatten and ruin them.

It is customary on most roads to increase the brake-pipe and main-reservoir pressure before starting down long, heavy grades. Also, the speed of the air pump is increased to meet conditions. When frequent applications are made on a descending grade, the brakes should be released by moving the automatic brake valve handle to release position for 30 to 40 seconds, then to running position for 8 seconds, then back to release for 2 seconds, to kick off any brakes that may have reapplied, and then back to running position. If a stop is made, steam should not be used for 1 full minute, so as to allow the rear brakes to release and blow down to zero. The driver brake should be released by the independent brake valve after each application except the first and the last, to prevent overheating the tires. On starting the train, the independent brake should be applied at once to prevent the head end from running out too quickly and snapping the train in two. After the engine has moved five or six car lengths, the engine brake should be graduated off.

After the first release note should be taken of the efficiency of the pressure-retaining valves; that is, the manner in which they are holding. They should always be able to hold the speed of the train in check during the time required to recharge the auxiliaries completely.

A steam pressure of at least 175 pounds must be maintained while on a grade so as to insure sufficient steam pressure for the air pumps to maintain main-reservoir pressure. If for any reason the brake-pipe pressure cannot be maintained, the train must be stopped at once and the assistance of the train crew obtained for controlling the train. If a reduction of

more than 12 pounds is required to control the speed when the retainers are up, the engineer should receive the assistance of the train crew. Also, when ascending a grade, the trainmen must always be prepared in the event of a break-in-two to prevent the detached part from running down grade by promptly applying the hand-brakes.

22. If a train is to be held standing on a grade for any length of time, the automatic brake should never be depended on to hold it. Instead, just as the train comes to a stop, the independent brake should be applied in full and the engine reversed. The handle of the automatic brake valve should then be placed in release position for a few seconds and then in running position. If the independent brake is not sufficient to hold the train standing, enough hand-brakes to supply the deficiency should be applied. In this way, the auxiliaries may be kept fully charged and full brake power will be available at any instant it is required.

A train with the engine detached should never be left standing on a grade unless sufficient hand-brakes are applied to hold it. The air brake may leak off and disastrous consequences result, as has been the case in several instances in the past when the air brake alone has been depended on to hold the train.

If a train becomes parted on a grade, whether accidentally or in some other way, the angle cocks on each car at the point of separation must be closed and the part of the train not coupled to the engine secured by hand-brakes on all cars, beginning at the car on the lowest part of the grade.

23. The number of retainers to use on a grade depends on local conditions as to grade, the make-up of the train, the condition of brakes, etc. Each road usually prescribes the number to be used under given conditions, and these instructions should always be lived up to. Where no instructions are given, the following may be used as a guide as to the number of retainers to use on a grade of $1\frac{1}{4}$ per cent. or more: With a train of all loads, all retainers should be used; with a train of all empties, the retainer handles at the head end on one-third of the cars should be turned up; on mixed trains of 50 or more cars, the retainer handles on all the loads and on one-third of the empties should be turned up; and on trains of more than 55 cars the retainer handles on all except the 6 rear cars should be turned up. Retainer handles should not be turned down until the train is at the bottom of the hill. In the event of a car journal heating while on the grade, the brake of that car should be cut out until the foot of the hill is reached, when it should again be cut in.

24. Double-Heading.—In double-heading, the engine having the larger air-pump capacity should be placed ahead and have control of the brakes. The double-heading cock on the following engine, whether coupled next to the leading engine or placed elsewhere in the train, should be closed and both brake-valve handles carried in running position. The cylinder pressure on the following engine may be regulated as desired by means of the independent brake valve, either in the way of reducing or increasing it, without interfering with any of the other brakes on the train. The enginemen should watch the brake-cylinder gauges so as to govern the cylinder pressure in such a manner as to prevent overheating of tires and prevent shocks in the train, which produce tendencies to break it in two. The engineer of the second engine should also watch the brake-pipe air gauge so as to know that the proper brake-pipe pressure is being carried at all times and that the operating engineman is making the proper reductions when applying the brake.

If, for any reason, the air on the head engine fails, the engineer on that engine should signal the second engineer by the proper whistle signal of the road, and when answered he should cut out the air on the lead engine so that the second engineer can control the train until his engine changes positions with the lead engine. On cutting in, the engineer of the second engine should try the brakes at once to determine whether or not he can control the train. If he does not do this, the engineer of the head engine should immediately cut in and apply the brake, stop the train, and have a definite understanding before proceeding.

In making a service stop with two engines coupled together and placed at the head of the train, the aim should be to have the brake-pipe pressure reducing at the operating brake-valve as the train comes to a stop, and thus avoid a possible break-in-two.

25. If more than one engine having the E T equipment is used on the same train, the rule governing the older equipment should be observed, no matter in what part of the train the engines may be. In other words, the double-heading cock, or the brake-valve cut-out cock, on all engines except the one from which the brakes are to be operated should be closed and the handle of the brake valve carried in running position. The brake valve on the engine from which the brakes are operated, will operate the brakes on the engine or engines in the train that have their double-heading cocks closed.

In double-heading, the independent brake valve on the engines fitted with the E T equipment may always be used to control the brakes on that engine without interfering with the operation of the automatic brakes on the rest of the train or even on the same engine. After a release of the automatic brake is made by the operating engineer there is danger of overcharging the pressure chamber of the distributing valve of the locomotive having its double-heading cock closed; this is apt to cause the brakes to creep on. To avoid this annoyance the operating engineman should be signaled to release brakes, which he should do by moving the automatic brake-valve handle to release position and immediately back to running position.

26. Stuck Brakes.—By so-called *stuck brakes* are meant brakes that do not release along with the others or brakes that remain applied for some time after the others have released. They are often caused by some defect in the foundation brake gear, such as the fouling of a lever or the wedging of a bolt between the brake beam and the spring bolster; also, a retainer with the handle turned up, a plugged exhaust port, and, sometimes, a leaky emergency valve in the triple may be the cause of the trouble. All these defects should be discovered during the terminal test of the brakes and corrected before the train is allowed to leave the yard.

Causes of stuck brakes attributable to wrong manipulation are those resulting from reapplication of the brakes on the head part of the train, due to overcharging during release, and those resulting from delayed release, especially toward the rear, due to reducing the brake-pipe pressure below that at which the auxiliary and brake cylinder equalize during the service application. To avoid this trouble, the handle of the brake valve, when releasing the brakes, should not be held in release longer than from 10 to 15 seconds with any length of train, and in 4 or 5 seconds after returning it to running position it should be moved to release and back to running once or twice. These manipulations will kick off any of the head brakes that may have reapplied without appreciably increasing permanently the brake-pipe pressure. When making a service application, a reduction of more than 15 pounds should not be exceeded, if possible. Then, when release is attempted, all triple pistons will be balanced between auxiliary and brake-pipe pressure, and the increase of brake-pipe pressure will move them promptly to release position.

27. Wheel Sliding.—Probably more wheels are flattened by starting a train and pulling it a long distance before the brakes release than in any other way. The engineer should therefore endeavor to manipulate the brake valve in such a way as to effect a prompt release of all brakes in the first instance, and to determine whether or not all wheels are turning the train crew should watch the train as it pulls past them. It is especially necessary to watch the wheels on long trains, because variation in piston travel will sometimes hold a brake applied long enough before releasing to slide the wheel until it is flattened. The resistance of one or two applied brakes does not affect the large, powerful locomotives sufficiently to call the attention of the engine crew to the fact that they are sliding, and flat wheels are likely to result unless prompt measures are taken to bleed auxiliary pressure below that in the brake pipe, or to knock the shoes loose.

Wheel sliding that is chargeable to the air-brake apparatus may be said to be due largely to the causes mentioned for stuck brakes. If carried far enough, sliding will cause injurious flat spots. Therefore, when flat wheels are found, their condition may usually be traced to sliding a short distance when under loaded cars, and to sliding a long distance when under empty cars. In the consideration of the flat-wheel problem, the length of the train, the location of the car in the train, the load carried by the car having the flat wheel, the amount of sand used, as well as the time of applying it while making stop and when starting, and the distance the sliding wheel is pulled along the track, must all be considered.

Much wheel sliding could be prevented by making a thorough and systematic inspection at terminals and then adjusting the piston travel intelligently and repairing all defects in the foundation brake gear before the train leaves the terminal, as already explained. After the train leaves the terminal, the precautions necessary in manipulating the brakes to prevent them from sticking will at the same time prevent the wheels from sliding, and in the majority of cases flat wheels.

Cars that are being handled in yards with the hand-brakes applied have their wheels flattened because they are slid over long distances. In cold weather, the brake shoes may often be frozen to the wheels so hard as to prevent them from rotating when moved. If a train fitted with pressure retainers stops and is then started, there is danger of some wheels sliding and of being dragged far enough to flatten them. The same thing is true where hand-brakes are applied to hold the train while standing on grades and the train is then started without releasing the hand-brakes.

28. Break-In-Twos.—When a service application is started, the brakes on the front of a train commence to act immediately, causing the slack to close in tight and compress all drawbar springs, and later, usually at the time that the speed of the rear is considerably reduced, the rear brakes commence to take hold. The energy in the compressed drawbar springs then asserts itself, and this, added to the retarding effect of the rear brakes, brings on a heavy stretching strain in the train that not infrequently is greater than the drawbars can stand, and as a result the train parts, sometimes breaking into three or more pieces. To avoid this undesirable occurrence, the independent brake valve should be held in release. This will prevent the locomotive brakes from going on, and thus help to diminish the drawbar compression during the early part of the application. When the brake-pipe pressure has reduced about 8 pounds from the first reduction, the independent brake-valve handle should be returned to running position and a further service reduction made—one that will cause brake-pipe air to be flowing from the service exhaust at the time the train stops. In this method, a heavier braking power is maintained on the front of the train during the course of the stop than can be maintained at the rear. Hence, the rear cannot pull away hard from the front part of the train and break it in two.

On trains of 90 cars or more, the difference in time between the beginning of action of the front brakes and that of the rear brakes in service applications permits the closing in of the rear and the front ends, which, later, when speed reduces considerably, commence to separate rapidly and thus break the train in two just before coming to a stop. On many roads the service application is made in the manner just recommended, and, in addition, the slack of the train is prevented from closing up during the progress of a service stop and, later, in running out again with consequent danger of breaking in two, by using a light throttle while the first service reduction is being made.

If it is necessary to back up a train and stop it by means of the brakes, when the first reduction is made the brakes near the engine apply first and hardest, so that there is a tendency for the slack on the front part of the train to run out hard and break the train in two.

When applying the brake in backing up, therefore, the locomotive brake should be released by means of the independent brake valve and a light throttle should be used until the train stops.

In the starting of a long train, care must be exercised in taking the slack so as not to break the train in two. Slack should be taken out gently, and when the locomotive has moved forwards about its own length, the throttle may be opened sufficiently to put the train in motion.

29. No attempt should be made to release the brakes on a train of more than 45 cars if the speed is 10 miles or less per hour, or if retainers are not in use. In such cases there is great danger of breaking the train in two, because the rear brakes cannot release in time to prevent the slack from running out. With trains of fewer than 60 all loaded cars running at speeds greater than 12 miles per hour, the brakes may be released without breaking the train in two if the locomotive brake is kept fully applied until the rear brakes have released. On trains of fewer than 45 cars, the release may be effected at slow speeds without danger of parting by the skilful use of the holding feature of the H-6 brake valve, or by the use of the independent brake valve; that is, by holding the locomotive brakes applied until all the train brakes have released.

In any case of release of brakes while the train is in motion, steam should not be used until sufficient time has elapsed for all brakes to release and for the slack to adjust itself.

30. Bleeding Off a Brake.—Whenever it is necessary to bleed a brake off the auxiliary-reservoir release valve should be used for the purpose, and just enough air should be drawn through the release valve from the auxiliary to permit the triple to return to release position. If the release valve is held open after the triple returns to release, it may cause the other brakes in the train to apply.

In the case of long freight trains, it may occasionally be found that a car near the rear of the train contains a brake that has not released along with the others. Before opening the release valve it is necessary to determine whether or not the pressure-retainer handle is in the proper position to permit the brake to release. If the handle is not in the proper position, it should be turned down at once; if it is already down, the release valve rod should be pulled quickly once or twice, but it must not be held open an instant after the brake commences to release. If the release valve is held open until the piston is clear back in the cylinder, other brakes will likely commence to apply. Indeed, this will almost invariably result if the cars are cut off from the engine. In releasing any brake with the release valve, it should be closed the instant that the air commences to exhaust from the cylinder. Holding the release valve open longer than this will deplete the auxiliary, which will commence to take air from the brake pipe to supply the deficiency, and this is likely to create sufficient reduction in the brake-pipe pressure to cause other brakes to apply. In case a number of brakes located together at the rear of a long train fail to release, a partly closed angle cock should be looked for.

31. Burst Hose.—If a hose ruptures or bursts, if the conductor pulls the conductor's valve, or if the train parts, the handle of the automatic brake valve should be placed in lap position. If a burst hose is the cause of the trouble, the crew should immediately institute a search for the defective hose. As soon as the train comes to a stop, the brake-valve handle should be moved far enough into running position to feed air into the brake pipe and thus cause a blow from the ruptured hose so as to attract their attention. It is important to remember and to practice this method, in such cases, as it will help materially to save time in finding the defective hose.

In the event of a hose bursting, the engineer should immediately lap the brake valve, and as soon as the train stops, send out flags. The hose should be replaced by a new one or by the extra hose on the last car of the train, and the brakes then tested to see whether they operate properly. If unsafe to replace the hose and test the brakes at this time, the angle cock immediately in front of the burst hose should be closed; the brakes back of it should then be bled off, and the train moved to a safe place, where the hose can be replaced and the brakes tested.

32. Setting Out a Car.—When a car is to be set out or left on a side track, the brakes should be released, the angle cocks on each side of the hose that are to be parted should be closed, and the hose parted by hand. When the car is set out, the release valve on the auxiliary reservoir should be held open until the auxiliary is depleted, and the hand-brake applied with sufficient force to prevent the car from moving of its own accord.

If the car is to be left standing on a heavy grade, the brakes should be examined before setting it out, so as to be sure that they are in perfect working order. When the car is set out, the air brake should be released and the auxiliary reservoir drained; also, before leaving it, the hand-brakes should be set securely so as to hold the car. If there is any doubt about the hand-brake holding, the wheels should be blocked or some other suitable precautions taken. In all cases, the air brake should be released before the hand-brake is applied.

When recoupling the train after setting out the car, it is necessary to make certain that all angle cocks, with the exception of the rear one, are wide open and that the system is properly charged, after which the required test of the brake should be made before proceeding.

TRAINS EQUIPPED WITH K TRIPLES

REMARKS

33. To handle satisfactorily a long train made up partly of K triples, the general location of the K triple valves throughout the train must be known. If the K triples are evenly scattered throughout the train, then, regardless of the length of the train, all service applications should be made with an initial reduction of not more than 7 pounds. This will cause all brakes to apply with a light cylinder pressure; that is, with a pressure just sufficient to adjust the slack gently. After it is felt that the slack has adjusted itself, such additional reductions should be made as the conditions of the case require to bring the train to a stop at the desired place. The brake should then be held applied until the train stops.

After a train has been stopped the brake should be released in the usual way; that is, by moving the automatic brake-valve handle, regardless of type of brake valve, to release position for a period of 15 seconds, then to running position, and after 2 or 3 seconds to release position for a moment and quickly back to running position. This latter operation, called the *kick-off*, will release any of the head brakes that may have reapplied due to overcharging without permanently causing an appreciable increase in brake-pipe pressure.

34. If all the K triple valves are placed together at the front end of the train and are over 10 in number, then the initial brake-pipe reduction should be not over 7 pounds. After this reduction has taken place and it is learned that more is needed to bring the train to a stop, an effort should be made to have the brake-pipe air flowing from the brake valve as the train comes to a stop. This will prevent the head end of the train from surging ahead during the progress of the stop and breaking the train in two. The brakes may be safely released at slow speed if desired, because, if the number of K valves is at least ten and all are at the front of the train, its retarded-release feature, as well as the holding feature of the H-6 automatic brake, will prevent the slack from running out and parting the train. If the engine is not equipped with the E T brake, then the straight-air brake may be used to retain the locomotive-brake pressure for at least 15 seconds while the rear brakes are starting to release.

If the train is composed entirely of K valves, the initial reduction for a service stop should be about 7 pounds. This amount will usually be found sufficient to stop the train. However, if the train is short, say one containing 35 cars or fewer, and the speed is comparatively high, an additional service reduction as heavy as the circumstances require—that is, to within the limits of the equalizing point, or 18 pounds—may be made. The release may be made in the usual manner when desired, either before or after the train has come to a stop.

If all the K valves in a train are located together at the rear and are over ten in number, then the initial reduction should not be over 7 pounds. When this reduction is about to cease at the brake valve, it should be followed by another reduction

of 6 or 8 pounds; that is, one sufficiently heavy to cause brake-pipe air to flow from the brake valve at the instant the train stops. No release should be attempted until after the stop is made. In such cases, too, if the train is long, say one consisting of 50 cars or more, it is considered good practice to make the first service reduction before or without shutting off steam.

CHARGING THE TRAIN

35. The method of charging a train consisting wholly or partly of K triples does not differ materially from that already recommended. It will be well, however, to observe, that some of the earlier types of K valves that take air through the non-return check-valve to supply the uniform recharge port make a buzzing noise while charging the auxiliary. This noise should not be mistaken for a similar noise made by a leaky emergency valve. When an emergency valve leaks, there is a blow at the exhaust port of the retainer at the same time that the buzzing noise is heard; but if the buzzing continues for a part of the time that the auxiliary is charging and then ceases, without any blow taking place at the retainer exhaust, it is caused by the air that is passing through the non-return check-valve to supply the uniform recharge part.

HANDLING THE TRAIN

36. Slow-Downs.—If a train is entirely equipped with K triples, slow-downs may be made with the automatic brake and the release accomplished without any danger of parting the train. The same thing holds true if ten or more K valves on a partly equipped train are all placed together at the front end. With the K triples scattered throughout the train, however, it will be better, provided the train is long, to observe the precautions in regard to releasing recommended for the type H triple valve type. In other words, if the speed is less than 10 miles an hour, no release should be made before coming to a stop.

37. Emergency Stops.—In emergency applications, the K triple operates in the same manner as the H triple. Therefore, the instructions regarding the application of the H triple in emergency apply to the K type. In all cases of emergency, place the handle of the automatic brake valve quickly in emergency position and leave it there until the train stops. When releasing after an emergency, leave the handle of the brake valve in release position until the brake-pipe pressure has reached at least 60 pounds.

