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THE AUTOMATIC VACUUM BRAKE.

JAN. 1967

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THE AUTOMATIC VACUUM BRAKE

SCOPE OF BOOKLET

On British Railways all passenger and coaching stock, and a large proportion of freight stock, is fitted with an automatic continuous power brake, which may be operated by air or by vacuum. A few vehicles are dual brake fitted.

The air brake, in various forms, is in use or is being fitted to an increasing proportion of trains, and will be the standard brake of the future. The majority of brake fitted stock, however, will for many years be vacuum braked.

This booklet, on the Automatic Vacuum Brake, has been compiled to provide essential information for staff engaged on work in connection with vacuum brake equipment, and to promote standard practice in its maintenance. It has been written with particular reference to Carriage and Wagon requirements.

For the operational part of the subject, reference should be made to :-

"General Regulations for working the Standard Automatic Vacuum Brake" - B.R. General Appendix pages 4 - 12.

"Additional Instructions with respect to Continuous Brakes" - B.R. General Appendix pages 12 - 14.

"Instructions relating to the testing of Automatic Vacuum Brakes on Freight Vehicles" - B.R. General Appendix pages 14 - 16.

"Working of Multiple-Unit Mechanical Diesel Trains" - B.R. General Appendix pages 39 - 43.

"Regulations for the guidance of Train Examiners and Oilers".

SECTION I

GENERAL DESCRIPTION

AUTOMATIC VACUUM BRAKE EQUIPMENT

DEFINITION AND MEASUREMENT OF VACUUM

The atmosphere exerts a pressure, at sea level, of approximately 15 lb. per square inch. As however we are normally quite unaware of this pressure, it is generally regarded as a datum, and values of pressure are measured above it, or measured below it for vacuum, zero in each case actually being atmospheric pressure. Fig. 1(a) gives a comparative diagram of pressure (known as 'gauge pressure') measured above atmosphere, vacuum measured below atmosphere, and absolute pressure.

Fig. 1(b) shows a U shaped tube, containing mercury. If the air in the suction side of the tube is gradually withdrawn, then the pressure of the atmosphere acting on the open side will force the mercury down on that side and correspondingly up on the suction side till the difference in height between the two sides balances the partial vacuum in the suction tube. Since the atmospheric pressure of 15 lb. per square inch is equivalent (approximately) to the pressure exerted by a column of mercury 30" high, it can be seen therefore that if all the air is withdrawn and a perfect vacuum is thus created in the suction tube, then the difference in level will be 30", and correspondingly various degrees of partial vacuum will be indicated in the same manner by corresponding heights of the mercury column. In practice any degree of partial vacuum is generally simply referred to as "vacuum", and the chemical symbol for mercury, Hg, is sometimes used as an abbreviation. Thus as 30" of mercury (or 30" Hg), is approximately equivalent to 15 lb. per square inch, so correspondingly a difference in vacuum of 1" is almost equal to a pressure change of $\frac{1}{2}$ lb. per square inch. Hence 21" of vacuum is equivalent to about $10\frac{1}{2}$ lb. per square inch. (Exact values are:- 30" Hg = 14.69 lb./sq. inch, 21" Hg = 10.29 lb./sq. inch).

Obviously it is impracticable to use U tubes for measuring the vacuum on railway vehicles, and so dial and pointer gauges are used, with the scales marked in "inches of vacuum" or "inches of mercury". A Bourdon tube similar to that of a pressure gauge is used in the internal construction.

APPLICATION OF VACUUM FOR BRAKING

The first application of vacuum to train braking arose from a need for a better brake than that of the locomotive and guard's hand brake, and a system was then devised comprising a continuous pipe along the train with flexible connection between vehicles, known as a "train pipe", which was connected to brake cylinders on each vehicle pushing on to the brake blocks. To apply the brake, the driver opened the steam valve to an ejector and created vacuum in the train pipe, which operated the brake pistons and applied the brake blocks. This was known as the simple vacuum brake, and though an improvement on previous braking, suffered from the serious disadvantages of being slow in action, and in the event of a break-loose, was useless on the rear part, and only very slightly effective on the front part.

To overcome these defects, the action of the brake cylinder was changed to the present arrangement, where the vacuum in the train pipe exhausts the air from both sides of the brake cylinder piston, from one side directly, and from the other through a non-return device; both sides are thus subject to an equal vacuum, the piston will be in equilibrium, and the brake off. If the vacuum on the train pipe side of the piston is then allowed to fall, the non-return device will operate to preserve the vacuum on the other side, and so the piston will have acting on it a force corresponding to the fall in vacuum. Thus, after the creation of vacuum throughout the system, by admitting air to the train pipe the driver can apply and regulate the brake, and in case of a break-away the train pipe is opened to atmosphere and the brake is applied automatically with full force on both parts of the train. In other words, a vacuum is created and maintained in the train pipe in order to keep the brake <u>released</u>, and so any equipment failure or damage or a break-away automatically applies the brake. Hence the brake as now used is known as the Automatic Vacuum Brake. It is interesting to know that the continuous and automatic features are a British legal requirement for passenger trains by the "Regulation of Railways Act, 1889".

AUTOMATIC VACUUM BRAKE EQUIPMENT

General

On a vacuum brake fitted train a continuous brake pipe is provided throughout the train, or fitted portion of a partly fitted train. This pipe is most aptly and clearly referred to as a "brake pipe", though the term "train pipe" has up to now been in general use. "Brake pipe" is used throughout this booklet except in the historical passages above.

All passenger and coaching stock, except the air braked stock mentioned above, is fitted with the automatic vacuum brake. All passenger trains must be worked with the brake in use, and other coaching stock trains are almost always so worked.

Freight stock can be divided into three categories :-

(a) "Fitted" vehicles, which are provided with brake equipment to enable the brake blocks to be operated by the power brake, provision may also be made for the brakes to be operated by hand lever or wheel. Vacuum brake pipes at the ends of these vehicles are painted RED for identification.

(b) "Piped" vehicles, which are provided with hand brake equipment, and with a continuous brake pipe and hose couplings, but are not fitted with equipment to enable the brake blocks to be operated by the power brake. Vacuum brake pipes at the ends of these vehicles are painted WHITE for identification. Some goods brake vans are equipped with continuous brake pipe and a guard's brake application valve and gauge, to enable them to be used for Class 4 freight trains, (brake or pipe fitted throughout).

(c) Unfitted vehicles, on which the brake blocks are worked by hand, and which have no power brake equipment.

Freight trains may be worked fully fitted with the continuous (air or vacuum) brake, partly fitted, or unfitted; in each case the fitted vehicles are Instanter (short position) or tight-coupled, and the unfitted vehicles, which are in rear of the fitted vehicles, are usually loose-coupled.

<u>Arrangement on Trains</u>

Fig. 2 shows a general arrangement of vacuum brake equipment on a train consisting of a diesel locomotive and two B.R. passenger vehicles. Fig. 3 gives the brake arrangement on a typical diesel mechanical multiple unit train, these trains are fitted with a quick release two pipe system of automatic vacuum brake; Fig. 4 shows the brake pipework layout on a power car, and Fig. 5 shows that on a trailer car.

Each vehicle has a brake pipe 2" internal diameter along it, to which flexible coupling hoses and coupling heads are fitted at each end for coupling and uncoupling vehicles, and to allow for relative movements when running. Fig. 6 shows the standard vacuum hose coupling head with joint washer.

The brake cylinders are connected through branch pipes to the brake pipe, and in the case of passenger stock, and some freight stock, D.A. valves are often used, (see later). Branch pipes also lead off the brake pipe for the passenger communication and guard's brake valves.

At the front of the locomotive and the rear of the train the brake pipe hoses are sealed off by placing the heads on "dummy" couplings, which are provided at the ends of each vehicle, and which consist of a coupling head with the pipe connection portion blanked off, see Fig. 6.

The standard working vacuum for British Railways is 21" of mercury, measured at the locomotive or driving position. The actual operational requirements for vacuum are given in the General Appendix p. 7.

Brake pipe vacuum gauges are provided on locomotives and in the driving cabs of M. U. Stock, so that the driver can check the working and measure the application of the brake. Gauges are also provided in vans and guard's compartments so that the guard can check the working of the brake, carry out the necessary tests before starting, and apply the brake if necessary.

During railway operation it is often required to release the vacuum brake on a stationary vehicle by hand. This is done by pulling on the release cord or wire, which is connected to the release valve. The cord is usually found under the solebar, and its position is indicated by a white star. On vehicles with two brake cylinders, and where two cords are provided, both must be pulled. (Continental sleeping-cars running on the Southern Region have a different arrangement; no release cords are fitted, and in their place gravity release caps are used).

When vehicles detached from a train are required to have the vacuum brakes fully released, it is important that this should be done before the coupling heads are put on the dummy couplings at both ends. The vacuum brake should not be released till the vehicles are properly secured, especially on gradients.

General instruction with regard to coupling, uncoupling, etc., are given in the General Appendix, p. 11.

The various types of vacuum brake layout, and design and working of components, are described in the following pages, in this order :-

Locomotive brake equipment
Common items
Passenger stock equipment
Diesel mechanical multiple-unit train equipment
Freight stock equipment.

Locomotive Brake Equipment

For creating and maintaining vacuum, diesel and electric locomotives are provided with exhausters of suitable total capacity, usually with two stages, the higher used intermittently to create vacuum rapidly, and the lower in use continually to maintain vacuum in the system against leakages. Steam locomotives are usually fitted with two ejectors of different capacity, the large and small used intermittently together to raise vacuum rapidly, and the small used continuously to maintain the system against leakages.

A vacuum limit valve (often called "relief valve" or "snifter valve") is fitted to keep the working brake pipe vacuum at the standard value of 21". This valve opens and admits air to the brake pipe should the vacuum rise above the standard value. Fig. 7 shows a typical example of a simple type of valve. Diaphragm operated limit valves are now increasingly in use on locomotives with powerful exhausters to give more sensitive control of brake pipe vacuum combined with greater capacity.

The vacuum brake is applied by means of the driver's brake valve, which admits air to the brake pipe, and may also cut off or restrict the exhausters or ejectors. The valve is arranged to be able to exercise a sensitive control for a partial application, and to give a full opening to destroy the brake pipe vacuum suddenly and completely for an emergency application.

On vacuum braked diesel and electric locomotives, the brake blocks of the locomotive itself are usually applied by compressed air, which can either be controlled independently (known as the "straight air brake"), or proportionally and automatically by the vacuum. Some electric locomotives have also a rheostatic brake. On steam locomotives the braking is either vacuum, or by steam with either independent or vacuum-controlled operation.

Brake pipe vacuum gauges are fitted to all locomotives, and air pressure gauges are also fitted for the locomotive brake as required.

Diesel and electric locomotives, and railcars, are usually provided with a Driver's Safety Device (D. S. D.), formerly known as a deadman's apparatus, which is arranged so that power is cut off and a brake application made if the driver does not keep depressed a foot treadle or hand push button on diesel and electric locomotives, or if he releases his grip on the throttle control on railcars.

Many lines are now equipped with Automatic Warning System (A. W. S.) which gives in the cab audible indications of the aspects of distant and other signals capable of displaying a caution aspect. If a warning indication is not cancelled, the brake is applied automatically.

Detailed descriptions of locomotive braking, of D. S. D., and of A. W. S., are considered outside the scope of this booklet.

Common Items of Vacuum Brake Equipment (Passenger & Freight Stock)

Brake Cylinders (General)

Vacuum brake cylinders are made in a range of sizes, the figure given being the nominal inside diameter of the cylinder. The usual sizes are 15", 18" and 21". In addition there are 22" (sliding band); and 22" and 24" (rolling ring) cylinders. Brake cylinders (except some of those of the diaphragm type) are usually arranged vertically with the piston rod coming out of the bottom, the piston moving upwards to apply the brake and downwards to release; the weight of the piston then assists the brake release. It is usual to refer to the "top-side" and "bottom-side" in this way, the top-side thus being that part of the cylinder in which the vacuum is retained during brake application, and the bottom-side that which communicates with the brake pipe, and to which air is admitted to apply the brake. The terms are used in this way throughout the booklet, as being the most suitable description. The terms "upper chamber" and "reservoir" have also been widely used for the top-side space, and indeed it has been quite usual to refer to the "top-side" as the "reservoir" side, although no separate reservoir is in fact fitted, (see below).

Brake cylinders can be classified into two general divisions, where :-

(a) The brake cylinder is in one unit, the required top-side volume being obtained by arranging a suitably large outer casing; this is called the "combined" brake cylinder.

(b) A top-side reservoir is provided separate from the brake cylinder, connected to it by a flexible hose; this is called the "separate" brake cylinder.

As explained earlier, the vacuum brake is applied by a reduction in vacuum below the piston, which moves upwards to apply the brake, the force being dependent on the difference between top-side and bottom-side vacuum. With a full application, the bottom-side is at atmosphere, hence the maximum brake force will depend on the top-side vacuum, which is affected by piston stroke, for the following reason. With brakes off, the initial top-side vacuum is about 20",* which means that about 1/3 of the original air is still present, and as the piston moves up, the top-side volume is decreased, slightly compressing this residual air, and for a combined cylinder reducing the top-side vacuum by 3"- 4" for average piston strokes, thus giving a maximum pressure difference of 16"- 17" to work the brake. This will normally be allowed for in brake calculations, where a pressure differential figure of $8\frac{1}{2}$" lb./sq. inch (= 17.34" Hg) has often been used. It will be seen, however, that longer strokes than normal lead to greater compression of the top-side volume, and so to a loss of brake power.

* It is usual to take an initial top-side vacuum of 20" in service for an initial brake pipe vacuum of 21". The drop of 1" allows for the vacuum difference required to lift the ball valve or to pass the sliding band, and allows also for any drop in brake pipe vacuum along the train due to inevitable small leaks.

If the top-side volume is made greater by the use of a separate reservoir, then the reduction in top-side vacuum due to piston stroke becomes less, hence separate cylinders and top-side reservoirs are used when a high brake force for a given sized cylinder is required. In a few special instances, (some ferry wagons), a combined type cylinder is used with a top-side reservoir.

In almost all vehicles, the piston stroke will be found to be in the range 3" to 6", and it is generally considered that adjustment of brakegear is required, especially on passenger stock, if the stroke is more than $4\frac{1}{2}$" - 5". Wagons fitted with S. A. B. Loaded/Empty brakegear, or ferry wagons, are an exception, on some ferry wagons the strokes normally to be expected are shown on the vehicle.

A flexible piston rod sleeve of treated canvas or plastic cloth is fitted below the cylinder, attached to the gland box studs and looped round the eye of the piston rod. It protects the piston rod from scoring due to grit thrown up from the track, and lessens atmospheric corrosion.

On the brake cylinder outer casing are fixed two trunnions which allow the cylinder to be carried in suitable brackets, with freedom to swing in an arc as the piston moves upwards. Brake pipe and other connections to the cylinder are made with flexible hoses.

Three varieties of brake cylinders are in use :-

1. Rolling ring, in which the air-tight joint between piston and cylinder is made by a rubber ring about $\frac{1}{2}$" dia. cross-section, which rolls as the piston moves. B.R. Type E1 and most of the other brake cylinders have rolling rings.

2. Sliding band, standard on the former Great Western Railway and also used for earlier B.R. cylinders. The piston is kept air-tight by a sliding band.

3. Diaphragm. Two designs of vacuum brake cylinder have recently been introduced in which the piston is made air-tight by means of a diaphragm. One type employs a short-stroke horizontal cylinder, and the other is interchangeable with existing type E1 cylinders.

<u>Type E1 Brake Cylinder (B.R. Standard)</u> Fig. 8.

A range of rolling ring vacuum brake cylinders of improved design, the type E1, is now standard for British Railways. These cylinders are of the combined type and consist of an outer steel shell which forms the top-side space, and an inner cast-iron cylinder. The piston fits easily in the cylinder, and has a deep head with relieving groove to take the rolling ring in the 'brake off' position. The groove keeps the rolling ring in alignment, and prevents permanent distortion of the ring when the cylinder stands for a long time with the piston in the off position.

The bore of the cylinder and the circumference of the piston are machined with a corrugated surface to help the ring to roll evenly. It is important that no graphite or other lubricant is used on the cylinder bore.

The piston carries a ball valve fitted in a cage, with a direct communication between underneath the ball and the top-side space, and with a passage from above the ball to the outside of the piston, and thus to the underside of the rolling ring in the "off" position (see part view on Fig. 8).

The piston rod is fixed in the piston head by means of a right-hand thread, with a parallel portion below it which fits in a closely machined hole in the piston head, this construction making sure that the head is concentric with the rod. The thread engages with a captive nut in a recess in the piston head. The recess has an air-tight cap to prevent leakage between top and bottom side.

The piston rod, which is nickel plated along its working length, passes out of the cylinder through a gland box with a bronze bush and a rubber gland with nylon insert, so arranged that atmospheric pressure on the outside of the gland rubber makes an air-tight joint on the rod when the cylinder is under vacuum. The bottom end of the piston rod has a slotted hole for the pin which connects to the brake levers. The brake gear is arranged to come against a stop at release, so that the piston can fall the extra distance permitted by the slot. On brake application the first $\frac{1}{2}$" or so of piston movement thus takes place freely, which helps the piston ring to move out of its recess evenly. The maximum stroke of the piston is $8\frac{1}{2}$", and in usual working the stroke is kept at not more than about $4\frac{1}{2}$" - 5".

The operation of the cylinder is as follows. When vacuum is created in the brake pipe, air passes freely from the bottom-side of the piston, which will fall to the bottom (off) position by its own weight when an equal vacuum exists on both sides of it. With the piston in its off position, air can be withdrawn from the top side through the ball valve, till working vacuum is attained in both bottom and top sides.

When the brake is applied, air enters the bottom side from the brake pipe and presses down the piston ball valve, thus preserving the vacuum in the top side. The piston therefore rises due to the difference of vacuum, and so applies the brake. The ring rolls between the piston and cylinder wall, preserving an air-tight seal, and also cutting off communication between the top of the ball and the bottom-side space, thus preventing loss of top-side vacuum due to leakage past a worn or damaged ball valve seat.

Type E1 cylinders have a large E1 cast on the under side of the cylinder, so that they can be distinguished from Type C, which do not carry a letter.

During store and transportation Type E1 cylinders are sent with the piston rod and release valve packed separately, and the piston is held in the 'brake off' position by means of a transit screw. It is most important that in assembly the cylinder should be placed in its correct working position, either on trestles or on its own trunnion brackets on the vehicle, before the transit screw is removed and the piston rod screwed in from underneath.

Type E1 cylinders are made in three sizes, 15", 18" and 21" dia. Under standard conditions (21" brake pipe vacuum, $4\frac{1}{2}$" stroke) their pulls on full brake application are 0.63, 0.90 and 1.26 tons respectively.

The release valve for a Type E1 cylinder is shown on Fig. 9. It is fastened to the bottom of the cylinder by an oval flange with two 3/8" dia. studs, with a rubber or composition washer. The bottom side of the cylinder is always in communication with the brake pipe, (directly or through a **D.A.** valve), by a passage in the casting. The top side can be connected to the bottom side when the flat rubber-seated valve is operated by hand by pulling the release cord. When the cord is pulled the flat valve opens; air then flows into the top-side till conditions are equalised, the piston falls by its own weight, and the brake is released. The operating lever on the release valve is arranged so that the valve opens whether the cord is pulled from one side or the other.

Once pulled open the valve will stay open till vacuum is again created in the brake pipe. A diaphragm is used to form a seal where the spindle enters the body, the diaphragm being connected to the spindle to form a flexible but air-tight joint, and having atmosphere on its outside face. When the vacuum is re-created in the release valve the diaphragm thus is moved inwards, shutting the valve automatically.

In order to prevent twisted diaphragms due to an oblique pull on the operating lever, Type E1 release valves are being fitted with a lever guide bolt.

Type E1 release valves have the letters RV (Release Valve) and E cast on the outside of the body, so as to prevent confusion with the similar Type C ball and release valves which have the same flange. It should be noted that if a Type E release valve is fixed on a Type C cylinder the brake will not work. (See later for description of Type C cylinder).

Type E Brake Cylinder

In addition to the new standard Type E1 cylinders described above, a number of the older Type E cylinders are in use on some of the Regions. They can be identified by E cast on the bottom. They are generally similar in construction to the E1 cylinders, and have the same main features of a ball valve in the piston and a flat-seated release valve below the cylinder. Some cylinders have a slightly different packing in the gland box, and some are of the separate type. The piston rod screws directly into the piston head.

The release valve is generally similar to the Type E1 release valve, and for separate cylinders is suitably modified to include a top-side connection. Separate type release valves are made with a number of variations in the disposition of the two connections.

Sliding Band Brake Cylinder, ex G. W. R. and earlier B. R. Fig. 10.

This brake cylinder is of the combined type, and has a piston with a rubber sliding band, arranged to allow air to be withdrawn from the top-side to the bottom, but not to pass in the opposite direction. The band is kept in contact with the cylinder wall by means of a cast-iron piston ring, and is secured to the piston by a thin steel hoop.

The bottom-side of the cylinder is always connected to the brake pipe. When vacuum is created, the piston is at the bottom of its stroke, or will fall to the bottom. The sliding band is then in contact with the cylinder wall where an undercut forms a recess or "well", (see part view on Fig. 10). This recess reduces the pressure by which the piston ring holds the band against the wall, and so enables the top-side vacuum to be created more readily. When the brake is applied, the upward movement of the piston carries the sliding band out of the recess, and the band then bears against the cylinder wall with full pressure, and gives a better seal. The sliding band thus acts both as a piston packing, and non-return valve between top and bottom side.

In this type of cylinder the bore has a smooth finish, and is treated with graphite to lubricate the sliding band.

The piston rod screws directly into the piston head by a right-hand thread and a cone seating. Leakage from the bottom to the top of the piston through the thread is avoided by a piston head washer and packing. The piston rod passes out of the cylinder through a gun-metal bush and rubber gland.

Sliding band cylinders are made in two sizes, 18" and 22" dia., and the pulls at full brake force under the standard conditions of 21" initial brake pipe vacuum and $4\frac{1}{2}$" stroke are respectively 0.84 and 1.26 tons.

There are three types of brake pipe connection for sliding band cylinders, as shown in Fig. 11. For stock with D. A. valves and with screw couplings or "Buck-eye" couplers, a tail piece is used (Fig. 11 top), which is a simple through connection. For stock without D. A. valves, and with screw couplings or "Buck-eye" couplers, a restrictor elbow is used (Fig. 11 bottom), which slightly retards the brake application. For freight stock without D. A. valves and with Instanter couplings a moderating valve is used (Fig. 11 right), which is described later.

Sliding band cylinders, when in transport or in store, should be placed in a vertical position, preferably with the dome at the bottom.

The release valve for a sliding band cylinder, Fig. 12, is fixed on the side of the case, and communicates directly with the top-side. When after a full brake application the cord is pulled to operate the valve, air is admitted straight from atmosphere to the top-side, equalising the air pressure on the bottom side. The piston then falls by its own weight to release the brake.

Sliding band cylinders were adopted for earlier B.R. stock, but have been superseded by the new Type E1 cylinders described above. In general the 18" sliding band and 18" E1 are interchangeable, and the 22" sliding band is interchangeable with the 21" E1 cylinder.

Type C. Brake Cylinders. Figs. 13 and 15.

These cylinders have a rolling ring, and are generally similar to Type E cylinders, except that there is no ball valve in the piston. The ball valve is located in the release valve, this fitting being then known as a "combined ball and release valve". The piston rod screws directly into the piston head. Type C cylinders can be either of the combined type (Fig. 13) or of the separate type (Fig. 15).

The ball and release valve for a Type C combined cylinder is shown on Fig. 14. The passages are made so that the bottom-side of the cylinder is always in communication with the brake pipe, by passages on each side of the section shown in Fig. 14 (see arrows on top view), while the top-side and brake pipe are connected by the ball valve, so arranged that air can pass from the top-side by lifting the ball, but cannot pass in the opposite direction. Consequently when vacuum is created in the brake pipe and bottom side the ball valve lifts and allows vacuum to be created in the top-side; when the brake is applied, the ball valve seats to preserve the top-side vacuum.

Embodied in the release valve casting is a sliding cage in which the ball is contained, the outer end of the cage being connected by a spindle to the cord lever. When the release cord is pulled, the cage unseats the ball; air then flows into the top-side to release the brake. (See Fig. 14 lower view). A diaphragm is fitted to return the cage and ball to the normal position when vacuum is re-created in the brake pipe.

A typical combined ball and release valve for a Type C separate cylinder (Fig. 16) has an extra top-side connection, on which fits a flexible hose which is connected to the top-side reservoir mounted on the vehicle underframe. Release valves are also in use which have different dispositions of the connections.

Type F. Brake Cylinder. Fig. 17.

Type F brake cylinders, Fig. 17, are the same in principle as the Type E cylinders, but the mechanical parts are arranged differently so that the rolling ring can be more readily changed without removing the main casting from the underframe. Type F cylinders are of the separate type.

The release valve for a Type F cylinder, Fig. 18, is generally similar to the E1 release valve illustrated in Fig. 9 and described above, but with an additional connection for a flexible pipe to the reservoir, and with the flange connection to the cylinder suitably designed to make the release valve reversible.

Diaphragm Brake Cylinders. Fig. 19.

The diaphragm brake cylinder has recently been re-introduced in a light and simple form for disc-braked vehicles, which do not require a cylinder with as long a stroke as for block brakes. The brake cylinder is fixed horizontally. The piston carries a rubber diaphragm to make a positive seal between "bottom-side" and "top-side". The cylinder is fixed rigidly on the vehicle, and the arc movement of the outer end of the piston rod is allowed for by a spherical bearing and by slight movement of the diaphragm. Instead of a gland a miniature sack is used, which corrugates as the piston moves. An E1 release valve is used, mounted on an elbow which fits on the side of the cylinder, and the elbow incorporates the ball-valve.

A number of diaphragm cylinders (known as ED type) are also in use which are interchangeable with E1 cylinders. They have a special nylon reinforced diaphragm, otherwise they are closely similar to the E1.

Direct Admission Valves. Figs. 20 and 21.

As the length of a vacuum-braked train increases, the greater delay in the application of the brake at the rear becomes a serious disadvantage, and in order to speed up the application of the brake various devices have been employed, one of the best known being the Direct Admission Valve (D. A. valve), which is shown on Fig. 20. These valves are now fitted as standard on B. R. coaching stock (except most types of multiple-unit diesel trains), and are also in use on some freight vehicles.

The principle employed is to use the air from the driver's brake valve during a brake application to fill the brake pipe and operate the D. A. valves only, while the air which operates the brake cylinders is admitted locally by the D. A. valves. The application of the brake along the train is thus greatly speeded up, as each brake cylinder has in effect its own independent air supply. Brake release takes place through a non-return valve, hence speed of release is the same as for a simple vacuum brake train without D. A. valves.

The D. A. valve is fastened by its flange to a branch from the brake pipe, and connected to the brake cylinder by a flexible hose. Figure 20 shows sketches of the valve in three conditions; Running, Brake Application, and Brake Release. Referring to the sketch marked "Brake Release", when vacuum is created in the brake pipe for the initial brake charging or for release after brake application, air is drawn from the brake cylinder through passage A, lifting non-return valve B, into the brake pipe. At the same time vacuum is created in chamber C, by air being drawn past the flat D on the spindle and along passage E. When release is complete the whole valve is under vacuum and the brake off, see sketch marked "Running".

When the brake is applied, as in sketch marked "Brake Application", air from the brake pipe enters the D. A. valve body, raising the diaphragm F, and keeping valve B shut. The diaphragm opens air valve G, thereby admitting atmospheric air through the filter and valve G to the brake cylinder along passage E. When sufficient air has been admitted to reduce the vacuum in chamber C (by entering the flat D on the spindle) to equal brake pipe vacuum, the diaphragm is again in equilibrium and is moved downwards by spring H, thus closing valve G. (In practice, on an emergency brake application the D. A. valve also feeds some air back to the brake pipe, as valve B will lift if the pressure in passage A is higher than that in the valve body).

In the event of a defective D.A. valve failing to close and causing a continual leak to the brake pipe, the valve can be put out of action as shown in the sketch marked "Defective Valve, Air Inlet Blanked Off" and explained later. The brake cylinder will then not apply when the brake is operated, or possibly come on very slowly due to leakage past valve B.

Figure 21 shows a different form of D. A. valve, used on ex - G. W. R. vehicles. The general principle is identical with that of Figure 20, but the air intake and filter are simpler, the valve is arranged in the run of the brake pipe, and the brake cylinder connection is at the bottom. The B. R. valve of Figure 20 was in fact derived from the G. W. R. valve.

It is interesting to notice that in addition to its usual function of opening on a brake application, a D. A. valve also opens on the hand release of a rolling ring cylinder. When the release cord is pulled, the top-side vacuum equalises with the bottom-side vacuum at a common value of about 12" - 14", and the D. A. valve then opens to admit air till the cylinder is at atmosphere, as in the brake pipe.

<u>Quick Service Application Valve.</u> (Fig. 22)

Quick Service Application (Q. S. A.) valves are used on some vehicles to speed up the application of the brake; the general principle of operation is similar to that of the D. A. valve. Fig. 22 shows a Q. S. A. valve fitted to a type E. 1 cylinder, the valve being made small and light so as to fasten directly under the brake cylinder on the release valve facing, with a flat-seated release valve incorporated in the body. On brake application, diaphragm A opens ball valve B to allow air to enter the cylinder through port D, and at the same time some air also passes back to the brake pipe through check valve C, thus speeding up the brake propagation along the train. An air strainer, connected by a flexible pipe to the Q. S. A. valve entry port, is used to prevent dirt from the track entering the valve. As a safety precaution, by-pass valve E is provided to lift automatically if the strainer becomes blocked or the air valve fails to open; air can then pass directly from brake pipe to cylinder to apply the brake. Release takes place through valves C and E. The Q. S. A. valve shown on Fig. 22 is for use with Type E, Type E1 and Type F brake cylinders; a design with combined ball and release valve is used with Type C cylinders.

Guard's Brake Application Valves. Figs. 23, 24 and 25.

A guard's brake application valve, sometimes known as a "van valve", is provided in the guard's compartment of coaching stock brake vehicles, driving cabs of multiple-unit mechanical diesel trains, and fitted or piped freight brake vans. By this valve the guard can carry out the necessary tests, or apply the brake in case of emergency. The valve is not graduable, and the lifting of the lever brings about a sudden application of the brake. Fig. 23 shows the standard B. R. design, which is a simple flat-seated valve operated by a lever, giving a full opening to the 2" brake pipe on which it fits. The valve shuts automatically when the handle is released. Adjacent to the valve it is usual to provide a brake pipe vacuum gauge.

A rather similar valve, Fig. 24, is used on some ex L. N. E. R. stock and on other regions. It has a flat valve as before, and a reservoir communicating with the brake pipe through a restricting orifice. In the case of an emergency brake application the vacuum in the brake pipe falls rapidly, but the reservoir vacuum cannot follow as quickly due to the action of the fine bore orifice nipple, consequently the valve opens automatically and helps the brake application. Valves of this type are being made non-automatic by removing the orifice nipple, and when so treated are distinguished by having N. A. stencilled on the body.

Fig. 25 shows a similar valve in use on ex G. W. R. stock, where it is generally known as a "brake setter". It is again of a type which was once automatic, and now being rendered non-automatic by the removal of the orifice nipple. On many valves the domed top has been removed, and the valve made similar to the standard B. R. valve of Fig. 23.

Passenger Stock Equipment and Arrangements

Passenger Communication Apparatus. Figs. 26 and 27.

Passenger communication apparatus is fitted to all passenger vehicles (as shown on Figs. 2 and 3). On all but some diesel multiple-unit and some ex L. N. E. electric stock, the apparatus is worked by pulling a chain which runs continuously along the inside of the coach and which is accessible to passengers. The pulling of the chain actuates a cross shaft at the end of the vehicle, which operates a flap valve in the communication box. The valve leads to a branch pipe which connects with the brake pipe. Fig. 26 shows the apparatus in the normal position with the flap valve closed. When the chain is pulled a cam on the shaft opens the flap valve, as shown in Fig. 27. Air from atmosphere then enters the valve box through holes in the bottom, and passes through the flap valve to the brake pipe to apply the brake.

In order to give an indication of the vehicle on which the chain has been pulled, the cross shaft which operates the valve is provided with a disc at each end. Normally these discs lie horizontally, but when the chain is pulled and the shaft turned, the discs move to the vertical (Fig. 27), to enable the coach to be identified. The disc is returned to the normal position by hand to reset the apparatus. (Some ex L. N. E. vehicles have special arrangements).