38. Trains on Grades.—A decided advantage is had in handling trains on long, heavy grades when all the cars in the train are equipped with the K type of triple, because the quick-service feature accelerates the service reduction throughout the whole length of the brake pipe, and the brake-pipe air vented at each triple goes into the brake cylinder to augment the pressure in this cylinder. Thus, time and economy in the use of air, two very important considerations in grade work, are conserved in the highest degree by the K-triple mechanism.

When handling trains equipped partly or entirely with K valves on heavy grades, the engineer should be governed by the rules and precautions given for trains equipped with the older type of valves. The manner in which the pressure retainers should be used in grade work is also governed by the rules prescribed for any other type of triple.

39. Stuck Brakes.—Stuck brakes occur most frequently in winter weather. They are more often due to the cold and frozen condition of the shoes than to any defect in the triple valve. However, as the causes of stuck brakes are precisely the same with the K triple as with the older type, the precautions to prevent them are the same. As a general rule, so far as the engineman is concerned, he must so manipulate the brake valve when releasing the brakes as to prevent unduly overcharging the brake pipe at the front end. In addition, he must practice the kick-off method to prevent the reapplication of the head brakes, and, after the brakes are all properly released and while the brakes are not wanted, keep the handle in running position. Foundation brake gears designed so that they will permit the levers to foul are occasionally responsible for what is termed a stuck brake. Proper inspection, resulting in all necessary repairs, replacement of missing bolts, cotters, etc., will prevent in a large measure stuck brakes chargeable to foundation brake gear. Stuck brakes caused by triples with leaky packing rings or by triples in bad condition with respect to cleanliness and lubrication are usually found at the rear of the train. Such brakes should be watched, to prevent them from doing damage to the wheels, and reported for attention when the terminal is reached

40. Break-in-Twos.—With K triples, a break-in-two produces no different results from what would be had with the older type of triple. The previous instructions governing this occurrence apply in the case of trains equipped with the K triple.

41. Wheel Sliding.—Wheel sliding on trains equipped with the K triple is caused in the same manner as wheel sliding on trains equipped with the older type of triples; also, the precautions necessary for its prevention are the same as those already recommended to be observed with the older types of triples. Care should always be taken to see that all brakes are released before starting the train.

42. Undesired Quick Action.—With the K triple, the likelihood of undesired quick action is very remote, even when from neglect the condition is bad with respect to cleaning and lubrication. However, when undesired quick action does occur, the method employed for finding the disorderly valve with the ordinary type of triple should be followed.

43. Switching With Three or Four K Triples Next to Engine.—When engaged in the work of switching and handling cars equipped with K triples, some difficulty will be experienced, because the retarded-release feature will operate and prolong the brake-cylinder exhaust. Annoyance from this delay of the exhaust, however, will be greatly lessened if the running position of the brake valve is used when releasing the brakes. In this way the main-reservoir excess pressure will be prevented from entering the brake pipe and moving the triples to retarded-release position rapidly. Returning the handle to lap position for a moment, say 2 seconds, and then back to running will effect a quick release of the forward brakes.

44. Bleeding Off a Brake.—When the release valve is used to release a brake that has a K triple, care should be taken not to reduce the auxiliary pressure more than is necessary to move the triple piston to normal release position. If a heavy reduction of auxiliary pressure is made through the release valve, the triple will move to retarded-release position and thus cause a slow release of the brake.

HANDLING OF PASSENGER TRAINS

TRAINS WITH P M EQUIPMENT

REMARKS

45. The passenger engineer will be greatly assisted in handling passenger trains smoothly and in making accurate stops by the E T locomotive brake equipment, because with it smooth brake work can be done with greater ease than is possible with the older type of locomotive equipment. The E T equipment usually has a large main-reservoir and pump capacity, and the B-6 feed-valve not only has large capacity but operates more sensitively than the older types, making it unnecessary when releasing to remain in release position longer than 4 or 5 seconds with a passenger train of 20 cars or fewer. In addition, the locomotive brake itself controls the locomotive in a reliable and satisfactory manner, regardless of its size and weight. The locomotive brakes may be released and reapplied without disturbing the brakes on the train. This brake therefore provides a margin of flexibility in handling trains that is very helpful in doing good braking and in preventing damage to driving wheels by sliding.

With the exception of the time that the handle must be held in release position and of the skilful use of the locomotive-brake holding feature, the method to be employed in handling a passenger train with the E T brake does not differ materially from that now used to handle a passenger train with the G-6 brake valve.

CHARGING THE TRAIN

46. A train equipped with the P M equipment should be charged in practically the same manner as one equipped with the G-6 valve. If long trains are to be charged up from zero, however, the handle of the automatic E T brake valve should be left in release position until the brake-pipe pressure reaches 80 or 90 pounds. If it is left in running position, all the angle cocks will be open and brake-pipe air will immediately flow into the long brake pipe and cause the pressure in the engine brake pipe to drop very low in a short time. This action will remove the feed-valve pressure from the top of the diaphragm in the excess-pressure head of the S F pump governor and cause it to operate so as to stop the pump; also, as main-reservoir pressure remains considerably more than 20 pounds higher than brake-pipe pressure for some time, the pump cannot start again until the brake-pipe pressure, combined with the excess spring pressure, is sufficient to force the diaphragm downwards and seat the pin valve. Then, of course, the governor will permit the pump to go to work and to continue without interruption until the system is fully charged. As modern locomotives usually have large main reservoirs and large pumps, the capacity of the feed-valve is not sufficient to permit the air to flow through it into a long, empty brake pipe as fast as the air can be supplied. Hence, if the handle is allowed to remain in running position while charging such a brake pipe, the main-reservoir pressure will remain more than 20 pounds higher than brake-pipe pressure for some time, and during this time the pump will remain stopped.

It therefore follows that good judgment must be exercised in regard to placing the handle either in release or in running position while charging, as well as to the length of time it should be kept in running position. In any case, the handle should be in running position when the brake-pipe pressure is within 10 pounds of the amount for which the feed-valve is adjusted. If it is not in running position at this time, overcharging of the front portion of the train is sure to result.

In many yards the trains are already charged when the locomotive is coupled to it, so that charging from zero by the locomotive is not required. In such cases, the handle should be allowed to remain in running position. However, as the brakes must be tested by applying and releasing before departure, the same care in regard to overcharging the front end of the train as just recommended should be observed when releasing. In no case of releasing brakes should the handle remain in release position for more than 15 seconds. Short trains may be charged in running position.

HANDLING THE TRAIN

47. Running Test.—With passenger trains the running test must always be made; there is no excuse for omitting it. Indeed, when the importance of such a test is realized by the engineer, he will feel obliged to use it in all cases with skill.

After the train has left a terminal and is running at a speed of about 15 miles an hour, the engineer should, without closing the throttle, make a service reduction sufficiently heavy to cause all brakes on the train to act and then slow it down against the pulling effect of the locomotive, noting meanwhile the length of the brake-valve exhaust. When it is seen that the brakes take hold as they should, he should release in the usual manner.

The running test must also be made when approaching meeting points, railroad crossings at grade, junction points, drawbridges, terminal stations, before commencing the descent of a long, heavy grade, and before getting close to any point when the brake must work to prevent disaster. The test should be made when sufficiently far away from such points to make sure that if the air brake does not respond there will yet be distance enough to bring the train to a standstill with

the hand-brakes. Just how far from the stopping point, then, that this test should be made will depend on the speed of the train, the grade, and the general condition, but in any case it should not be less than 1 mile.

Before reaching the point where the running test is to be made, the engineer should consult the air gauge so as to be sure that the maximum standard pressure is present in the brake pipe; also, at the moment that the service reduction is begun, he should note the length and the volume of the brake-pipe exhaust. These duties are important, because if other means for stopping is necessary, no time dare be wasted.

48. Running Precautions.—As the air brake is always relied on to control the motion of the train, both in service and in emergency applications, it should also be in condition to operate at its maximum efficiency every moment of the time that the train is in motion. Hence, it follows that certain precautions should be observed by the engineman while running so that he may know constantly and with certainty that the brake will respond promptly if needed.

These precautions include the frequent observance of the air gauge, so as to know whether or not the pump is maintaining the standard pressures for the road on which the train is running as well as the class of train; the careful observance of the position of the brake-valve handle, so as to see whether it is in the proper position to feed air into the brake pipe; and the observance of the position of the double-heading cock, so as to know that it is wide open, except as prescribed under the rule for double-heading, and not partly closed or accidentally shut.

In all brake applications, the length of the brake-pipe exhaust as well as its volume of sound should be carefully observed as soon as the reduction is commenced, so as to know whether it corresponds to the length of the train. While brakes are supposed to be released, as is the case while running, it is important that the handle of both brake valves be carried in running position, to avoid the possibility of locomotive brakes creeping on. In the case of double-heading or of helper engine, the enginemen of both engines should always know whether the proper brake-pipe pressure is being carried; also, when the controlling engineer is making applications, the engineer of the second engine should know whether the proper reduction in brake-pipe pressure is being made.

49. Service Stops for Both Long and Short Trains. The two-application method of stopping a train at any designated stopping point, with either long or short passenger trains, is preferable to the one-application method, because, as a rule, better time and smoother and more accurate stops can be made with it. However, with short passenger trains, good rail, and the exercise of excellent judgment, the one-application method may be used with equally as good results. When the one-application method is employed, say on trains of 6 or fewer than 6 cars, the aim should be to make the stop with not more than a 25-pound service reduction, and then, just before coming to a dead stop, to release the brakes in time to allow the trucks, which are sure to be tilted, to right themselves, and in this way prevent the disagreeable back lurch so annoying to passengers. But, as just remarked, the two-application method will usually be found smoother and more accurate; also, by using it, there is far less danger of causing damage to wheels by sliding them, and much less time is consumed in making the stop.

In stopping trains by the two-application method, the engineer should, if time is fast, permit the train to approach as near to the stopping point as his judgment dictates. He should then make a heavy service reduction, such as would be necessary to bring the train to a speed of 12 or 15 miles an hour. Next, he should release by moving the handle to release position momentarily; then back to running position for a second, to drop the locomotive cylinder pressure to 5 or 6 pounds; and, finally, depending on the time and other circumstances, either to lap or to service position, completing the stop with a light cylinder pressure.

The object of the two-application method is to permit a high rate of speed to be maintained up to a point as close to the station as circumstances and good judgment will warrant. Then, if the speed is high, a heavy continuous service application may be made without danger of shock to the train, or of sliding the wheels. The release at slow speed permits all tilted trucks to straighten up, and any wheel that may possibly be sliding to commence rotating again. The final application, which need only be a light one, may be held on until the train stops.

After a train has been stopped in this manner, the brakes may be released in the usual way; that is, by placing the handle in release for 4 or 5 seconds and then returning it to running position. If, however, a water-tank stop or a stop on down grade is made, the handle may be returned to holding position instead of to running position, and held there until ready to start, when, of course, it must be placed in running position.

50. Stopping Short or Running By.—If the engineer in handling a long passenger train finds that the train is going to stop short, he should release the brake in the usual manner and permit the locomotive cylinder pressure to escape slowly. In this way he will avoid the possibility of a jerk from the rear, which might take place if the rear brakes release slowly. If he finds that it is necessary to use steam to move up to the desired spot, he should not use the throttle until he is sure that all rear brakes have had time to release fully.

In all cases of running by stations, the brakes should be held applied until just about to come to a standstill, when they may be released in the usual manner. In such cases, the train usually has to be backed up to unload passengers and baggage. This, of course, makes it necessary to apply the brake with the train moving backwards so as to stop. Under such circumstances, the brake should be applied lightly and gradually in order to adjust slack as gently as possible, and then held applied until the train stops. In making brake applications while backing, it will sometimes help in the smoothness with which the slack is adjusted if the locomotive brakes are prevented from applying hard by moving the handle of the independent brake valve to release position and holding it there until after the car brakes are well on.

51. Stops on Grades.—All service stops on grades should be made with the two-application method. After the final release, which should not be made until after the train stops, unless the grade is very heavy and requires the train brakes to help hold the train while standing at the station, the handle should be moved back to holding position while there is still sufficient cylinder pressure, so as to prevent the train from moving, and it should be kept there until ready to start, when it must be placed in running position. If, after coming back to holding position, there is not sufficient cylinder pressure left in the locomotive brake cylinders to hold the train, it will be necessary to add enough with the independent brake valve.

52. Quick Action During Service Reduction.—Quick action during a service reduction, or undesired quick action, as it is generally called, is not only annoying but sometimes does great damage. It is due to a defective condition of one or possibly more than one of the triples in the train. Such triples may give trouble at each service application, or only occasionally during the trip. However, in passenger service, no triple should ever be allowed to leave a terminal in a defective condition. Instead, the troublesome triple should be located and removed. To locate a defective triple, the assistance of observers stationed along the train is required. When they are in their positions, the engineer, after charging the train to full pressure, should make a service reduction not to exceed 5 pounds. Any brake that fails to apply can then be noted by the observers. A further reduction of not more than 3 pounds should next be made, and the observers should note whether or not the piston that has failed to move on the previous reduction applies with a quick action. If it does, this brake should be cut out. The test should be repeated after the system has been fully charged to maximum pressure, and there has been sufficient time for the pressure to equalize thoroughly throughout the train. At terminals, of course, the defective triple should be replaced by one in perfect condition.

If undesired quick action occurs while the train is on the road, the cut-out cock should be closed and the drain cock on

the auxiliary reservoir opened; also, the engineman should be notified of this procedure.

When testing for defective triples that give undesired quick action, it is very important to have the maximum brake-pipe pressure in the brake pipe and the auxiliaries at the commencement of each test. If it is found impossible to locate the defective triple within a reasonable period of time, the train may proceed with the standard brake-pipe pressure. When making service stops under such circumstances, however, the two-application method should be employed. The first application should be made in the emergency position when speed is high. The second, which always follows close on the release of the first application, can be made in service with a greatly reduced brake-pipe pressure and hence without likelihood of undesired quick action.

53. Emergency Stops.—Emergency applications are required when it is necessary to stop the train to prevent loss of both life and property. In such cases, the handle of the brake valve should always be placed quickly in emergency position the instant the emergency appears and kept there until the train stops or the danger is passed. However, in the case of long passenger trains, if the danger passes before the train comes to a full stop and it is desired to proceed, the brakes may be released in the manner already explained. However, the locomotive cylinder pressure should not be allowed to escape entirely until it is certain that the rear brakes have released, when the handle of the brake valve may be moved to running position and the throttle opened gradually.

If an emergency application is made and the brake-pipe pressure entirely depleted, reducing the speed to 20 miles an hour or less when the danger disappears, it is better with long trains to stop before making the release. In all cases of emergency, sand should be applied to the rails as soon as the handle of the brake valve is in emergency position.

54. Backing Trains With Tail-Hose.—In order to move passenger trains from yards to terminal stations, or from the main line to branch stations at the end of short branches, it is necessary in many instances to back them long distances. In such cases, the brakes should be operated from the rear of the train by means of a tail-hose that is equipped with a valve that can be opened and closed as gradually as desired by the operator. Before commencing to back the train, the engineer should charge the brake system in the usual manner. The brakes should also be tested both from the brake valves on the engine and from the tail-hose valve at the rear of the train, so as to make sure that all of them can be applied and released from either end of the train.

No hard-and-fast rule can be made as to where the handle of the brake valve on the engine should be carried while backing the train. The practice most generally adopted is to carry it in running position continuously until the terminal is reached. In this way, all the responsibility for the safe handling of the train is placed on the man that manipulates the tail-hose exhaust valve. However, the engineer should be as vigilant as circumstances will permit. In the event of an emergency application, he should quickly lap the brake-valve handle to prevent possibility of release. After the train stops or after he is signaled from the rear to release, he should release in the usual manner, and then return the handle to running position.

55. Wheel Sliding.—In passenger service, the injudicious use of sand often cuts the wheels so badly from sliding that they must be removed. It is important to remember that modern passenger equipment is much heavier than that built a few years ago; hence, a wheel does not have to slide so far as formerly to become flat.

To prevent injurious wheel sliding, the engineman handling any passenger train except one with the L triple equipment should practice the two-application method of making all stops except emergency stops. This method, as already explained, requires high cylinder pressure while the speed of the train is high, which is the time that the wheels are least likely to slide, and the first release takes place at the time that the speed is considerably reduced, when the wheels are most likely to pick

up; also, the second application is a comparatively light one—one that will not cause the wheels to slide although the speed is much slower than when the first application was made.

If the condition of the rail is such that sand must be used to assist in making the stop and to prevent wheel sliding, it should be dropped under the entire length of the train before commencing to use the brake. The reason for this should be well understood. It is because of the careless and unskilful use of sand in stopping that many wheels are badly damaged. If the brake is applied a little later than it should be in order to make the stop within the distance available, it is likely to be applied full; then, when the stopping point is approached, if it is thought that the train is going to run by, there is a strong temptation on the part of the engineer to drop sand, because if sand is used it may prevent the train from running by. At the same time, if there happens to be one or more pair of wheels sliding while sand is dropped, they will be cut badly, and in a very short distance. In all cases of emergency, however, wheels should not be considered, and sand should be dropped just as soon as possible after the brake valve is placed in emergency position.

If, in starting, the train drags and the drivers slip considerably, the engineer sometimes makes the mistake of dropping sand to prevent the slipping while at the same time they work the engine in the corner with full throttle. When a train starts unusually hard, a stuck brake and a sliding wheel are usually the cause. Therefore, in a case of this kind, the proper thing to do is to manipulate the brake valve in the manner recommended for releasing brakes. If sand is required, only sufficient should be dropped to prevent the drivers from slipping. In such a case, using sand too freely will of itself cause the train to pull hard.

56. Stuck Brakes.—Brakes that do not release promptly or that remain applied for some time after the other brakes have released are a serious annoyance in train handling. They not only cause damage to wheels but are often responsible for break-in-twos.

There are a number of causes for sticking brakes. Some stuck brakes are attributed to the manner in which the brake valve is handled on the engine; some to the condition of the triple valve; some to the condition of the feed-valve; some to the condition of the foundation brake gear; some to the piston travel; and so on. The pressure retainers are also responsible for the non-release of brakes in some cases, and the slack adjuster sometimes causes brakes to drag because of taking up the slack too close.

57. The careful observance of the proper method of releasing brakes will almost invariably prevent the sticking of brakes so far as the air-brake equipment proper is concerned. On trains of average length, a service reduction of at least 10 to 12 pounds should be made before the release is attempted. This reduction need not be made continuous in all cases, but the total reduction before attempting the release should be not less than this amount. The reason for having the brake-pipe reduction not less than 10 pounds before commencing the release is to provide a larger difference between the main-reservoir and the brake-pipe pressure, so that when the handle is placed in release position the wave effect will be more pronounced throughout the whole length of the brake pipe, and, therefore, more effective in moving the triple piston to release position.

When releasing, the engineer should place the handle of the automatic brake valve in release position for 4 or 5 seconds—no longer—and then return it to running position. After about 3 seconds he should move it quickly to release and immediately back to running, especially if the train is unusually long. This latter movement will release all brakes in the front of the train that may have reapplied on account of lightly overcharging.

58. If triple valves become defective on account of excessive packing-ring leakage or their condition is bad on account of dirt and gum, they will not respond promptly to slight variations in brake-pipe and auxiliary-reservoir pressures. Therefore, as it frequently happens, especially in long trains, that the rise in brake-pipe pressure is comparatively slow, such triples are likely to remain in the applied position and thus prevent the release of the brake. Such triples should be removed from the car at the first inspection point and other triples in perfect condition put in their places. The removed triples should then be sent to the repair shop for overhauling and for testing on the repair-test rack.

The feed-valve will cause the brakes to stick if it becomes sluggish in its action or if its supply passage becomes gummed with oil or plugged up with dirt; that is, if it does not respond to slight variations in brake-pipe pressure. The feed-valve must supply the brake pipe with air promptly and in generous volume up to the desired pressure and then maintain it at that pressure without variation of over $1\frac{1}{2}$ pounds. If the feed-valve allows the pressure to fluctuate or vary widely, then, of course, the brakes might creep on and stick, unless, in such cases, the brake-valve handle is thrown to release position for an instant. Therefore, to avoid stuck brakes from this cause, the feed-valve should be maintained in first-class condition.

A defective foundation brake gear is sometimes responsible for stuck brakes. For instance, a loose bolt or a loose hanger chain may wedge between the brake beam and sand plank of the foundation brake gear, or one of its levers may become fouled in some other manner. In such cases the shoes cannot fall away from the wheels, even if the air does exhaust properly from the brake cylinder. As a result, the brake will stick on one or more pair of wheels, depending, of course, on the nature of the brake-gear defect.

Short piston travel can, and often does, cause the brakes to hang for some time, especially on long trains. Since short piston travel causes the auxiliary and brake cylinder to equalize higher than the average pressure, brakes having this short piston travel fail to release until the brake-pipe pressure comes up to a point sufficiently high to force the triple to release position. As this point is considerably higher than that for the other triples in all full-service applications, it follows that the brake will be longer in coming off and hence may be considered as sticking. The remedy for this, of course, is to adjust the piston travel to the proper length. It is also advisable to avoid the practice of making over reductions on service applications.

Emergency valves that occasionally stick open will prevent brakes from releasing. The remedy in such cases is to close the cut-out cock and then open it quickly, so that any foreign substance on the valve seat that is causing the leakage may be blown off. If this does not effect a remedy, the cut-out cock should be closed and the auxiliary bleed cock opened.

If hand-brakes are not entirely released, the brakes are on this account sometimes said to stick.

59. Bleeding Off Brakes.—In passenger service, all brakes should release from the engine; and they can be so released unless they are improperly manipulated or are in a defective condition. If difficulty is experienced in releasing brakes or if they stick, bleeding off should never be resorted to for the purpose of releasing or getting out of the difficulty, because it is a dangerous practice. The better plan is to investigate and remedy the defect that may be causing the brake to refuse to release.

If it is necessary to cut out the brake on a car because of the failure of some part of the foundation brake gear or because of broken or defective air-brake apparatus, the cut-out cock should be closed and the release cock on the auxiliary opened and left open until the terminal is reached. The engineer of the train should be informed about any brake that is cut out, and at the terminal the matter should be reported to the proper authorities for attention.

60. Break-in-Twos.—Although more or less trouble from breaking in two has always been experienced with both passenger and freight trains, it is becoming a more serious matter with the modern heavy and long trains of both classes. To prevent this dangerous, expensive, and annoying occurrence should be the aim of all persons concerned in the safe operation of trains over the road. With passenger trains, a break-in-two should never be allowed to occur, because it is attended not only by damage to equipment and delay to traffic, but by great danger of injury to passengers as well as loss of life.

Since the braking power of the passenger equipment should be, and generally is, such as to make it as nearly uniform as

possible, the retardation of each vehicle during a brake application will be the same; hence, the strain on the couplers is reduced to a minimum. This uniformity of retardation is largely or wholly due to the designs of the foundation brake gear, and the further freedom from the danger of breaking in two is due to the adoption of a strong and suitable draft gear.

The brake and the throttle are in the hands of the engineer, and on the manner in which these are handled depends the smooth running of the train. Service application of the brakes must be made as prescribed in the rules. However, when a release is to be made, the speed at that moment must be considered. If it is slow, the holding feature of the H-6 brake valve should be intelligently employed, so that the slack may not run out hard, and that no shock at the rear will be caused by retaining too little pressure in the locomotive brake cylinders. If the release is made while the train is in motion and it is desired not to stop, the throttle should be opened gradually after sufficient time has elapsed for all the rear brakes to release and the slack taken out gently. Then, in the event of a rear brake not having released, the strain brought to bear on the couplers will not be sufficiently violent to cause them to part. Also, sufficient time should always be allowed between the release and the reapplication of the brakes to prevent those on the head part of the train from coming off and then reapplying before the rear has released. If this precaution is not observed, the train will stretch and then suddenly close the slack, which will be followed by another violent stretch from the rear.

61. Picking up Cars.—When picking up passenger equipment the engineer should stop the engine or the train about 10 feet from the cars to be picked up and then move it slowly in making the coupling. After the cars have been coupled to the train, care should be taken to see that both the brake and the signal hose are properly coupled together and that all angle cocks and stop-cocks except the rear one on the rear car are opened. The rear angle cock on the car coupled to those picked up should then be opened gradually until the air is heard to flow into the empty hose and brake pipe. After a few seconds, this angle cock should be opened wide and the auxiliaries permitted to charge properly to the required pressure for testing the brakes, which, if the high-speed brake is used, is usually the maximum brake-pipe pressure, or 110 pounds. When charging is completed and all hand-brakes are properly released, the brakes should be tested to make sure that they will operate throughout as desired.

The reason for opening the angle cock gradually on the car ahead of the one picked up is to prevent an emergency application of the brakes and a consequent waste of air and of the time necessary to pump the air back. While the auxiliaries are charging, it is well to see that all release valves and bleed cocks are closed and that no bad leaks exist.

When two train sections that are already charged are coupled together, care should be taken to prevent an emergency application on the rear section. Such an application can be prevented after coupling the hose by first opening gradually the angle cock nearest the locomotive and then gradually opening the other angle cock.

62. Setting Out a Car.—A car that is to be set out or left on a side track should not be detached from the engine or train until it is moved to the place where it is to be left standing. When in its proper place the angle cocks on its brake pipe, also the one on the rear of the car ahead, should be closed, the hose parted by hand, the bleed cock on the auxiliary reservoir opened and left open, and the hand-brake applied with sufficient force to prevent the car from moving of its own accord. A car that is to be left standing on a grade or an incline, must by all means have its hand-brake applied, but care should always be taken to have the air brake entirely released before setting the hand-brake.

When a train from which a car has been set out is recoupled, it is necessary to make sure that all angle cocks except the rear one are wide open and that the system is properly charged; also the required test of the brake should be made before proceeding.

TRAINS WITH L N EQUIPMENT

CHARGING THE TRAIN—MIXED L AND P TRIPLES

63. If a train is only partly equipped with L triples, it is customary to cut out the supplementary reservoir, so that only the auxiliary will have to be charged. Hence, in such cases, the charging of all auxiliaries in the train will be uniform in regard to time and pressure, and the amount of time required will be about the same as if all the triples were of the P type.

If the auxiliaries and supplementary reservoirs of a train that is wholly equipped with L valves have to be charged from zero to maximum pressure, more time, of course, will be required than if the auxiliaries alone were to be charged; but after both the supplementary and the auxiliary are fully charged, the brakes require no more air for this operation than the brakes on a train equipped with the P triple. Hence, the auxiliaries regain their maximum pressure in recharging just as quickly as they would with P valves alone. Nevertheless, sight should not be lost of the following facts: With L valves and supplementaries cut in, the auxiliaries regain very quickly a large percentage of the pressure that is reduced by the flow of auxiliary air into the brake cylinders during the application of the brakes; also, after the release is made, by reason of the supplementary and the auxiliaries combining and equalizing, the remaining increase of pressure is obtained comparatively slow, because the air from the brake pipe must charge the auxiliary and the supplementary reservoirs simultaneously.

HANDLING THE TRAIN

64. To handle trains with the L N equipment so as to get the best results in service, the engineer should make the initial reduction, while the speed of the train is high, at a sufficient distance from the stopping point to bring the train to a standstill some distance short of this point, if it were desired to do so; then, as circumstances require, he should commence to graduate the brake off by moving the handle of the brake valve from lap to running and back for each graduation, so as to bring the train to a stop at the desired spot, aiming to have the cylinder pressure at the instant of stopping reduced to such a point that the disagreeable lurch that would occur if the cylinder pressure were high at the instant of stopping will not take place.

From the preceding statement it will be seen that the object aimed at is to get the brakes on just as hard as the speed of the train will warrant at the time that the initial reduction or the application is made, and then to commence graduating off the instant that it is seen that the stop will be short of the mark unless cylinder pressure is reduced, aiming always to complete the stop with one application and a light final cylinder pressure.

When graduating off the brakes, the handle of the brake valve should be moved to running position only for an instant and then back to lap. The reason for this should be clear from the explanation of the construction and operation of the L triple. The method of handling the brake valve applies to both long and short trains. Experience, however, will indicate clearly whether or not it can be improved.

An important consideration in handling a train having L N equipment is to avoid overcharging the brake pipe. If this pipe is overcharged, trouble will be experienced, as the brakes are liable to creep on when it is desired that they remain released.

65. Service Stops and Releasing.—On all passenger trains where the running time is fast, as little time should be utilized in making service stops as is consistent with good braking. Therefore, a high initial service reduction should be made when a service stop is required, so that the speed of the train may be quickly reduced and brought down to a rate of stopping, or of retardation that, if continued, would cause the train to stop short of the desired mark; then the brake cylinder pressure should be graduated down so that the train will come to the desired spot and stop with a light pressure retained in the brake cylinders. After the train has stopped, unless it happens to be on a down grade, the handle should be placed in

release for 4 or 5 seconds and then returned to running position. When making the complete release the engineer should be careful not to overcharge the brake pipe; if this happens, trouble will be experienced by the brakes going on when it is desired that they remain released.

In making close, accurate stops, the engineer should remember that the L triple will graduate the brake on as well as off. Hence, if it is found in a service stop that the cylinder pressure has been graduated off too much to bring the train to a stop at the desired spot, a light service reduction, say one just sufficiently heavy to produce the required brake-cylinder pressure to bring the train to a final stop, may be made.

66. Emergency Stops.—Emergency stops with trains having the L N equipment are made in the same manner as emergency stops with trains equipped with any other type of triple valve. In other words, when an emergency arises, the brake-valve handle should be quickly placed in emergency position and left there until the train stops or the danger is passed. After this, if it is desired to release the brakes immediately, the handle should be placed in release for 5 to 6 seconds and then returned to running position. The rails should be sanded throughout the stop, as with the other equipments. It is well to remember that in emergency applications a very high cylinder pressure is developed and that the auxiliary pressure does not drop much. Thus, if the handle is left in release too long during release, overcharging of the brake pipe may result. In such cases, this would cause the triple to reapply the brakes and produce annoyances from graduating the brakes on when they should remain entirely released.

67. Trains on Grades.—When about to descend a long, steep grade with a train having the L N equipment, the brakes should be thoroughly tested, just as with any other type of triple. The auxiliaries and supplementary reservoirs should also be fully charged before commencing the descent, and the handle on the pressure-retaining valves should be turned up so as to assist in the safe handling of the trains. However, for moderate grades that are 20 miles or less in length, pressure retainers are not needed.

While the train is descending the grade, the method of manipulating the brakes recommended for trains having the type P triple should be observed, so that advantage may be taken of curves and let-ups for recharging purposes. The train should not be allowed to gather too much headway before commencing the application of the brakes; also, the brake applications should be as light and as frequent as they can possibly be made, in order to maintain as uniform a rate of speed as possible throughout the entire descent, and also to maintain as high a general brake-pipe and auxiliary-reservoir pressure as possible.

When making the release for the purposes of recharging and keeping the train moving at the desired speed, the brake-valve handle should be placed in release position and left there for 4 or 5 seconds and then returned to running position.

68. Bleeding Off a Brake.—When the locomotive is detached from a train having the L N equipment, or when the brake pipe is accidentally overcharged, it will be necessary to release the brakes by means of the drain, or release, cock. In the case of an overcharge brake pipe, the brakes will apply and it will be impossible to release them from the locomotive and keep them released with the brake-valve handle in running position. Hence, if the train is in motion the brake-valve handle should be carried in release position until the next stop is made, when the brake-pipe pressure should be reduced to 60 pounds by placing the brake-valve handle in service position. The drain cock on the supplementary reservoir should then be opened and kept open for about 10 seconds. This will reduce the supplementary-reservoir pressure to a point where the brakes may be released from the locomotive in the usual manner. It is very important in handling L N equipment to avoid the overcharging of the brake pipe.

If it is desired to release the brake on one or more cars when the locomotive is detached, the drain cock on the auxiliary should be opened and held open until the air commences to escape from the brake cylinder. It should then be closed and

note made of whether the brake releases entirely or not. If the brake does not release entirely and stay so, the auxiliary drain cock should again be opened and, as before, closed the instant that the brake-cylinder air commences to escape at the exhaust port of the triple. This operation should be repeated until the brake remains released.

It is well to remember that when releasing by means of the auxiliary drain cock, the supplementary-reservoir air commences to feed back into the auxiliary the instant that the triple slide valve reaches release position, and that this air will increase the pressure therein and cause the triple to return to graduated-release lap position or to service-application position; hence, the necessity for opening and closing the drain cock a second or a third time, or until the brake-pipe, auxiliary-reservoir, and supplementary-reservoir pressures are equalized, with the triple piston finally in release position. To allow the drain cock to remain open longer than is necessary to do this would reduce both the auxiliary-reservoir and the supplementary-reservoir pressure below that remaining in the brake pipe, and then a reduction in brake-pipe pressure caused by the brake-pipe air feeding into the auxiliary would begin and possibly cause some of the brakes on the other cars attached to commence to apply.

TYPE K FREIGHT-CAR BRAKE EQUIPMENT

Serial 2509 Edition 1

DESCRIPTION AND OPERATION

INTRODUCTION

1. The air-brake equipments for freight cars which were used prior to the type K equipment were known as the H C and H D freight-car brake equipments. The only difference between the H C and H D equipments was that the auxiliary reservoir and the brake cylinder were combined in the first instance, whereas these parts were detached in the latter in order to permit their application to certain types of cars. The brake cylinder was known as the type C with the combined equipment and as the type D with the detached equipment. The same kind of triple valve or the type H was used in both cases, and the equipments were designated by combining the letters H C and H D.

DISADVANTAGES OF H C EQUIPMENT

2. Effect of Long Trains.—Longer freight trains and heavier cars introduced problems in the control of these trains which could not be met successfully by the type H triple valve used with the H C and H D freight-brake equipments. The H triple valve was designed for trains with a maximum length of about fifty cars, and it was found that, with trains of much greater length, too great an interval elapsed between the application of the front and the rear brakes when applied in service as well as between the release of the brakes and the recharging of the auxiliaries at the front and the rear ends of the train.

3. How Brakes Should Operate.—In order to control a train safely and with the least damage to equipment and lading, the brakes should apply and release and the auxiliary reservoirs should recharge simultaneously or as near the same time as possible. If the brakes do not operate in this manner, the action is as follows: When the brakes apply on the front part of the train at a considerable interval before they apply near the rear, the speed of the cars on the front end will be retarded while for a time the speed of the cars at the rear will not change. As considerable slack exists in a long train, the rear cars close up to the front cars or, as usually stated, the slack runs in. The result is a shock, the severity of which will depend on the difference in the velocity between the two parts of the train, the weight of the cars, and the time required for the velocities to equalize. When the brakes finally begin to apply on the rear cars, the slack, assisted by the draft-gear springs, runs out, and may cause the train to break in two.

When the brakes release on the front part of the train first, and the train is in motion with the slack not all out, the front part of the train will pull away from the rear part, and the result will be a severe shock or a break-in-two.

When the brake pipe and the auxiliary reservoirs recharge faster on the front end of the train, the pressure banks up in this part of the train, and when the brake valve is placed in running position, the air begins to move to the rear of the train where the pressure is lower. The fall in pressure on the front part of the train due to the movement of the air, is equivalent to a brake-pipe reduction, and some of the head brakes are liable to apply lightly or creep on, and may cause the wheels to slide.

4. Why Front-End Brakes Apply First.—The reason why, with the H triple valves, the brakes on the front end of the train apply considerably in advance of the brakes on the rear is as follows: The discharge of the air from the brake pipe when applying the brakes in service occurs at the front end of the brake pipe at the brake valve. The rate at which the air discharges is

dependent on the opening at the exhaust port in the brake valve and on the friction the air encounters in passing through the pipe. The size of the opening at the brake valve remains the same, and the volume and friction of the air increases with the length of the pipe, therefore more time is required to discharge the air as the length of the brake pipe is increased. The air cannot pass from the auxiliary reservoirs to the brake cylinders any faster than the air discharges from the brake pipe, and therefore the delay in the application of the brakes toward the rear of the train increases with its length. The effect is to set up undesirable stresses in the train as already described. The rate of reduction on the rear part of the train may be so slow that sufficient difference between the pressure in the brake pipe and in the auxiliary reservoir may not be formed to move the triple valves to service position, and the air from the auxiliary reservoir will pass through the feed grooves into the brake pipe. Also, when the difference in pressures is small, the triple valve, in its movement to service position, stops as soon as the slide valve starts to open the port to the brake cylinder, because the reduction which then occurs in the pressure in the auxiliary reservoir destroys the difference of pressures which acts to move the triple piston. As a result, the air from the auxiliary reservoirs may not pass to the brake cylinders faster than the air escapes through the leakage grooves.

5. The air in the brake pipe could be exhausted more rapidly if the opening at the brake valve were increased, but if this were done there would be a liability of quick action. Furthermore, a quicker reduction in pressure at the head end of the train would, even if quick action did not occur, cause heavy shocks by the slack running in and out at the rear.

Therefore, proper brake operation requires as nearly a simultaneous application and release of the brakes as possible, as well as a uniform recharge of the auxiliary reservoirs.

6. Introduction of the Type K Triple Valve.—The undesirable features of the type H triple valve as just explained, led to the introduction of a freight-brake equipment in which the type H triple valve was replaced by the type K triple valve.