It has been usual in the past to arrange the size of the air opening of the flap valve to produce a partial application of the brake when the chain is pulled, leaving it to the discretion of the driver as to where he actually stops. However, on trains hauled by locomotives fitted with powerful exhausters or ejectors, it has been found that the effect of the passenger communication valve is not definite enough in some circumstances. Coaches are now being altered to make the effect more powerful by increasing the size of the flap valve and branch pipe, and in such cases the driver has no discretion in stopping. Fig. 26 shows an altered type (1" dia. branch pipe) and Fig. 27 shows the original size (5/8" dia. branch pipe).

On some diesel multiple-unit trains different arrangements are in use, and no external indicators are fitted. On one type the chain actuates valves fitted in the driver's compartment or in the vestibule, which are re-set by pulling back a spring-loaded bolt. On another type the passenger communication valve is a red-painted cock inside the vehicle which when pulled down admits air to the brake pipe. The cock cannot be closed by hand after operation, and a key must be used.

Diesel multiple-unit trains of Western Region design have Passenger Communication gear operating on the D. S. D. control.

On some Pullman cars the apparatus and indicators on the two sides operate independently of each other, and both sides of the train need to be examined to find the car concerned when a chain has been pulled.

Brake Gear Arrangements

General

The brake cylinder force is transmitted and multiplied by a linkage arrangement of shafts, levers, and rods to operate the brake cross-beams or levers which carry the brake blocks. Links and levers are also fitted to suspend the brake gear, and take the brake block friction forces. A return spring is often fitted, either on the bogie, or acting on the main pull rod, which latter also prevents brake rod chatter. Safety loops are provided to catch broken or detached brake gear parts and prevent their dropping on the track.

The braking forces should be sufficient to stop the vehicle as effectively as possible, but without risk of skidding in wet weather. Experience has shown that the most satisfactory arrangement, for cast-iron brake blocks and passenger vehicles, is to have a total brake block force of up to about 90% of the tare weight.* In the case of a typical bogie carriage weight 33 tons tare, two 21" dia. E1 cylinders are used, with total cylinder force of $2 \times 1.26 = 2.52$ tons. Brake leverage is 2.7 to 1 on the underframe and $4\frac{1}{4}$ to 1 at the bogie, hence :- Total brake block force $= 2.52 \times 2.7 \times 4\frac{1}{4}$ $= 28.9$ tons, which is $\frac{28.9}{33} \times 100 = 87.6\%$ of coach tare weight.

A large number of different brake gear arrangements are in use, some of those more frequently found are shown in the following figures. For brake vans a hand brake with handwheel and screw operated gear is provided, acting on the same linkage and brake blocks. For six-wheeled bogies or vehicles the arrangements are generally similar to those for four-wheeled bogies, with additional levers as required.

Brake Regulator (Slack Adjuster)

In order to keep the brake rigging in correct adjustment, especially for high-speed or intensively worked vehicles, it is becoming increasingly usual to fit a brake regulator, often called a slack adjuster. This apparatus automatically maintains the clearance between brake blocks and tyres at its initial pre-set value, irrespective of wear in blocks, tyres or rigging, thus the power of the brake and its speed of application are maintained as when the vehicle is in new condition.

Brake regulators can be either single-acting, in which case they are usually known as slack adjusters, or can be double-acting. Single-acting slack adjusters take up too-large a clearance and are of comparatively simple construction; they require re-setting by hand after brake block renewal. Double-acting brake regulators are more complicated, but in addition to taking up can also let out to increase too-small a clearance. This need arises after brake block renewal, or during normal service when a vehicle is loaded or unloaded, and the difference in brake block position relative to the tyre then alters the clearance.

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* Following usual practice, the figure of 90%, and the calculation of brake percentage which follows, are based on the standard value of brake cylinder pull and the theoretical brake leverage, hence no account is taken of brake rigging friction losses.

Brake regulators will normally be opened up and repaired in main works only, and for fuller particulars of construction and operation the maker's literature should be read.

B.R. Standard Bogie Brake Arrangement. Fig. 28.

The arrangement of the brake gear on the standard bogies of a B.R. coach, with one brake cylinder per bogie, is shown in Fig. 28. The brake cylinders are fixed to the underframe, operating the main brake shaft and underframe brake lever. The pull rod to the bogie is connected to the middle point of the bogie equalising link. The brake gear linkage is arranged centrally on the bogie, and operates on the brake beams to apply the brake blocks. This type of brake gear is equalised and compensated; i.e. the force at each of the eight brake blocks is equal, and the linkage automatically compensates for wear.

The brake arrangements on the Commonwealth bogies and some ex L.M.S.R. and ex L.N.E.R. bogies, are similar.

B.R. B.4 and B.5 Bogie Brake Arrangement. Figs. 29 and 30.

On earlier B.4 bogies, Fig. 29, the cylinder pull rod acts on the centre of the equalising beam, and the force from the ends of the beam is transmitted to sets of levers down each side of the bogie to operate the blocks. The brake gear is equalised and compensated.

On later B.4 and B.5 bogies (Fig. 30), the pull rod from the brake cylinder to bogie acts, through a brake regulator, on to the central linkage of the inner bogie wheels, through which the force is transmitted by the divided pull rod to the central linkage of the outer bogie wheels. The brake gear is equalised and compensated.

Ex G.W.R. and earlier B.R. Bogie Brake Arrangement. Fig. 31.

The G.W.R. standard bogie is shown in Fig. 31 and uses a central leverage system. This bogie is not compensated, and reliance is placed in service on careful adjustment to make sure that all brake blocks are touching the wheels simultaneously.

The earlier B.R. standard bogies are fitted with this type of brakegear. In some cases this has been altered to the equalised and compensated type of Fig. 28, but the majority have not been dealt with.

Ex L.N.E.R. Bogie Brake Arrangement. Fig. 32.

A type of bogie brake arrangement used on some L.N.E.R. coaches, and also on other lines, is shown in Fig. 32. This arrangement, using central leverage, is compensated for wear and the brake block loads remain the same, but the actual loads on the outer and inner blocks of a wheel are unequal. Some of the earlier L.M.S.R. coaches have a similar brake arrangement.

Ex S. R. Bogie Brake Arrangement. Fig. 33.

The S. R., for some coaches, used a central leverage arrangement shown on Fig. 33. The brake gear is not compensated.

Diesel Mechanical Multiple Unit Train Brake Equipment and Arrangements.

Description of System. Fig. 34.

Diesel mechanical multiple unit trains are fitted with the Gresham & Craven Quick Release Vacuum Brake System, as shown in Fig. 3. Typical brake pipework layouts are shown for power cars on Fig. 4, and for trailer cars on Fig. 5. The system employs two continuous pipes, the brake pipe and the exhauster pipe, and high vacuum release reservoirs on each vehicle.

In this quick-release system the exhausters are not joined directly to the brake pipe, but to a $1\frac{1}{2}$" diameter exhauster pipe connecting the release reservoirs on each car. This pipe carries normal size hose couplings, made opposite hand to prevent attachment to the brake pipe couplings. The exhauster pipe system and the brake pipe can only be connected to each other through one of the driver's brake valves provided in each driving cab, and to make sure that the brake pipe and exhauster pipe are not joined at more than one point, the brake valve handles are removable, and only one handle is provided for a train. The handle can only be attached or removed with the valve in the "lap" position, where all ports in the valve are closed, thus any valve left without a handle isolates the two pipes at that position.

The main features of the system, (drawn for a layout on a single car), are given in Fig. 34(1), and comprise:- the exhauster E, which is belt-driven from the diesel engine; high vacuum release reservoir A; feed valve B; two pipe driver's brake valve C; automatic isolating valve F; and standard vacuum brake cylinder D. The brake valve handle has the following positions:- "brake off", used in running and for release; "lap"; and "brake on", which in a range of movement can give a range of graduated applications from service to emergency.

Fig. 34(1) shows the equipment in the running position, the car is in motion and the exhauster running at maximum speed. The brake valve handle is at "brake off", connecting the brake pipe and exhauster pipe, thus the brake cylinder and brake pipe are evacuated through the feed valve, which is set to prevent the brake pipe vacuum from rising above 21" (see Fig. 35(a) and description). The exhauster creates its maximum vacuum (29" to 30") in the release reservoir to give storage capacity for subsequent brake releases. No vacuum limit valve is required or fitted. Fig. 34(2) shows the driver's valve in the "lap" position, which it passes through on movement of the handle towards brake application. In the "lap" position the feed valve and exhauster are isolated from the brake cylinder, and the brake cylinder cut off from the rest of the system.

Fig. 34(3) shows the "brake on" position with air being admitted to the cylinder to apply the brake, with the high vacuum preserved in the release reservoir. Brake applications thus made can be maintained by returning the handle to the "lap" position.

Fig. 34(4) shows the brake in the "quick release" condition, with the brake handle returned to "brake off" and the automatic isolating valve open. The driver's brake valve now links the brake pipe with the reservoir via the feed valve, which is opened fully. Air from below the brake cylinder piston and brake pipe flows into the release reservoir, which is large enough to absorb the air rapidly. When 21" is reached in the brake pipe the feed valve closes. It will be seen that the speed at which the exhauster is running has almost no effect on the speed of brake release, which is fixed by the reservoir capacity. It is thus possible to release a full brake application in a few seconds, even though the main engine and exhauster are at idling speed. The driver's valve handle then remains in this position and full-release vacuum is re-created in the reservoir when the vehicle is again running and the exhauster revolving at its full speed.

The automatic isolating valve is set to close at 18"-19" vacuum, and thus isolate the reservoirs when they are no longer of any assistance in the quick release of the brakes. If no isolating valve were used, after a heavy brake application the reservoir would require to be charged, by the use of the exhauster only, before the brakes would release, thus leading to long release times. Fig. 34(5) shows such a brake release, with the automatic isolating valve closed. Air is now being withdrawn from the brake cylinder by the exhauster as for a normal vacuum brake.

The duplex vacuum gauges in the driver's cab show on one side the brake pipe vacuum, and on the other side the exhauster pipe vacuum, (not the brake cylinder top-side vacuum as is common for duplex gauges).

The system is capable of dealing with a limited number of extra vehicles attached to a railcar. The vehicle is attached and vacuum coupled in the usual way; the exhauster pipe hose on the rear diesel car is placed on the dummy coupling. The release reservoirs have sufficient storage capacity to deal with the small additional volume without slowing down the rate of release seriously. Another feature of the system is that a dead railcar can be coupled to a normal vacuum brake train and the railcar brakes will work in the usual way, (the railcar D. S. D. being isolated).

The passenger emergency, D. S. D., and A. W. S. apparatus are all arranged to give an emergency brake application.

Feed Valve and Automatic Isolating Valve. Fig. 35.

As described above, the feed valve, Fig. 35(a), is the central part of the two-pipe braking system. It is placed between the exhauster pipe and the driver's brake valve, and limits the brake pipe vacuum to the working value (21"), irrespective of the higher vacuum in the exhauster pipe and reservoir. This fitting has at the top a flat-seated valve which is balanced by a small top diaphragm. The valve is arranged to be opened by a spring in the bottom part, and closed by a main diaphragm which has brake pipe pressure above it and atmospheric pressure below; the diaphragm force is balanced against the spring so that the flat valve closes when the brake pipe vacuum rises to 21". The valve is arranged to open and close sensitively. It is mounted vertically.

The automatic isolating valve, Fig. 35(b), is generally similar in construction and operation to the feed valve, except that no small balancing diaphragm is fitted. It is normally open when the release reservoirs are at above 19" vacuum, and closes if the reservoir vacuum falls below this value. It is mounted vertically. For initial charging of the reservoir the flat valve can lift against a light spring.

D. M. U. Bogie Brake Gear Arrangements.

Power Bogie. Fig. 36.

A number of different bogie brake gear arrangements are in use; Fig. 36 shows a typical arrangement. The brake cylinder is mounted on the outer end of the bogie, and the brake gear is arranged partly along each side, so as to avoid the final drive. It is equalised and compensated.

Some power bogies have the brake cylinder mounted on the coach underframe.

Trailer Bogie.

The brake cylinder is mounted on the coach underframe, and the brake gear on the bogies themselves is generally similar to that on the B.R. equalised and compensated bogie shown on Fig. 28.

Freight Stock Equipment and Arrangements.

Moderating Valves. Figs. 11 and 43 (b)

On freight vehicles, moderating valves are often fitted to the brake cylinders to restrict the rate of airflow into the cylinders during brake application, and consequently delay the rate of brake force build-up. An additional effect is that air flows more readily along the brake pipe towards the rear of the train, as compared with simple vacuum brake vehicles where the brake cylinders of the first vehicles can take air rapidly. Both these moderating valve features of gradual build-up and quicker propagation rate help to minimise shocks on fitted or partly-fitted freight trains.

Figure 11 (right) shows a horizontal moderating valve fitted to a sliding band cylinder; Figure 43(b) shows a vertical moderating valve for Type E1 rolling ring cylinder, arranged for fitting between cylinder and release valve.

The fitting consists of a ½" ball which normally occupies the position shown on the drawings, where the diameter of the passage is 5/8" and the area past the ball is then equivalent to that of a 3/8" diameter hole. When the brake is applied, the air entering the cylinder moves the ball into a passage 33/64" diameter, which leaves round the ball an area equal approximately to that of a 1/8" diameter hole, giving a restriction which delays brake application.

On brake release the ball is in the large passage, thus giving a normal release time.

Brake Gear Arrangements. Fig. 37.

On freight vehicles a large number of brake gear arrangements are in use. Typical examples of the more widely used are given in Fig. 37, as applied to four-wheel wagons and vans.

It is usual to employ brake block forces which are rather lower than for passenger stock, and for some modern freight vehicles, brake regulators are being fitted.

Freight vehicle brake gear, for four-wheeled vehicles, can be divided into two main types:- Push-rod, and clasp.

The push-rod type, Fig. 37(a), has four brake blocks per vehicle. This type is essentially the power brake adaptation of the Morton hand brake, and is light, convenient, and cheap. It has, however, the disadvantage that there is a horizontal thrust on the axleboxes, which is consequence prevents high brake block loads being used with plain bearing axleboxes. This brake gear is non-compensated for brake block wear. The brake blocks are of the usual wagon type with lip to go over the tyre flange. This type of brake gear is fitted extensively on open wagons and on vans, and on some Minfit wagons.

The clasp type Fig. 37(b), (c), (d), has 8 brake blocks per vehicle, with two per wheel, clasping it from opposite sides; the horizontal loads on the axleboxes are thus much reduced, or may be eliminated. Types of brake gear vary considerably in detail, but all have a central leverage, acting on crossbars which carry the brake blocks, (hence no flange lip is needed). This brake gear is partially or wholly compensated for brake block wear, and in some types, e.g. Fig. 37(b), the brake block loads are also equalised. Clasp brake gear is fitted chiefly to vans, and on some Minfit Wagons.

Bogie bolster and similar 8-wheeled wagons, when fitted with a power brake, have generally similar brake gear, usually with one brake cylinder for each bogie. The cylinder is mounted on the underframe. The linkage on the bogies operates one block per wheel, pushing outwards horizontally from the bogie centre line.

<u>A. F. I. System.</u> Figs. 38, 39, 40 and 41.

The A. F. I. system has been produced by Messrs. Gresham and Craven, primarily for freight vehicles, to give quick propagation of an emergency application, and a controlled rate of build-up of brake force. Vehicles fitted with this system have A. F. I. marked on the solebar.

The system can be arranged for vehicles with one brake cylinder, two brake cylinders working together, or two cylinders with Empty/Loaded braking by one or both cylinders. The A. F. I. system incorporates an accelerator valve, freight type direct admission (F. D. A.) valve, and inshot chamber with timing port. (A. F. I. stands for Accelerator-Freight D. A. -Inshot). The vacuum pipe layout on a freight vehicle with two cylinders working together is shown on Fig. 38. Fig. 39 shows one set of apparatus in sketch form.

Fig. 40 shows the accelerator valve, which is mounted vertically and connected directly to the brake pipe. This valve opens only on emergency applications. It is controlled by a diaphragm 9, open to atmosphere on the lower side, and open to a vacuum chamber on the upper side. The chamber is connected to the brake pipe by a restricted orifice K (Figs. 39 and 40). On an emergency brake application, brake pipe vacuum is destroyed more rapidly than that in the chamber, and valve 6 opens suddenly to give a full atmospheric opening to the brake pipe. Valves open successively down the train to give a very quick propagation from front to rear, thus avoiding run-in shock. The upper valve seats, and the second smaller orifice L (Figs. 39 and 40) gives a delay of about 6 seconds before main valve 6 re-closes. For normal service applications the brake pipe vacuum does not fall fast enough to operate the accelerator valve.

Fig. 41 shows a detailed drawing of the Freight D. A. valve, which fastens directly under a Type E1 brake cylinder, and incorporates a hand-operated flat-seated release valve. The inshot chamber is shown on Fig. 39.

Referring to Fig. 39, on brake release air passes from the brake cylinder to brake pipe through non-return ball valve A: all internal parts are under vacuum.

On brake application, air from the brake pipe enters the chamber B below the diaphragm, but cannot pass non-return ball A. Diaphragm C moves upwards and unseats ball valve D, allowing air to flow from the inshot chamber to the brake cylinder and apply the brake. The air in the inshot chamber E rapidly moves the brake blocks on to the wheels, and the rate of subsequent air admission to the cylinder is fixed by the timing port F in the inshot chamber.

When air pressure above the diaphragm in chamber H equals that in the brake pipe and chamber B, the diaphragm moves back and ball valve D shuts. The freight D. A. valve thus reproduces brake pipe vacuum in the cylinder, with a controlled rate of build-up of brake force, taking 25-30 seconds to give full force in the case of freight vehicles.

A choke G is incorporated near the release ball valve A to slow down the release, thus avoiding run-out shocks if the brake is released with the train running.

The hand-operated release valve J, when pulled open by the release cord, connects the top-side to the brake pipe. It is important that if vehicles require to have their brakes fully released, this must be done before the hose coupling head is put on the dummy coupling. It should be noted that release takes rather longer than for a normal vacuum brake cylinder.

Locomotives working freight trains of A. F. I. - fitted vehicles should also have a corresponding rate of brake build-up.

This system can also be applied to passenger vehicles, in which case the inshot chamber is not required, and a timing port is fixed in the D. A. valve to give a build-up time of 3-5 seconds.

<u>Wagons with Empty/Loaded Braking (Manual Changeover).</u> Fig. 42.

When fitted mineral and high capacity wagons, which have a large load/tare ratio, are required to make stops from high speeds, it has been found necessary, in some cases, to provide braking which gives alternative low or high brake block forces, suitable for braking the wagon under empty and loaded conditions respectively. In the case of some of the 16-ton mineral wagons (Minfits), 21-ton mineral wagons, other high-capacity wagons, and tank wagons, this is done by having two brake cylinders, one of which only is in use when the wagon is empty, while both are in use when the wagon is loaded. The brake gear is so arranged that the cylinders can work in this way, and the brake blocks can also be applied by the hand brake. The brake gear is equalised and compensated. The Empty/Loaded changeover is carried out manually by a cock in the vacuum system, as described in detail later, worked by co-acting handles on each side of the vehicle on the solebar, with the positions marked "Empty" and "Loaded". Fig. 42 shows a 21-ton mineral wagon with this brake arrangement; the 16-ton mineral wagon (Minfits) are closely similar.

A D. A. valve is also fitted on these wagons, with moderating valve in the loaded cylinder hose connections. The purpose of the moderating valve, in this application, is to equalise the action of the D. A. valve between empty and loaded conditions. This moderating valve is in the earlier wagons fitted in the Tee piece for the D. A. valve, and is of the same internal type as in Fig. 11, i. e. it has a ball working horizontally. On later wagons the moderating valve is as shown in Fig. 43(b), working vertically, in the same fitting as the top-side connection to the Empty/Loaded cock, this arrangement gives a quicker hand release of the loaded cylinders.

Some wagons are fitted with moderating valves on both cylinders.

It should be noted that these wagons have two release cords, and that both should be operated when the brakes are released by hand.

On Empty/Loaded braked vehicles with manually operated changeover gear the position of the operating handle is indicated on the body side by a white triangle mark 6" long and 3" wide at the top, with the point downwards just above the position of the handle, ▼. In operating this changeover, care must be taken that both brake cylinders are fully released and the vacuum completely destroyed <u>before</u> the changeover lever is moved from Loaded to Empty.

To cure troubles which have been experienced due to the need for care in this manipulation, a modification, as described below, is being made to the Empty/Loaded gear which enables the changeover handle to be operated at any time without causing trouble, and wagons so treated have the triangle mark with a half-round top, thus :- . Fig. 42 shows a wagon where this modification has been made.

<u>Empty/Loaded Changeover Gear (Manual, 2-cylinder wagons)</u>

Fig. 43 (a), (b) and (c).

1 As originally fitted on 2-cylinder wagons, the changeover was carried out by a simple cock in the pipe to the loaded cylinder, which cuts off the cylinder when Empty braking is required. This arrangement has, however, given some trouble in service if the changeover lever is accidentally worked wrongly after the wagon has been running with loaded braking. If the handle is moved from "Loaded" to "Empty" with vacuum in the loaded cylinder, this cylinder may later creep on and cause dragging brakes. In order to make sure that the loaded cylinder is always equalised and so released when the handle at "Empty", the cock arrangement is being altered so that the connections are as follows :-

"Empty" position	(Top and bottom sides of loaded brake cylinder (connected together. Small atmospheric (opening connected to loaded brake cylinder. (Brake pipe cut off.
"Loaded" position	(Top side of loaded brake cylinder cut off. (Atmospheric opening cut off. Brake pipe and (bottom side of loaded brake cylinder connected (together.

On some wagons the existing cocks have been modified to give this result by taking a top-side connection out through the large end of the plug, leaving the other two connections as before; the atmospheric opening is a small hole drilled in the top of the plug body. For new wagons, the 3-way cock shown in Fig. 43(a) is used, where the top-side connection comes vertically downwards. These new cocks also have the supporting flange with bolts at 45° to the vertical. The alternative pipework layouts are shown on Fig. 43(c).

The top-side connection on a Type E1 loaded brake cylinder (Fig. 43(b)) is a fitting between the cylinder and the release valve, which also incorporates the moderating valve in the bottom side connection as described earlier.

For sliding band cylinders, the top-side connection is taken from a fitting between the release valve and the cylinder case.

Vehicles with this improved changeover are, as stated earlier, fitted with the ∇ sign.

Empty/Loaded Changeover Gear (Automatic) Fig. 44(a) and (b)

Empty/Loaded changeover gear for 2 cylinder wagons, of the type where "Empty" braking is carried out by one brake cylinder and "Loaded" braking by both, can be arranged so that the changeover is operated automatically by the weight of the load of the wagon. The system made by Gresham and Craven, as applied on tank and similar high-capacity 4-wheeled wagons, operates on this principle.

Fig. 44(a) shows the Empty/Loaded 3-way unit, and Fig. 44(b) the leverage system and the brake pipework layout, as applied to a wagon which has also A. F. I. equipment. It will be seen from Fig. 44(b) that the weight of one end of one spring is taken, through the Empty/Loaded weighing lever 27 and vertical link, to the Empty/Loaded Unit 26. Fig. 44(a) shows the unit, where the weight from the bearing spring is taken by a horizontal lever 10 to a balancing spring 8; as the weight on the wheel increases, the balancing spring is deflected, and the end of the lever moves the spindle of the Empty/Loaded valve 2 downwards. Excess movement of the balancing spring and lever is taken up by the over-ride box 7 at the bottom of the valve spindle. Changeover is set to take place at about half load.

The 3-way valve gives the following connections through the appropriate passages in the F. D. A. valve :-

"Empty" position	(Top and bottom sides of loaded brake cylinder (connected together. Brake pipe cut off.
"Loaded" position	(Top side of loaded brake cylinder cut off. (Brake pipe and bottom side of loaded brake (cylinder connected together.

It will thus be seen that in "Empty" the loaded brake cylinder is equalised between top and bottom sides and thus is released. As an additional precaution, a ball valve 12 is incorporated in the Empty/Loaded valve, and on the first full brake application after changeover from loaded to empty, air from the brake pipe lifts the ball valve to destroy and loaded cylinder vacuum.

S. A. B. Brake Wagons. Fig. 45.

A number of wagons have been built with S. A. B. Empty/ Loaded brake equipment, a Swedish design. This S. A. B. (Svenska Aktiebolaget Bromsregulator) brake equipment consists of :-

(a) one brake cylinder, which is large enough to brake the Loaded wagon, and which is always in use.

(b) a mechanical leverage system which has two leverage ratios as required for Empty and Loaded braking. In Empty braking the Empty rod (Fig. 45) acts as the fulcrum; in Loaded braking the Load rod becomes the fulcrum. It should be noted that this arrangement causes the piston strokes to be longer when the wagon is loaded than when it is empty.

(c) a vacuum operated empty/load box, which alters the mechanical leverage (b), and which is worked by the weight on one end of one side bearing spring. At any value above about half wagon load the empty/load box disengages the Empty rod. It should be noted that the wagon requires to have vacuum in the brake pipe before the leverage can alter from Empty to Loaded.

(d) a double-acting S. A. B. brake regulator, which automatically takes up excess slack due to brake block and pin wear, and will let out if the brake block clearance is too small, (as might arise when new blocks are fitted). The regulator also automatically adjusts the brake block clearance to be correct both for empty and loaded brake block heights.

On the wagons fitted with S. A. B. brake gear a D. A. valve has been included to enable them to operate in long trains making stops from high speeds.

This type of brake gear is equalised and compensated.

A number of bolster wagons have also been fitted with S. A. B. Empty/Loaded brake, but with two brake cylinders permanently connected to the brake shaft, and with the empty/load box mechanically worked from a handle similar to that on a Minfit wagon.

It is intended that the S. A. B. components should be changed complete if defective, and repaired only in main works. For a detailed description and working, the firm's literature should be read.

Girling Disc Brake Wagons. Fig. 46.

A number of wagons of different types have been fitted with disc brakes of a design made jointly by B. R. and by Messrs. Girling. The chief features are :-

(a) A horizontal short-stroke diaphragm vacuum brake cylinder (Fig. 19).

(b) An automatic Empty/Loaded changeover worked mechanically by the weight on one end of one side bearing spring. When the wagon is empty, the fulcrum strut is held into an abutment on the fulcrum bracket, and the lever pivots about pin X, giving Empty braking. When the wagon is loaded the weighing mechanism moves the end of the fulcrum strut out of its abutment, and the lever then pivots about pin Y to give Loaded braking.

(c) A Gresham and Craven slack adjuster (take-up only).

(d) A disc brake which operates with a calliper mechanism on both sides of a flat surface formed as part of one wheel on each axle. The opposite wheel only of each pair has the usual holes for sprags.
Some wagons have special cheek pieces bolted to the wheels to form the braking surfaces.

Composition brake pads are used, which can be adjusted to a small clearance when the brake is off. This clearance is fixed in the works. A brake return spring is fitted to ensure full release.

On 16-ton mineral wagons, one brake cylinder, with automatic changeover mechanism and slack adjuster, is mounted at the centre of the wagon underframe and actuates the calliper brake mechanism at both ends of the wagon. On larger 4-wheeled wagons (See Fig. 46) two independent sets of brake gear are installed, one at each end, to operate the brake on one wheel of the adjacent axle.

A D. A. valve has been fitted on the wagons to enable them to operate in long trains which require to make stops from high speeds.

In some wagons the hand brake is separate from the power brake, and uses cast-iron brake blocks of the usual type acting on the tread.

It should be noted that on the larger wagons there are two release cords, one at each end of the wagon, and that both require operating when the brakes are to be released by hand, irrespective of whether the wagon is loaded or empty. Some of these wagons have been altered to have a special release valve with only one cord for the wagon.

SECTION II

(A) EXAMINATIONS AND REPAIRS OF A.V.B. EQUIPMENT

(B) BRAKE BLOCK ADJUSTMENT

(A) EXAMINATIONS AND REPAIRS OF A.V.B. EQUIPMENT

SAFETY PRECAUTIONS

THE ATTENTION OF ALL CONCERNED IS DIRECTED TO THE NECESSITY OF COMPLYING WITH THE REGULATIONS IN THE RULE BOOK AND GENERAL APPENDIX FOR THE PROTECTION OF STAFF WORKING ON CARRIAGES AND WAGONS.

EXAMINATIONS

General

The trouble-free operation of A.V.B. equipment on coaching and freight stock depends on careful examination and maintenance of the equipment. It is essential, therefore, that trains or vehicles be examined on arrival at stations, sidings, etc., and particular attention be directed to the points in the following section.

Every effort should be made to test the brake equipment on vehicles before they are brought into use in order that irregularities in the operation of the equipment or leakages may be located and rectified.

Care must be taken in the examination or adjustment of brakegear to ensure that all parts work freely, all parts are properly secured, and the legs of all split cotters are well opened.

The defects likely to cause delays and trouble en route are:-

(a) leakage in system and piston rod glands.
(b) defective hosepipes and dummy plugs.
(c) defective brake cylinders and release valves.
(d) defective D.A. valves.
(e) missing or broken release cords.
(f) incorrectly adjusted brakegear or worn brake blocks.
(g) brake pins becoming displaced, or cotters missing.

(This list is taken from General Appendix p.14).

Description of Test Apparatus

The standard apparatus for testing vacuum brake equipment consists of :-

(a) Leak discs, for testing the efficiency of the vacuum exhausters or ejectors on the locomotive (Fig. 47). These are circular discs with a leak hole in the centre, and are fixed on a brake pipe coupling head.

(b) Vacuum test cock (Fig. 48), which is used for isolating portions of the train and recording the vacuum. These cocks have a standard hose coupling at each end, and can be used at the end of a train, between vehicles, or in connection with a leak disc.

For a description of tests using these pieces of equipment see the appropriate General Appendix instructions.

Brake Pipe and Brake Cylinder

In the examination of vehicles standing with the Automatic Vacuum Brake in use, attention should be given to the air-tightness of the equipment and any tendency to "leak-off" noted. Particular attention should be paid to piston rod glands and D. A. valves.

When opportunity permits, brake piston rods which are not protected by flexible sleeves should be cleaned with dry spun yarn. No abrasive cleaning compound or oil is to be used on the spun yarn. Defective sleeves should be changed.

The pipe system should be examined for such defects as leaking or worn hoses, defective or damaged couplings or dummy plugs, and defective joint washers. The clips securing flexible hoses to coupling heads and brake pipes should be examined.

Release valves showing any sign of leakage should be noted and attention given. In the case of the sliding band type of release valve (Fig. 12) it is only necessary to change the washer when the valves are leaking, and not the complete valve. Missing or defective cords or wires should be replaced or repaired. When new release cords are fitted they should be of sufficient length to ensure that subsequent shrinkage (up to about 7%) will not release the brake.

If a brake cylinder with a moderating valve works sluggishly the moderating valve should be examined for blockage, and cleaned or replaced if necessary. No grease should be allowed in the moderating valve.

The piston strokes should be observed and brakegear adjusted if necessary. Brake blocks should be examined for wear.

Passenger Communication Apparatus

At laid-down intervals the passenger communication system must be operated from the compartment or coach-end farthest from the discs to ensure that the apparatus works freely, and all parts must be left in a clean condition and in good working order. Any worn, hardened, or otherwise defective valve seating washers must be changed and defective chains renewed. The maximum pull on the chain to operate the apparatus should not exceed 25 lbs. on vehicles in service.

Guard's Brake Application Valve

Guard's brake application valves must be tried to ensure that they operate freely and that the valve seating washer is in good condition.

Vacuum Gauges

Vacuum gauges must be examined for defects such as loose connections, bent needles, broken glass or defaced dials, and when tested under vacuum, care must be taken to see they are registering correctly when compared with the reading of the test cock gauge (Fig. 48).

Diesel Mechanical Multiple Unit Trains

See the special instructions for the quick-release vacuum brake, giving service examinations, maintenance and testing, and possible brake defects and remedies.

Adverse Weather Conditions - Frost

Whenever severe frost is expected, steps must be taken as required to prevent the brake blocks of vehicles stabled in exposed positions from becoming frozen to the wheels. Care must be taken to see that brakes are fully released as far as practicable, and scotches should be used where necessary to keep the vehicles properly secured and unable to move accidentally.

REPAIRS

General. (This section is taken from General Appendix p. 10).

In cases of failure of the brake, provided the defect is not in the train pipe, the defective cylinder or cylinders should, where practicable, be put out of action and the brake will then be effective on the remainder of the train.

If the defect is in the train pipe, or in the absence of facilities for putting the cylinder or cylinders out of action, the hose pipe at the leading end of the defective vehicle must be disconnected and the hose pipe at the rear end of the vehicle next in front placed on the dummy coupling. The brake on the front vehicles can then be worked as usual. The brake on the defective vehicle, and on vehicles in rear of it, must be released, care being taken to ensure that at least one hose is removed from the dummy coupling before this operation is carried out, and the train worked forward under the control of the handbrake, with the assistance the Driver can give with the vacuum brake on the vehicles still connected to the locomotive, to the next station where the defective vehicle can be detached conveniently or the defect remedied.

If the Driver is, from any cause, unable to work the vacuum brake, the hose pipes between the locomotive and the train must be disconnected and the brake then released throughout the train, care being taken to ensure that at least one hose is removed from its dummy coupling before this operation is carried out. The train should then be worked by hand brakes only, the speed being so regulated as to enable the Driver to have full control of the train by the hand brakes. A guard must travel in the rearmost brake van on the train, be on the alert, and assist in stopping the train with the hand brake.

NOTE:- Whenever any action is taken temporarily to isolate or render ineffective any part of the vacuum brake equipment of a vehicle a "For Repair (Defective Brake)" card must be attached to each side of the vehicle concerned, at the nearest examination point, and a comprehensive repair must be made at the earliest opportunity.

Whenever a cylinder is rendered inoperative by any means, the Carriage and Wagon Examiner must advise the Driver and Guard of the train.

Brake Cylinders

Should a brake cylinder be found defective, the cylinder should first be released by pulling the release valve cord and holding it until all vacuum in the cylinder has been destroyed. If the defect cannot be located precisely, or is known to be in the branch pipe or release valve, the flexible branch pipe to the brake pipe or the D. A. valve should be disconnected from the brake cylinder, or cut, and the pipe plugged on the brake pipe side with the special plug provided for the purpose. If the defect is known to be in the cylinder itself, the nuts securing the release valve or tail piece to the cylinder should be released and an india-rubber blank joint washer inserted, after which the nuts should be re-tightened. In the case of sliding band cylinders, leather blank washers may be inserted at the brake pipe or D. A. valve end of the flexible branch pipe. For leaking release valves on sliding band cylinders, see p.30.

The D. A. valve should not be blanked off (as given below) to remedy a leak on a brake cylinder, as air can still pass from the cylinder to the brake pipe.

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Where a brake piston sticks in the cylinder it is not desirable to uncouple the piston rod, and the action outlined above will generally suffice. Should the piston be held fast with the brake hard on, however, so that it cannot be moved towards the "off" position, the piston rod must be disconnected from the rocking shaft by removing the connection pin. When such action is taken, the cylinder must be prevented from turning over by securing it suitably through the piston rod pin-hole. The long arm of the brake shaft must also be secured so that it cannot fall downward and foul the permanent way. Soft iron wire must be used in every case for securing the cylinder and brake shaft arm. Steps must also be taken to see that the brake blocks affected are left clear of the wheels, and that the wheels have not sustained any damage through prolonged braking or skidding.

Flexible Hoses

Defective flexible hoses, whatever the defect, should be replaced, and care must be taken in fitting the replacement hose to see that the clip is in contact with the hose throughout its circumference and the tongue is not in any way distorted. Pins and chains, where fitted, must be in good condition. Care should be taken to ensure that the coupling head is in the correct position to couple to that of another vehicle.

Direct Admission (D. A.) Valves

If a D. A. valve sticks in the open position, first release the brake cylinder fully. Then take out the split pin holding the D. A. valve cover wing nut and remove the wing nut, cap, and air filter gauze; place a piece of card (a repair card can be used) slightly smeared with oil on the top of the valve; place the cap washer upside down next to the card on the stud, and replace the parts as shown on Fig. 20, sketch marked "Defective Valve , Air inlet blanked off". The brake cylinder is then out of action.

If time will allow for further work, the lower valve cage can be unscrewed, valve B removed, and the cage replaced. The brake cylinder will then act normally as on a non-D. A. vehicle.

If a valve sticks in the closed position, the non-return valve can be removed as described in the last paragraph above.

Ex G. W. R. D. A. Valves

If an ex G. W. R. D. A. valve sticks in the open position, first release the brake cylinder fully; the shield on the D. A. valve top should then be removed, a $\frac{3}{4}$" cork inserted in the hole, and the shield replaced. The cylinder is then out of action.

If time will allow for further work, the flexible pipe to the brake cylinder can be disconnected, the valve cage unscrewed, the non-return valve removed, and the cage and flexible pipe replaced. The brake cylinder will then act normally as on a non-D. A. vehicle.

If a valve sticks in the closed position, the non-return valve can be removed as described in the last paragraph above.

Quick Service Application (Q. S. A.) Valves

In the event of a defect arising in a Q. S. A. valve which permits air to leak through the filter into the brake system, the inlet port from the filter to the valve may be plugged up, when the cylinder will operate in the normal manner by air from the brake pipe. If practicable the Q. S. A. valve can be removed and replaced by a release valve (Type E1 cylinders) or combined ball and release valve (Type C cylinders).

A. F. I. System

If an accelerator valve sticks in the open position, loosen the three nuts holding the valve down on the companion flange (Fig. 40, Item 4), insert a thin tinplate or fibre disc about 3" dia. to act as a blank, and re-tighten the nuts. The accelerator valve will then be out of action, but the Freight D. A. valve and cylinder will work normally.

If a Freight D. A. valve sticks in the open position, the failure should be treated in the same way as for a defective brake cylinder release valve, i.e. the cylinder should first be released fully, and the flexible branch pipe between brake pipe and F. D. A. valve (Fig. 38, Item 5), disconnected from the brake cylinder, or cut, and the brake pipe side plugged. The brake cylinder will then be out of action.

Disc Brake Wagons

If the brakes stick on, first release the cylinders fully by pulling the release cords. The brakes can be released manually by pulling out the slack adjuster pin and then screwing the body of the adjuster anti-clockwise as seen from the end nearer the braked wheel. The slack adjuster pin must be replaced after this has been done and the cylinder made inoperative by inserting a blanking-off washer at the release valve. Under no circumstances must any attempt be made to release the brake by levering the brake arms, as this may cause serious damage.

B) BRAKE BLOCK ADJUSTMENT

General

The efficiency of brake gear is dependent upon its being adjusted as closely as possible.

Any brake blocks which have worn down to scrapping size must be replaced without delay, and adjustment made as described.

Steps must be taken to prevent vehicles moving in either direction when the brake has been released for brake block adjustment or other repairs.

B.R. Standard Bogie (and similar type bogies). Fig. 28.

Adjustment of the brakework is necessary when with the brake "on", the arm of the brakeshaft (2) is above the horizontal position, which occurs when the reserve stroke of the piston is less than about 4". On B.R. vehicles fitted with handbrake in the Guard's compartment, adjustment of the brake blocks should be made when the number of turns of the brake wheel required to apply the brake exceeds 12.

Before proceeding with the adjustment of brake blocks the automatic vacuum brake cylinder (1) must be released by means of the release valve cord, care being taken to see that the piston is in its lowest position and the equalising lever (5) back against its stop (8) in a vertical position; the hand brake, where fitted, should be released to the "off" position. The vehicle must be standing on straight track.

The brake blocks (7) should be adjusted by the following procedure :-

Remove adjusting pin (6) from adjusting rod (3) and pull the brake levers together until the blocks make contact with the tyres on the pair of wheels concerned. The adjusting rod should then be released approximately ½", and the pin inserted in the nearest matching hole, special care being taken to see that the cotter is fully opened. This process should then be repeated with the brakegear on the other pair of wheels.

Adjustment for reduction in diameter of wheels by turning should be made at the three hole end of the adjusting rod (3) in order to maintain the full use of the 13 hole adjustment at the opposite end.

B.R. B.4 and B.5 Bogies. Figs. 29 and 30.

Earlier B.4 bogie. Fig. 29.

Adjustment is made when the long arm of the brake shaft is above the horizontal position, which occurs when the reserve stroke of the piston is less than about 4".

The vehicle must be standing on straight track, with the vacuum in the cylinder released and the piston in its lowest position.

Remove pins for 9-hole adjustment jaws(19)pull jaws individually till free lever brake block is against wheel, then move fixed lever till its brake block is ¼" clear of wheel, and replace pin in 9-hole jaw to nearest hole.

If insufficient adjustment holes remain in the 9-hole jaw, the adjustable pull rod 18 must be released at the free lever end and moved to the other hole.

With correct adjustment the upper 1" dia. pins in the secondary equalising links 8 will be vertically above the lower 1" dia. pins, and the equalising beam 6 will be parallel with the axle.

Later B. 4 and B. 5 bogie. Fig. 30.

These bogies are always fitted with a brake regulator, consequently manual adjustment is not necessary, and no brake block wear adjustment holes are provided in the brake rigging.

Ex G. W. R. and earlier B. R. Bogie. Fig. 31.

Adjustment of the brakework is necessary when with the brake "on" the long arm of the brake shaft (2) is above the horizontal position; this occurs when the reserve stroke on the piston is less than about 4". On vehicles fitted with handbrakes in the Guard's compartment, adjustment of the brake blocks should be made when the number of turns of the brake wheel required to apply the brake exceeds 12 turns for B. R. stock, or 5 turns for W. R. stock. The vehicle must be standing on straight track.

Before proceeding with the adjustment of brake blocks, the brake cylinder (1) must be released by means of the release valve cord, care being taken to see that the piston is in its lowest position; the handbrake, where fitted, should be released to the "off" position.

The brake blocks (7) should then be adjusted by the following procedure :-

Remove brake pin in 13 hole joint (position 'A' on the diagram) and pull the adjusting pull rod (3) by hand until the blocks make contact with the tyres on all wheels, notice being taken of the particular hole in the 13 hole end of the pull rod which corresponds to the hole in the brake shaft lever (2).

The brake pull rod should then be released "half" a hole, i.e. the next hole in the top or bottom row in the direction of the brake shaft lever (2), according to whether, with the blocks contacting the tyres, the matching hole is in the bottom or top row. The brake pin is then inserted and cottered up, special care being taken to see that the cotter is fully opened.

The pull rod support spring (10) should be adjusted so that it is approximately in the position shown in the diagram when the brake is in the "off" position, so that it will always tend to pull the brake "off".

When new brake blocks are required, the whole of the blocks on one bogie must be changed at the same time; this is most important.

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Adjustment for reduction in diameter of wheels is made when the wheel tyre diameter becomes sufficiently reduced by re-turning for the original travel of the 13 holes in the pull rod to become exhausted before the brake blocks (7) have been worn out. Further adjustments must be made between the brake beams (6) and the fulcrum levers (4) at points 'B' shown on the diagram. To make this adjustment the four brake beams require to be disconnected from the two fulcrum levers and use made of the second hole in the joint ends of the four brake beams.

The final adjustment should then be made on the pull rod (3), in accordance with the procedure previously described.

Ex L.N.E.R. Bogie (and similar type bogies). Fig. 32.

Adjustment of the brakework is necessary when with the brake "on" the long arm of the brake shaft (2) is above the horizontal position; this occurs when the reserve stroke of the piston is less than about 4".

Before the clearance between brake blocks and wheels can be checked, the brake must be fully released, i.e. the brake piston must be in its lowest position, and where equalising links on the bogie are fitted, these should be against the stops. The vehicle should be on straight track.

The brake block adjustment on four-wheeled bogies should allow free movement of one $\frac{1}{2}$" gauge (Fig. 49) between the brake blocks and the wheels. (NB. One gauge only is used). For these vehicles having the long and short arm type of brake beam, the $\frac{1}{2}$" gauge should be inserted on the "long" arm side, i.e. the right hand side of the wheels as shown on Fig. 32.

The adjustment of the brake blocks on a six-wheeled bogie requires the use of two gauges, which must be inserted between the brake blocks and the tyres of two wheels on the same side of the bogie.

Ex S.R. Bogie. Fig. 33.

Adjustment is governed by the piston strokes of the brake cylinders. All cylinders up to and including 21" diameter should work within a piston stroke of 3" minimum and $5\frac{1}{2}$" maximum, and all cylinders of 22" and 24" diameter should work within piston strokes of $4\frac{1}{4}$" minimum and $6\frac{1}{2}$" maximum.

The adjustment is made on the screwed bogie adjusting pull rods (3), till the correct piston strokes are obtained. No clearance gauges are used between the block and the wheel. A clearance of about 3/16" on each block is obtained. The reason for making adjustments on pull rods (3) is so that the original angles of the fulcrum levers can be maintained irrespective of block wear.

The long pull rods from the brake cylinder are fitted with three adjusting holes and these are only used in cases of emergency.

Diesel Mechanical Multiple Unit Trains.

Power Bogie. Fig. 36.

The brake gear design of the power bogies varies to some extent on the various designs, but the usual arrangement employs a brake cylinder on the outer end of the bogie, connected to the blocks by a system of levers which avoids the final drive. The method of adjustment is as follows :-

Adjustment of the brake work is required if the stroke is more than $4\frac{1}{2}$ ins. - 5 ins.

Before adjustment the cylinder must be fully released and the piston in its lowest position; the handbrake must be off. The brake is then adjusted by the following procedure (see Fig. 36) :-

Loosen lock nuts 27, and make adjustment by adjusting nuts 28 till the clearance between wheel and each brake block is 1/8".

Trailer Bogie

For trailer bogies, which have the same type of brake gear as the B.R. standard bogie, the method of adjustment is as for that bogie, see p. 35.

Freight Stock

There are numerous types of brake gear on four-wheeled freight stock and the methods of adjustment are as follows; in each case the brake block clearance after adjustment should be about 1/8", except for disc brake wagons.

(a) Clasp brake. Adjustment is made on the brake beams of each axle. See Fig. 37 (c) and (d).

(b) Fitted mineral wagons with clasp brakes. The adjustment is made in the main pull rod to compensate for block wear, and at the upper ends of the outer vertical links to compensate for wheel wear.

(c) S. A. B. wagons. Normally no adjustment for block or wheel wear will be required, as the brake regulator carries this out automatically. After brake block renewal the brake regulator will adjust the clearance in one or two brake applications.

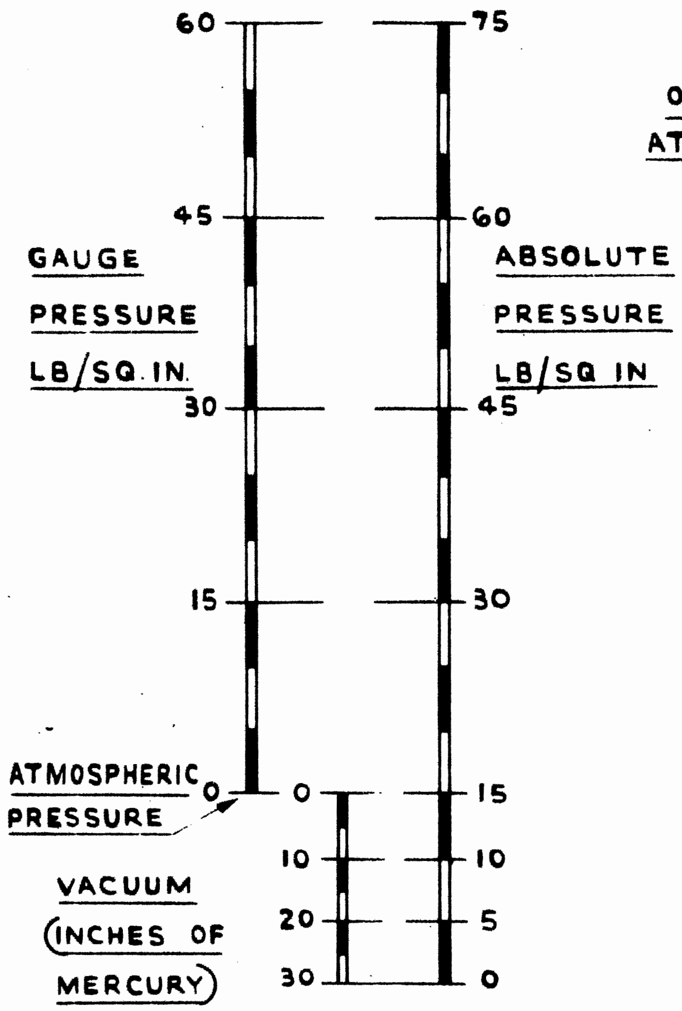
(d) Girling disc brakes. See book of Maintenance Instructions.

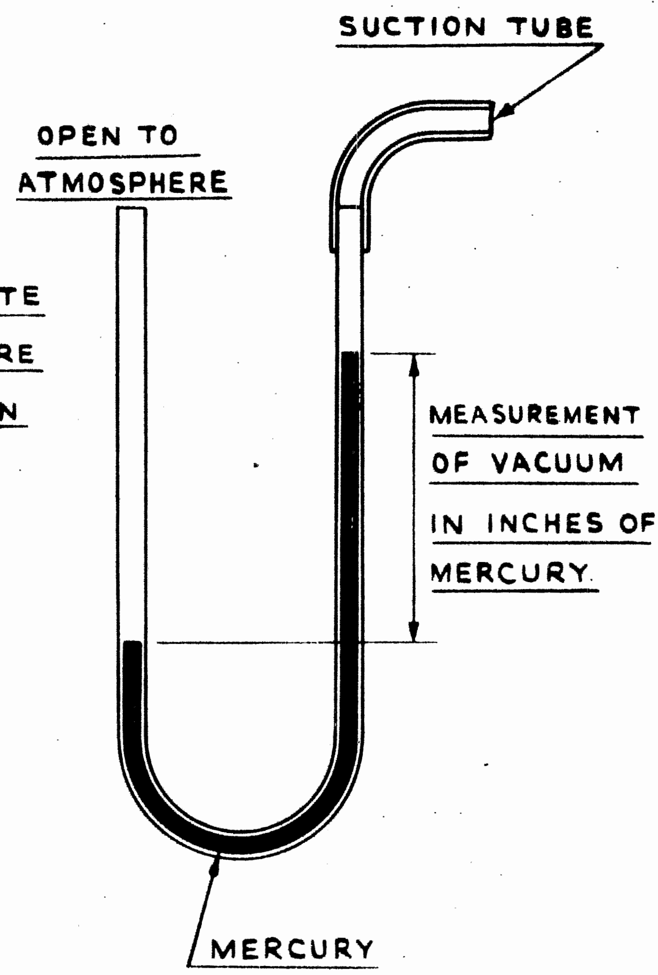
(e) Push rod brakes (4 brake blocks per vehicle). The adjustment is made on each push rod.

2.

Hand Brakes

Hand brakes must be examined and tried as vehicles come to hand in carriage depots or freight sidings, to ensure that the brake is properly workable. If found to be in need of adjustment, this must be carried out before the vehicle is allowed in traffic. In the case of wagons the hand brake lever should not travel more than a third to a half of the way down the rack before the brake starts to apply, except for loaded S. A. B. wagons.





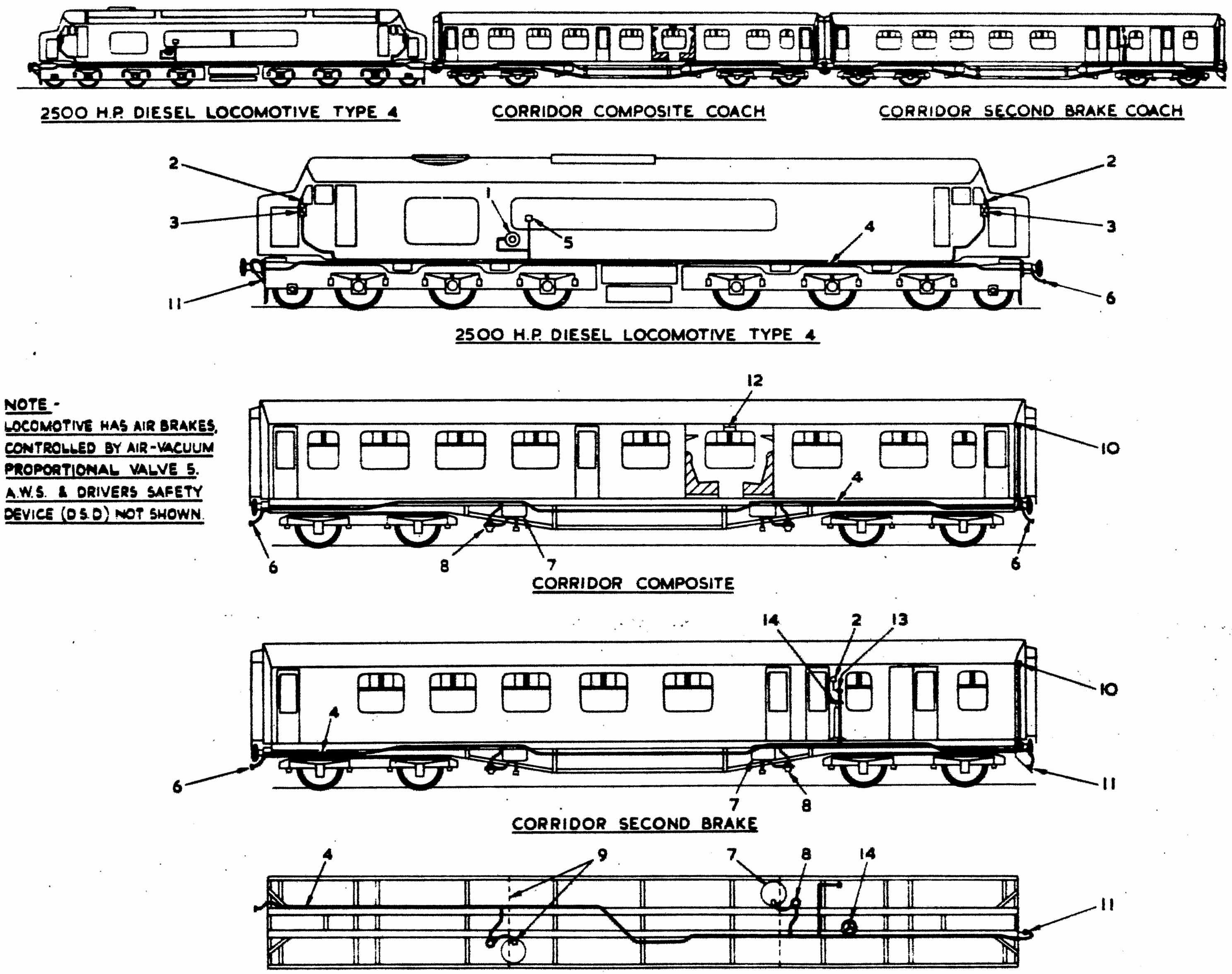
PRESSURE & VACUUM SCALES

FIG. 1 (a)

U TUBE.

FIG. 1 (b)

FIG. 1 (a & b).

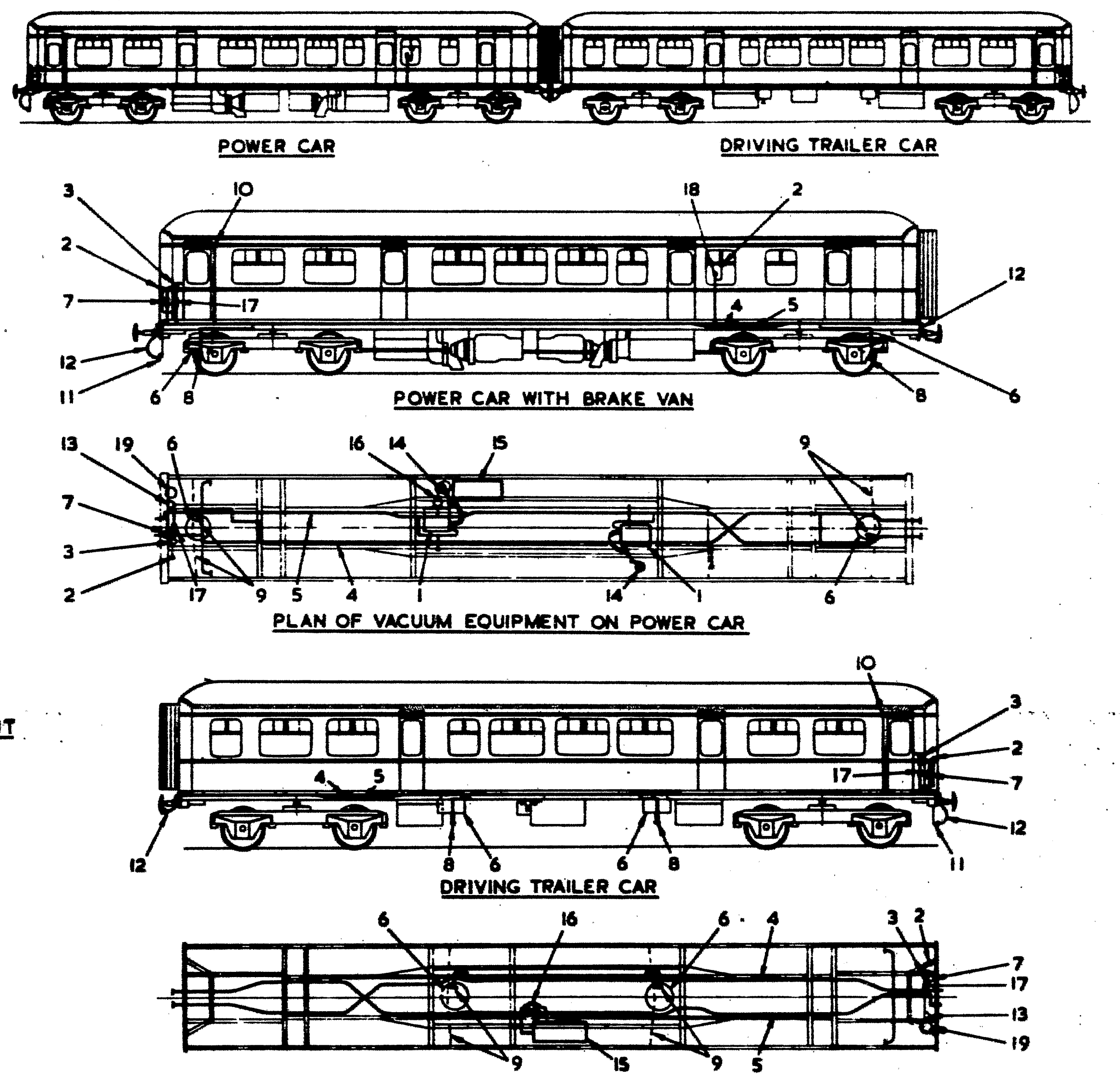


DESCRIPTION

1 EXHAUSTER 2 VACUUM GAUGES 3 DRIVER'S VACUUM BRAKE VALVE 4 BRAKE PIPE 5 AIR-VACUUM PROPORTIONAL VALVE
6 VACUUM HOSE COUPLING 7 BRAKE CYLINDER 8 DA VALVE 9 RELEASE VALVE & CORD 10 PASSENGER COMMUNICATION VALVE
11 DUMMY COUPLING 12 COMMUNICATION CHAIN 13 GUARD'S APPLICATION BRAKE VALVE 14 GUARD'S HANDBRAKE

GENERAL ARRANGEMENT OF VACUUM BRAKE, DIESEL LOCOMOTIVE & PASSENGER TRAIN

FIG. 2

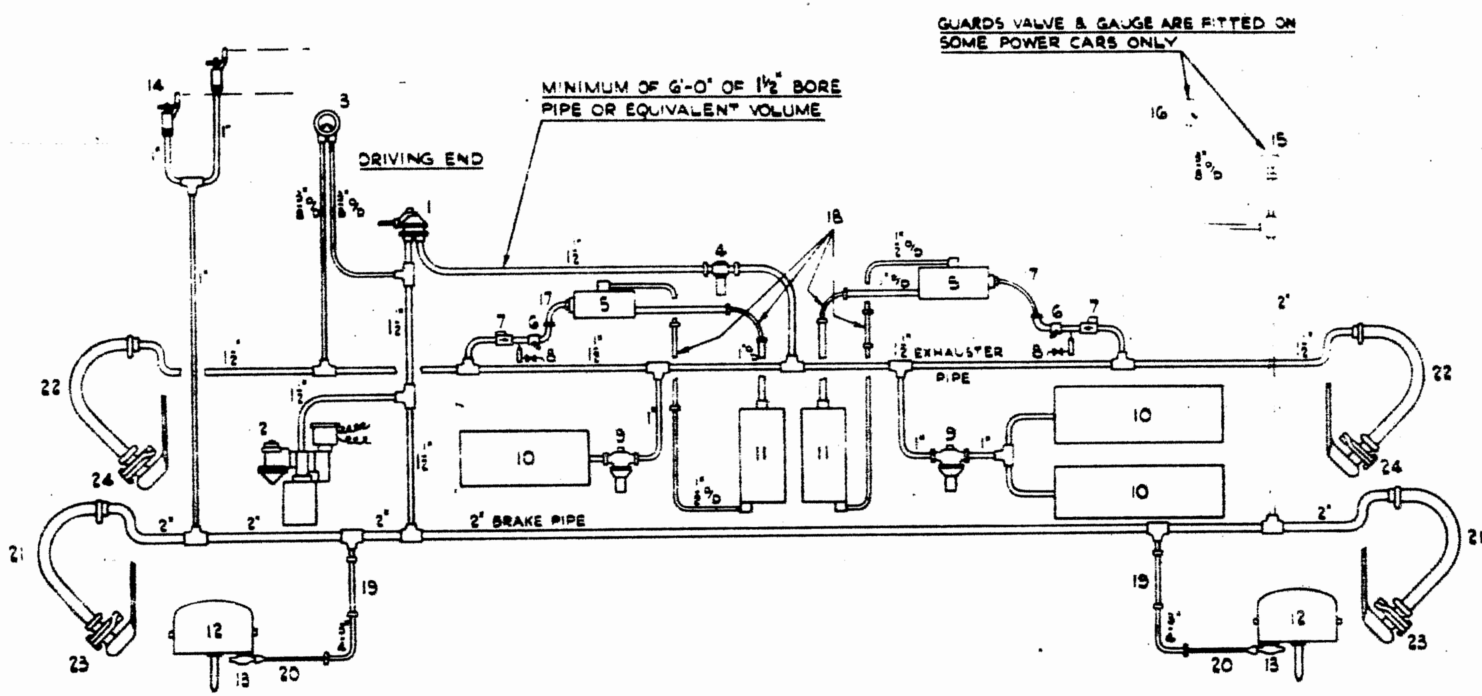


NOTE.
A.W.S EQUIPMENT
NOT SHOWN

DESCRIPTION -
1. EXHAUSTER 2 VACUUM GAUGES 3. DRIVER'S BRAKE VALVE 4 BRAKE PIPE 5 EXHAUSTER PIPE
6. BRAKE CYLINDER 7. AUTOMATIC FEED VALVE 8 PISTON ROD 9. RELEASE VALVE & CORD
10. PASSENGER COMMUNICATION VALVE 11. DUMMY COUPLING 12. VACUUM HOSE COUPLING 13 EMERGENCY BRAKE VALVE
14 OIL SEPARATOR 15. RELEASE RESERVOIR 16. ISOLATING VALVE 17. DRIVER'S SAFETY DEVICE (DSD) &
EMERGENCY BRAKE VALVE 18 GUARD'S VALVE 19. HANDBRAKE

GENERAL ARRANGEMENT OF VACUUM BRAKE,
DIESEL-MECHANICAL MULTIPLE UNIT TRAIN.