This equipment is known as the type K freight-car brake equipment, and is designed to overcome the objectionable features of the brake equipment that used the H triple valve.

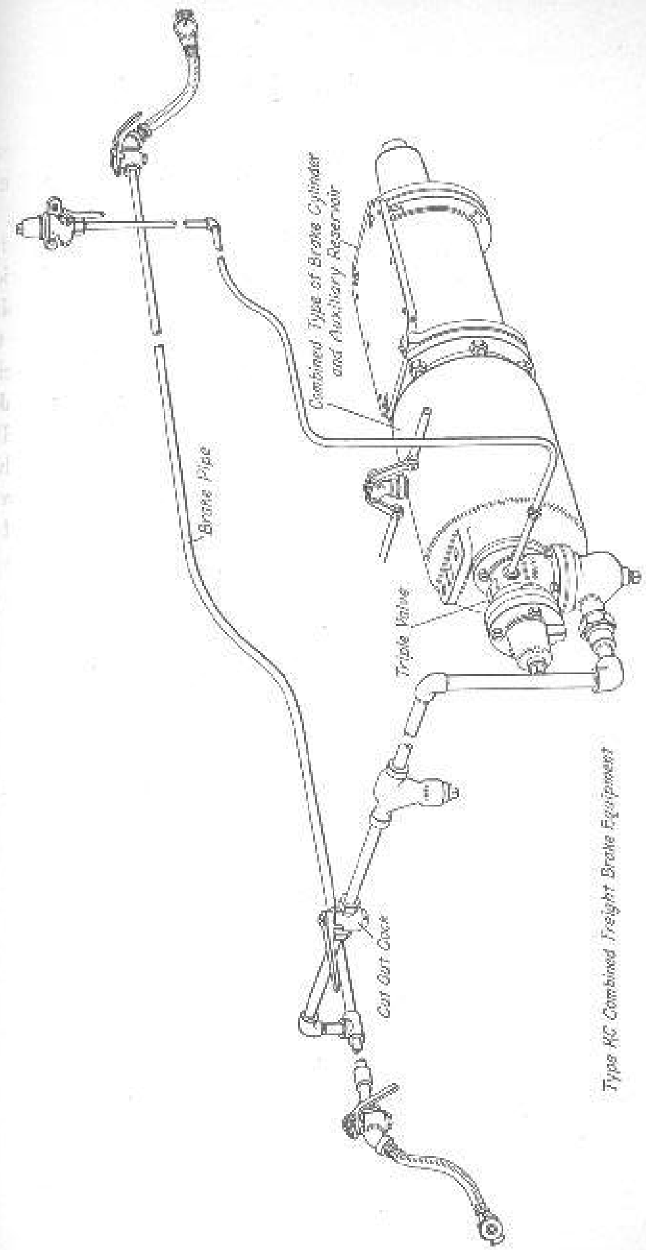
The purpose of any triple valve is to apply its brake, release the brake, and recharge the auxiliary reservoir, and it is due to these triple functions that the valve obtains its name.

The K triple valve performs the same functions as the H triple valve, and also has the following new features: (*a*) A quick-service feature, so called because, when the brakes are applied in service on a long freight train, the triple valves assist the brake valve in reducing the brake-pipe pressure, the result being a more rapid, positive, and uniform application of the brakes throughout the train; (*b*) a uniform release feature, so called because, when the brakes are being released, the triple valves discharge the air slowly from the brake cylinders on the front part of the train, and at the normal rate from the brake cylinders on the rear part of the train, thereby making possible a more uniform release of all brakes; (*c*) a uniform recharge feature, so called because, when the auxiliary reservoirs are being recharged, the triple valves restrict the passage of air to the auxiliary reservoirs on the front portion of the train where the pressure is highest and permit a normal rate of feed to the auxiliary reservoirs on the rear, thereby causing all of the reservoirs to recharge at about the same rate.

The object of the quick-service feature is therefore to bring about a more rapid service application of the brakes, and the object of the uniform release and uniform recharge features is to cause the brakes to release and the auxiliary reservoirs to recharge at about the same rate.

PIPING DIAGRAMS OF TYPE K EQUIPMENTS

7. Types of Equipment.—The type K freight-car brake equipment is classified according to the arrangement of the auxiliary reservoir and the brake cylinder. The equipment is referred to as the type K C when the auxiliary reservoir and the brake cylinder are combined as shown in the piping diagram in Fig. 1, because a type K triple valve and a type C brake cylinder are used. The detached equipment is shown in Fig. 2, and



Type KC Combined Freight Brake Equipment

Fig. 1

is known as the type K D because a type K triple valve and a type D brake cylinder are used. This type of brake cylinder is always separate from the auxiliary reservoir.

8. Description of Arrangement.—The equipment for one freight car as shown in Fig. 1 consists of a $1\frac{1}{4}$-inch brake pipe with a $1\frac{3}{8}$-inch hose at each end, a $1\frac{1}{4}$-inch branch pipe that connects the brake pipe to a 1-inch pipe at the triple valve, a type K triple valve, an auxiliary reservoir with a release valve, a brake cylinder, and a pressure retaining valve connected by a $\frac{3}{8}$-inch pipe to the exhaust port of the triple valve. A cut-out cock and

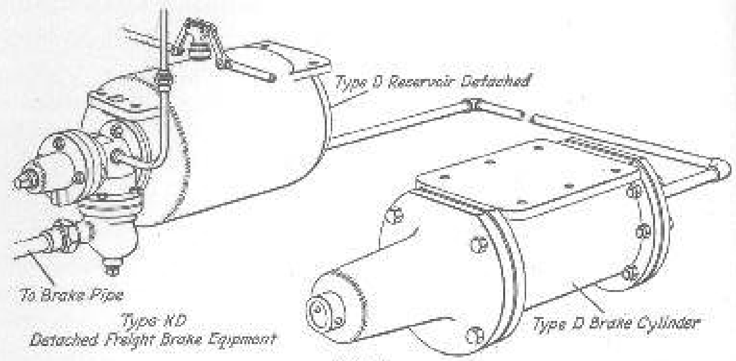


FIG. 2

a centrifugal dirt collector are placed in the branch pipe. The tee at the point where the branch pipe is taken off the brake pipe is installed so that the side opening of the tee is uppermost. The purpose of this arrangement is to prevent moisture that may be deposited in the brake pipe from draining into the branch pipe and triple valve. Wherever practicable, the triple valve should be placed above the general level of the piping, and the piping should be so arranged as to avoid pockets where moisture may collect.

The arrangement shown in Fig. 2 comprises the same parts with the exception of the 1-inch pipe, used to connect the auxiliary reservoir to the brake cylinder.

DESCRIPTION AND OPERATION OF PARTS

TYPE K TRIPLE VALVE

9. Views of Triple Valve.—There are two sizes of K triple valves; the K-1 valve used with brake cylinders that are 6 and 8 inches in diameter, and the K-2 that is used with a 10-inch brake cylinder.

In Fig. 3 is shown a perspective view of a K-2 triple valve, and in Fig. 4 is shown a sectional view of the valve. The K triple valve can be identified by the symbol letter and number

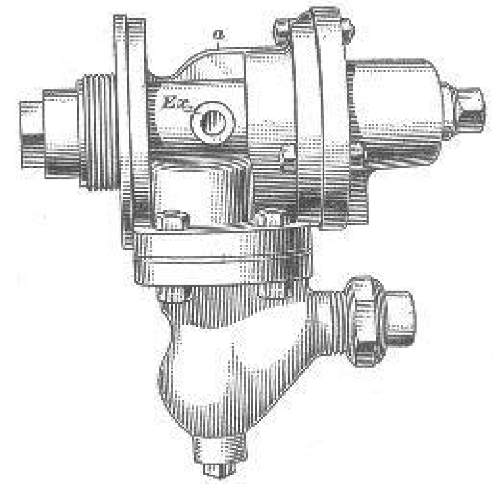


FIG. 3

K-1 or K-2 cast on the side of the valve body. The fin *a* cast on the top of the valve body also serves to identify a K triple valve. Triple valves of the H type that have been converted to K triple valves have this fin applied by a setscrew.

The K-1 triple valve is further distinguished from the K-2 by having two bolt holes in the reservoir flange where it is bolted to the auxiliary reservoir, whereas the K-2 triple valve has three holes.

The exhaust port of the triple valve is marked *Ex.*, and the pipe that leads to the retaining valve is screwed into this port, There is a similar port on the other side so as to permit the pipe to be connected to the most convenient side. The opening not used is closed by a plug.

10. Names of Parts.—The names of the parts of a K-2 triple valve, Fig. 4, are as follows: *2*, valve body; *3*, slide valve; *4*, triple piston; *6*, slide-valve spring; *7*, graduating valve;

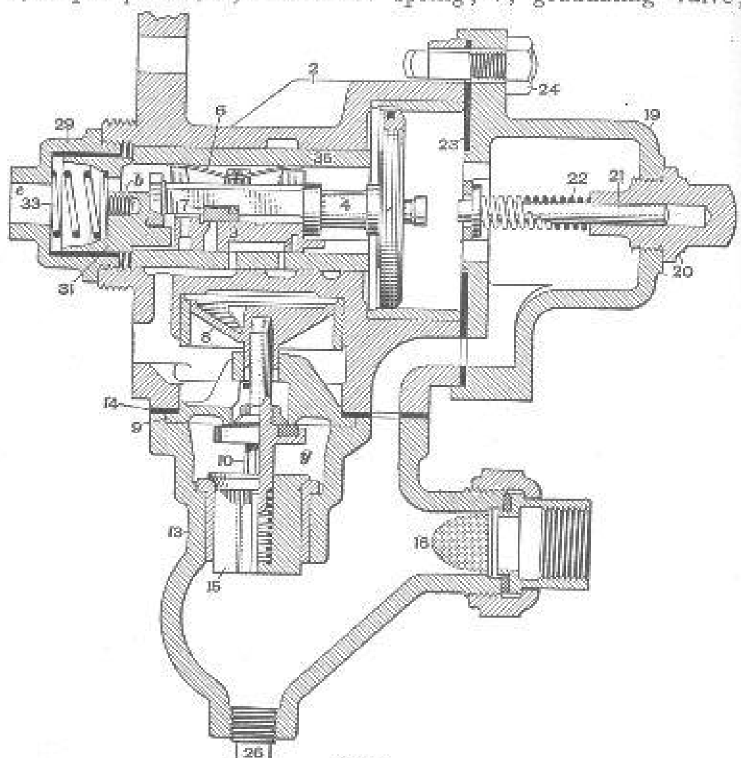


FIG. 4

8, emergency piston; *9*, emergency-valve seat; *10*, emergency valve; *13*, check-valve case; *14*, check-valve case gasket; *15*, check-valve; *16*, strainer; *19*, cylinder cap; *20*, graduating-stem nut; *21*, graduating stem; *22*, graduating spring; *23*, cylinder-cap gasket; *24*, cylinder-cap bolt and nut; *26*, drain plug; *29*, retarding-device body; *31*, retarding stem; *33*, retarding spring; *35*, slide-valve bushing.

11. Movable Parts.—The K triple valve contains two sets of movable parts, the service parts and the emergency parts. The latter parts operate only when an emergency application is made; the service parts operate in both service and emergency.

The service parts of the triple valve, Fig. 4, are the triple piston *4*, the slide valve *3*, and the graduating valve *7*. The emergency parts are the emergency piston *8*, the emergency valve *10*, and the check-valve *15*.

12. Triple Piston.—The triple piston, the graduating valve, and its spring, are shown removed from the triple valve in Fig. 5. The purpose of the triple piston is to move the graduat-

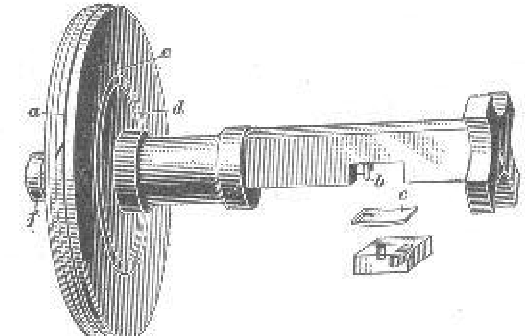


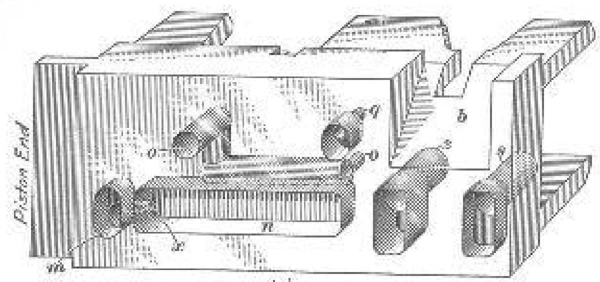
FIG. 5

ing valve and the slide valve and also to open and close the feed groove. The triple piston is moved by the difference of pressures between the auxiliary reservoir and the brake pipe, and it may be regarded as being a movable wall between these pressures. The packing ring *a* causes the piston to form as nearly as possible an air-tight joint between the pressures in all positions except release..

The graduating-valve pin *b* holds the graduating-valve spring *c* in position in the slot in the piston stem. The pin also extends into a hole in the top of the graduating valve and prevents it from being assembled in the wrong position on the stem. The purpose of the spring *c* is to hold the graduating valve on its seat in the absence of air pressure, and thereby prevent dirt from getting under the valve.

The circular ridge *d*, in a certain position of the triple valve, makes an air-tight joint with the brass bushing *35*, Fig. 4, with the exception of what air can leak through the small feed groove *e*, Fig. 5. The knob *f* is used so that the triple piston can be grasped readily when applying or removing it from its bushing.

13. Slide Valve.—In Fig. 6 (*a*) is shown a bottom view of the slide valve removed from the triple valve. The valve is shown transparent in order to bring out the relation of the ports, passages, and cavities.



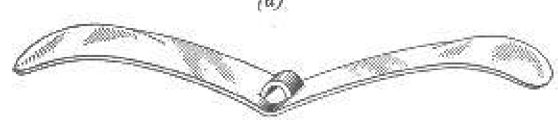

(b)

Fig. 6

The purpose of the slide valve is to make a joint between the auxiliary reservoir and the atmosphere at all times, to connect the auxiliary reservoir and the brake pipe to the brake cylinder, and the brake cylinder to the atmosphere, as well as to connect the auxiliary reservoir to the space above the emergency piston. The purpose of the various ports and passages will be explained when the operation of the triple valve is taken up.

The slide-valve spring, Fig. 6 (*b*), is pinned to the slide valve, and as the outer ends of the spring bear against the slide-valve bushing, the valve is held firmly to its seat. Dirt is thereby prevented from getting between the valve and its seat in the absence of air pressure.

The ends of the six wings on the slide valve bear lightly against the interior of the slide-valve bushing, and serve to keep the valve in the proper relation to its seat.

14. Graduating Valve.—The graduating valve as viewed from the face is shown in Fig. 7. The face of the valve contains a cavity *v* as shown.

The purpose of the graduating valve is to open and close the service port in the slide valve, and thereby make possible a graduated application of the brake. The cavity in the graduating valve also permits air from the brake pipe to pass through the

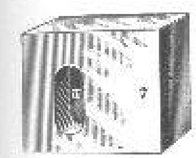


Fig. 7

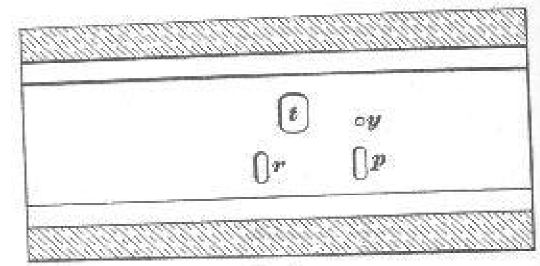


Fig. 8

slide valve to the brake cylinder in quick-service position. On this account the plug type of graduating valve as found in older triple valves cannot be used with the K triple valve, and the graduating valve therefore has to be made flat.

15. Slide-Valve Seat.—The slide valve *3*, Fig. 4, works within a brass bushing *35*, the lower part of which is flat so as to form a seat for the valve. In Fig. 8, the bushing is shown sectioned so that the slide valve seat can be seen. The seat has four ports *r*, *t*, *y*, and *p* cut through it, which register with passages in the triple-valve body.

16. Triple-Valve Body.—A sectional view of a part of the triple-valve body is shown in Fig. 9. The purpose of this illustration is primarily to show passage *y* that leads from a chamber in the body and terminates in a port *y* in the slide-valve seat. The purpose of passage *y* is to reduce the pressure in the brake pipe and thereby quicken the application of the brakes when they are applied in service on long trains. Port *r* in the slide-valve bushing leads to the brake cylinder because the auxiliary tube comes opposite the lower end of passage *r* at *d*. Port *p* leads to the exhaust port and the pressure retaining valve, and port *t* is drilled through the bushing and the valve body into the chamber below.

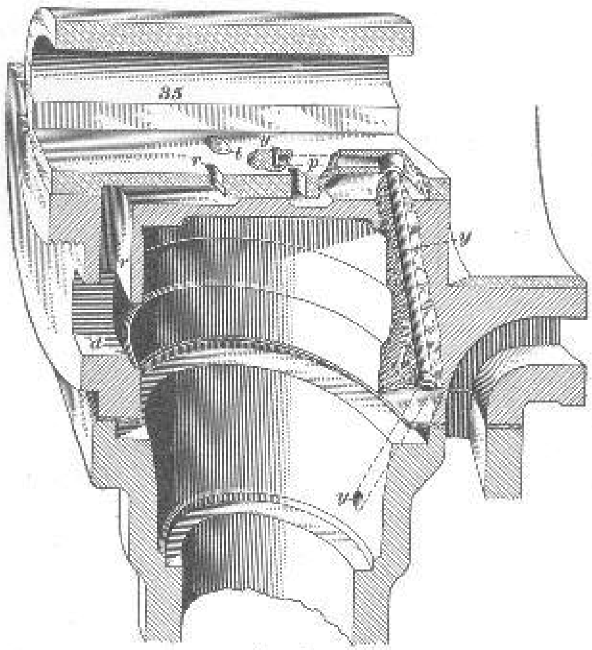


Fig. 9

17. Graduating Stem and Spring.—The purpose of the graduating stem, *21*, Fig. 4, when properly supported by the graduating spring *22* is to prevent the triple piston from moving to emergency position during a service application on a short train.

18. Emergency Parts.—The emergency parts of the triple valve as shown in Fig. 10 are the emergency piston *8*, shown sectioned, the emergency valve *10* with a rubber seat *11*; the brake-pipe check-valve *15*; the emergency-valve seat *9*; and the check-valve spring *12*.

The purpose of the emergency parts is to cause brake-pipe air to be vented to the brake cylinder in emergency-brake applications, thereby transmitting serial quick action from car to car throughout the train, and also to prevent the return of brake-cylinder air to the brake pipe.