FIG. 3



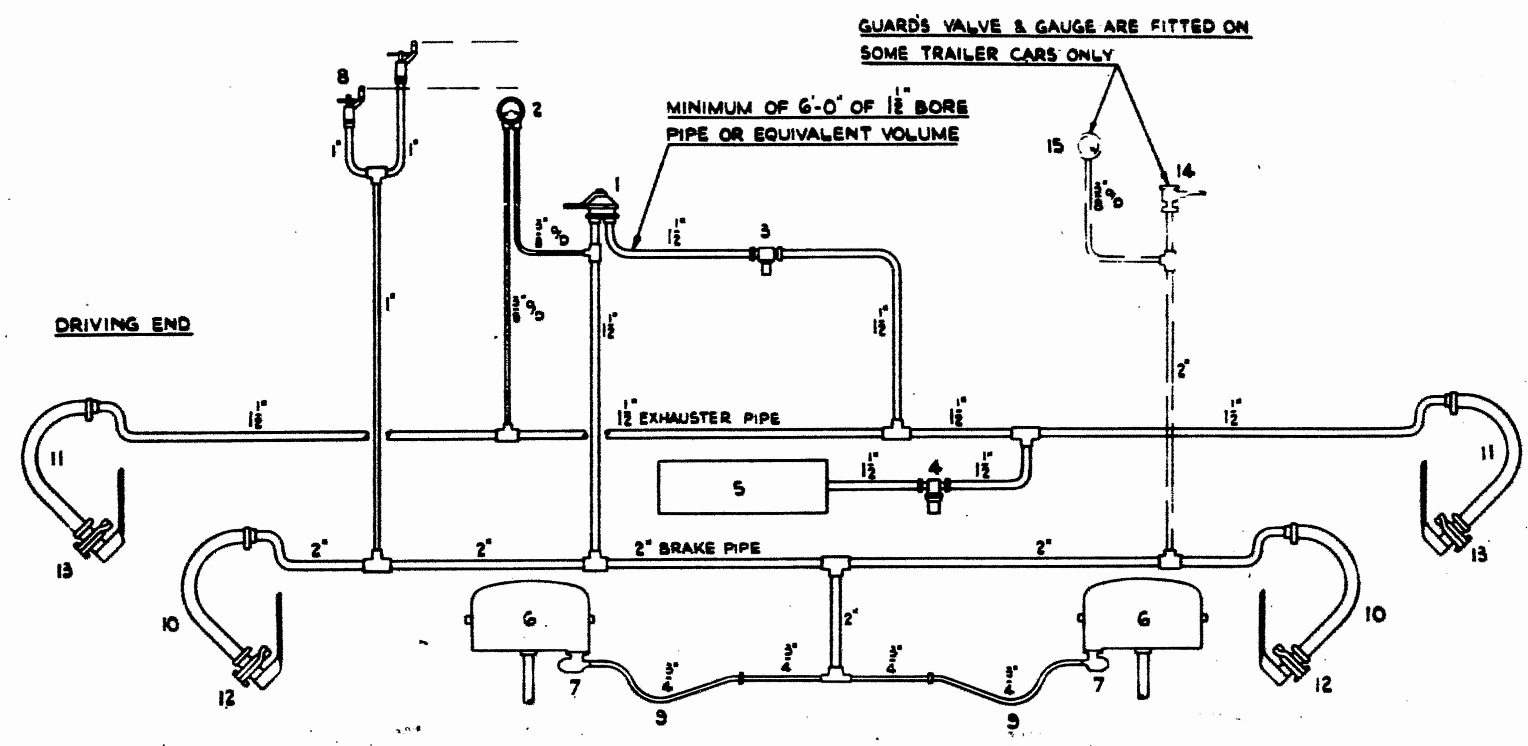
DESCRIPTION

1. 1½" DRIVER'S BRAKE VALVE
2. COMBINED DRIVER'S SAFETY DEVICE (D.S.D) AND EMERGENCY VALVE
3. 4" DUPLEX GAUGE
4. 1½" FEED VALVE
5. CLAYTON DEWANDRE EXHAUSTER, TYPE C.725
6. FILTER
7. 1½" NON - RETURN VALVE
8. OIL SUMP AND DRAIN
9. 1" AUTOMATIC ISOLATING VALVE
10. RELEASE RESERVOIR
11. OIL SEPARATOR
12. BRAKE CYLINDER
13. RELEASE VALVE
14. PASSENGER COMMUNICATION VALVE WITH OPERATING LEVER
15. GUARD'S VALVE
16. 6" SINGLE GAUGE (GUARD'S VAN)
17. 1" x 20½" HOSE
18. 1/2" HOSE AND CLIPS
19. ¾" HOSE (UNDERFRAME TO BOGIE)
20. HOSE AND CLIPS FOR BRAKE CYLINDER
21. 2" VACUUM HOSE COUPLING AND COUPLING HOSE FOR BRAKE PIPE
22. 2" VACUUM HOSE COUPLING AND COUPLING HOSE FOR EXHAUSTER PIPE (L.H COUPLING)
23. DUMMY AND CARRIER FOR BRAKE PIPE
24. DUMMY AND CARRIER FOR EXHAUSTER PIPE

NOTE A.W.S. EQUIPMENT NOT SHOWN

BRAKE PIPEWORK LAYOUT, POWER CAR,
DIESEL-MECHANICAL MULTIPLE UNIT TRAIN

FIG. 4



DESCRIPTION

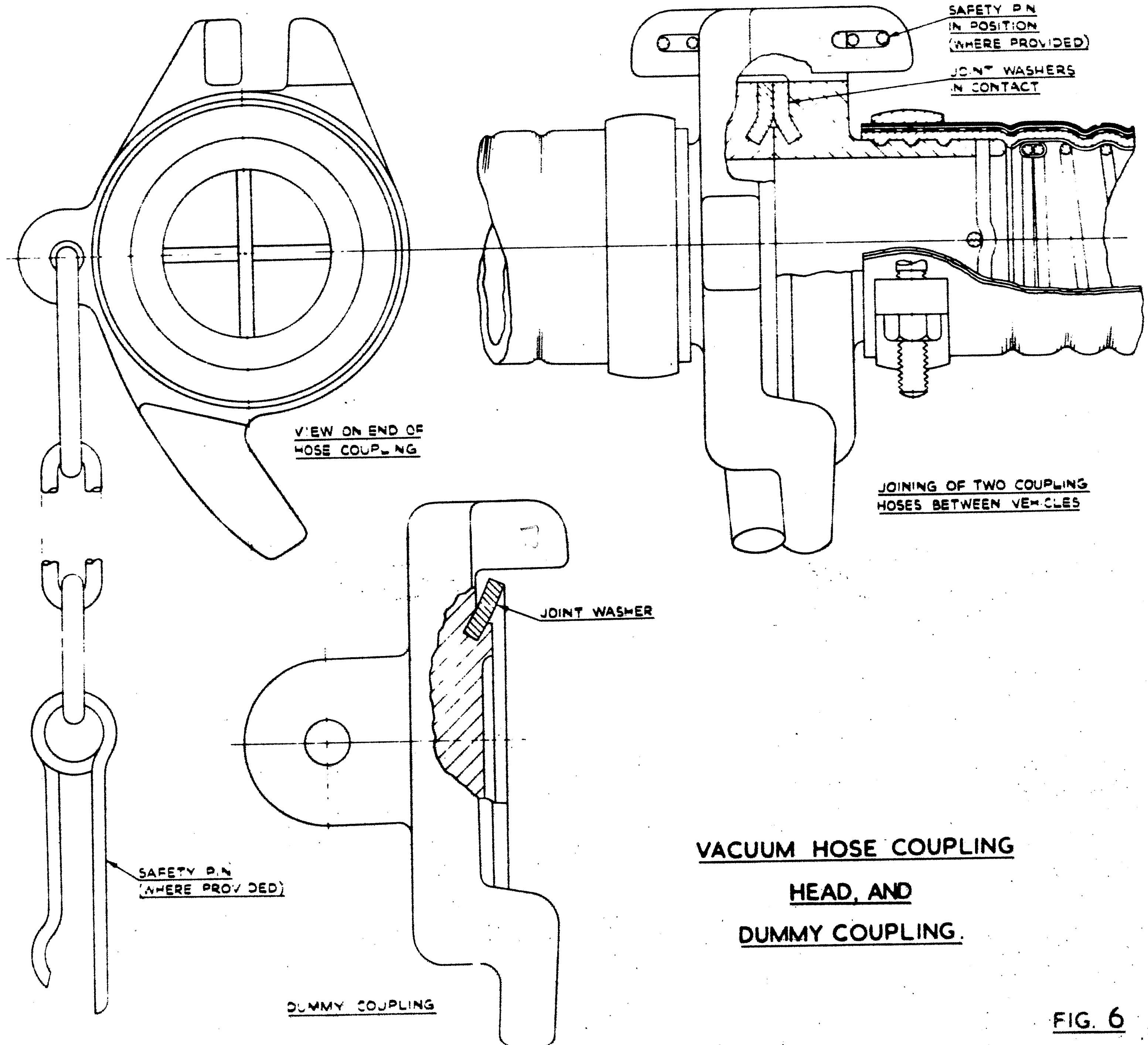
1. 1½" DRIVER'S BRAKE VALVE
2. 4" DUPLEX GAUGE
3. 1½" FEED VALVE
4. 1½" AUTOMATIC ISOLATING VALVE
5. RELEASE RESERVOIR
6. BRAKE CYLINDER
7. RELEASE VALVE
8. PASSENGER COMMUNICATION VALVE WITH OPERATING LEVER
9. HOSE AND CLIPS FOR BRAKE CYLINDER
10. 2" VACUUM HOSE COUPLING AND COUPLING HOSE FOR BRAKE PIPE
11. 2" VACUUM HOSE COUPLING AND COUPLING HOSE FOR EXHAUSTER PIPE (L.H. COUPLING)
12. DUMMY AND CARRIER FOR BRAKE PIPE
13. DUMMY AND CARRIER FOR EXHAUSTER PIPE
14. GUARD'S VALVE
15. 6" SINGLE GAUGE (GUARD'S VAN)

NOTES. a. A.W.S. EQUIPMENT NOT SHOWN

b. ITEMS 1, 2 AND 3 ARE NOT FITTED ON TRAILER CARS WHICH DO NOT HAVE A DRIVING CAB

BRAKE PIPEWORK LAYOUT, TRAILER CAR, DIESEL-MECHANICAL MULTIPLE UNIT TRAIN

FIG. 5

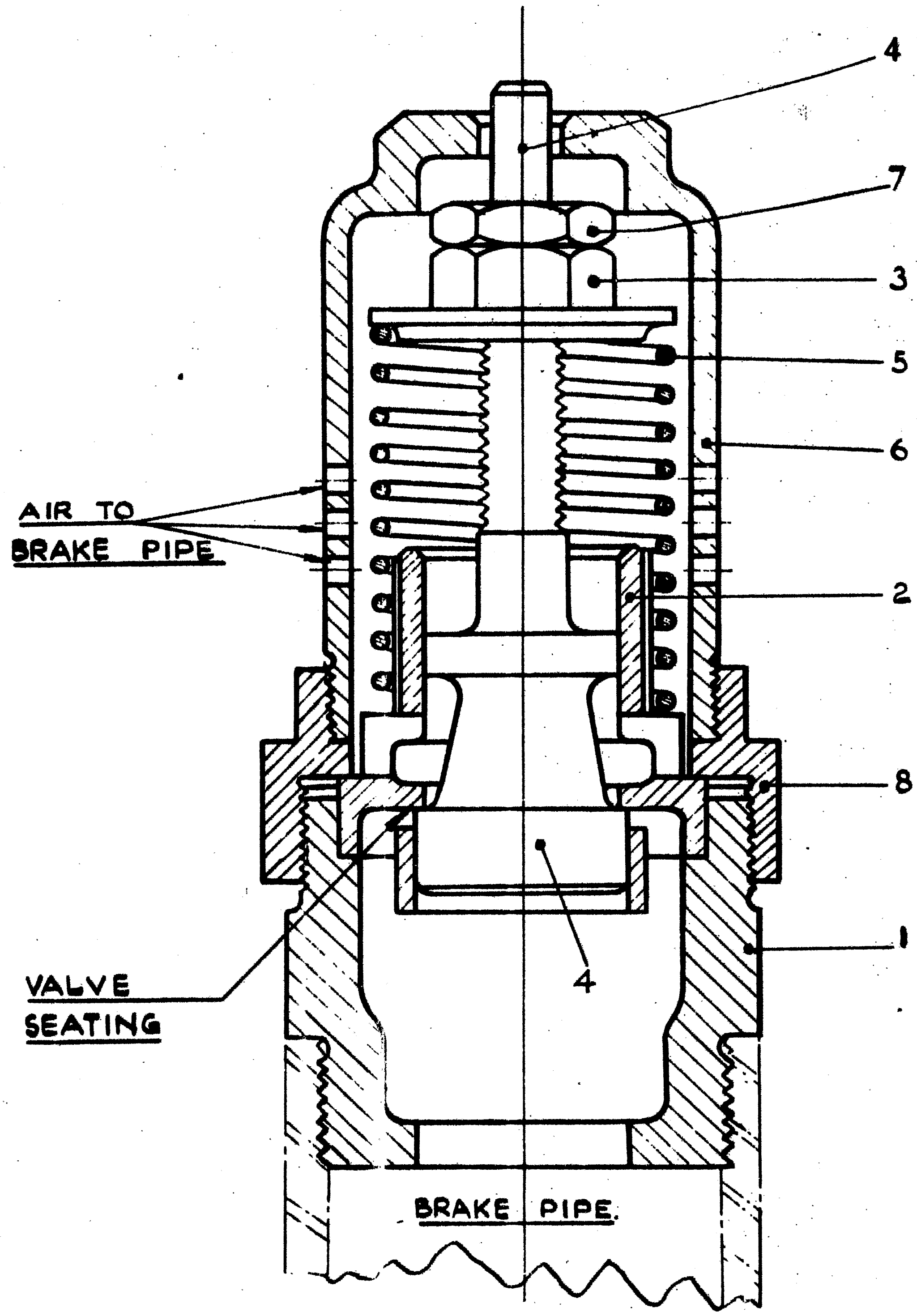


VACUUM HOSE COUPLING

HEAD, AND

DUMMY COUPLING.

FIG. 6

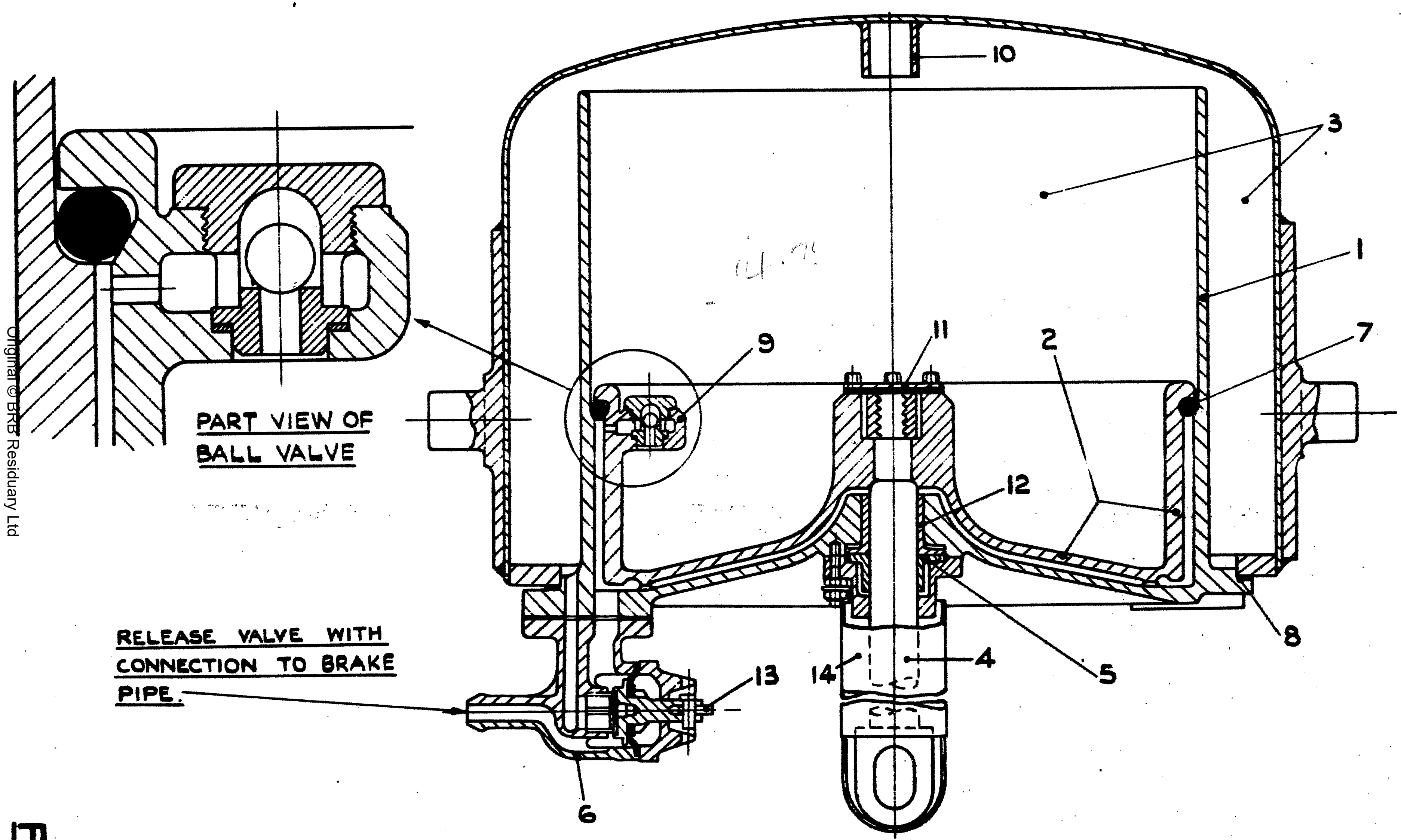


DESCRIPTION.

1. ADAPTOR.
2. SLEEVE.
3. ADJUSTING NUT.
4. VALVE.
5. SPRING.
6. CAP.
7. LOCK NUT.
8. ADAPTOR CONNECTION.

VACUUM LIMIT VALVE

FIG.7



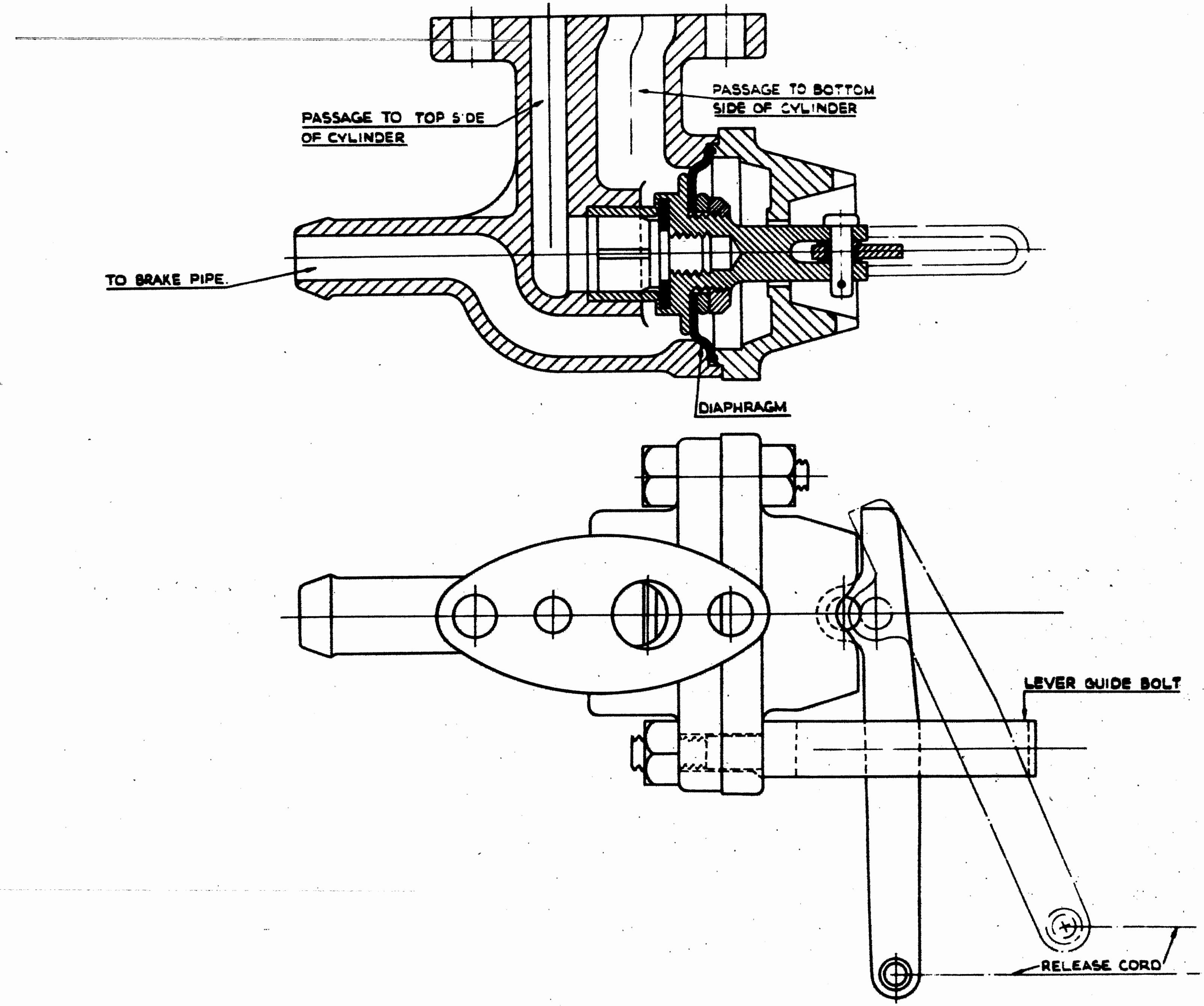
DESCRIPTION OF PARTS

1. VACUUM CYLINDER
2. PISTON HEAD
3. TOP SIDE SPACE
4. PISTON ROD
5. PISTON ROD GLAND & PACKING
6. RELEASE VALVE
7. ROLLING RING
8. SEALING RING
9. BALL VALVE
10. STOP FOR PISTON
11. PISTON ROD CAP
12. PISTON ROD GUIDE BUSH
13. RELEASE VALVE LEVER
14. PISTON ROD SLEEVE

TYPE 'E1' BRAKE CYLINDER

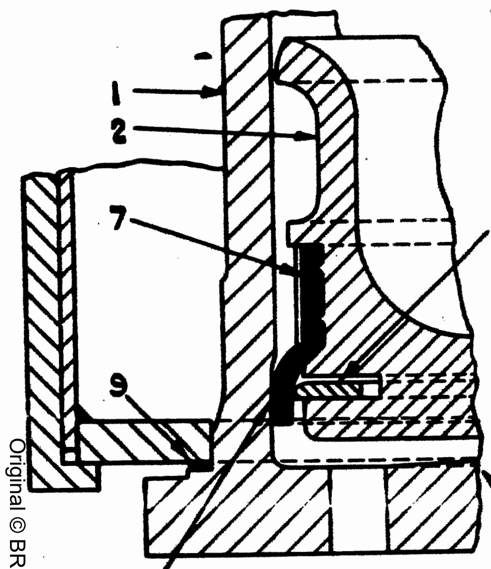
FIG. 8

FIG. 8



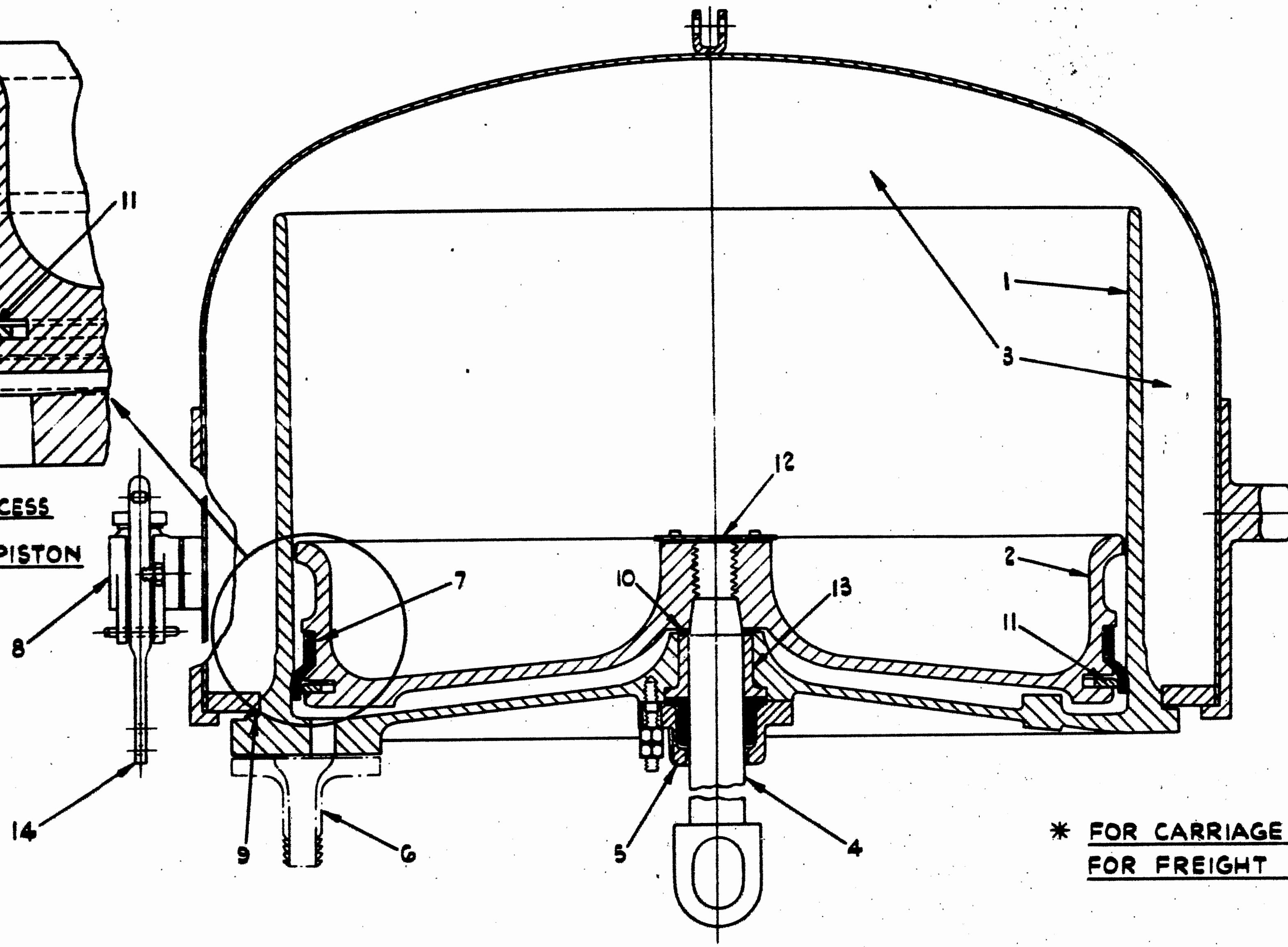
RELEASE VALVE FOR TYPE 'E1' BRAKE CYLINDER.

FIG. 9.



ANNULAR RECESS

PART VIEW OF PISTON



DESCRIPTION OF PARTS

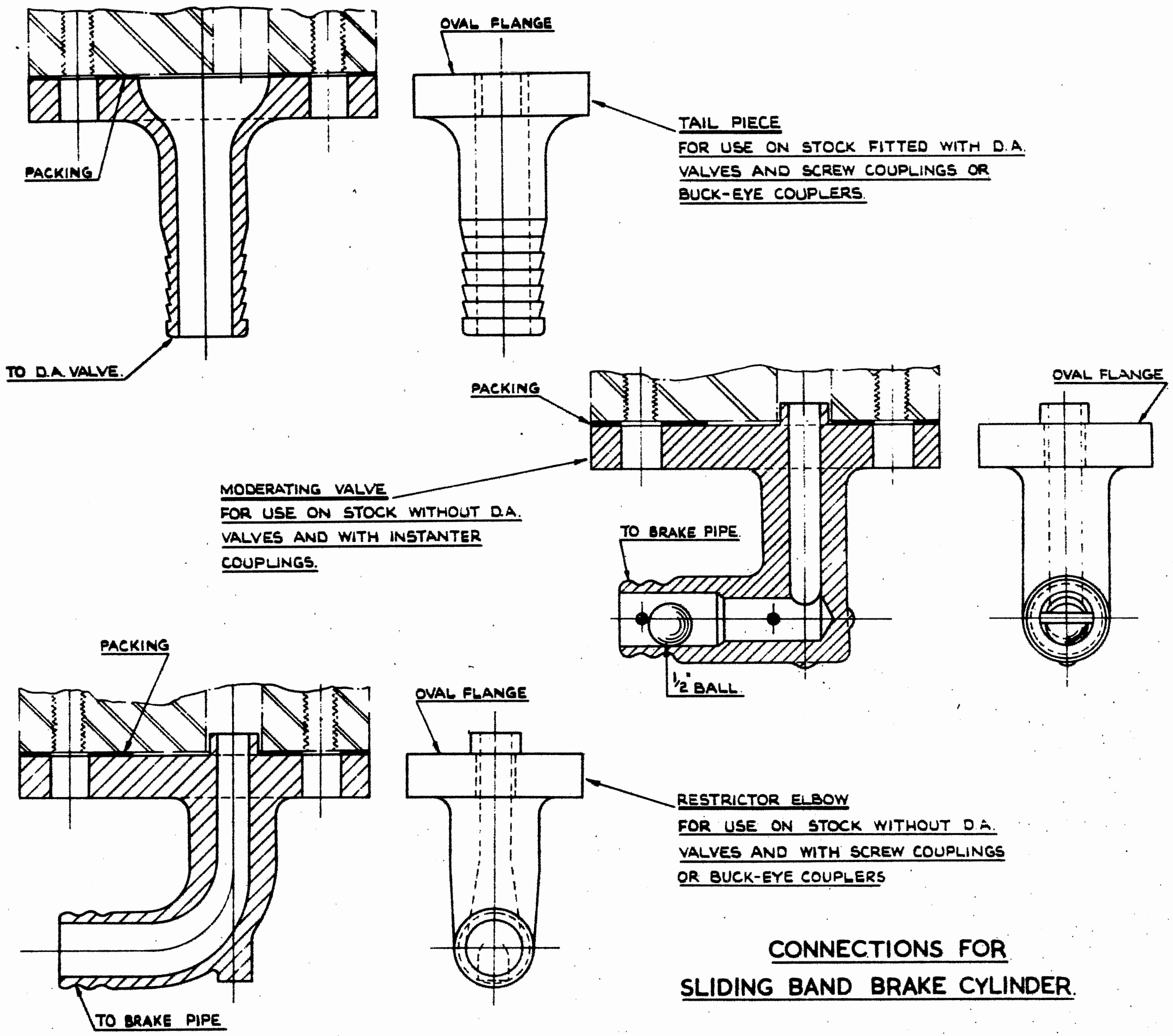
1. VACUUM CYLINDER
2. PISTON HEAD
3. TOP SIDE SPACE
4. PISTON ROD
5. PISTON ROD GLAND & PACKING
6. * TAIL PIECE
7. RUBBER SLIDING BAND & STEEL HOOP
8. RELEASE VALVE
9. SEALING RING
10. BUFFING RING
11. CAST IRON PISTON RING
12. PISTON HEAD WASHER
13. PISTON ROD GUIDE BUSH
14. RELEASE VALVE LEVER