The emergency-valve seat is of brass and is placed between the check-valve case *13*, Fig. 4, and the triple-valve body *2*. When assembled the rubber-faced emergency valve seats on the flange *a'*, Fig. 10, of the seat. The opening in the upper part of the seat acts as a guide for the emergency-piston stem, and

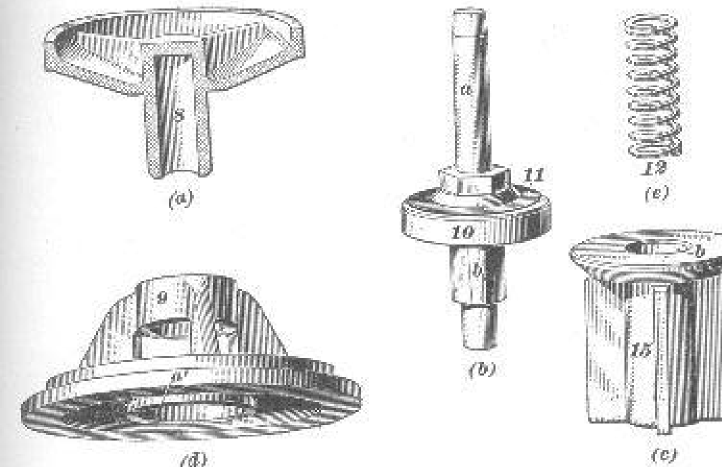


Fig. 10

the top of the upper part forms a stop for the emergency piston when it is forced downwards during an emergency application.

The purpose of the emergency valve is to prevent air from the brake pipe and chamber *y*, Fig. 4, from passing to the brake cylinder except in emergency. The stem *a*, Fig. 10 (*b*), of the emergency valve *10* extends into the hollow stem of the emergency piston *8*, and the piston rests on the upper part of the stem. A downward movement of the emergency piston will therefore unseat the emergency valve. In normal position, the lower rounded part of the stem *b* of the valve partly extends into a cavity *b* in the check-valve *15*; this cavity not only acts as a guide for stem *b*, but also as a receptacle for spring *12*.

The purpose of the check-valve *15* is to prevent a backflow of air from chamber *y*, Fig. 4, and the brake cylinder to the brake pipe, which would result in a loss of brake-cylinder pressure whenever the pressure in the brake pipe was lower than that in the brake cylinder, as happens when the brake pipe is depleted during emergency applications. Under such conditions, the brake-cylinder air would force the emergency valve down and pass to the brake pipe.

The purpose of the spring *12*, Fig. 10 (*e*), is to hold the emergency valve and check-valve in their normal positions, or seated when not being operated, and to return them as well as the emergency piston to their normal positions after an emergency application.

19. Retarding Device.—The retarding device is a very simple piece of apparatus, yet it performs an important function because, without it, a uniform release and recharge of the brakes could not be obtained.

As shown in the sectional view in Fig. 4, the retarding device consists of a retarding stem *31*, a retarding spring *33*, and a retarding-device body *29* that holds the stem and spring in position in the end of the triple valve.

The opening *e* in the body serves to connect the slide-valve chamber of the triple valve to the auxiliary reservoir. The threaded hole *b* permits a tool to be screwed in when the stem is being removed, should it stick. The purpose of the retarding device is either to stop the triple piston and slide valve in release position or to return these parts from retarded-release position to release position.

If the pressure in the brake pipe is less than 3 pounds higher than the pressure in the auxiliary reservoir, the retarding device acts as a positive stop, and prevents the triple piston from moving back any farther when it engages the stem *31*. The slide valve is then said to be in full-release position.

20. If the pressure in the brake-pipe exceeds the pressure in the auxiliary reservoir by more than 3 pounds, the push exerted by the end of the triple piston becomes more than the spring *33*, Fig. 4, can withstand. The retarding stem then moves outwards and in so doing compresses the retarding spring *33*. The slide valve and triple piston are now carried to another position known as retarded-release position. Therefore, the triple valve has two release positions; namely, a full-release position and a retarded-release position.

When the end of the triple piston strikes the retarding stem and stops in full-release position as in the first instance, the position of the slide valve is such as to cause the auxiliary reservoir to recharge at the normal rate from the brake pipe, and the air from the brake cylinder to discharge in the usual time.

When the triple piston and the slide valve move all the way back as in retarded-release position, the change in the position of these parts causes the air to discharge more slowly from the brake cylinder, and also causes the auxiliary reservoir to recharge more slowly from the brake pipe than when the valve is in full-release position. However, when the difference between the pressure in the auxiliary reservoir and the brake pipe becomes less than 3 pounds, the retarding spring moves the parts back to full-release position.

It has been found that a pressure in the brake pipe of 3 pounds in excess of the pressure in the auxiliary reservoir cannot be obtained much more than thirty cars back of the engine. Accordingly, the triple valves on these cars assume a position in which the brakes release and recharge slowly, while behind about the first thirty cars, the release and the recharge occur at a normal rate.

It will be explained farther on how the action just described brings about a uniform release and recharge of all the brakes throughout the train.

AUXILIARY RESERVOIR AND BRAKE CYLINDER

21. An exterior view of the auxiliary reservoir and the brake cylinder used with the combined type K freight-car brake equipment is shown in Fig. 11. The equipment is attached to the car by bolts that pass through the holes in the brackets cast on the auxiliary reservoir and the brake cylinder. The small hole shown in the end of the auxiliary reservoir is the triple-valve end of the auxiliary tube, and when the triple valve is bolted to the auxiliary reservoir the retarding device on the triple valve extends into the large opening shown.

In Fig. 12, the auxiliary reservoir and the brake cylinder are shown in section. The purpose of the auxiliary reservoir is to store compressed air for applying the brake on the car on which it is placed; the brake cylinder is used to convert the pressure of the compressed air into a force that acts through the foundation brake rigging on the brake shoes. The importance of the brake cylinder on the operation of the brake and the necessity for maintaining it so that no leakage exists, will be evident when it is recalled that the whole function and purpose of the air-brake system is to deliver and maintain certain air pressures in the brake cylinder.

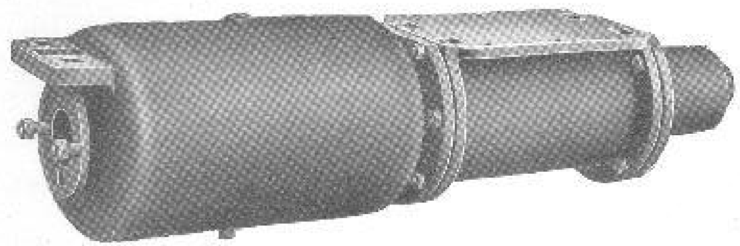


FIG. 11

The connection between the auxiliary reservoir and the brake cylinder when the brake is being applied, between the brake cylinder and the atmosphere when the brake is being released, and between the brake pipe and the auxiliary reservoir when the latter is being charged, is made by the triple valve.

22. The auxiliary reservoir is made of cast iron and of a size proportionate to the brake cylinder with which it is used. When used with an 8-inch freight-car brake cylinder, the auxiliary reservoir has an approximate volume of 1,650 cubic inches, and when used with a 10-inch brake cylinder, the volume of the auxiliary is 2,440 cubic inches. The triple valve is secured to the auxiliary reservoir by reservoir studs and nuts, two being used with a K-1 triple valve and a brake cylinder 8 inches in diameter, and three with a K-2 triple valve and a brake cylinder 10 inches in diameter. A gasket *15*, Fig. 12, is used to make an

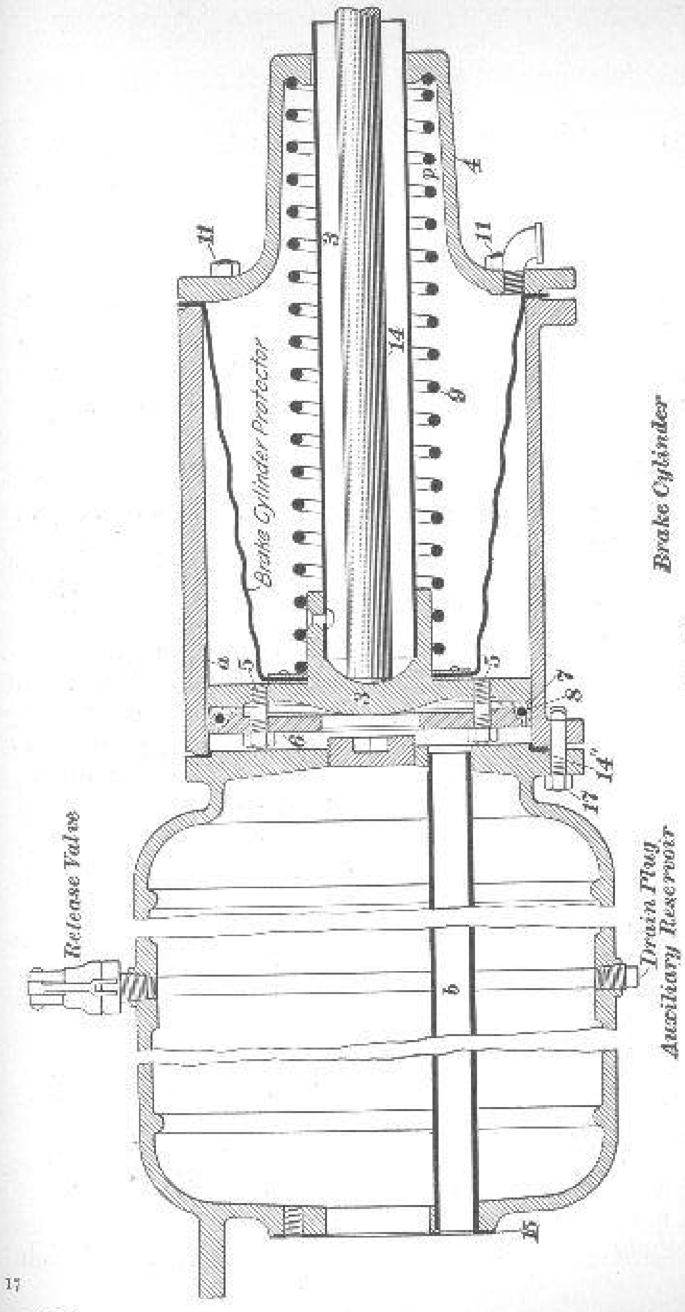


FIG. 12

air-tight joint between the triple valve and the auxiliary reservoir. The auxiliary tube *b* is used to connect the triple valve to the brake cylinder. The purpose of the tube is to conduct the air from the auxiliary reservoir by way of the triple valve to the brake cylinder when applying the brake, and also to conduct the air from the brake cylinder when releasing the brake. The release valve is employed to discharge air from the auxiliary reservoir and release the brake when the engine is detached or when coupled, if the engineer cannot release it. When the valve is opened, the pressure on the auxiliary side of the triple piston is reduced, the higher brake-pipe pressure on the other side moves the piston and the slide valve to release position, and the air exhausts from the brake cylinder.

23. The brake cylinder contains a piston *3*, Fig. 12, with a hollow piston rod *3* riveted to it. The piston rod acts as a guide for the piston, it serves to keep the release spring *9* in its proper position during the movement of the piston, and it also serves to guide the push rod *14*. The inner portion of the push rod is merely inserted into the piston rod and is not connected to it in any way; the outer end of the rod is connected to the cylinder lever of the foundation brake rigging. The purpose of the push rod is to enable the hand brake to be applied without having to pull out the piston, the resistance of which is considerable. Therefore, when the hand brake is being set, the push rod draws part way out of the piston rod. When the air brake is applied, the piston and the push rod move out together.

The release spring forces the piston to release position when the air is exhausted from the brake cylinder. The push rod is then returned into the piston rod owing to the tendency the wheels have to push the brake shoes away from them as soon as the brake is released.

The pressure head of the brake cylinder is formed by the end of the auxiliary reservoir. The non-pressure head *4*, which is attached to the brake cylinder by the cylinder-head bolts and nuts *11*, is so constructed as to form an extension or pocket *p*, which prevents the release spring *9* from closing solid in case of long piston travel. The piston is made to operate air-tight

by a packing cup *7*, clamped to the piston by the follower *6* and the studs and nuts *5*. An expander ring *8* is used to hold the cup out against the wall of the cylinder.

24. The brake cylinder is bolted to the auxiliary reservoir by reservoir-cylinder bolts and nuts *17*. The cylinder gasket *14''* is used to make an air-tight joint between the auxiliary reservoir and the brake cylinder. The distance between the pressure head of the brake cylinder and the brake cylinder piston *3*, when the brake is fully applied, is called the piston travel.

The leakage groove *a* is a shallow groove cut in the wall of the cylinder and a travel of about 2 inches is necessary before the piston moves beyond it. The leakage groove prevents unsupplied brake-pipe leakage from applying the brake. The brake-pipe leaks are ordinarily kept supplied by the action of the feed valve. Thus, should the triple valve move to service position, thereby closing its exhaust port, the air passing slowly from the auxiliary reservoir to the brake cylinder will pass through the leakage groove and the brake will not apply.

The exhaust port in the triple valve is open in release position and permits such air to escape as may leak into the brake cylinder.

Freight-car brake cylinders are either 8 inches or 10 inches in diameter and are of such a length as to permit of a piston travel of 12 inches. They are designated as 8 in.×12 in., or 10 in.×12 in.

The purpose of the brake-cylinder protector is to prevent the dirt and moisture that enters the brake cylinder through the opening where the hollow piston rod passes through the non-pressure head from being deposited on the walls of the cylinder. The exclusion of dirt from the brake cylinder reduces the wear on the packing cup and thereby lessens brake-cylinder leakage. The protector, a cone-shaped collapsible hood of waterproof fabric is flanged at the large end; the flange is held between the cylinder and the non-pressure head when the latter is applied. At the small end the protector is held against the piston by the release spring. The street ell permits the moisture to drain out.

Brake cylinder protectors are used to a greater extent in passenger-car brake cylinders than in freight-car cylinders.

OPERATION OF TYPE K FREIGHT-CAR BRAKE EQUIPMENT

25. Diagrammatic Views.—Owing to the number and the location of the ports in the K triple valve, it is difficult to illustrate the valve in its different positions by true sectional views. Therefore, the operation of the triple valve will be explained from diagrammatic views in which all the ports and passages are shown in one plane.

26. Full-Release and Charging Position.—If, when releasing the brakes and charging or recharging the brake system, the pressure in the brake pipe cannot be raised high enough above the pressure in the auxiliary reservoir to force the triple piston *4*, Fig. 13, inwards and compress the retarding spring *33*, the triple valve will assume full-release and charging position.

The air from the brake pipe enters the triple valve and passes by way of the passage *a* to the chamber *b*. The air then passes through the feed groove *i* into the chamber behind the triple piston and enters the auxiliary reservoir through the opening in the retarding-device body. The brake cylinder is connected to the atmosphere through the auxiliary tube, passage *r*, cavity *n* in the slide valve *3*, and through passage *p* and port *Ex.* to the exhaust port in the retaining valve.

The air in passage *a* lifts the check-valve *15* against the tension of the spring *12* and charges the chamber between the check-valve and the emergency valve *10* with air at brake-pipe pressure.

There will be a pressure of 70 pounds to the square inch in the brake pipe and in the auxiliary reservoir when the brake system on the car is fully charged. Therefore, the triple piston is balanced between the equal pressure in the brake pipe and the auxiliary reservoir.

27. Quick Service.—The action of the triple valve in moving from full-release position, Fig. 13, to quick-service position, Fig. 14, is as follows: When the brakes are applied in service, the pressure in the brake pipe and in chamber *b*, Fig. 13, reduces more rapidly than the air can pass from the auxiliary reservoir through the feed groove *i* to the brake pipe. The triple piston *4* is then moved outwards beyond the feed groove by the greater pressure in the auxiliary reservoir, thereby breaking the connection between the brake pipe and the reservoir. At the same time, the triple piston carries the graduating valve *7* forwards on top of the slide valve *3*, and opens port *z*, Fig. 14. The collar on the rear of the piston stem next engages the slide valve *3* and all of the parts move outwards until the piston is arrested by its knob striking the graduating stem *21*. The triple valve is now in quick-service position in which port *z* in the slide valve registers partly with part *r* in the valve seat. The air from the auxiliary reservoir passes by the end of the graduating valve *7*, through port *z* and port *r* to the brake cylinder, and moves out the piston; this action applies the brake. Cavity *n* in the slide valve is moved out of register with ports *r*, *p*, and exhaust port *Ex.* before port *z* connects to port *r*, therefore the air that enters the passage *r* cannot escape through passage *p* to the retaining valve.

The air in the check-valve chamber passes through passage *y*, port *o* in the slide valve, cavity *v* in the graduating valve, port *q* in the slide valve, and port *t* in the slide-valve seat, thence past the emergency piston *8*, which is a loose fit, to the brake cylinder. As soon as the pressure in chamber *y* reduces sufficiently below the pressure of the brake pipe in chamber *a*, the check-valve *15* lifts against the tension of the check-valve spring, and permits air from the brake pipe to pass through the ports just mentioned to the brake cylinder. The size and arrangement of these ports is such that the passage of air from the brake pipe to the top of the emergency piston is not sufficient to force it downwards and cause an emergency application.

However, enough air is taken from the brake pipe to cause a definite local reduction in brake-pipe pressure, which is transmitted to and repeated by each triple valve, thereby increasing the rapidity with which the brake-pipe reduction travels back through the train. The advantage of quick service is that, with the brakes applying rapidly, the action of the slack in producing shocks in the train is lessened because the more rapid application of the brakes prevents the slack from running in to the same extent as when the brakes apply more slowly.

28. The serial action of the brakes, or the action of one triple valve in assisting to apply the next by the venting of air from the brake pipe to the brake cylinder, is similar in principle to the serial action during an emergency application with the exception that less air is taken from the brake pipe. The operation of the brakes in emergency is referred to as serial quick-action application, and their operation in quick-service as serial quick-service application of the brakes.

The air that is taken from the brake pipe by the triple valves during quick service shortens materially the duration of the exhaust at the brake valve, and also gives a pressure in the brake cylinder, when the pressure in it and the auxiliary reservoir equalizes, about one pound higher than with the older type of triple valve.

The brake-cylinder pressure in chamber *r*, Fig. 14, cannot move the emergency valve *10* downwards because the greater pressure in chamber *y*, which is about equal to that in the brake pipe, assisted by the check-valve spring, holds the emergency valve up to its seat.