* FOR CARRIAGE STOCK
FOR FREIGHT STOCK SEE FIG. 11

SLIDING BAND BRAKE CYLINDER

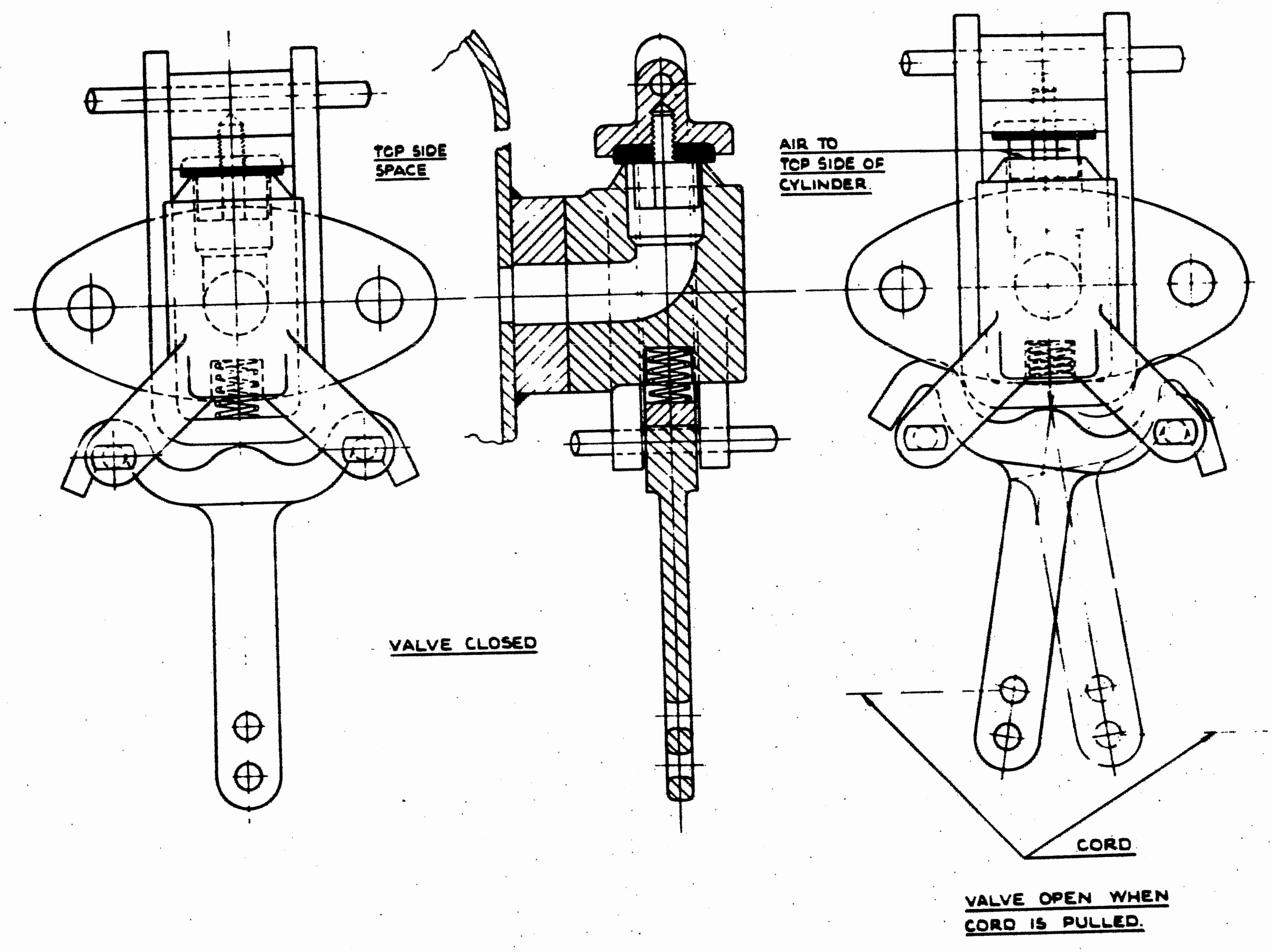
FIG. 10

FIG. 10



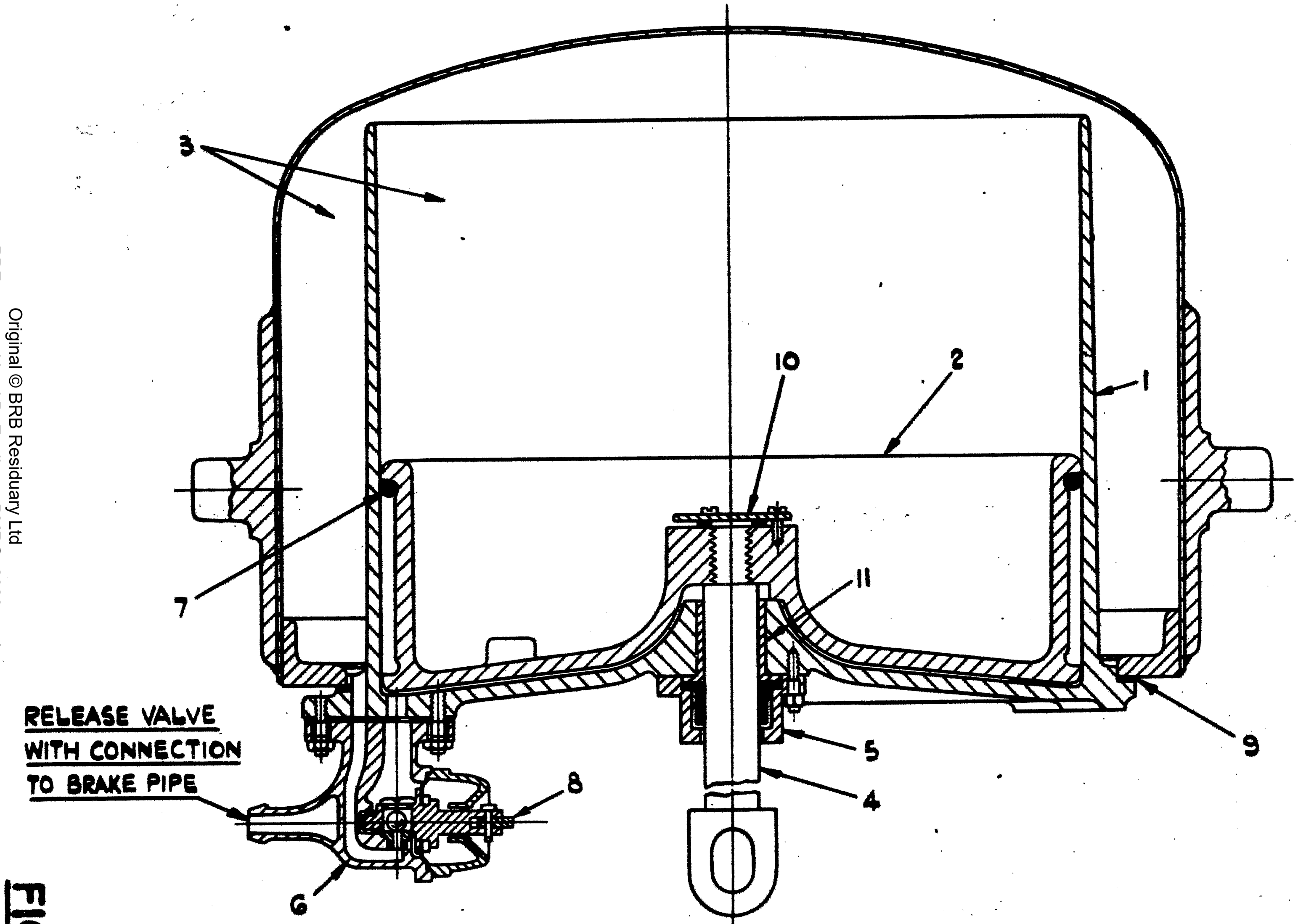
CONNECTIONS FOR
SLIDING BAND BRAKE CYLINDER.

FIG. 11



RELEASE VALVE FOR SLIDING BAND BRAKE CYLINDER.

FIG. 12.



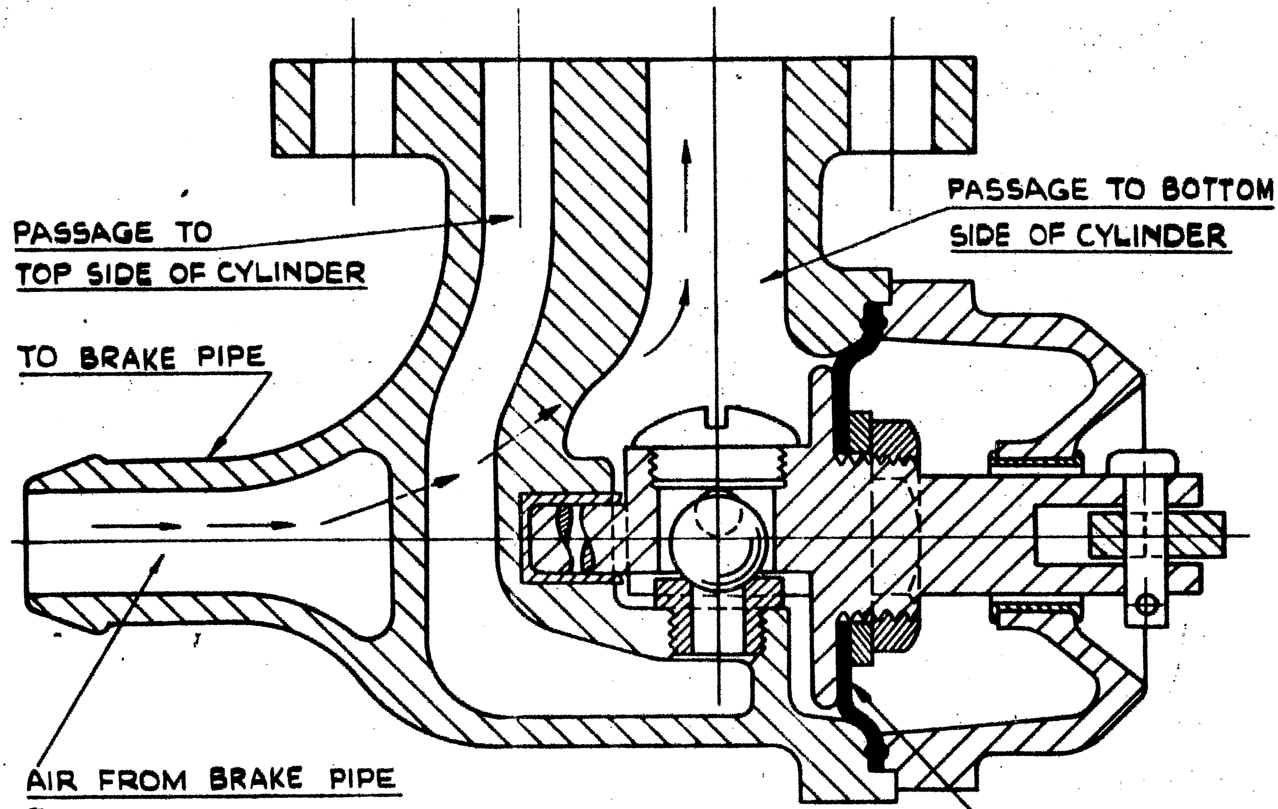
DESCRIPTION OF PARTS

1. VACUUM CYLINDER
2. PISTON HEAD
3. TOP SIDE SPACE
4. PISTON ROD
5. PISTON ROD GLAND & PACKING
6. COMBINED BALL & RELEASE VALVE
7. ROLLING RING
8. RELEASE VALVE LEVER
9. SEALING RING
10. PISTON ROD CAP
11. PISTON ROD GUIDE BUSH

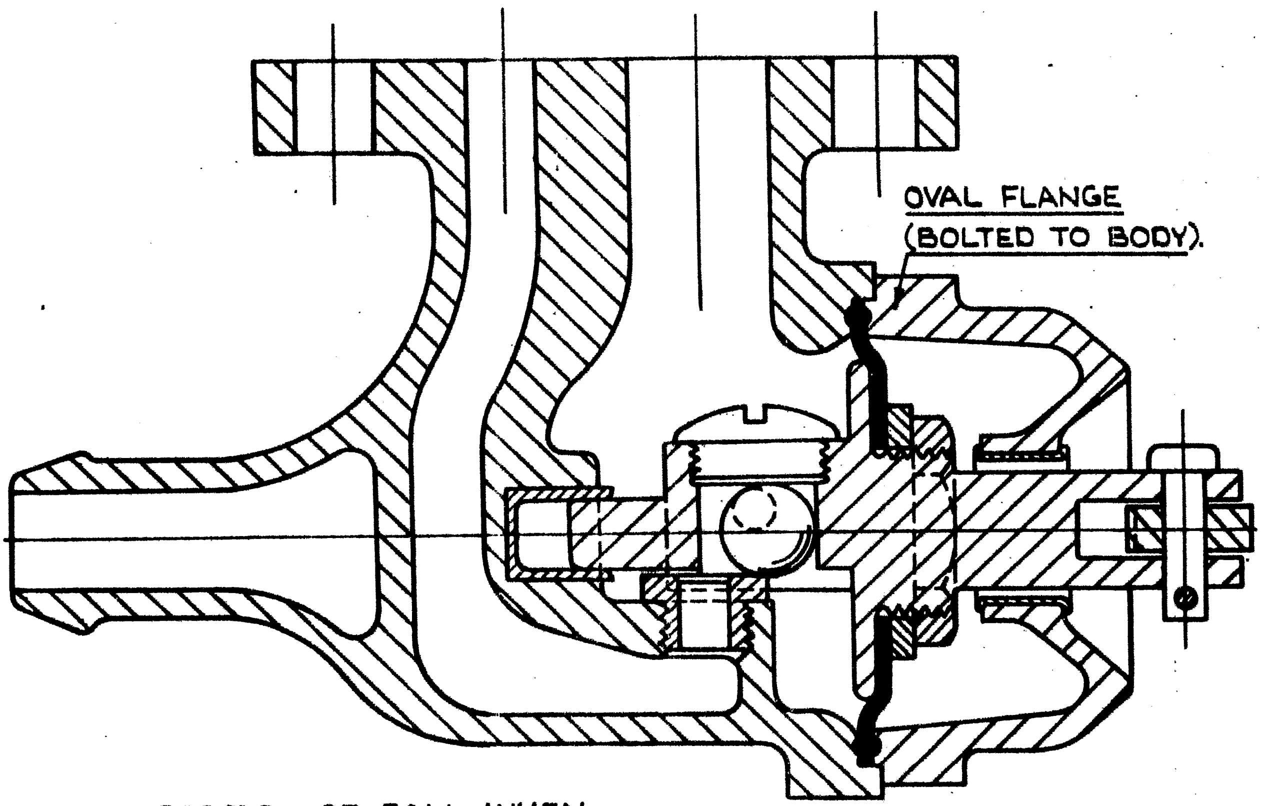
TYPE 'C' COMBINED BRAKE CYLINDER

FIG. 13

FIG. 13



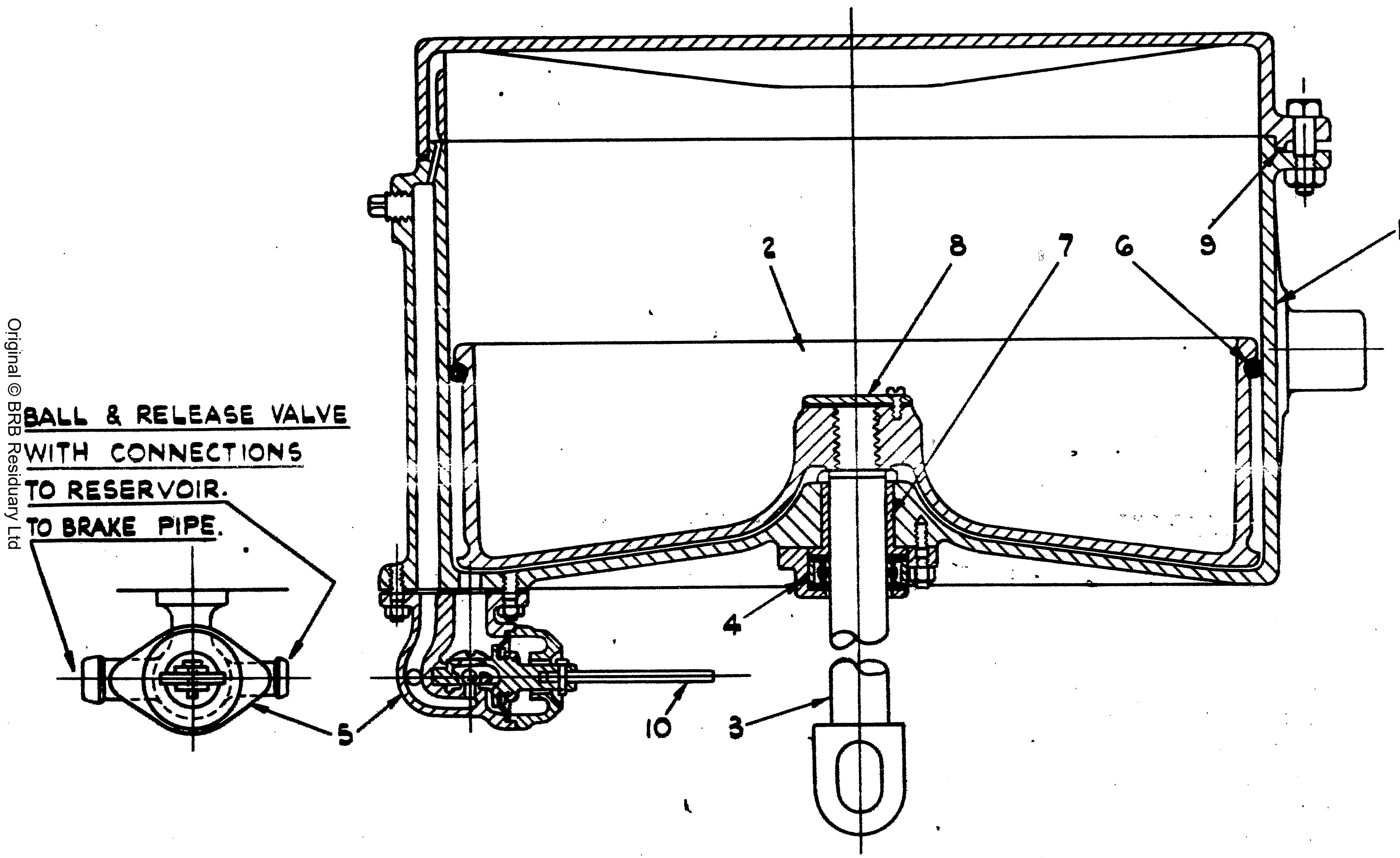
NORMAL POSITION OF BALL.



POSITION OF BALL WHEN CORD IS PULLED.

RELEASE VALVE FOR TYPE 'C' COMBINED BRAKE CYLINDER

FIG. 14.



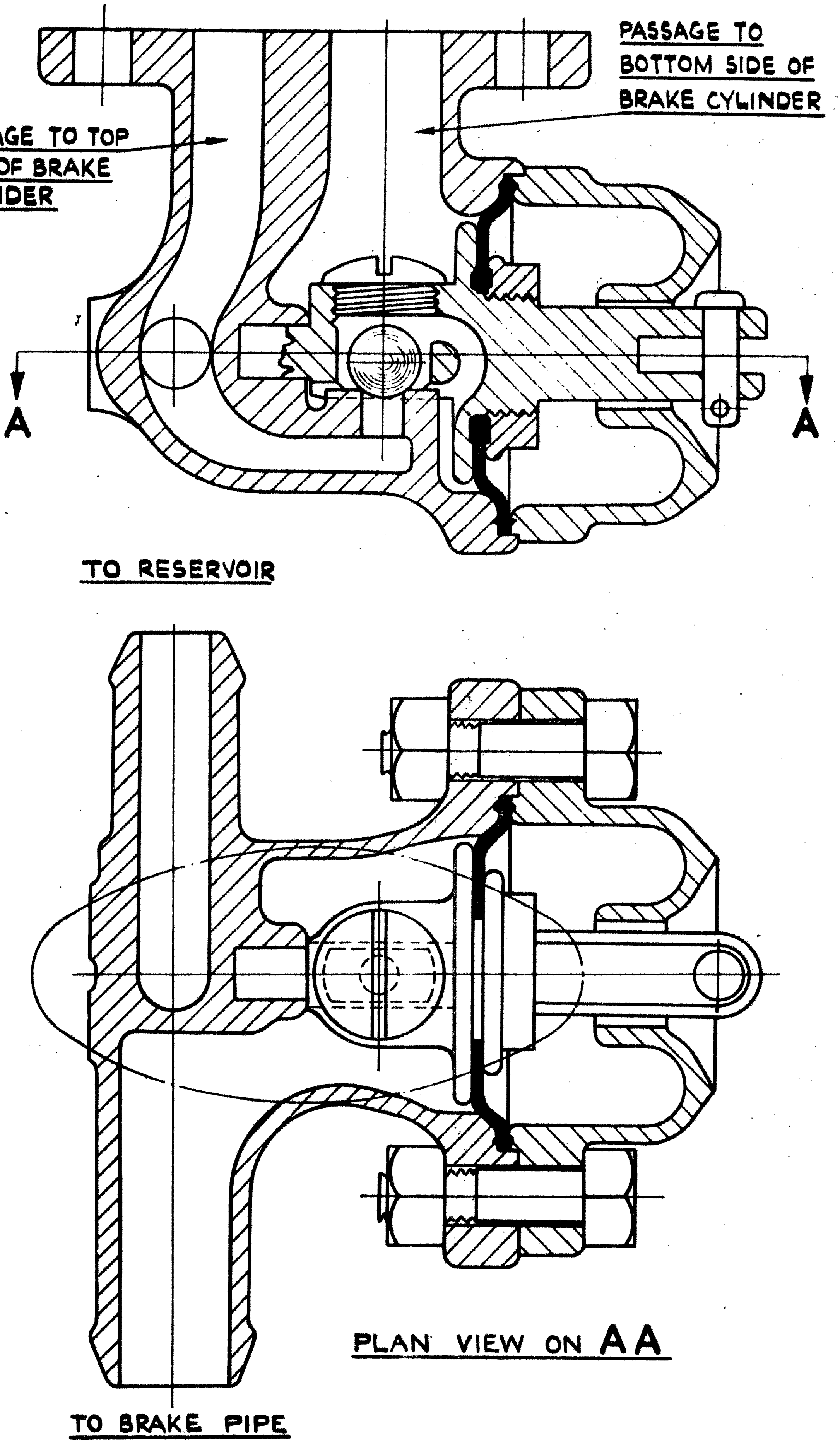
DESCRIPTION OF PARTS

1. VACUUM CYLINDER
2. PISTON HEAD
3. PISTON ROD
4. PISTON ROD GLAND & PACKING
5. RELEASE VALVE
6. ROLLING RING
7. PISTON ROD GUIDE BUSH
8. PISTON ROD CAP
9. JOINT RING
10. RELEASE VALVE LEVER

TYPE 'C' SEPARATE BRAKE CYLINDER

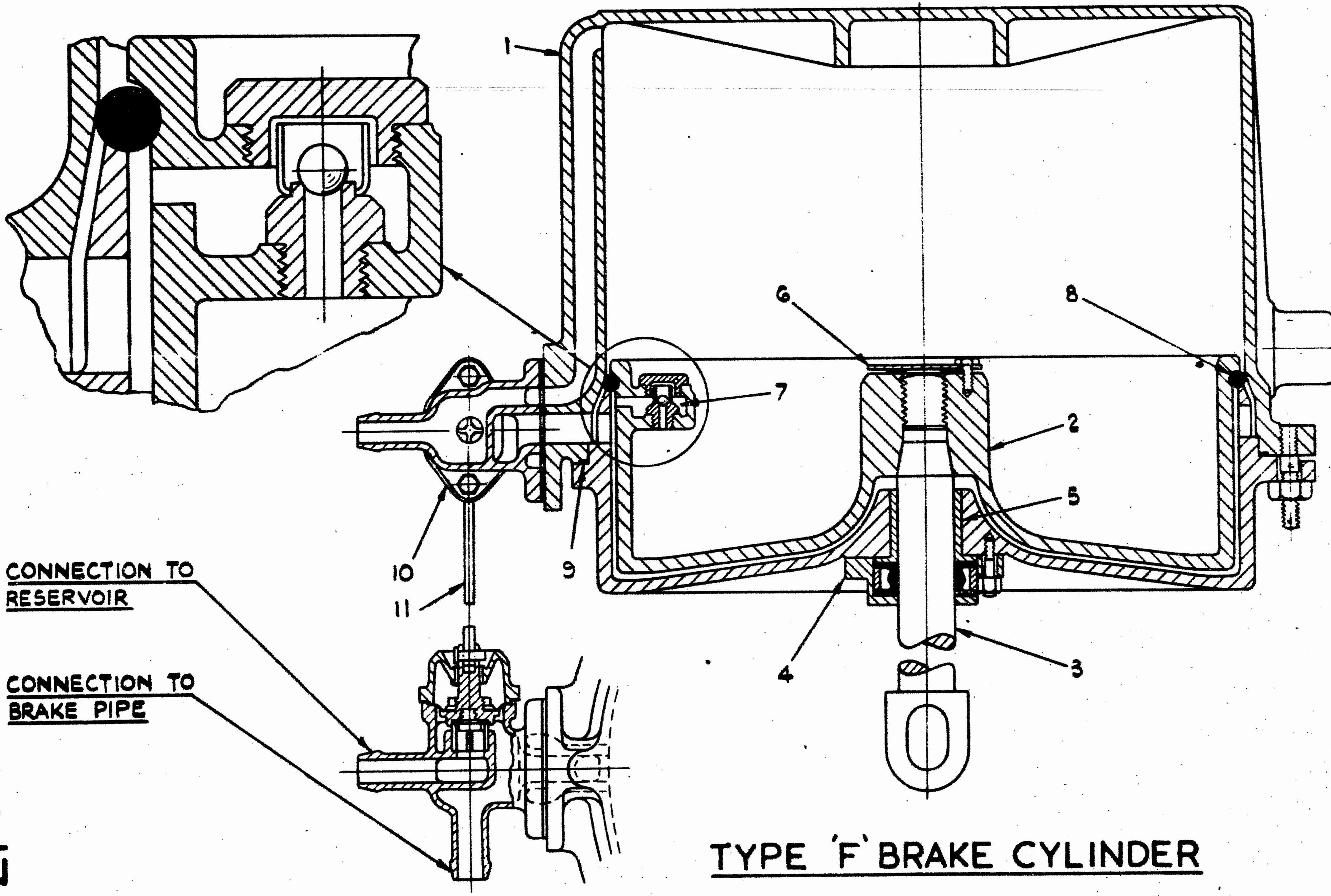
FIG. 15

FIG. 15



RELEASE VALVE FOR TYPE 'C' SEPARATE BRAKE CYLINDER

FIG. 16



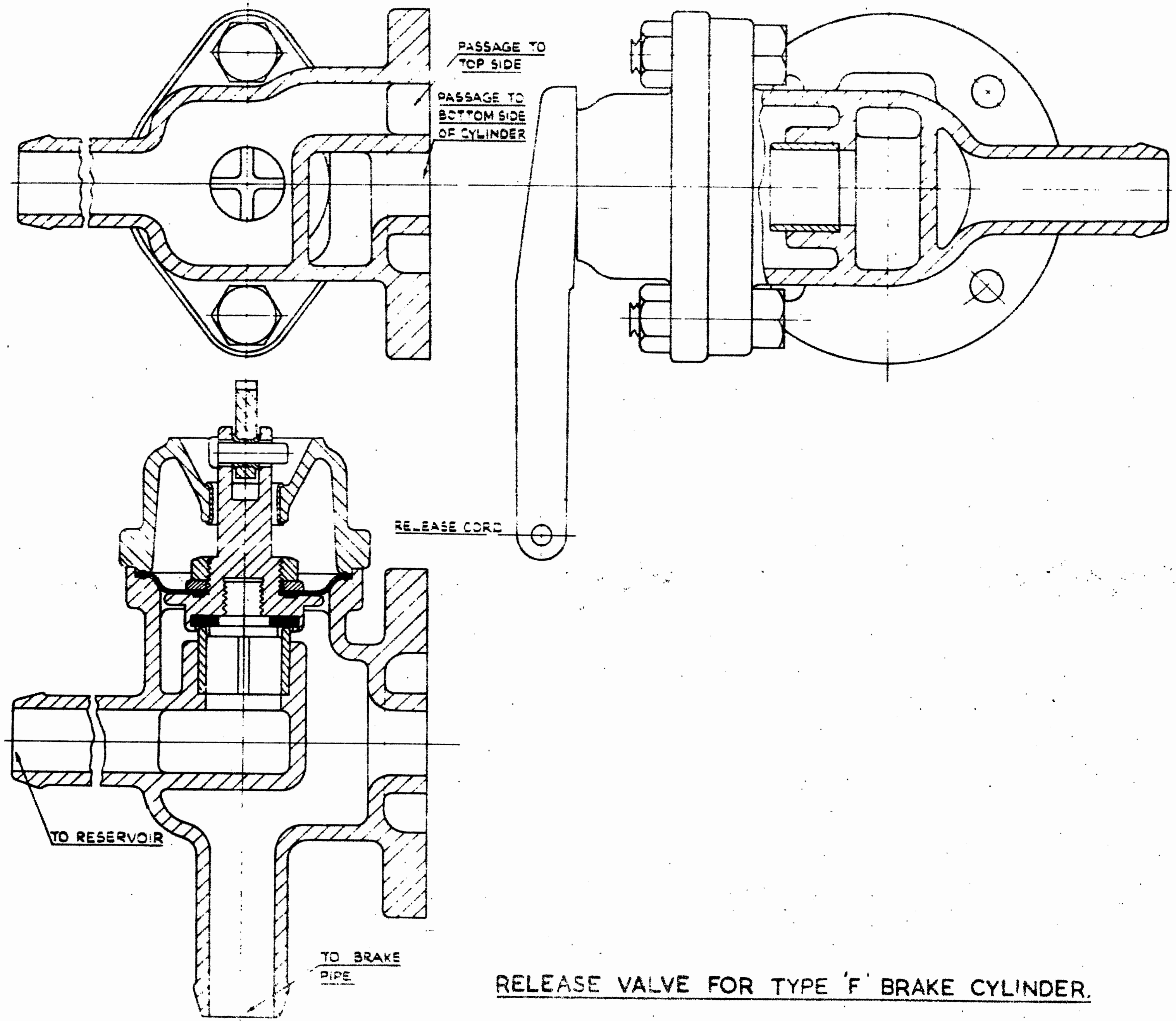
TYPE 'F' BRAKE CYLINDER

FIG. 17

DESCRIPTION OF PARTS

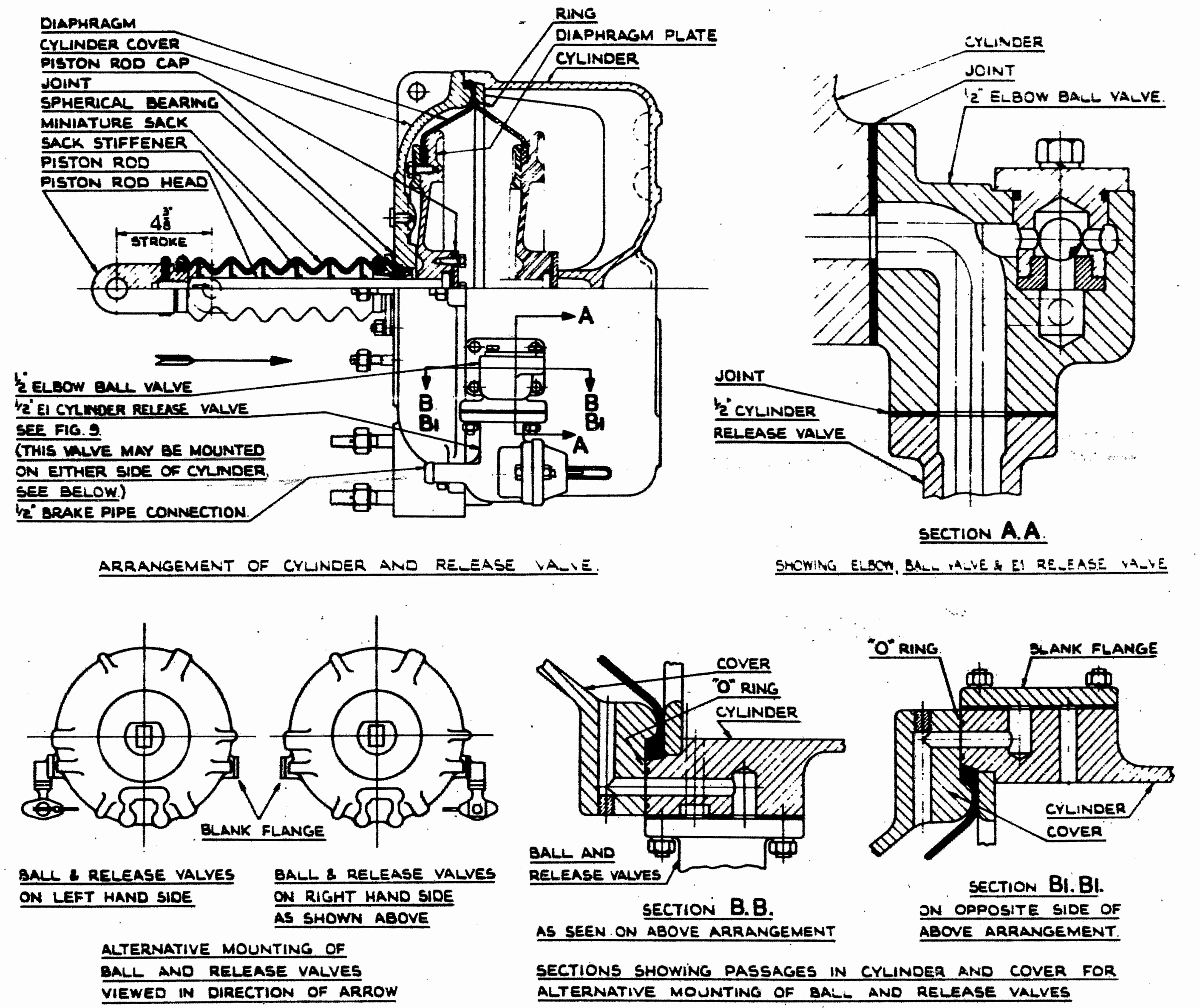
1. VACUUM CYLINDER
2. PISTON HEAD
3. PISTON ROD
4. PISTON ROD GLAND & PACKING
5. PISTON ROD GUIDE
6. PISTON ROD CAP
7. BALL VALVE
8. ROLLING RING
9. JOINT RING
10. RELEASE VALVE
11. RELEASE VALVE LEVER

FIG. 17



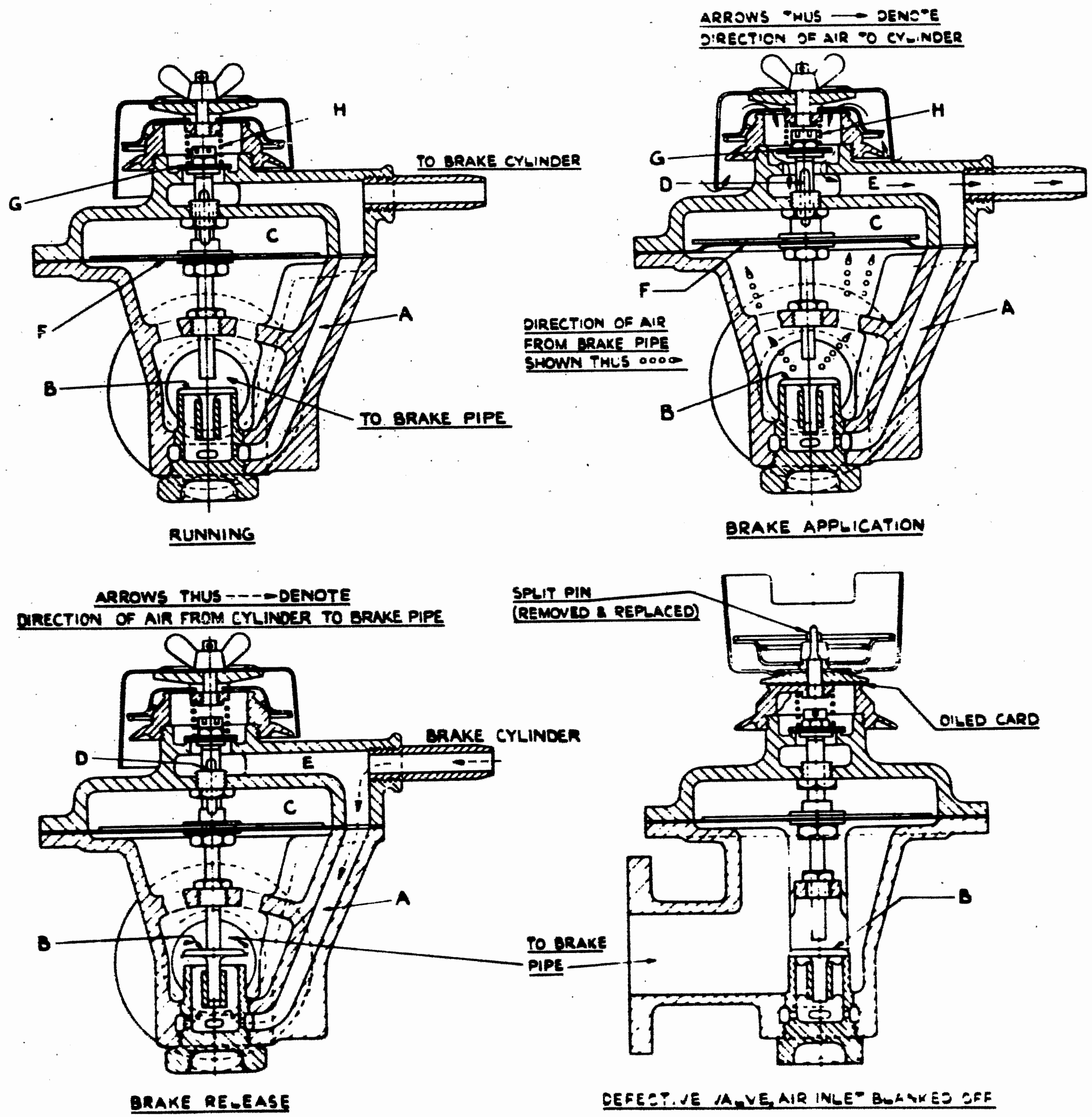
RELEASE VALVE FOR TYPE 'F' BRAKE CYLINDER.