29. Quick Service Lap.—The purpose of lap position is to hold the brake applied until it is desired either to apply it harder or to release it. The operation of the triple valve in moving to lap position is as follows: In Fig. 14, port *z* is in partial register with port *r*, and the quick-service port *y* is in full register with port *o*, but more air can pass from the auxiliary reservoir through port *z* to the brake cylinder than can pass through the quick-service ports by way of passage *y*. Therefore, after the brake-pipe reduction ceases at the brake valve, the air in the auxiliary reservoir passes to the brake cylinder until finally the pressure in the reservoir to the right of the triple piston becomes less than the pressure in the brake pipe in front of the piston. When the difference of pressures becomes great enough to overcome the friction of the parts, the triple piston is moved inwards, by the greater pressure in the brake pipe, toward the lesser pressure in the auxiliary reservoir. The graduating valve is carried along with the piston until the collar on the piston strikes the slide valve. The triple piston then stops because there is not

a sufficient difference of pressures on it to move the slide valve, which therefore remains in quick-service position. The triple valve is now in quick-service lap position, Fig. 15. The graduating valve *7* closes port *z* and stops the passage of air from the auxiliary reservoir to the brake cylinder through this port, and the valve at the same time breaks the connection between ports *o* and *q*, and therefore stops the discharge of air from the brake pipe to the brake cylinder.

30. If it is desired to apply the brakes harder, a further reduction in the pressure in the brake pipe will cause the triple piston and the graduating valve to move to quick-service position again, and these parts will return to lap position as soon as the reduction in the pressure in the auxiliary reservoir approximates that made in the pressure in the brake pipe. Each succeeding reduction decreases the pressure in the auxiliary reservoir and increases the pressure in the brake cylinder. The pressure in these parts becomes equal at about 51 pounds if the piston travel is 8 inches, after a brake pipe reduction of 20 pounds from 70 pounds. The brakes now cannot be applied any harder, and they must be released and recharged.

31. The triple valve does not operate in quick service after the first brake-pipe reduction, provided this reduction is about 10 pounds. The reason is as follows: When the triple valve first moves to quick-service position, the air from the brake pipe passes freely to the empty brake cylinder and a serial service application of the brakes results. After a brake-pipe reduction of 10 pounds, which gives a brake-cylinder pressure of 25 pounds with standard piston travel, the pressure in the brake cylinder is now high enough to prevent the air from entering from the brake pipe rapidly enough to bring about a serial-service application of the brakes. However, some air passes from the brake pipe to the brake cylinder each time the parts of the triple valve move from quick-service lap position to quick-service position until the pressure becomes near enough equal to prevent any further flow of air.

The quick-service feature is not needed after the brakes are once applied because a lighter reduction in brake-pipe pressure is required to move the triple pistons and graduating valves from quick-service lap position to quick-service position with the feed grooves closed and no back-flow of air, than is required to start these parts from release position when the feed grooves are open.

32. Full Service.—The triple valve is shown in full-service position in Fig. 16. On short trains, the service parts of the triple valve move to full-service position instead of to quick-service position, because, on account of the small volume of the brake pipe and the lesser friction of the air in the pipe, the air discharges more rapidly than with long trains.

The service parts of the triple valve assume momentarily quick-service position, but the air in the auxiliary reservoir cannot reduce in pressure by passing through the partly opened service port as fast as the pressure in the brake pipe reduces. The excess of pressure in the auxiliary reservoir then forces the triple piston outwards, compressing the graduating spring slightly, and the graduating valve opens the service port *z* fully. The larger port opening between the auxiliary reservoir and the brake cylinder then permits the pressure in the reservoir to reduce more rapidly and keep pace with the more rapid reduction of pressure in the brake pipe. In full service position, port *o* in the slide valve has moved past the quick-service port *y*, therefore no air passes from the brake pipe to the brake cylinder.

The triple valves may also move to full service position on long trains. Thus, when the pressure in the brake cylinder becomes so high that the auxiliary air cannot flow in quite as fast as the pressure in the brake pipe is being reduced by the brake valve and the quick-service ports, the auxiliary pressure will force the triple piston and the slide valve forwards, the graduating spring will be compressed slightly, and the triple valve will then assume full-service position.

33. Full-Service Lap.—The triple valve is shown in full-service lap position in Fig. 17. The triple piston and the graduating valve assume lap position for the same reason that they move to quick-service lap; that is, when the pressure in the auxiliary reservoir reduces enough below the pressure in the brake pipe for this latter pressure to overcome the friction of the triple-piston packing ring, and the graduating valve, the piston moves to the right until stopped by the collar striking the slide valve. The graduating valve *7* now closes the upper end of port *z*, and the brake is held applied because air is prevented from entering the brake cylinder. During further brake applications, the slide valve does not move, and the triple piston merely operates between full-service and full-service lap positions, thereby causing the graduating valve to open and close port *z*.

With a brake-pipe pressure of 70 pounds and a brake-cylinder piston travel of 8 inches, the brakes are applied fully when the pressure in the brake pipe has been reduced 20 pounds. There is then a pressure of 50 pounds in the brake pipe, the auxiliary reservoir, and the brake cylinder.

34. Uniform Release.—The uniform release of the brakes, by which is meant that all brakes release at about the same time, is brought about by providing the K triple valve with two release positions, a retarded-release position and a full-release position. The particular release position which the triple valve will assume, depends on the position of the valve in the train. The triple valves on about the first thirty cars in the train move to retarded-release position during a release because the pressure is raised more rapidly in this part of the brake pipe than at the rear. The reason for a slower increase in pressure at the rear is due to the friction encountered by the air in its passage to the rear of the train, and also to the fact that the auxiliary reservoirs at the front of the train begin to recharge and absorb air from the brake pipe.

When the pressure in the brake pipe on the first thirty cars becomes about 3 pounds higher than the pressure in the auxiliary reservoirs, each triple piston moves inwards and compresses its retarding spring *33*, as shown in Fig. 18, and the triple valves assume retarded-release position. The pressure in the brake pipe behind the first thirty cars cannot be raised 3 pounds higher than the pressure in the auxiliary reservoirs, and the retarding stem *31* and the spring *33* stop each triple piston and slide valve in full-release position, Fig. 13.

35. The effect when the triple valves on the front part of the train are in retarded-release position and on the rear in full-release position is to bring about a uniform release of all brakes. The reason is as follows: The air in the brake cylinder, and in passage *r*, Fig. 18, with the triple valve in retarded-release position can only escape slowly because, after entering cavity *n*, the air must pass through restricted port *x* before it can enter cavity *m* and pass to the atmosphere through port *p* and the exhaust port *Ex*. However, on the rear cars, as shown in Fig. 13, the connection between the brake cylinder and the atmosphere is made through cavity *n* only, and the air escapes at the normal rate.

36. The result of the brakes beginning to release first on the front of the train through a small port, and to release next on the rear of the train through a larger opening is to bring about a uniform release of the brakes throughout the whole train. A simultaneous release of the brakes permits of a release at low speeds without danger of a severe shock or a break-in-two.

The triple valves that are in retarded-release position will remain in this position until the pressure in the brake pipe and in the auxiliary reservoir becomes near enough equal for the retarding springs *33*, Fig. 18, to overcome the friction of the triple pistons and the slide valves. When this occurs, the springs force these parts to full-release and charging position as shown in Fig. 13.

The triple valves in retarded-release position at the point where the difference between the pressure in the brake pipe and the pressure in the auxiliary reservoirs is the least will return from retarded-release to full-release position first, because the rquired difference in the pressures necessary for the movement of the parts is obtained there sooner than where the difference in the pressures is greater. Therefore, the movement of the triple valves to full-release position begins at about thirty cars back and proceeds to the front of the train, where the pressure in the brake-pipe is the highest.

37. Uniform Recharge.—A uniform recharge of the auxiliary reservoirs occurs at the same time as a uniform release of

the brakes and is brought about in the folowing manner: With about the first thirty triple valves on the front part of the train in retarded-release position, Fig. 18, the air from the brake pipe can only recharge the auxiliary reservoirs through the small feed groove *e* (also see Fig. 5) in each one. The triple valves on the cars behind about the first thirty are in full-release position as shown in Fig. 13, and the reservoirs charge through the feed grooves *i*, which are considerably larger than the feed grooves *e*, Fig. 18.

Although the pressure is higher in the front part of the brake pipe, yet the small feed grooves *e*, prevent the auxiliaries on this part from charging faster than the rear auxiliaries through the large feed grooves *i*, Fig. 13. The combination of high pressure and small feed grooves on the front part of the train, and low pressure and large feed grooves on the rear, brings about practically a uniform recharge of the auxiliary reservoirs throughout the whole train. A uniform recharge prevents a reapplication of the head-end brakes by the air moving to the rear of the train after the brake valve is returned to running position.

38. Emergency.—The type K triple valve is shown in emergency position in Fig. 19. Emergency or quick action is brought about by a sudden and considerable reduction in the pressure in the brake pipe below that in the auxiliary reservoirs, no matter how caused. As a result, the movement of the parts of the triple valve is so rapid that there will be no time for the air to pass from the auxiliary reservoir to the brake cylinder through the service port *z* in the slide valve and the triple piston *4* will force back the graduating stem and spring and will seat firmly against the gasket in front of it. In this position, a slot *b*, Fig. 6 (*a*), in the slide valve *3* uncovers the emergency port *t*, Fig. 19, in the seat, and the air in the auxiliary reservoir passes down on top of the emergency piston *8*, and forces it downwards, thereby unseating the emergency valve *10*. The air in chamber *y* passes to the brake cylinder, and the brake-pipe air in chamber *a* raises the check-valve *15* and passes by way of the unseated emergency valve and the auxiliary tube, to the brake cylinder. The air in the auxiliary reservoir passes to the brake cylinder through port *s*.

39. When the pressure in the brake pipe and the brake cylinder nearly equalize, the check-valve spring seats the check-valve *15*, Fig. 20, and prevents the back-flow of air from the brake cylinder to the brake pipe in which the pressure finally reduces below the pressure in the brake cylinder. The emergency valve *10* is held open by the emergency piston *8* and will return to its seat when the pressure in the auxiliary reservoir above the piston and the pressure in the brake cylinder below the piston have nearly equalized.

The sudden discharge of brake-pipe air into the brake cylinder affects the next triple valve in the same manner as if the air were discharged to the atmosphere. In this way, each triple valve applies the next, and the transmission of quick action is so rapid that it requires less than 3 seconds to apply the brakes on a train of fifty cars. Owing to the air that is admitted from the brake pipe, the brake-cylinder pressure is about 10 pounds higher with standard piston travel after an emergency application than after a full-service application.

The joint made when the triple piston is forced against the gasket prevents any air that passes by the triple-piston packing ring from escaping into the brake pipe.

Owing to the amount of brake-pipe air that is vented to the brake cylinders in emergency, the discharge of air at the brake valve virtually stops after the first triple valve moves to emergency position.

DISORDERS

40. Common Disorders.—The common disorders to which the K triple valve, Fig. 13, is subject are as follows: Leaky slide valve *3*, leaky graduating valve *7*, leaky triple-piston packing ring, leaky check-valve case gasket *14*, leaky emergency valve *10*, defective graduating spring *22*, broken retarding spring *33*, leaky triple-valve body gasket *11*, and a leaky auxiliary tube.

The effect of the foregoing disorders on the operation of the brake can be more readily understood by remembering that a

reduction of brake-pipe pressure below the pressure in the auxiliary reservoir will cause a brake to apply, and that a reduction of auxiliary-reservoir pressure below the pressure in the brake pipe will cause a brake to release. However, when considering a disorder that reduces the pressure in the auxiliary reservoir, the leakage from the brake pipe must always be taken into account, because such leakage may modify or change entirely the effect of a leak from the auxiliary reservoir. For example, a leaky graduating valve will cause the air from the auxiliary reservoir to continue to pass to the brake cylinder if the brakes are applied lightly. With a tight brake pipe, the brake would release, but as the brake pipe always leaks, the action that will occur will depend on whether the brake-pipe pressure is reducing faster or slower than the pressure in the auxiliary reservoir.

41. Leaky Slide Valve.—A leaky slide valve *3*, Fig. 13, permits the air from the auxiliary reservoir to leak into the ports *p* or *r*, and causes a blow at the exhaust port of the pressure retaining valve, whether the brake is applied or not. This leak tends to release the brake because it reduces the pressure in the auxiliary reservoir below the pressure in the brake pipe. However, brake-pipe leakage may prevent the triple piston from moving the slide valve to release position.

42. Leaky Graduating Valve.—With a leaky graduating valve *7*, Fig. 13, the air will continue to pass from the auxiliary reservoir to the brake cylinder, after the valve has moved to lap position. The brake, if only partly applied, may release, provided the leaks in the brake pipe are not too great.

43. Leaky Triple-Piston Packing Ring.—A leaky triple-piston packing ring tends to prevent the formation of the required difference between the pressure in the brake pipe and the auxiliary reservoir for the operation of this brake. For example, the brake will not apply if the leak is great enough to keep the pressure in the auxiliary reservoir equal to that in the brake pipe. Neither will the brake release if the leak prevents the brake-pipe pressure from building up enough on this triple piston to move it to release position.

A leaky packing ring affects the release of a brake to a greater extent than its application. The reason is that the brake-pipe leaks assist the reduction when the brakes are being applied, but tend to prevent the required increase in pressure necessary for a release.

A triple valve with a leaky packing ring may release if on or near the head end of a long train, but, owing to the slow increase in brake-pipe pressure, may not release if in the rear portion of the train.

44. Leaky Check-Valve Case Gasket.—A leaky check-valve case gasket *14*, Fig. 13, that allows brake-pipe air to enter chamber *x* will cause a blow at the exhaust port of the pressure retaining valve when the triple valve is in release position because the air will pass to the exhaust port *Ex*. Also, the brake will apply harder when set with a light application because the leak not only reduces the pressure in the brake pipe and thereby causes a flow of air from the auxiliary reservoir to the brake cylinder, but the leak also increases the pressure in the brake cylinder. A leak through the gasket to the atmosphere affects the brakes the same as a leak from the brake pipe.

45. Leaky Emergency Valve.—The effect of a leak at the rubber seat of the emergency valve *10*, Fig. 13, is the same as if the gasket *14* leaks. In release position, the air from the brake pipe escapes through passage *r*, cavity *n* in the graduating valve, port *p*, and the exhaust port *Ex*., and causes a blow at the exhaust port of the retaining valve. When the brakes are applied lightly, the leak increases the pressure in the brake cylinder to an extent that depends on the leak, the volume of the brake pipe, and the length of time that the brake is held applied. With the brake applied fully, the brake-cylinder pressure in chamber *x* is equal to the pressure in the brake pipe and no leak will occur.

A leaky emergency valve frequently results in a buzzing noise in the triple valve. This is because the leak causes the check-valve *15* to chatter or to unseat and seat very rapidly. The check-valve unseats when the leak reduces the pressure in the chamber above the check-valve the required amount below the pressure in the brake pipe, and seats again when the pressure in the chamber is restored to the proper amount.

If the emergency valve is held open by the emergency piston sticking after an emergency application, the brake will remain applied because the air from the brake pipe can pass the valve to the brake cylinder faster than it can escape at the exhaust port of the pressure retaining valve. Sometimes the emergency parts can be made to assume normal position by tapping the check-valve case, but if not, the cut-out cock should be closed, the auxiliary reservoir should be drained, and the cock then opened quickly. The rush of air against the bottom of the valve will usually drive it up to its seat. If the blow does not stop, the cut-out cock should be closed, thereby cutting the brake out, and the release valve should be blocked open.

46. Defective Graduating Spring.—The purpose of the graduating stem, when properly supported by the graduating spring *22*, Fig. 13, is to prevent the triple piston from moving to emergency position during a service application on a short train. If the spring is broken or is too weak to stop the service parts of the triple valve in service position, and, if the train is short, these parts will move to emergency position.

However, on a long train, a defective graduating spring will not cause undesired quick action. The reason is as follows: When the slide valve and the graduating valve move to service position, the air from the auxiliary reservoir begins to discharge to the brake cylinder. Whether the slide valve will be moved by the triple piston beyond service position and begin to close the fully opened service ports and thereby restrict the passage of air from the auxiliary reservoir to the brake cylinder, depends on whether the brake-pipe or the auxiliary-reservoir pressure reduces the more rapidly. A short brake pipe contains a comparatively small volume of air and the pressure is reduced at the brake valve at a greater rate than the pressure in the auxiliary reservoir is reduced through the fully opened service ports. As soon as a sufficient difference in pressure is formed, the triple piston moves forwards and the slide valve begins to partly close the service port. The pressure in the auxiliary reservoir then becomes enough higher than the pressure in the brake pipe to force the triple piston and the slide valve to emergency position. With a long train, the volume of the air in the brake pipe and the frictional resistance to its movement are so much greater that the pressure in the brake pipe cannot be reduced at the brake valve any faster than the pressure in the auxiliary reservoir is reduced through the service ports of the triple valve. The brake-pipe and the auxiliary reservoir pressures remain about equal, and a sufficient difference of pressure is not formed after service position is reached to move the parts of the triple valve to emergency position.

47. Broken Retarding Spring.—A broken retarding spring *33*, Fig. 13, permits the triple piston and slide to move always to retarded-release position, and this brake will release slowly.

48. Leaky Triple-Valve Body Gasket.—The triple-valve body gasket *11*, Fig. 13, is designed to make an air-tight joint where the triple valve fits against the end of the auxiliary reservoir. A leak through the gasket into chamber *x* will cause a blow at the exhaust port of the pressure retaining valve when the triple valve is in release position. The brake will have a tendency to release when applied with less than a full application because the air from the auxiliary reservoir will pass to the brake cylinder and will reduce below the pressure in the brake pipe.

A leaky gasket causes no bad effect when the brake is fully applied because the pressure in the auxiliary reservoir is then equal to the pressure in the brake cylinder. A leak through the gasket to the atmosphere tends to release the brake whether partly or fully applied.

49. Leaky Auxiliary Tube.—A leaky auxiliary tube, Fig. 13, has the same effect on the operation of the brake as a leaky gasket *11*. The leak causes a blow at the exhaust port of the pressure retaining valve when the brake is released, and will tend to release a brake when applied with less than a full application.

50. Leaky Brake-Cylinder Packing Leather or Gasket. Should the brake-cylinder packing cup *7*, Fig. 12, or the gasket *14″* leak badly enough, the brake will not apply in service. The brake will apply in emergency, owing to the more rapid inflow of air, and will then leak off.

51. Weak or Broken Release Spring.—A weak or broken release spring *9*, Fig. 12, is indicated by the failure of the piston rod *3* to move all the way back into the cylinder when the brake is released.

BLOWS

52. Causes for Blows.—Certain disorders when the triple valve is in release position permit air to pass through the exhaust port and thence to the pressure retaining valve and cause a blow. The source of the leak can only be from the auxiliary reservoir or from the brake pipe.