FIG. 18



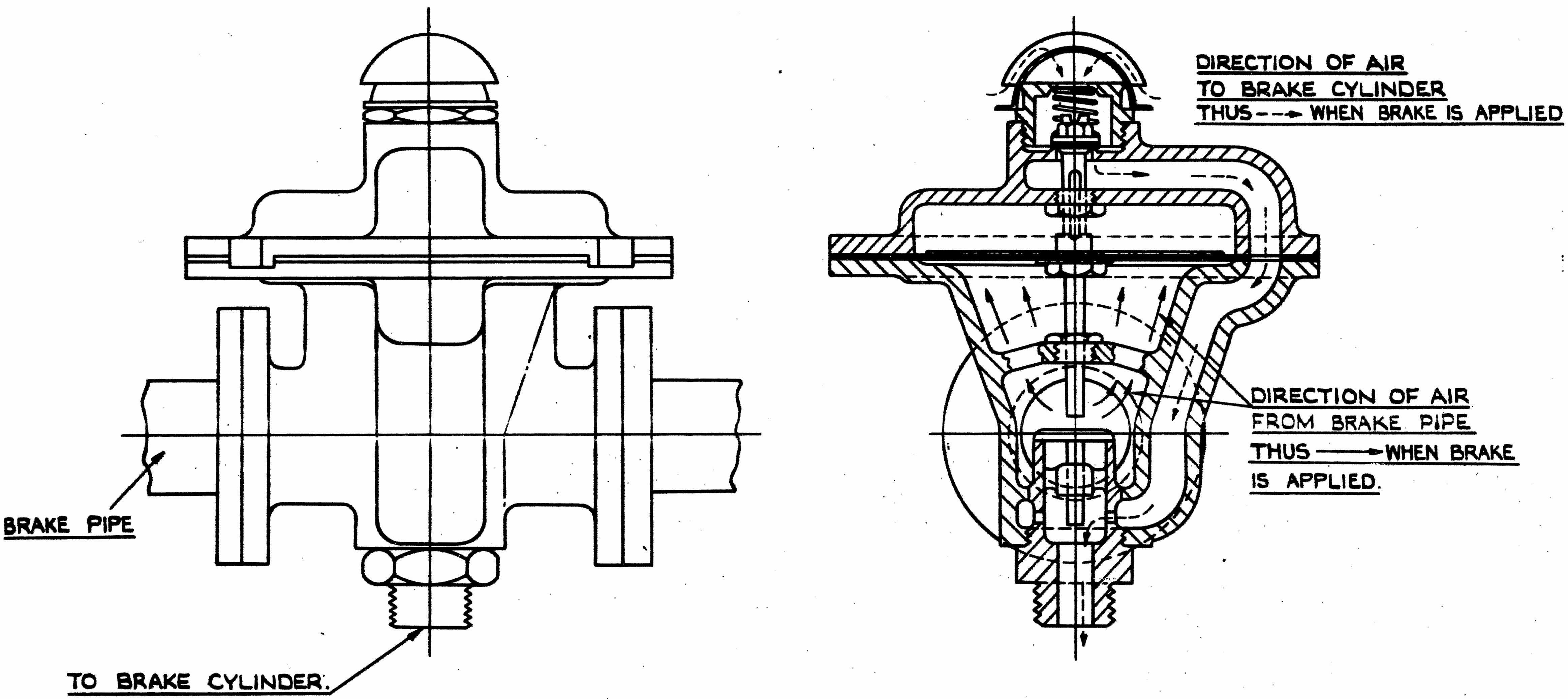
DIAPHRAGM BRAKE CYLINDER.

FIG. 19.



DIRECT ADMISSION VALVE, B.R. TYPE

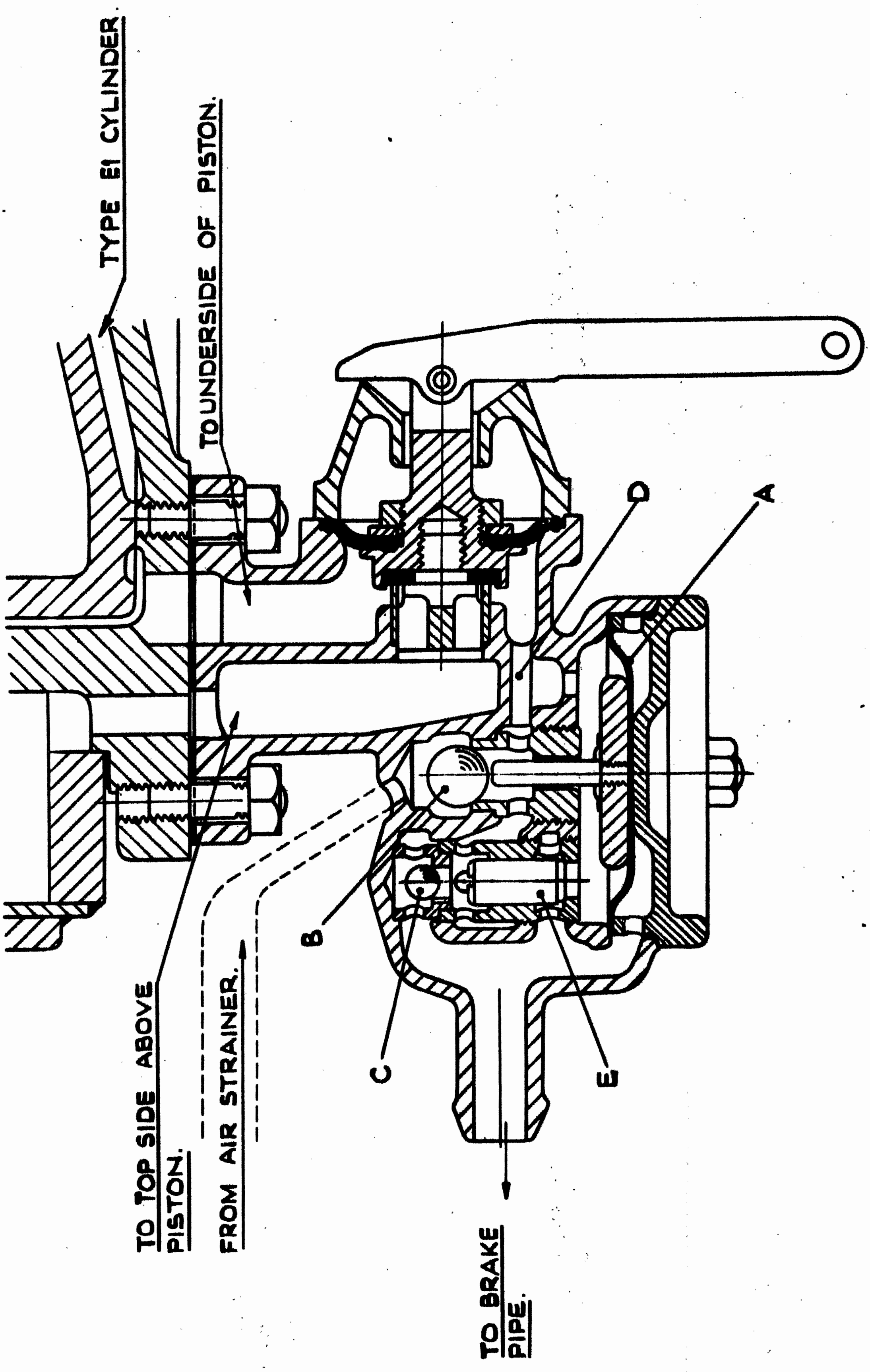
FIG. 20



DIRECT ADMISSION VALVE, EX. G.W.R. TYPE.

FIG. 21

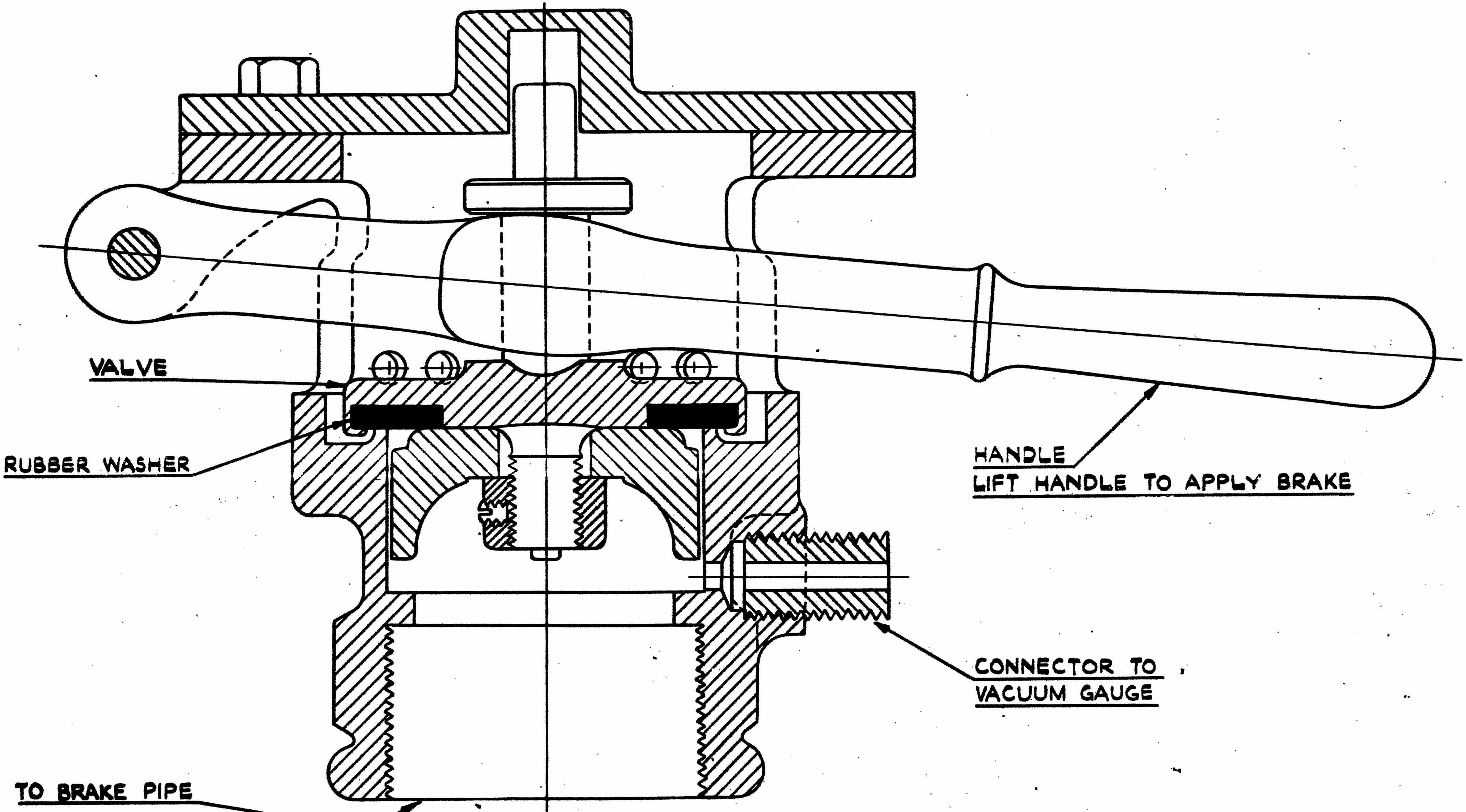
FIG. 21.



QUICK SERVICE APPLICATION VALVE

FIG. 22

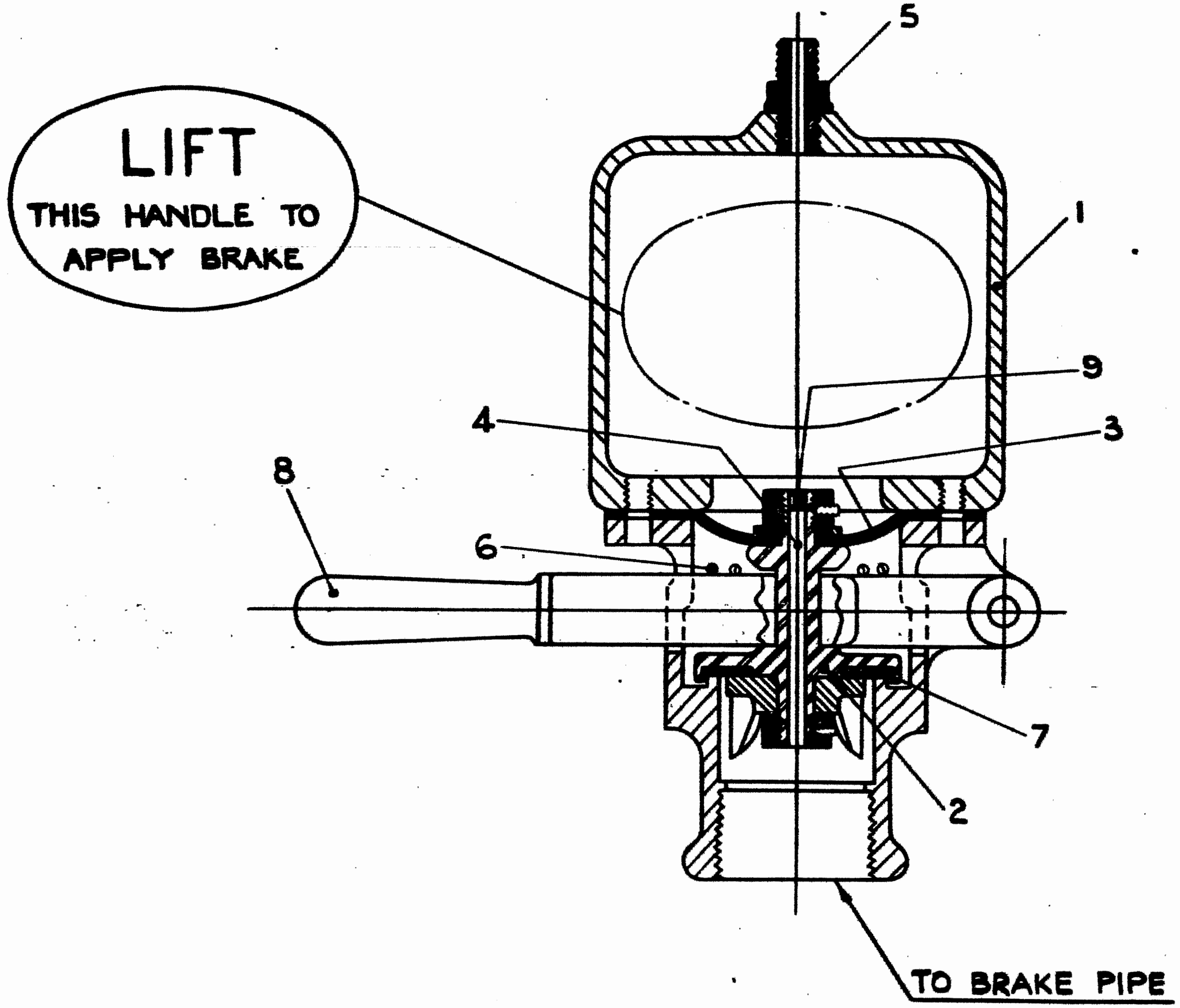
FIG.22.



GUARD'S BRAKE APPLICATION VALVE, B.R. TYPE

FIG. 23.

FIG. 23.



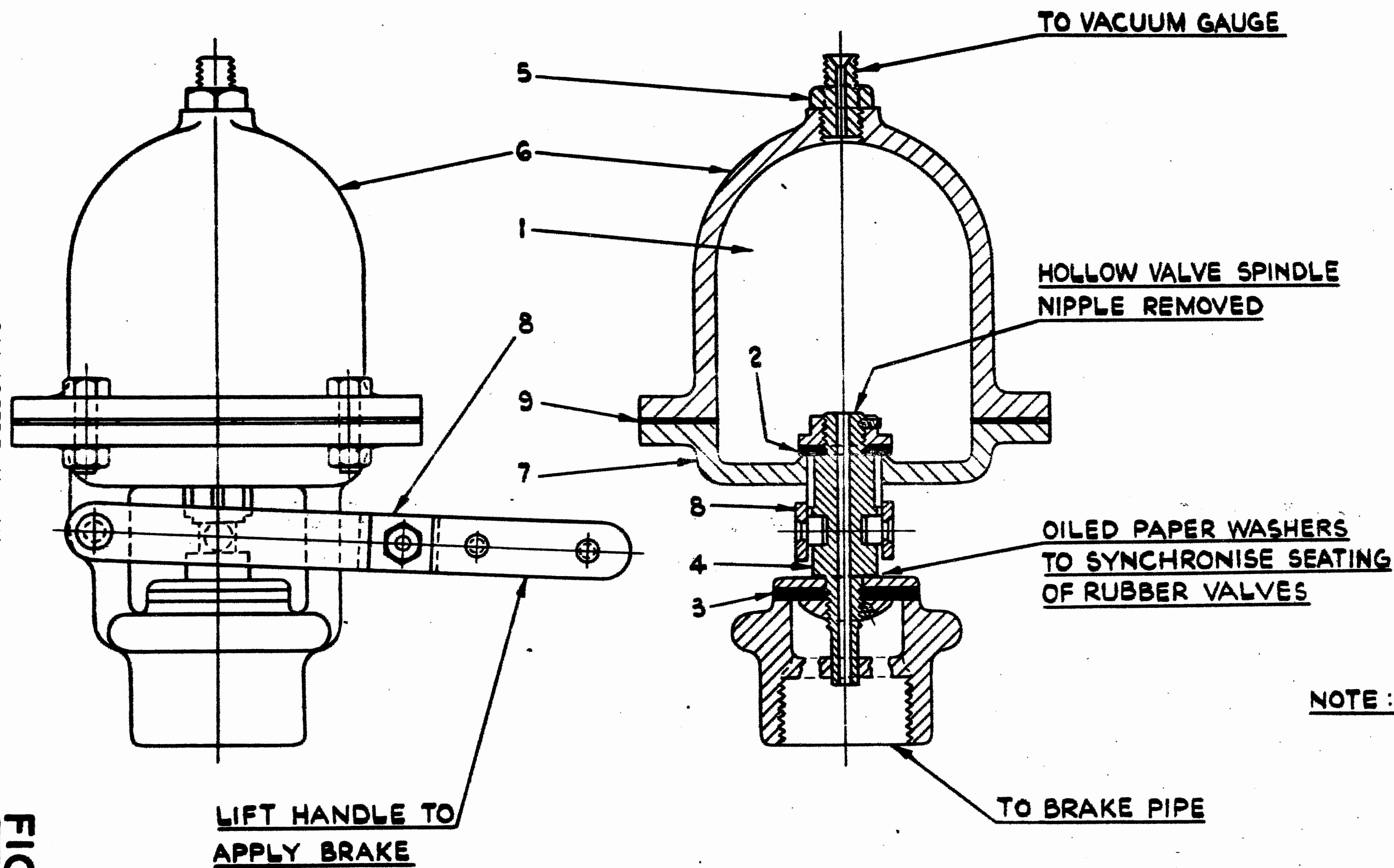
DESCRIPTION

1. RESERVOIR
2. VALVE
3. DIAPHRAGM
4. HOLLOW SPINDLE
5. CONNECTION TO GAUGE
6. AIR INLET HOLES
7. RUBBER VALVE
8. OPERATING HANDLE
9. NIPPLE WITH 1/16" DIA. ORIFICE

GUARD'S BRAKE APPLICATION VALVE, EX L.N.E.R. TYPE

FIG. 24.

FIG. 24.



DESCRIPTION

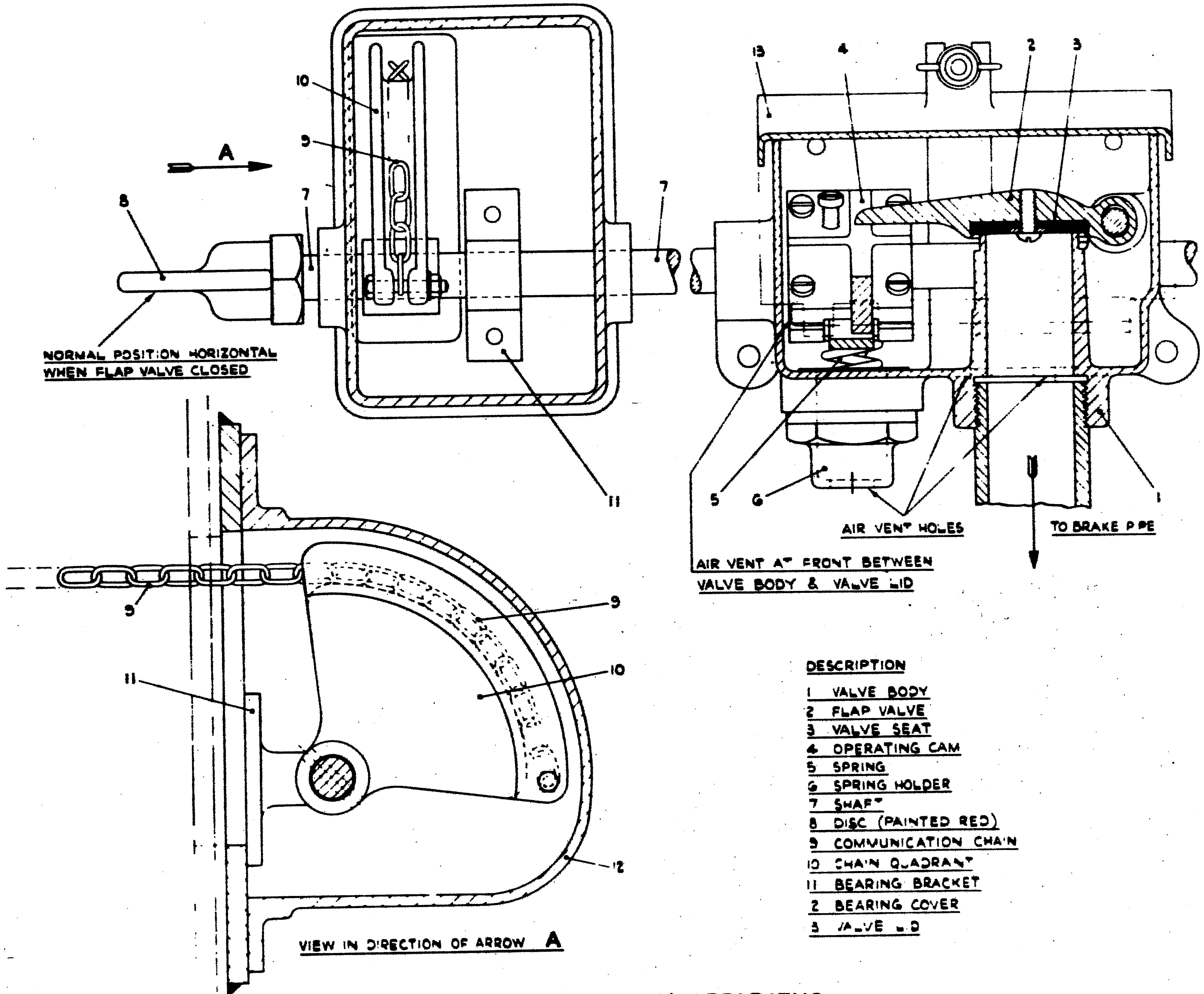
1. RESERVOIR
2. RESERVOIR VALVE - RUBBER
3. VALVE - BRAKE PIPE - RUBBER
4. HOLLOW VALVE SPINDLE (WITHOUT NIPPLE)
5. CONNECTION TO GAUGE
6. RESERVOIR CASING
7. VALVE BODY
8. HANDLE
9. SEALING WASHER

NOTE :- NEWER BRAKE SETTERS HAVE FLAT TOP IN PLACE OF RESERVOIR

FIG.25.