There are five causes for a blow at the exhaust port of the retaining valve; three of these causes permit the escape of air from the auxiliary reservoir, and two permit the escape of air from the brake pipe.

If the escape of air is from the auxiliary reservoir, the leak may be past the slide valve *3*, Fig. 13, or through the gasket *11*, or the auxiliary tube. If from the brake pipe, the leak may be due to a defective rubber seat on the emergency valve *10*, or to a leaky check-valve case gasket *14* that allows the air from the brake pipe to enter chamber *x*.

53. Locating the Leak.—To determine whether the leak is from the brake pipe or from the auxiliary reservoir, the brake should be cut out by closing the cut-out cock in the branch pipe. The leak is from the brake pipe if the brake applies and the blow stops. If the blow continues and the brake does not apply, the leak is from the auxiliary reservoir.

The brake applies and the blow stops with a leak from the brake pipe because, with the cut-out cock closed, the air from the brake pipe that has been supplying the leak is cut off. The leak then reduces the pressure and causes the triple piston to move the slide valve to service position, thereby breaking the connection between the brake cylinder and the atmosphere.

RELEASING A BRAKE

54. Purpose of Release Valve.—The purpose of the release valve, Fig. 13, on the auxiliary reservoir is to discharge air from it, and thereby release the brake when the locomotive is detached, or when coupled in case the engineer is unable to release the brake. When the release valve is opened, the pressure is reduced on the auxiliary-reservoir side of the triple piston, and the now higher pressure in the brake pipe moves the triple piston and the slide valve to release position and the air exhausts from the brake cylinder.

55. Arrangement.—The handle *c*, Fig. 13, of the release valve rests in a slot in the release-valve cylinder, and is held there loosely by the pins *d*.

A rod of sufficient length to reach to the side of the car is pinned to each arm of the handle. When either one of the rods is pulled the pin *d* nearest to that rod acts as a fulcrum for the handle, the central portion of which then moves down and unseats the rubber-faced vent valve *e*. The air then escapes from the auxiliary reservoir through the exhaust port *f*, and the triple valve moves to release position. The spring shown seats the vent valve when the rod is released. Two rods are provided so that the valve can be opened from either side of the car.

56. Releasing a Stuck Brake.—A brake is said to be stuck when it cannot be released in the ordinary way by increasing the pressure in the brake pipe. When releasing a stuck brake with the brake pipe charged, the release valve should be held open only until the exhaust of the air is heard to start. In this way, the pressure in the auxiliary reservoir is reduced only slightly below that in the brake pipe, and the triple piston and slide valve will stop in full-release position. If the release valve is held open longer than this, the pressure in the auxiliary reservoir will be reduced so much below that in the brake pipe, that the triple valve will assume retarded-release position, and the brake will release very slowly.

If the brake pipe is open to the atmosphere, the triple valve will be in emergency position, and the brake will have to be released by holding the release valve open until all of the air has escaped from the auxiliary reservoir. The action during a release at this time is as follows: The auxiliary reservoir and the brake cylinder are connected in emergency position and the pressure therein reduces when the release valve is opened until the graduating spring finally forces the triple piston and the slide valve back and breaks the connection between the auxiliary reservoir and the brake cylinder. The pressure in the reservoir then alone continues to reduce until the air in the brake cylinder is able to lift the slide valve against the resistance of its spring, and escape at the triple-valve exhaust port. If the pressure in the brake cylinder is not sufficient to lift the slide valve, the brake-cylinder piston is by this time generally far enough back to open the leakage groove and allow the air that remains in the brake cylinder to escape.

57. Cutting Out a Brake.—When it becomes necessary to cut-out a brake, the cut-out cock in the crossover pipe should be closed, and the air then drained out of the auxiliary reservoir by opening the release valve. The release valve should then be blocked open by wedging the rod where it passes through its keeper on the side of the car.

58. Slow Release.—A noticeable feature of the K triple valve is the slow release of the brakes under certain conditions due to the fact that the valve has two release positions, a full or normal release and a retarded or slow release. The release obtained depends on the manner in which the brake-pipe pressure is increased. If the pressure is increased slowly, the brakes will release quickly; if increased quickly, the brakes will release slowly. On short trains and in switching, the brake-pipe pressure can be increased rapidly; therefore, to avoid a slow release of the brakes, the handle of the brake valve should be returned from full-release position to running position sooner than otherwise. When this is done, the triple valves will stay in full-release position instead of moving to retarded-release position.

It can be determined whether the brake is stuck or whether it is in retarded-release position by noting whether air is escaping at the retaining valve. If so, the triple valve is in retarded-release position, and the release cannot be hastened by opening the release valve.

UNDESIRED QUICK ACTION

59. Undesired quick action means that a triple valve operates in emergency when a service application is made and thereby causes all the brakes to apply in emergency. There are many causes for undesired quick action, but whatever the cause, they all bring about a condition that prevents the pressure in the auxiliary reservoir from being reduced at about the same rate as the pressure in the brake pipe, the difference in pressure finally becoming so great as to force the parts past service to emergency position.

An emergency application of the brakes when a service application is made, is generally due to the slide valve being too hard to start. Therefore, the brake-pipe pressure reduces while the pressure in the auxiliary reservoir remains practically at standard pressure. The triple piston moves when the difference between the two pressures is sufficient to overcome the friction of the parts, but the movement of the slide valve is now so rapid that the air in the auxiliary reservoir does not have time to reduce through the service port while the slide valve is moving over it. The unreduced auxiliary-reservoir pressure then forces the triple piston forwards, compressing the graduating spring, and the slide valve is pulled to emergency position.

The lubrication of the slide valve and its seat with oil or grease, as this tends to seal the valve to its seat, is a common cause of undesired quick action. Dirt and gum in the triple valve also cause the parts to move less easily and induce undesired quick action. Brake-pipe leaks, especially if near the triple valve as in the cross-over pipe, may supplement a service reduction to such an extent as to cause quick action.

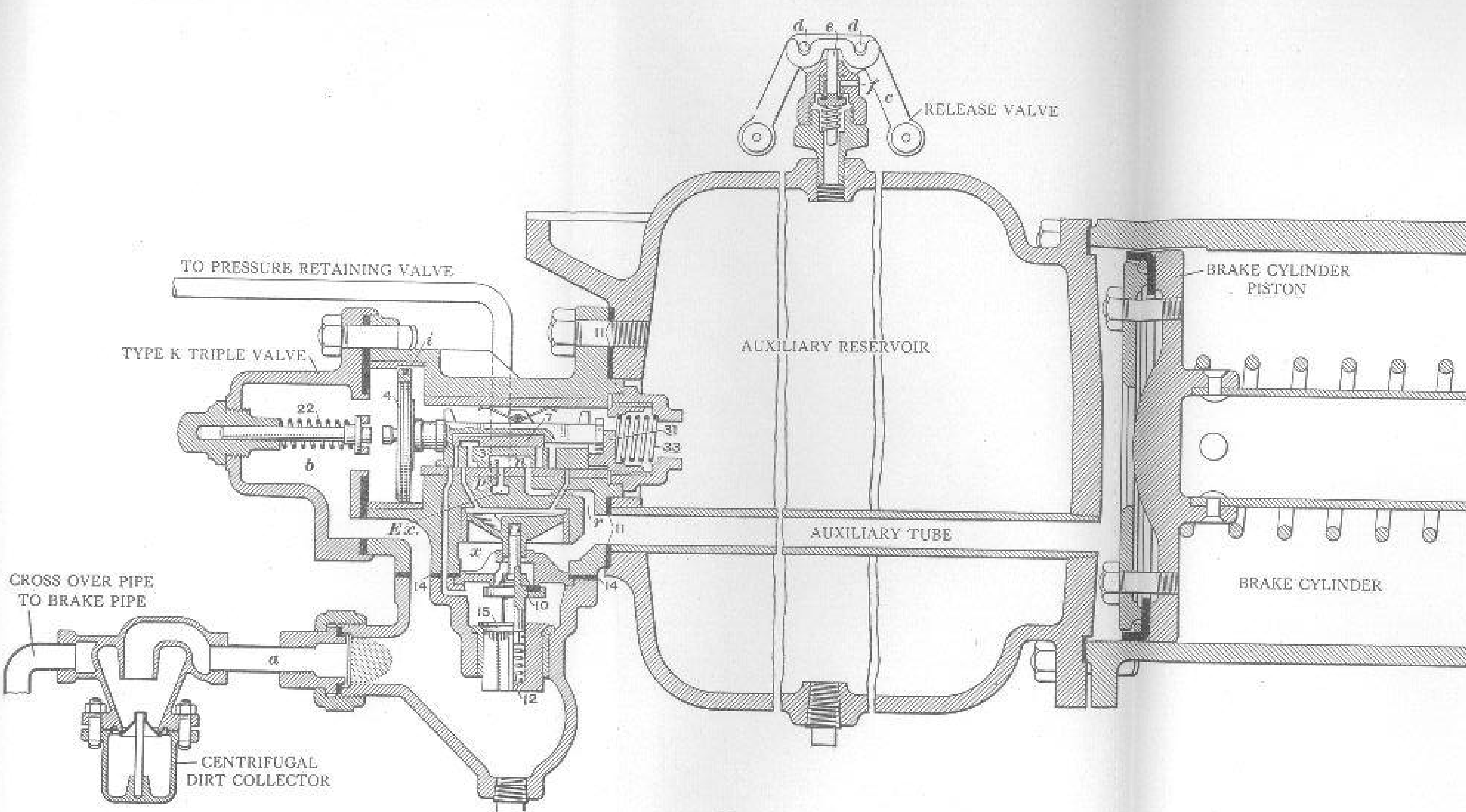


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Fig. 13

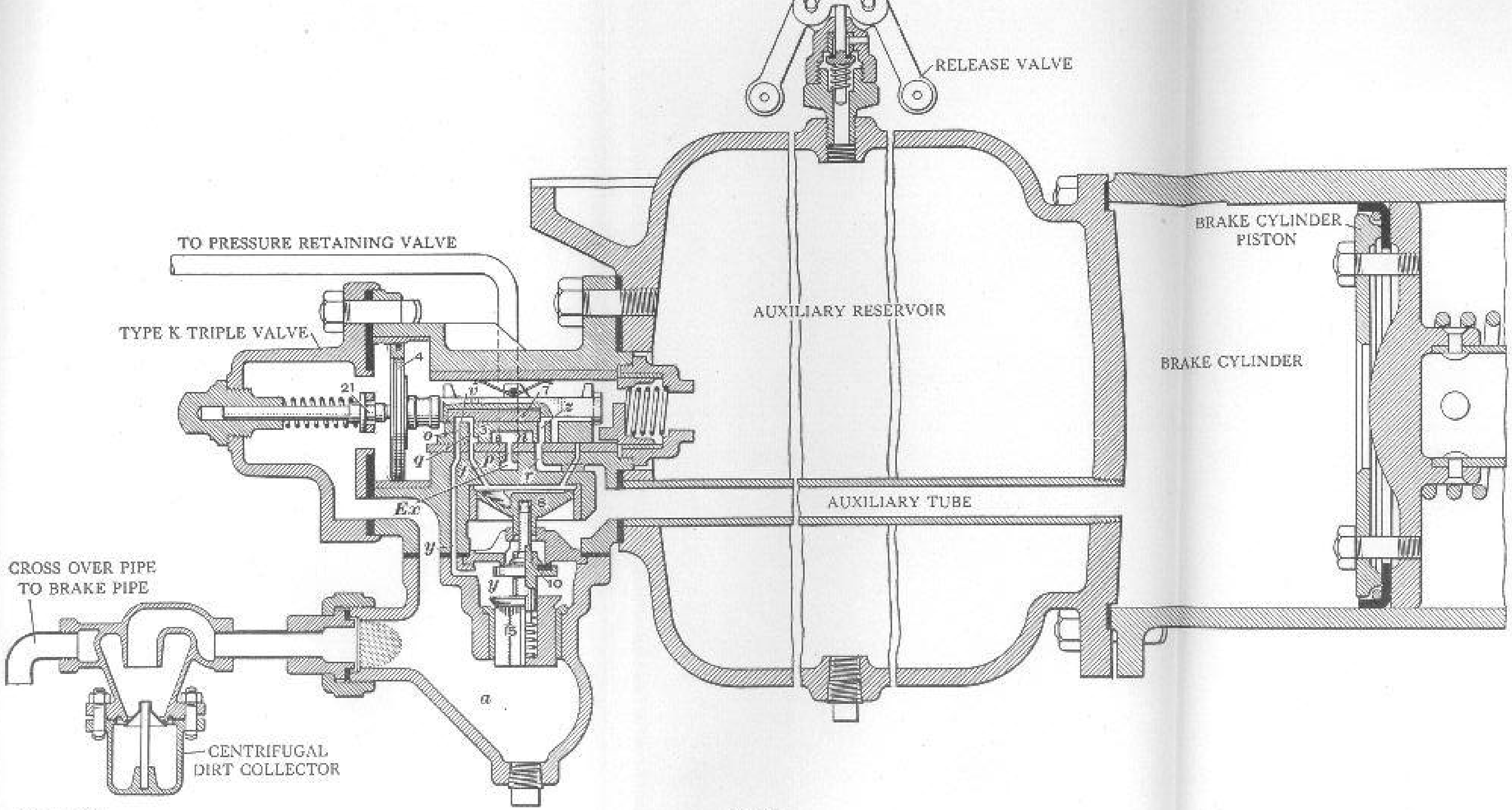

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Fig. 14

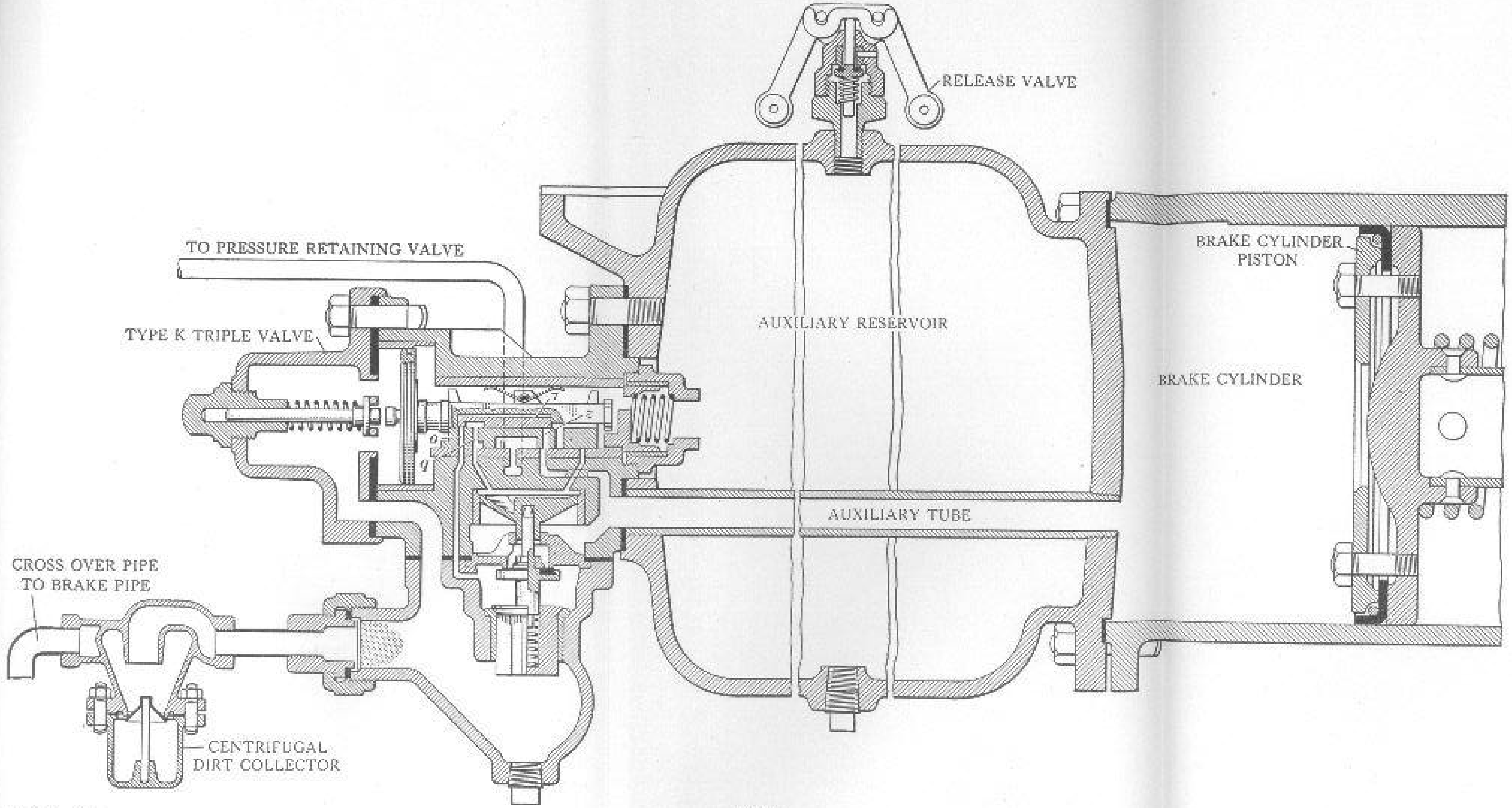
RELEASE VALVE
TO PRESSURE RETAINING VALVE
TYPE K TRIPLE VALVE
AUXILIARY RESERVOIR
BRAKE CYLINDER
PISTON
BRAKE CYLINDER
AUXILIARY TUBE
CROSS OVER PIPE
TO BRAKE PIPE
CENTRIFUGAL
DIRT COLLECTOR
B B 518 2509

Fig. 15

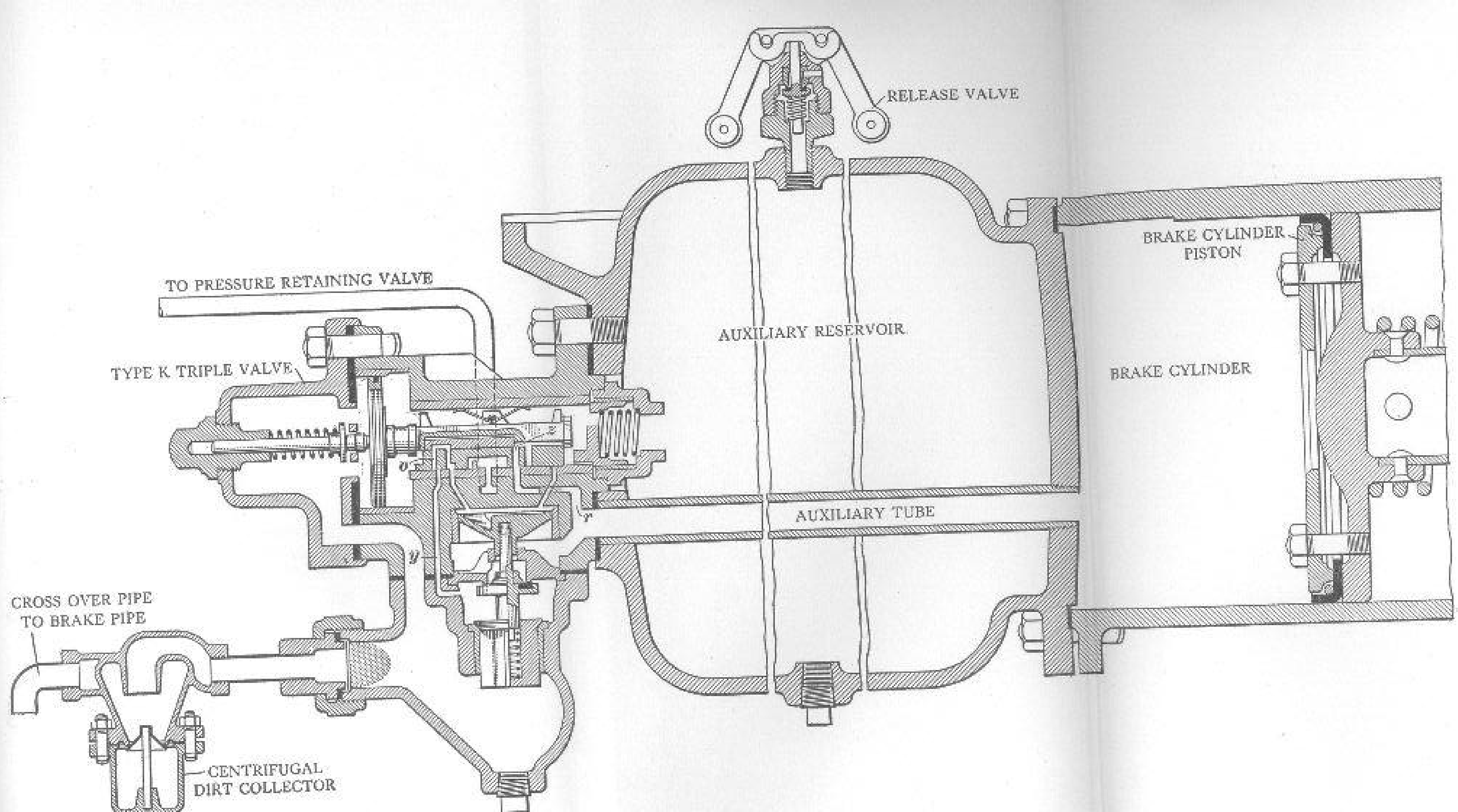

Fig. 16.