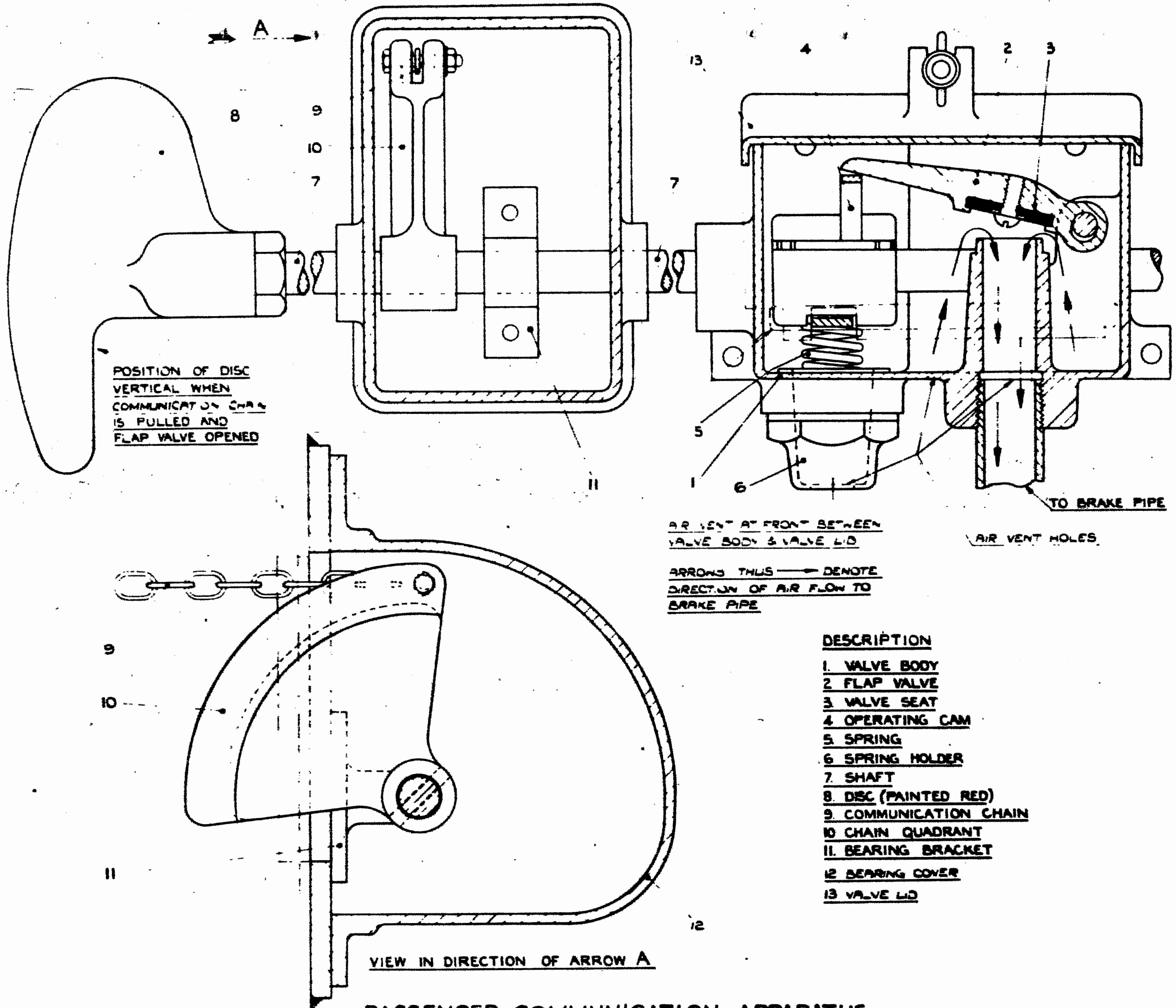
GUARD'S BRAKE SETTER, EX G.W.R. TYPE

FIG. 25



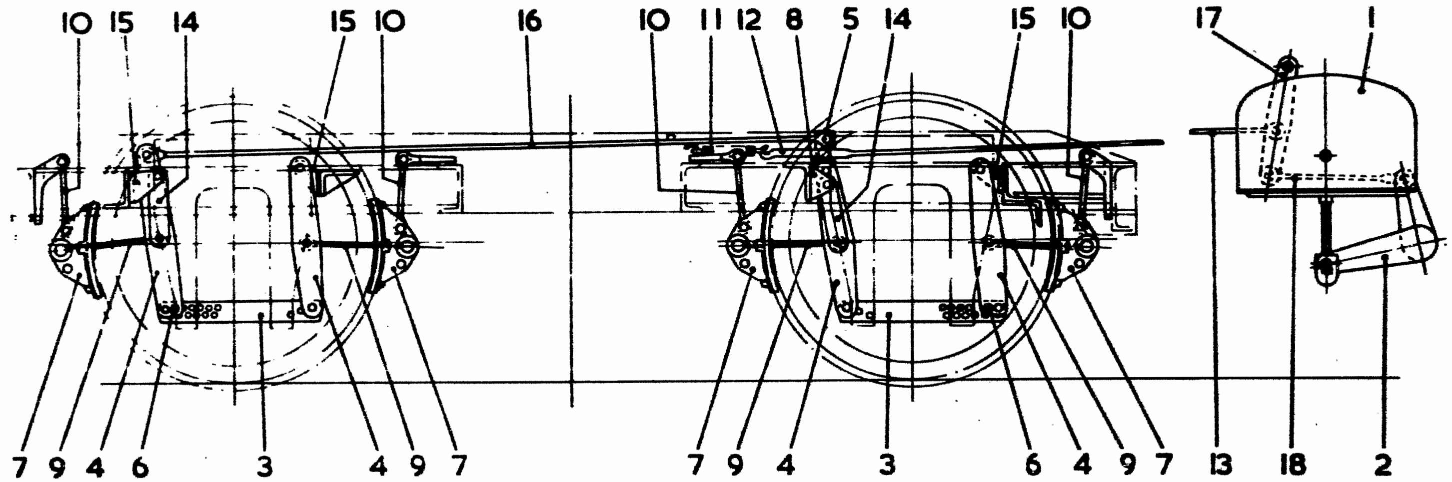
PASSENGER COMMUNICATION APPARATUS.
CLOSED (NEWER TYPE)

FIG. 26



PASSENGER COMMUNICATION APPARATUS, OPEN (OLDER TYPE)

FIG. 27

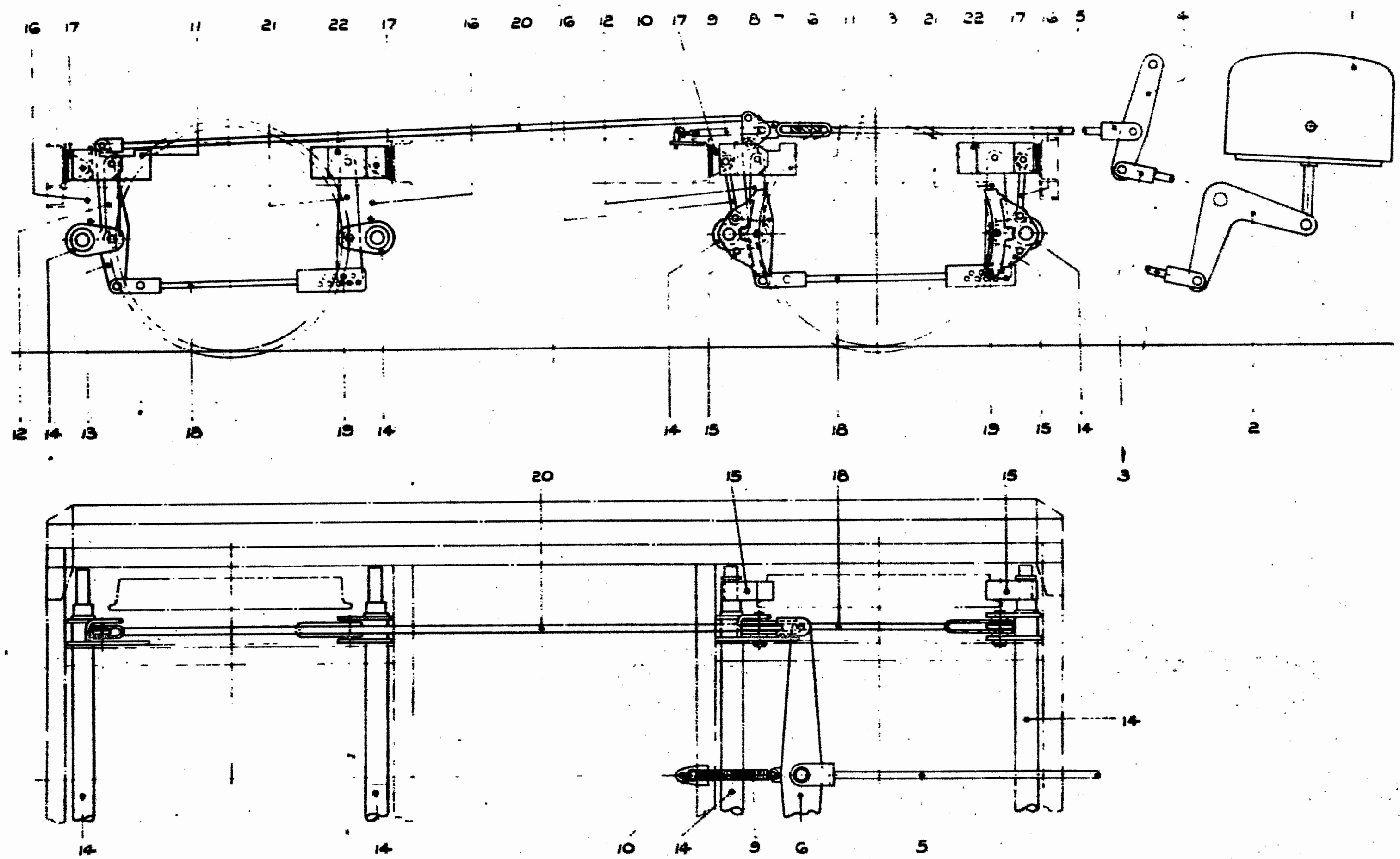


DESCRIPTION

1. BRAKE CYLINDER
2. BRAKE SHAFT
3. ADJUSTING ROD
4. BRAKE LEVER
5. EQUALISING LEVER
6. ADJUSTING PIN
7. BRAKE SHOE & BRAKE SHOE HOLDER
8. BRAKE LEVER BRACKET & STOP
9. BRAKE BEAM
10. BRAKE BLOCK HANGER
11. RELEASE SPRING
12. RELEASE SPRING SHACKLE
13. PULL ROD TO BOGIE
14. SUSPENSION LINK
15. BRAKE LEVER BRACKET
16. PULL RODS TO BOGIE OUTER AXLE
17. UNDERFRAME BRAKE LEVER
18. PULL ROD TO BRAKESHAFT

B.R. STANDARD BOGIE BRAKE ARRANGEMENT.

FIG. 28.

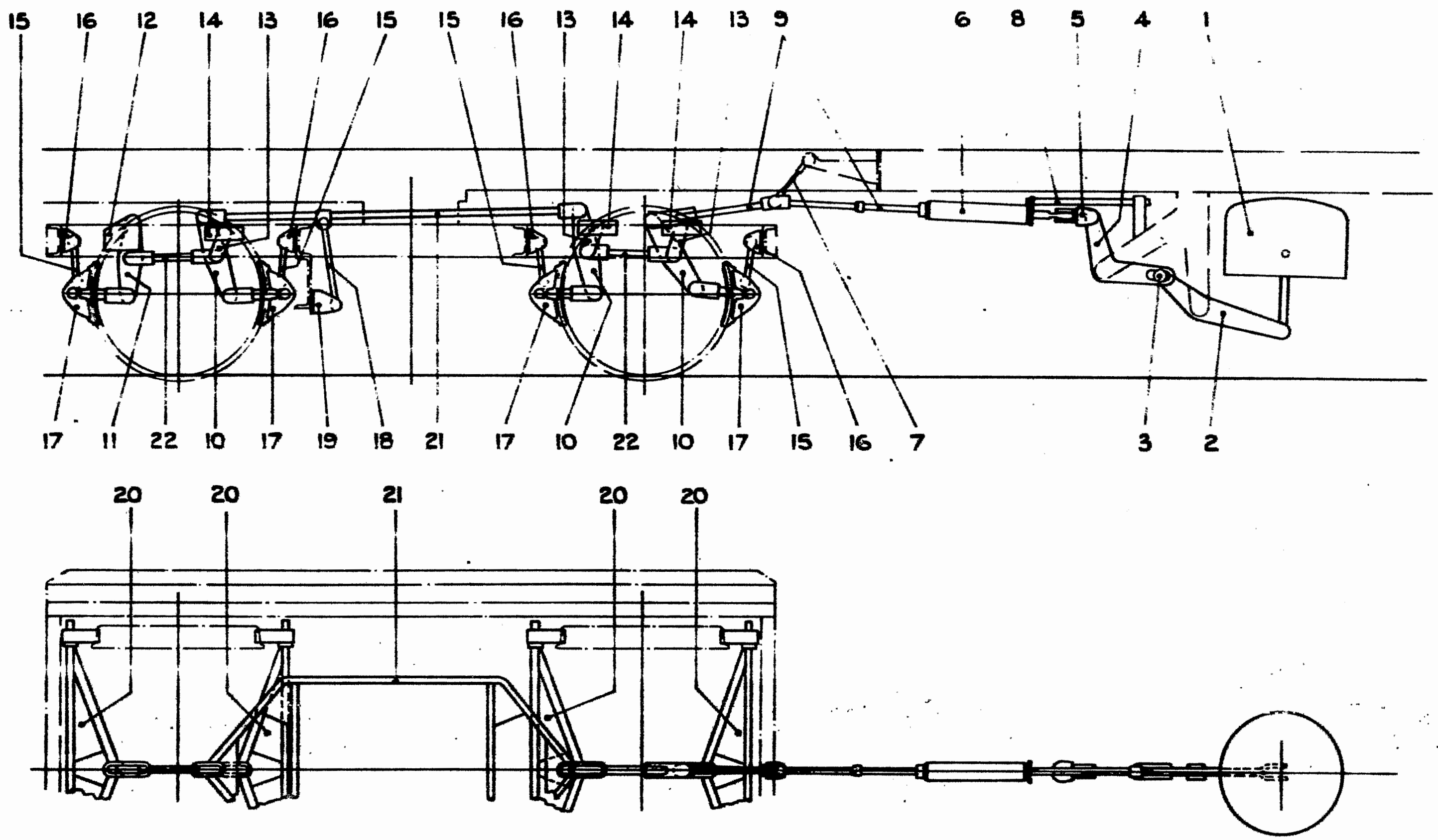


DESCRIPTION

1. BRAKE CYLINDER
2. BRAKE CYLINDER LEVER
3. PULL ROD TO CYLINDER
4. UNDERFRAME BRAKE LEVER
5. PRIMARY PULL ROD
6. EQUALISING BEAM
7. ADAPTOR
8. SECONDARY EQUALISING LINK
9. RELEASE SPRING
10. RELEASE SPRING SHACKLE
11. SUSPENSION LINK BRACKET
12. SUSPENSION LINK
13. FREE LEVER
14. BRAKE BEAM
15. BRAKE SHOE HOLDER & BRAKE SHOE
16. BRAKE BLOCK HANGER
17. BRAKE BLOCK HANGER BRACKET
18. ADJUSTABLE PULL ROD
19. ADJUSTING PIN
20. SECONDARY PULL ROD
21. FIXED LEVER
22. FIXED LEVER BRACKET

EARLIER B4 BOGIE BRAKE ARRANGEMENT.

FIG. 29.

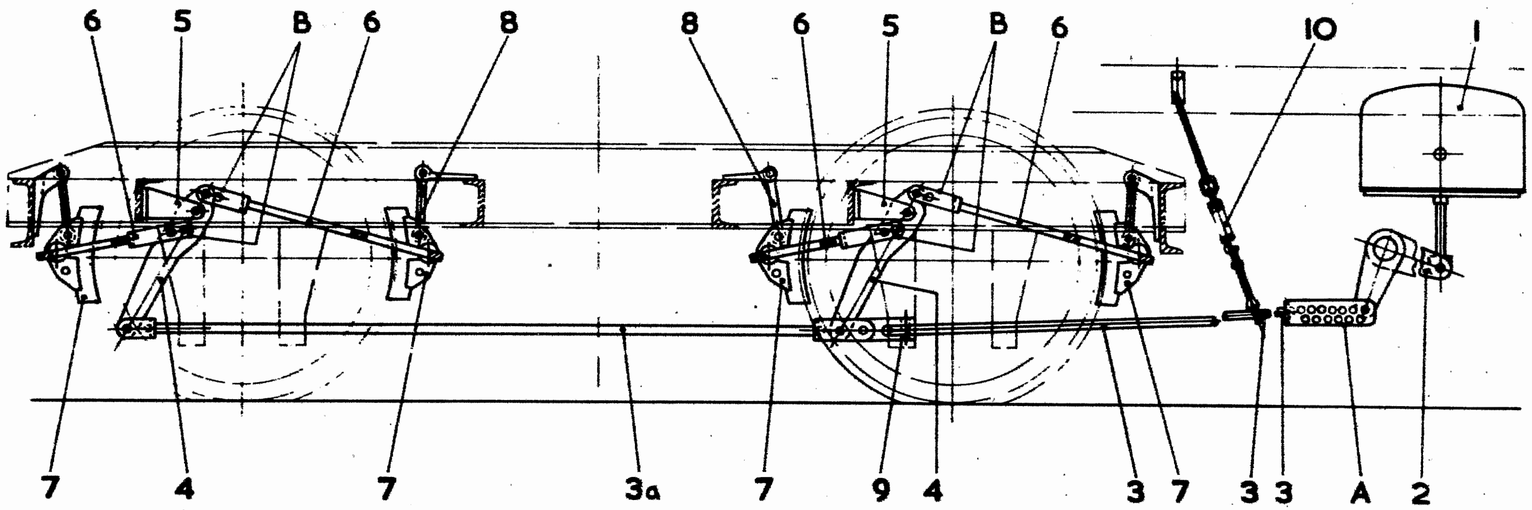


DESCRIPTION

1 BRAKE CYLINDER
2 BRAKE CYLINDER LEVER
3 SLIDING JOINT
4 BRAKE LEVER
5 KNUCKLE JOINT
6 BRAKE REGULATOR
7 BRAKE REGULATOR SUPPORT
8 BRAKE REGULATOR CONTROL ROD
9 PULL ROD
10 FREE LEVER
11 FIXED LEVER
12 FIXED LEVER BRACKET
13 SUSPENSION LINK
14 SUSPENSION LINK BRACKET
15 BRAKE BLOCK HANGER
16 BRAKE BLOCK HANGER BRACKET
17 BRAKE SHOE HOLDER & BRAKE SHOE
18 CONTROL ARM
19 CONTROL ARM BRACKET
20 BRAKE BEAM
21 DIVIDED PULL ROD
22 INTERMEDIATE PULL ROD

LATER B4 & B5 BOGIE BRAKE ARRANGEMENT.

FIG. 30

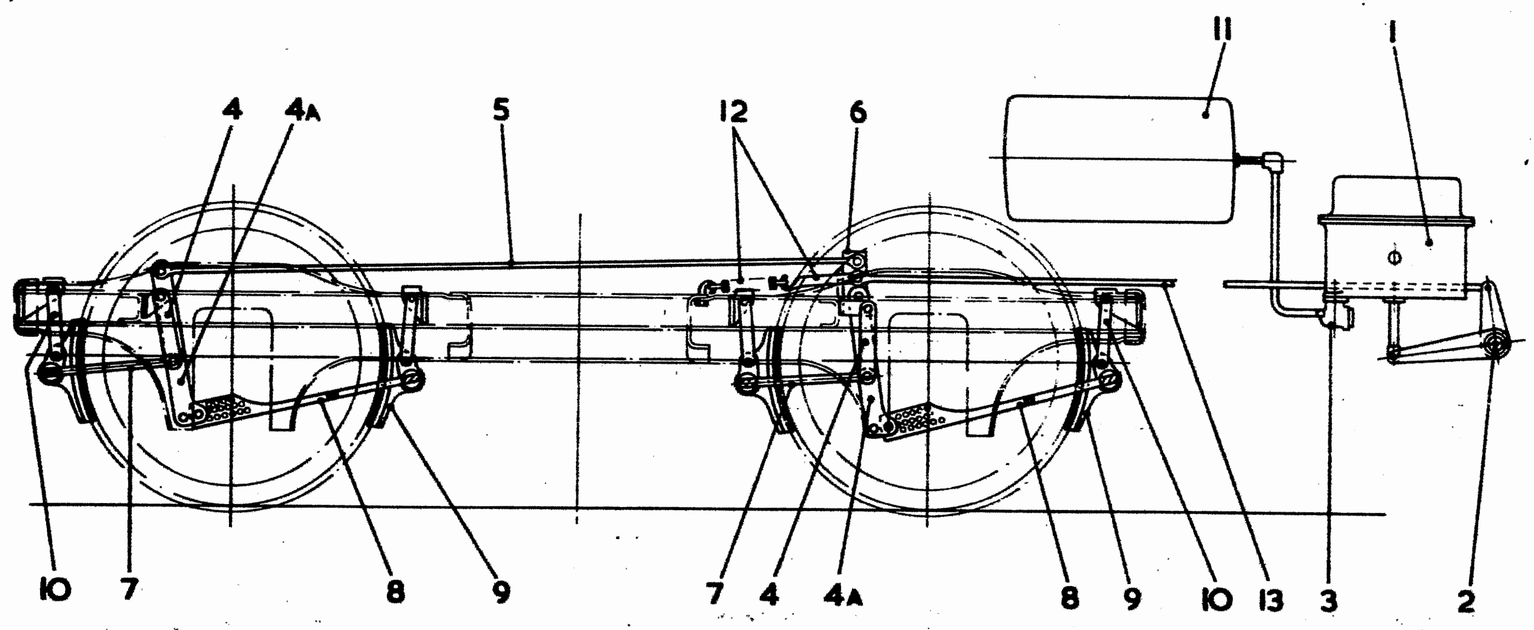


DESCRIPTION

1. BRAKE CYLINDER
2. BRAKE SHAFT
3. ADJUSTING PULL ROD
3a. BOGIE PULL ROD
4. FULCRUM LEVER
5. FULCRUM LEVER BRACKET
6. BRAKE BEAM
7. BRAKE SHOE & BRAKE SHOE HOLDER
8. BRAKE BLOCK HANGER
9. ADAPTOR
10. PULL ROD SUPPORT & SPRING

BOGIE BRAKE ARRANGEMENT.
EX. G.W.R. AND EARLIER B.R.

FIG. 31

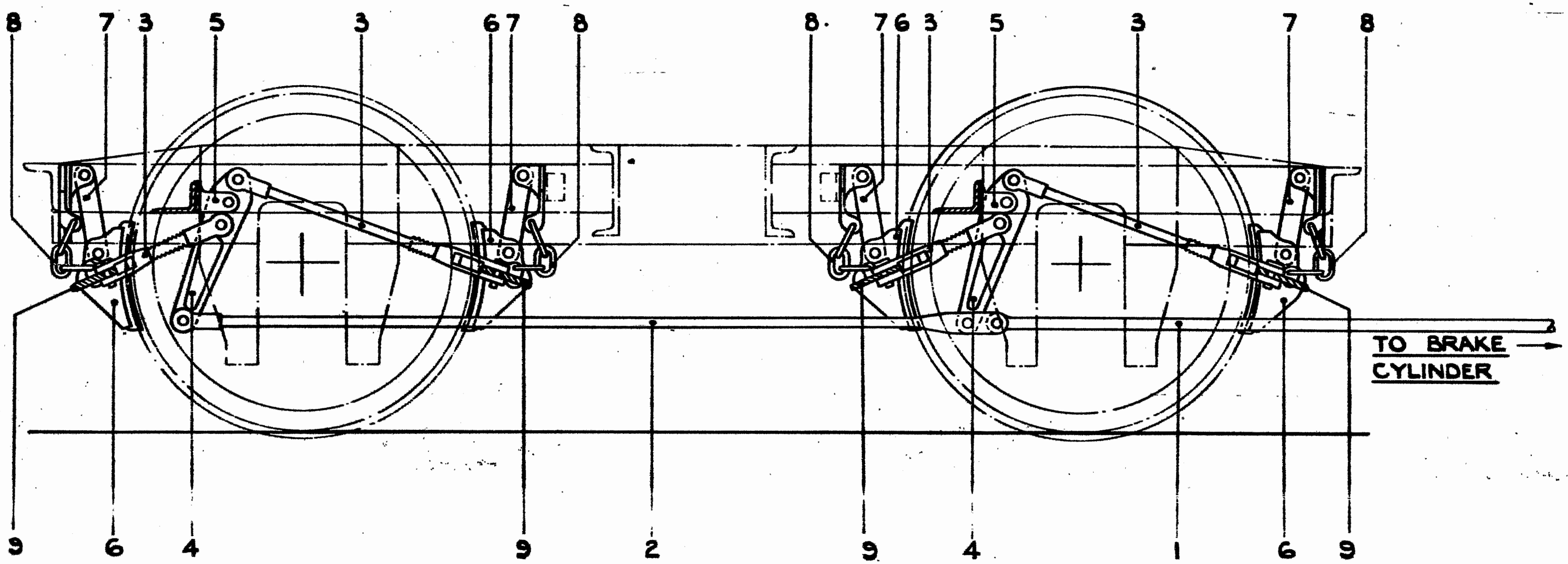


DESCRIPTION

1. BRAKE CYLINDER
2. BRAKE SHAFT
3. RELEASE VALVE WITH CONNECTIONS TO BRAKE PIPE & RESERVOIR
4. SUSPENSION LINK
4A. FULCRUM LEVER
5. BOGIE PULL ROD
6. EQUALISING LEVER
7. BRAKE BEAM
8. ADJUSTING ROD
9. BRAKE BLOCK
10. BRAKE BLOCK HANGER
11. RESERVOIR
12. RELEASE SPRING & LINK TO EQUALISER
13. PULL ROD TO BOGIE

BOGIE BRAKE ARRANGEMENT. EX L.N.E.R.

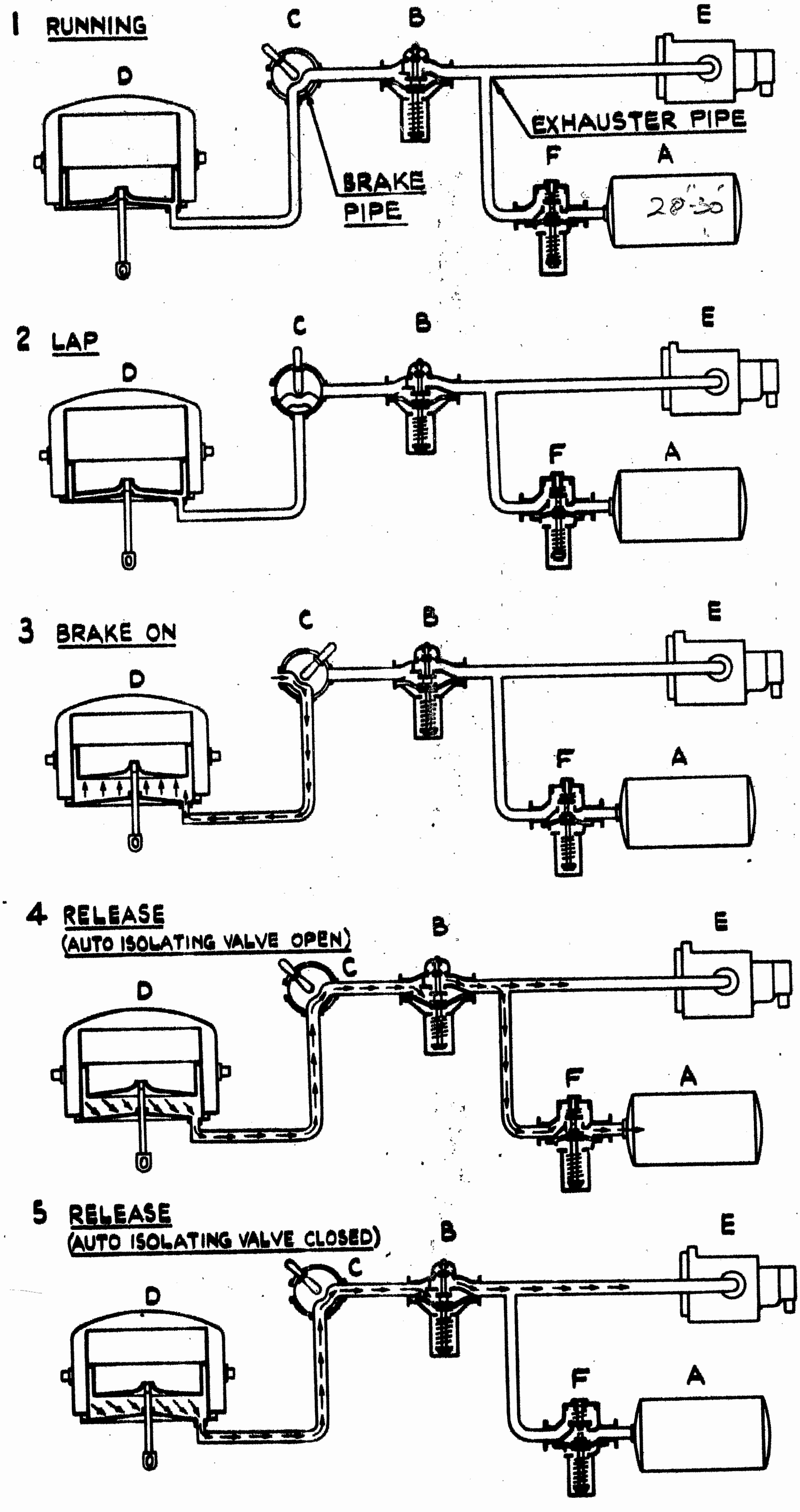
FIG. 32.



DESCRIPTION
1 PULL ROD TO BRAKE SHAFT
2 BOGIE PULL ROD
3 ADJUSTABLE PULL ROD
4 FULCRUM LEVER
5 FULCRUM LEVER BRACKET
6 BRAKE SHOE HOLDER & BRAKESHOE
7 BRAKE BLOCK HANGER
8 SAFETY CHAIN
9 BRAKE BEAM

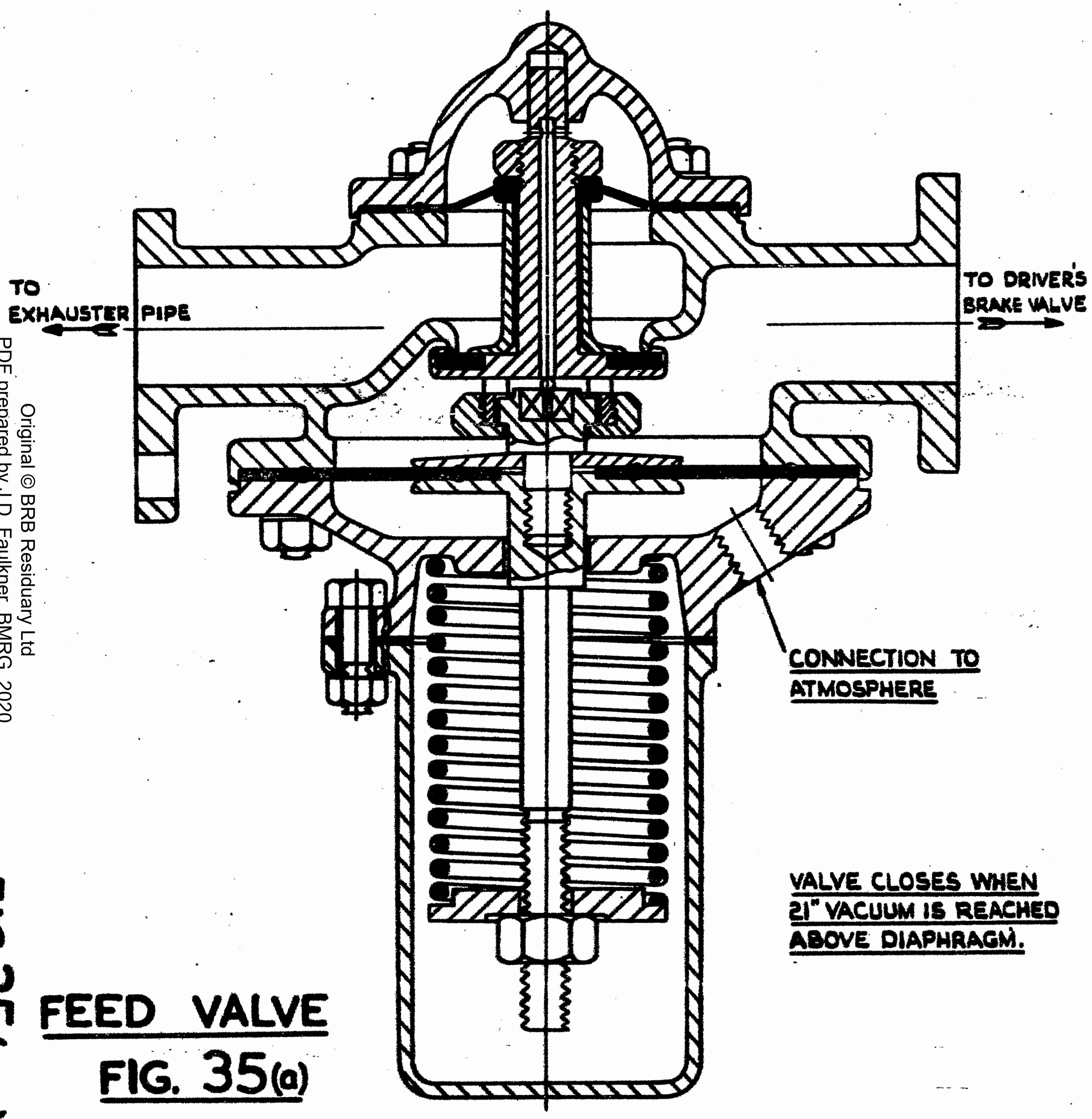
BOGIE BRAKE ARRANGEMENT EX S.R.

FIG. 33.