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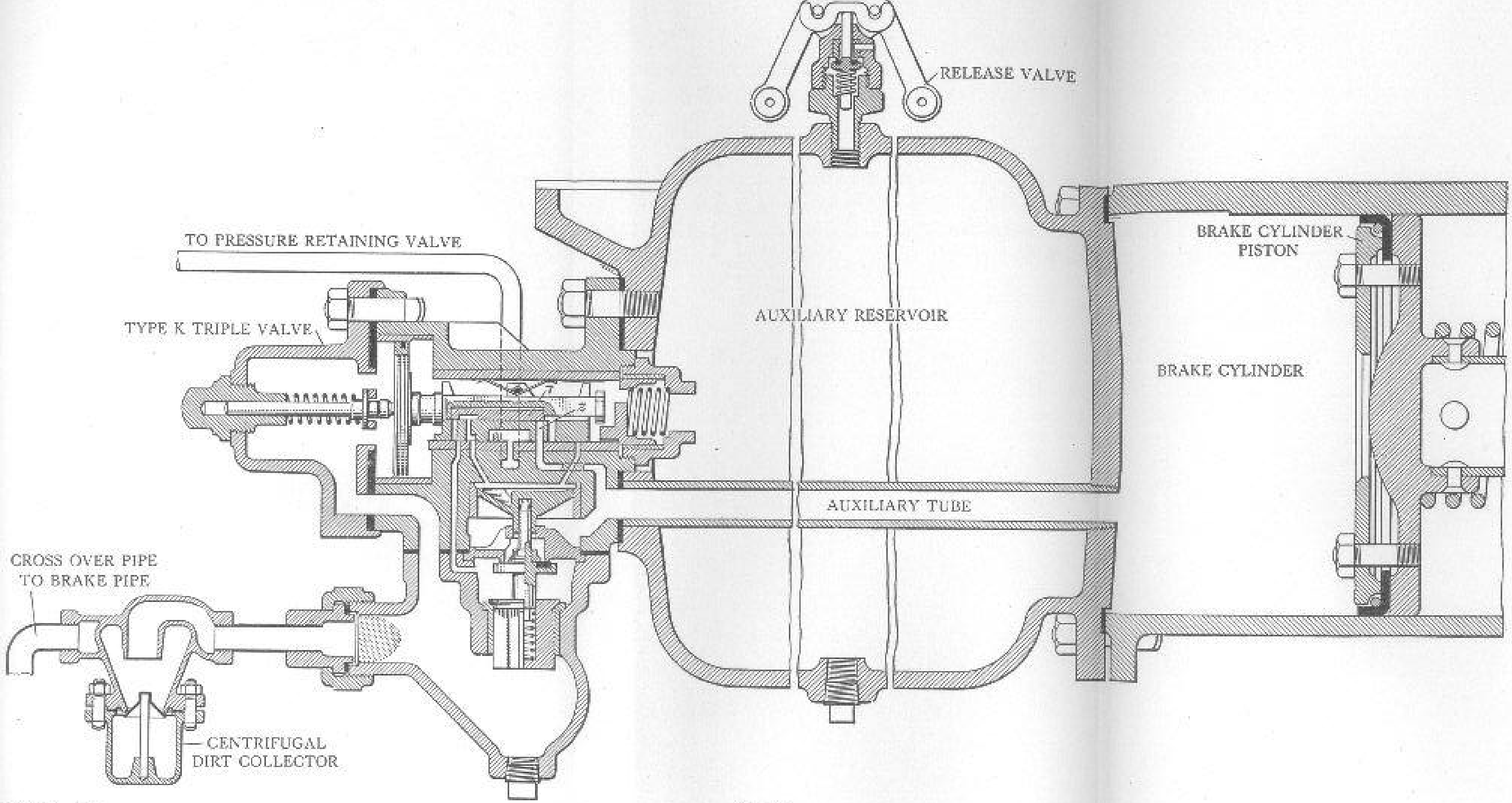
RELEASE VALVE
TO PRESSURE RETAINING VALVE
BRAKE CYLINDER PISTON
TYPE K TRIPLE VALVE
AUXILIARY RESERVOIR
BRAKE CYLINDER
AUXILIARY TUBE
CROSS OVER PIPE TO BRAKE PIPE
CENTRIFUGAL DIRT COLLECTOR
B B 518 2539

Fig. 17

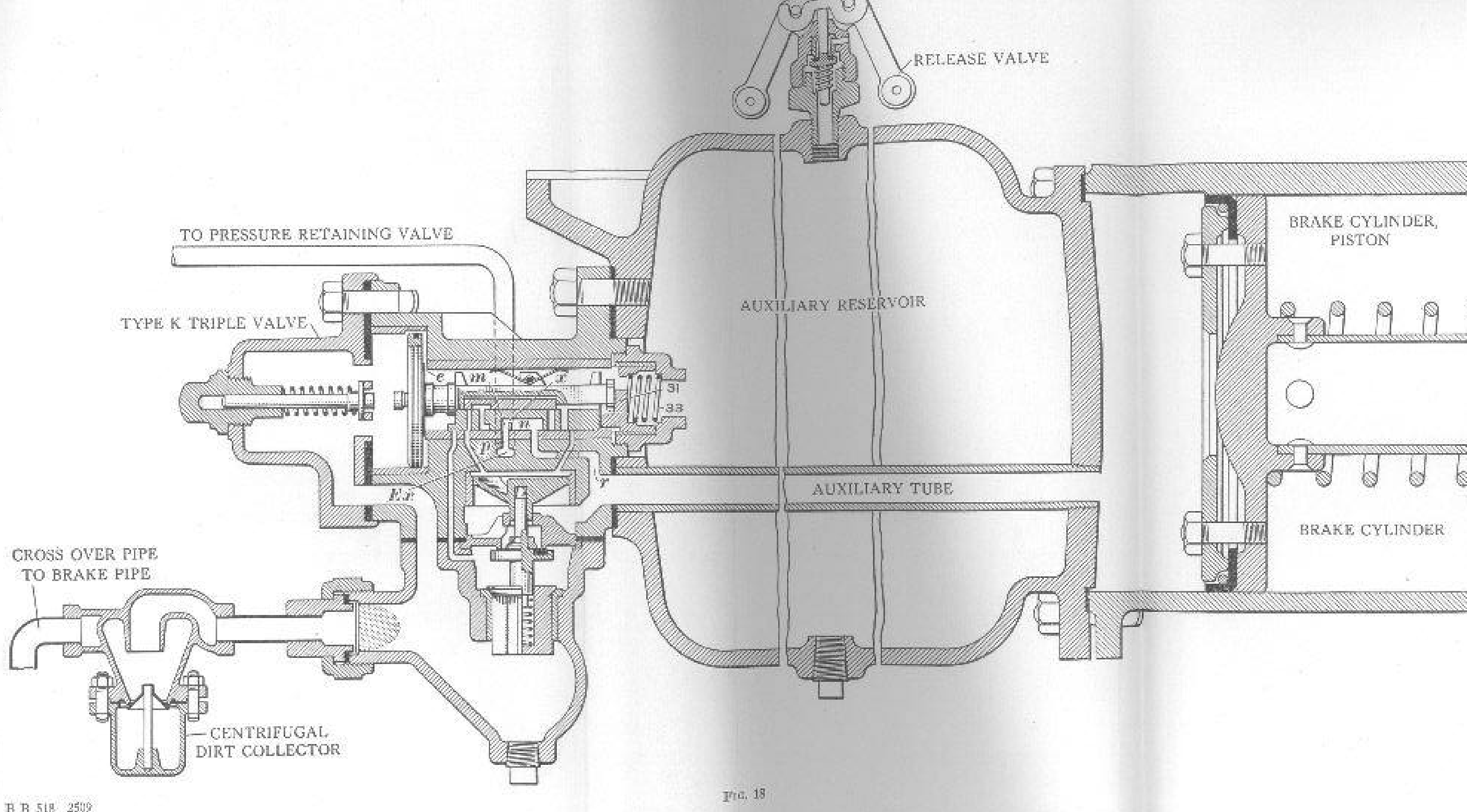
RELEASE VALVE
TO PRESSURE RETAINING VALVE
TYPE K TRIPLE VALVE
AUXILIARY RESERVOIR
BRAKE CYLINDER, PISTON
AUXILIARY TUBE
BRAKE CYLINDER
CROSS OVER PIPE TO BRAKE PIPE
CENTRIFUGAL DIRT COLLECTOR
31
33
B B 518 2509

Fig. 18

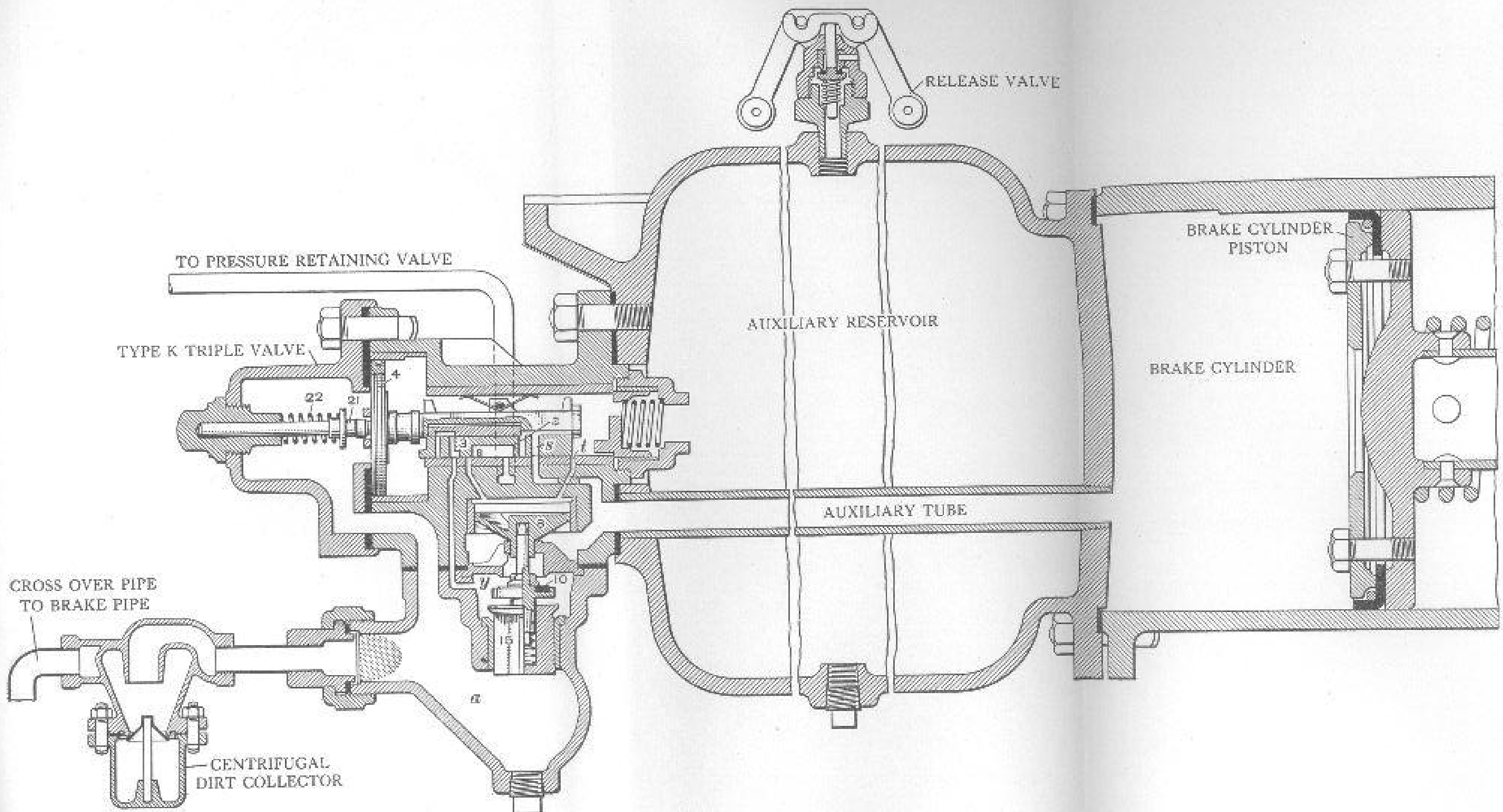

FIG. 19

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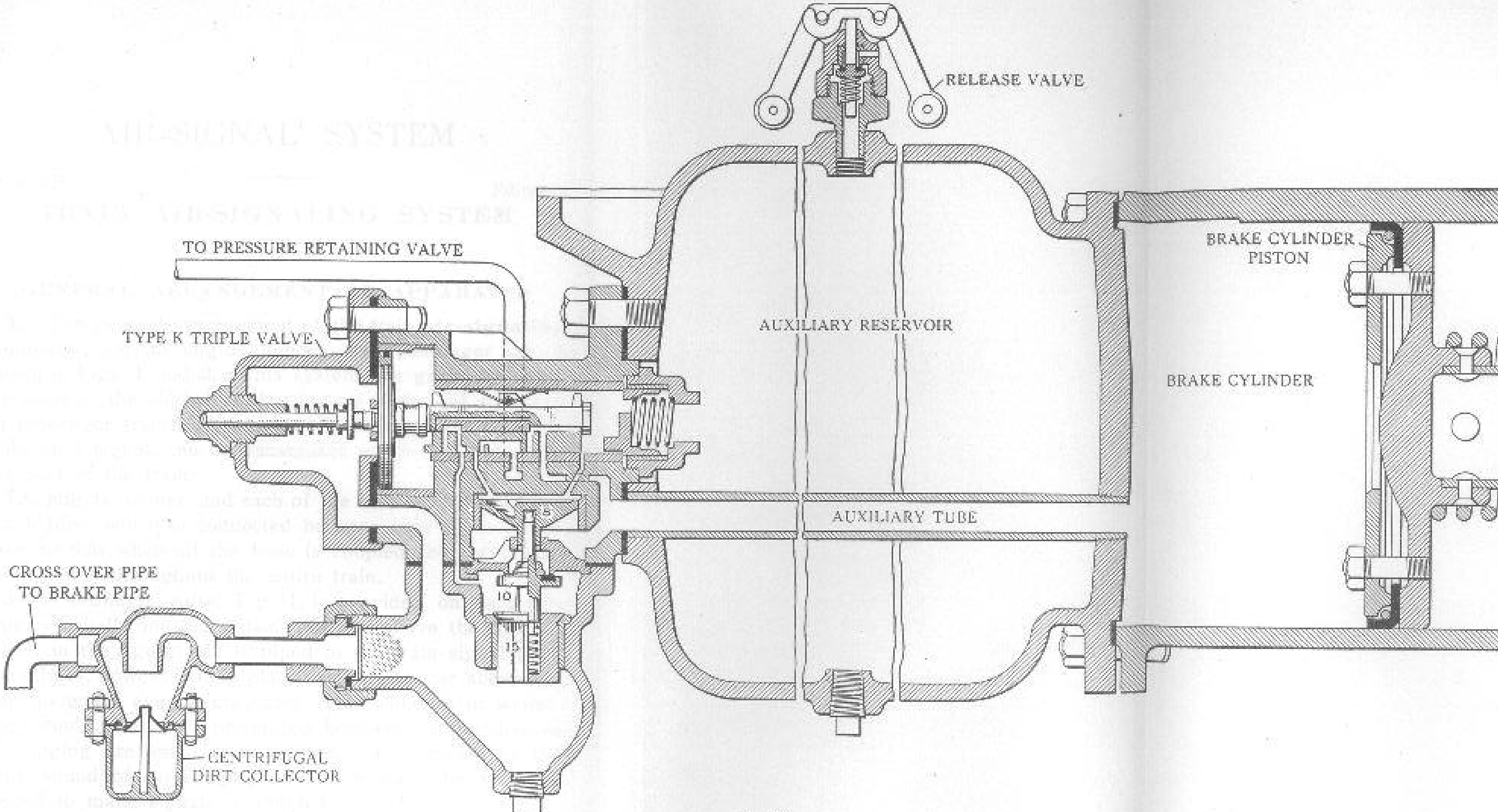

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Fig. 29