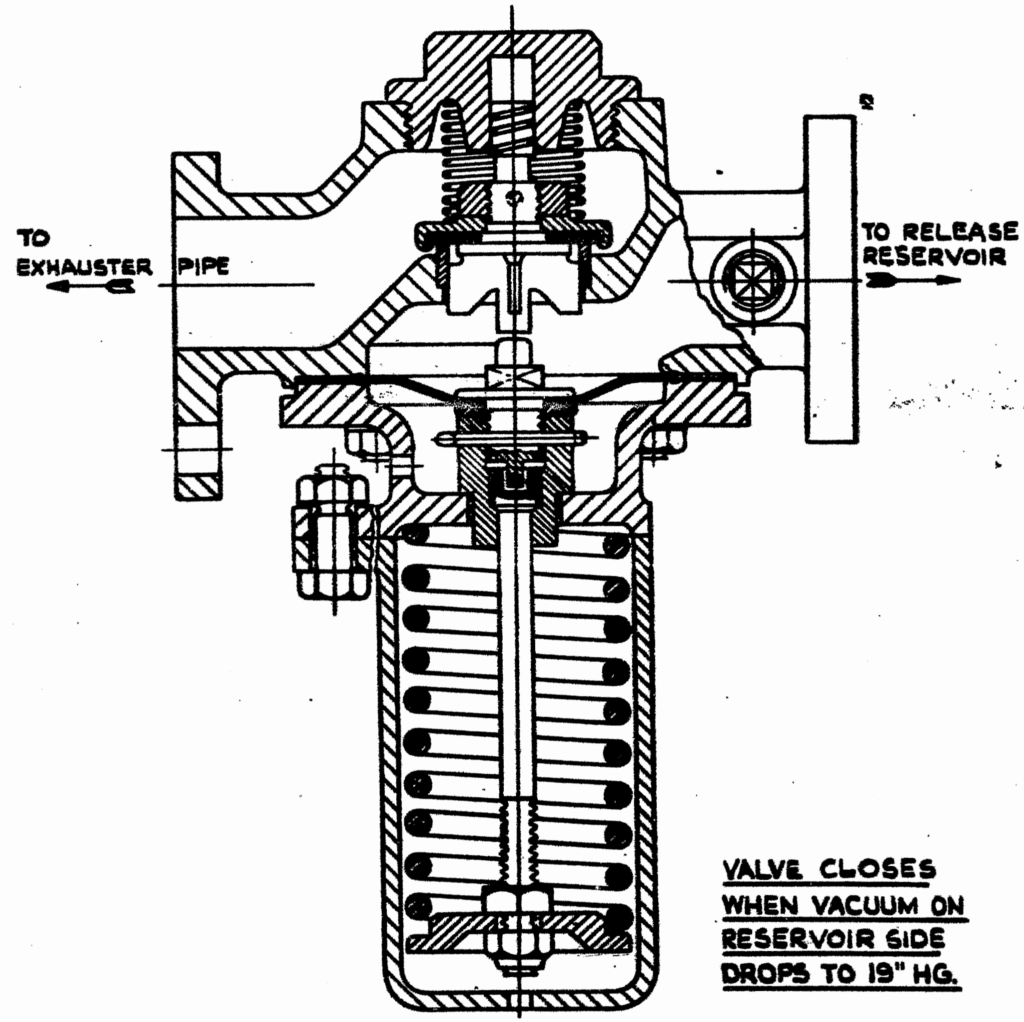


QUICK RELEASE VACUUM BRAKE, DIESEL-MECHANICAL MULTIPLE-UNIT TRAIN

FIG. 34

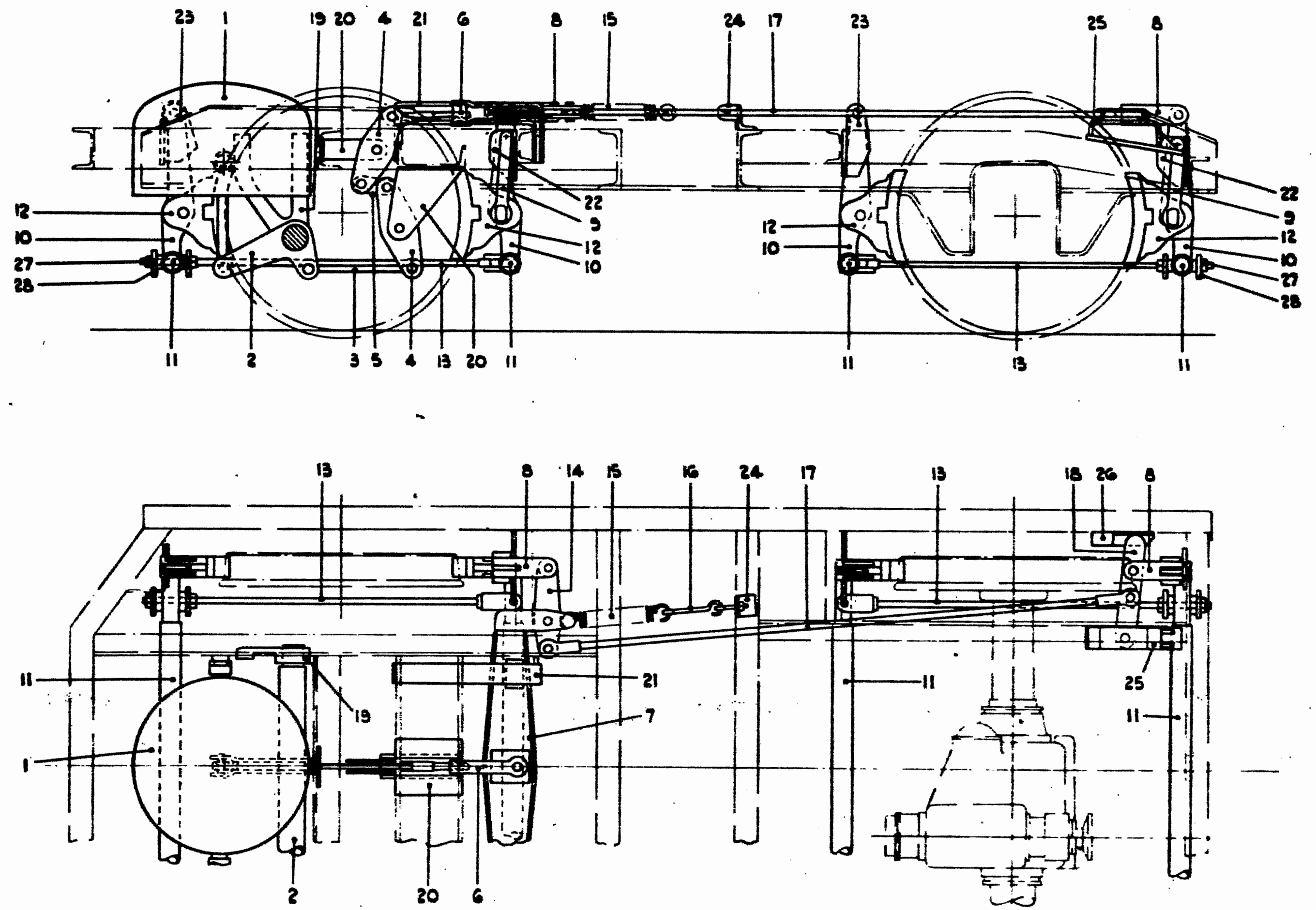


FEED VALVE
FIG. 35(a)



AUTOMATIC ISOLATING VALVE
FIG. 35(b)

FIG.35(a&b)



DESCRIPTION

1. BRAKE CYLINDER
2. BRAKE SHAFT
3. PULL ROD TO BRAKE SHAFT
4. INTERMEDIATE LEVERS
5. CONNECTING LINK
6. SCREW ADJUSTMENT
7. EQUALISING BEAM
8. ADAPTOR
9. SUSPENSION LINK
10. VERTICAL LEVER
11. BRAKE BEAM
12. BRAKE SHOE & HOLDER
13. ADJUSTABLE PULL ROD
14. HORIZONTAL CONNECTING LEVER
15. RELEASE SPRING
16. RELEASE SPRING SHACKLE
17. PULL ROD
18. HORIZONTAL LEVER
19. VEE HANGER
20. INTERMEDIATE LEVER BRACKETS
21. EQUALISING BEAM GUIDE
22. SUSPENSION LINK BRACKET
23. VERTICAL LEVER BRACKET
24. RELEASE SPRING SHACKLE BRACKET
25. HORIZONTAL LEVER BRACKET
26. HORIZONTAL LEVER SUPPORT
27. LOCK NUTS
28. ADJUSTING NUTS

POWER BOGIE BRAKE ARRANGEMENT, DIESEL-MECHANICAL MULTIPLE UNIT TRAIN.

FIG. 33

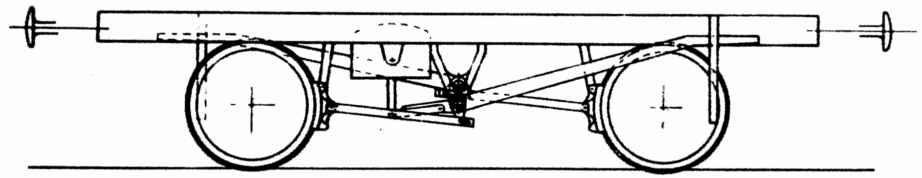


FIG. 37(a) B.R. & W. REGION. PUSH-ROD TYPE. 4 BRAKE BLOCKS.

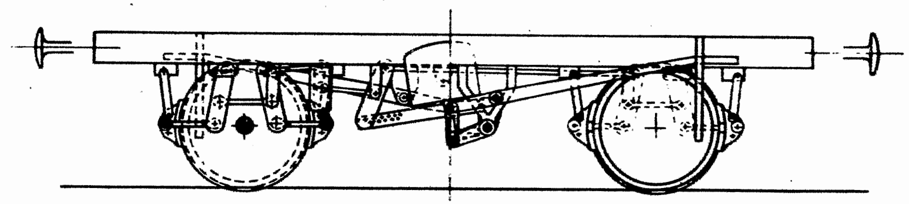


FIG. 37(b) B.R. PALLET VAN. CLASP TYPE. 8 BRAKE BLOCKS.

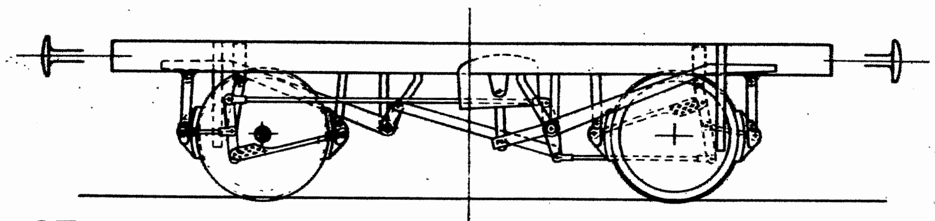


FIG. 37(c) E. & N.E. REGIONS. CLASP TYPE. 8 BRAKE BLOCKS.

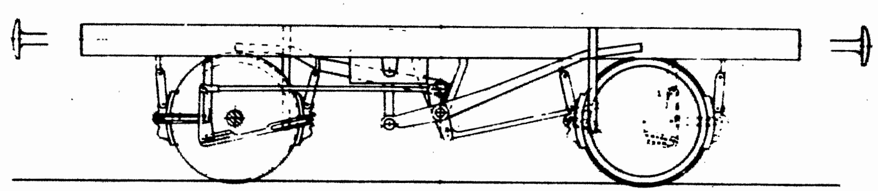
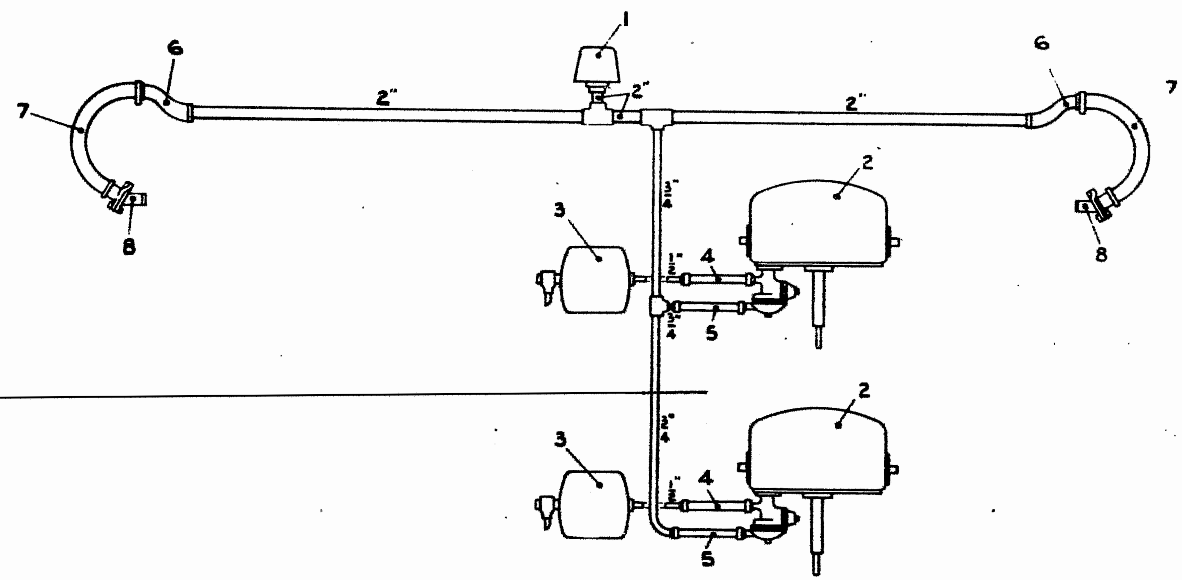


FIG. 37(d) L.M. REGION CLASP TYPE 8 BRAKE BLOCKS

BRAKE GEAR ARRANGEMENTS FOR FREIGHT STOCK.

FIG. 37(a,b,c&d).



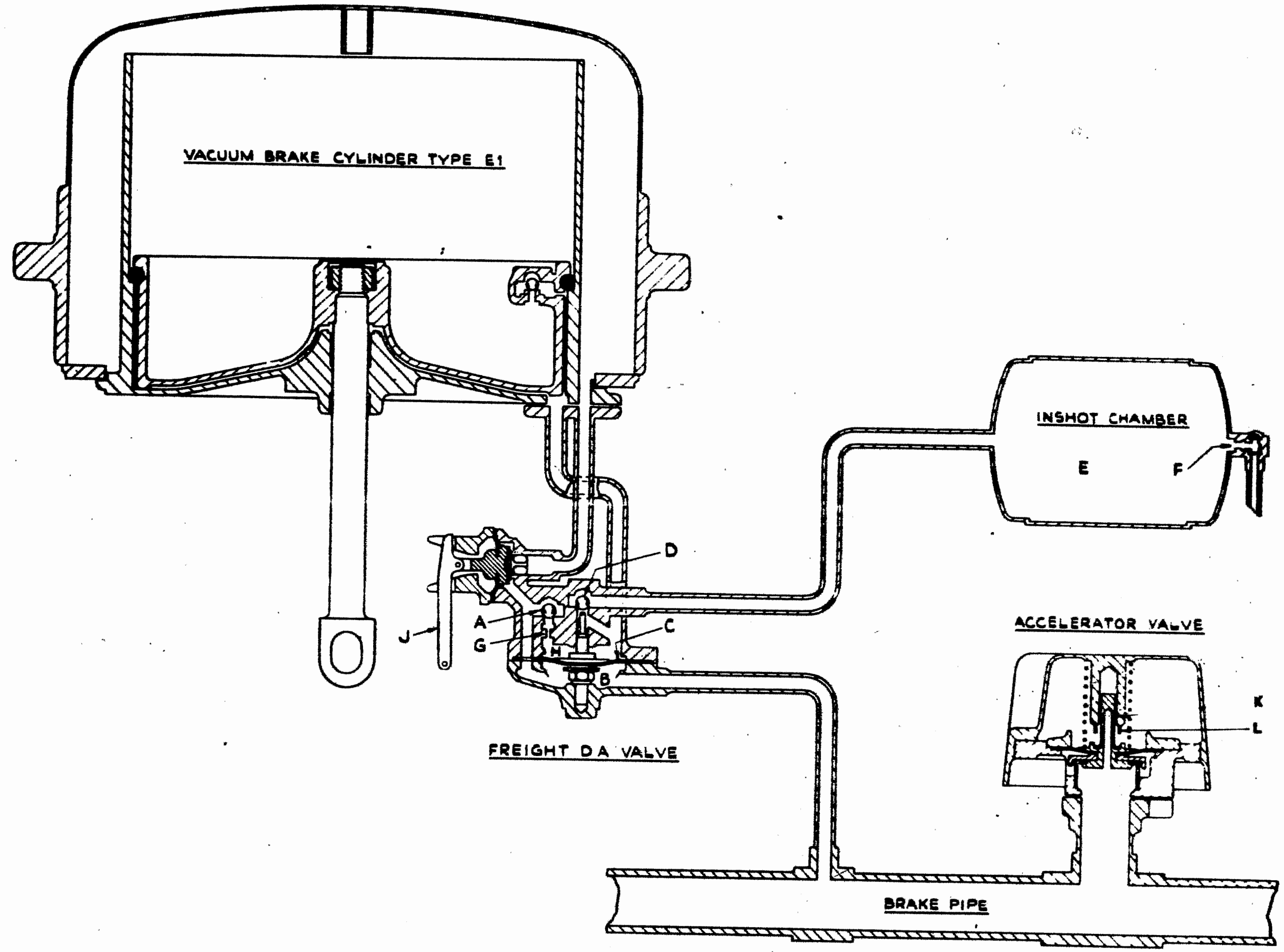
DESCRIPTION

1. ACCELERATOR VALVE
2. BRAKE CYLINDER TYPE E.I. WITH F.D.A. VALVE
3. INSHOT CHAMBER
4. 5/8" HOSE & CLIPS (BRAKE CYLINDER TO INSHOT CHAMBER)
5. 5/8" HOSE & CLIPS (BRAKE CYLINDER TO BRAKE PIPE)
6. 2" C.I. BEND
7. 2" HOSE COUPLING & CLIPS
8. 2" DUMMY COUPLING & CARRIER

A.F.I. SYSTEM, BRAKE PIPEWORK LAYOUT

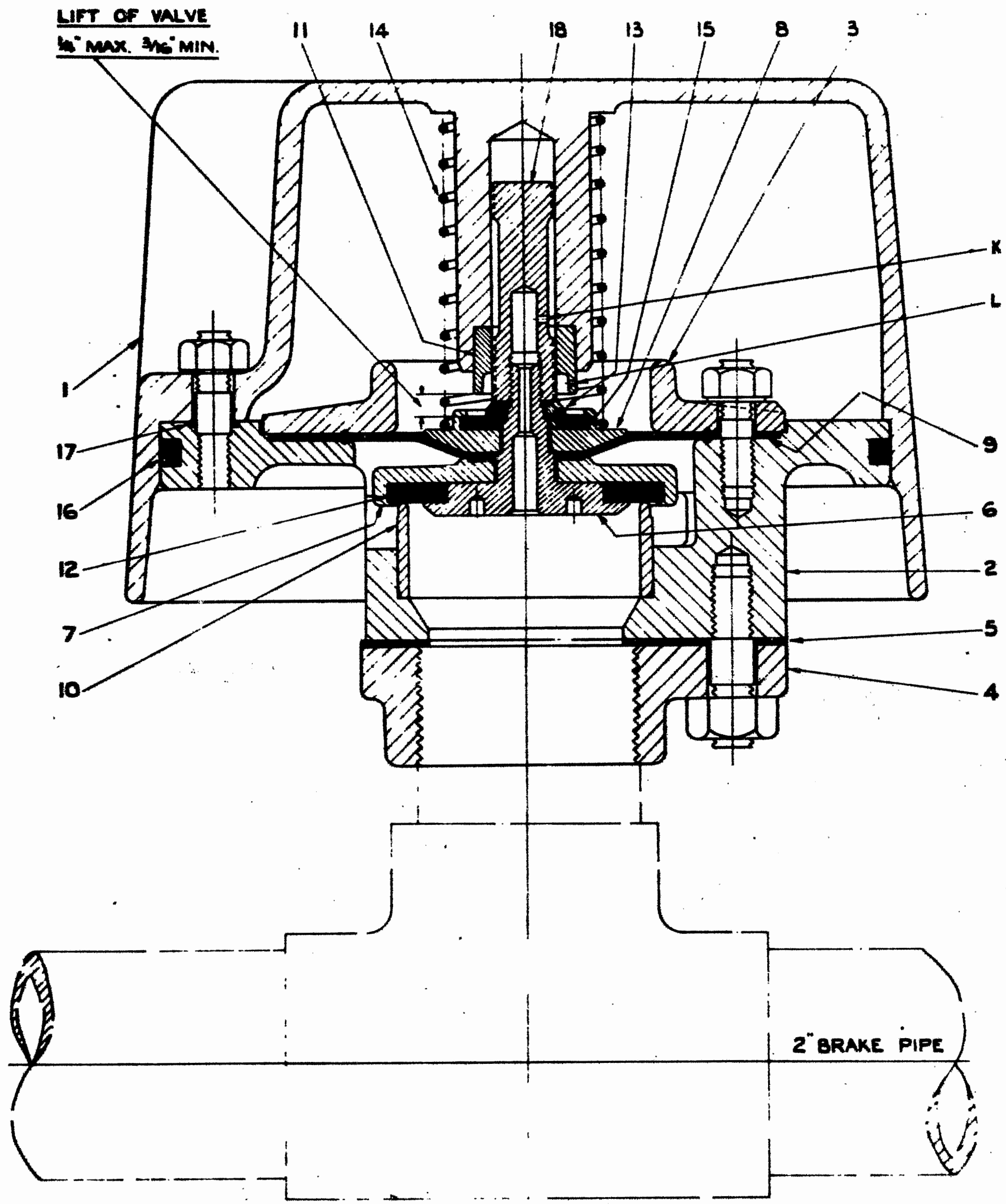
(TWO BRAKE CYLINDERS WORKING TOGETHER)

FIG. 38



A.F.I. SYSTEM

FIG. 39

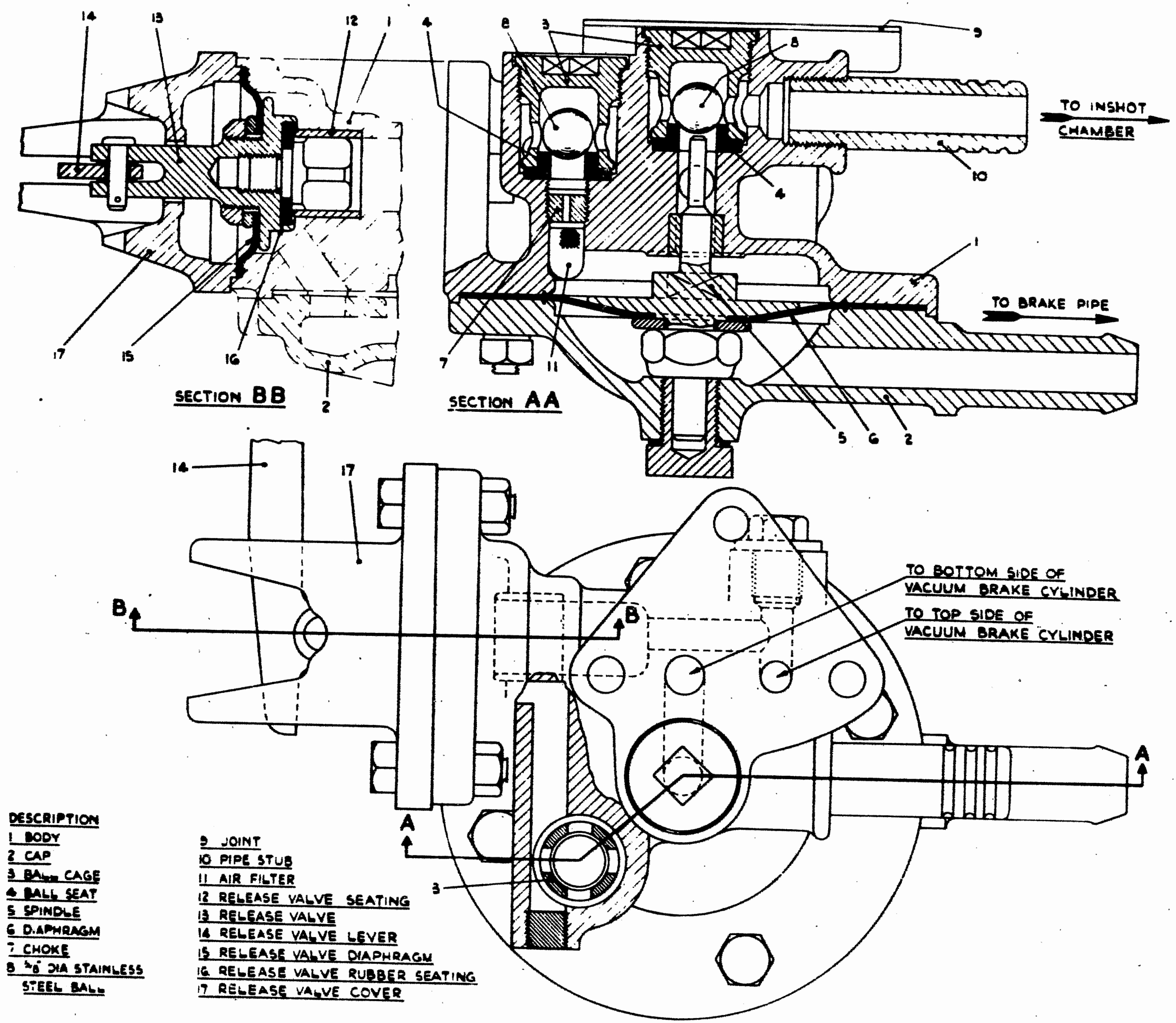


DESCRIPTION

1 CHAMBER
2 BODY
3 DIAPHRAGM PLATE
4 COMPANION FLANGE
5 JOINT
6 VALVE
7 VALVE COVER
8 SPRING LOCATOR
9 DIAPHRAGM
10 SEATING BUSH
11 SEATING BUSH
12 VALVE SEATING
13 WASHER
14 SPRING
15 VALVE SEATING
16 "O" RING
17 "O" RING
18 GUIDE NUT

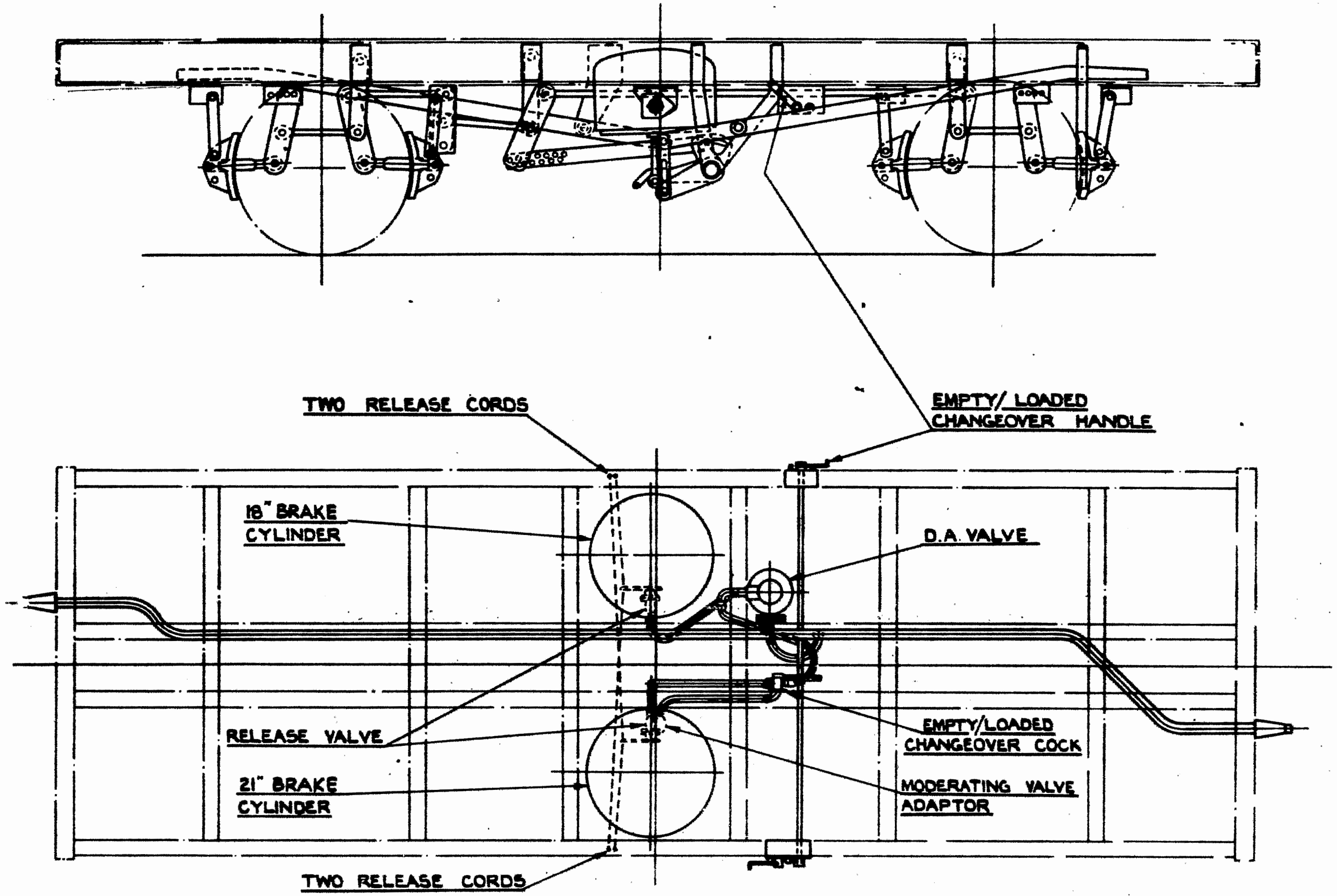
ACCELERATOR VALVE

FIG. 40



FREIGHT D. A. VALVE

FIG 41



PLAN VIEW SHOWING ARRANGEMENT OF PIPEWORK AND EMPTY/LOADED CHANGEOVER.

BRAKE ARRANGEMENT, 21 TON MINERAL WAGON

FIG. 42.

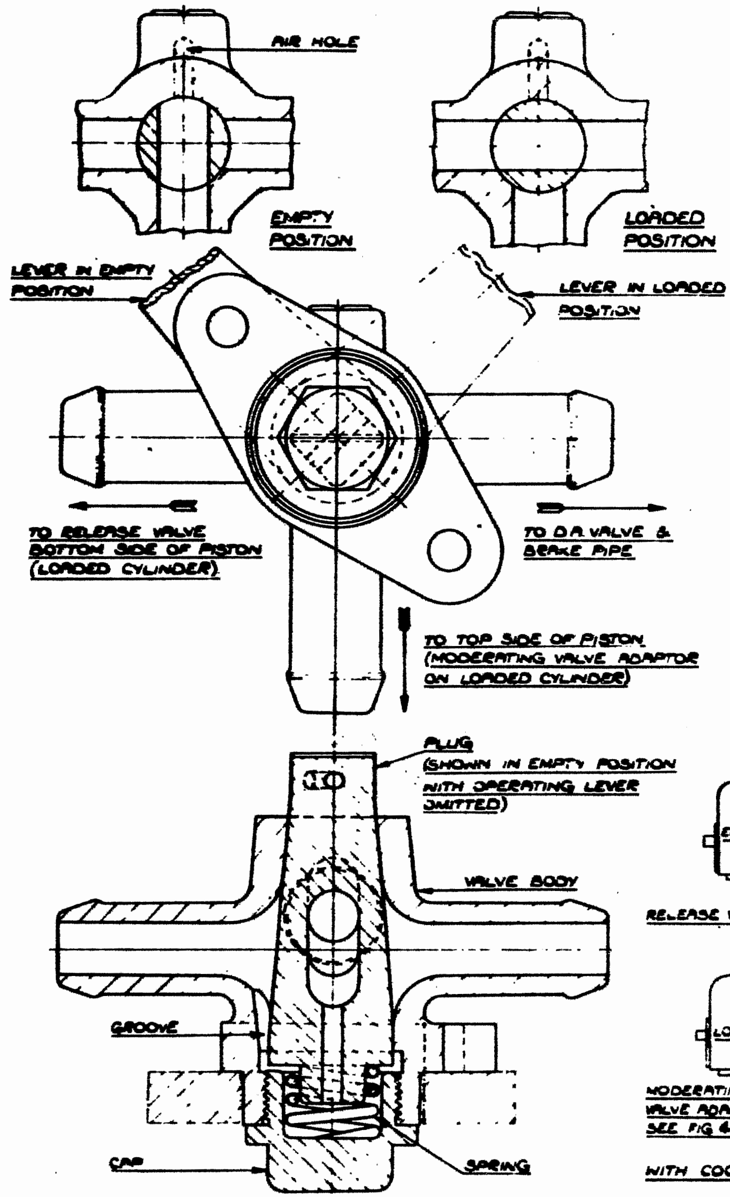


FIG. 43(a) CHANGEOVER COCK.

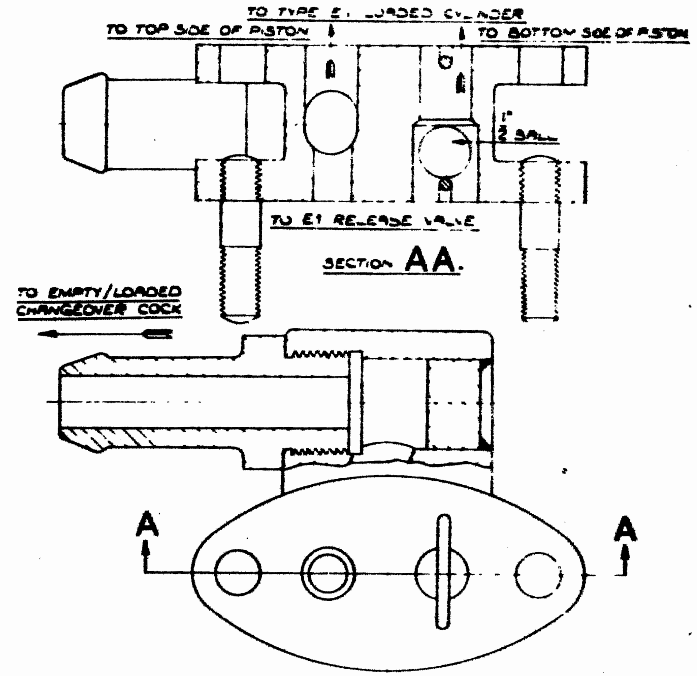
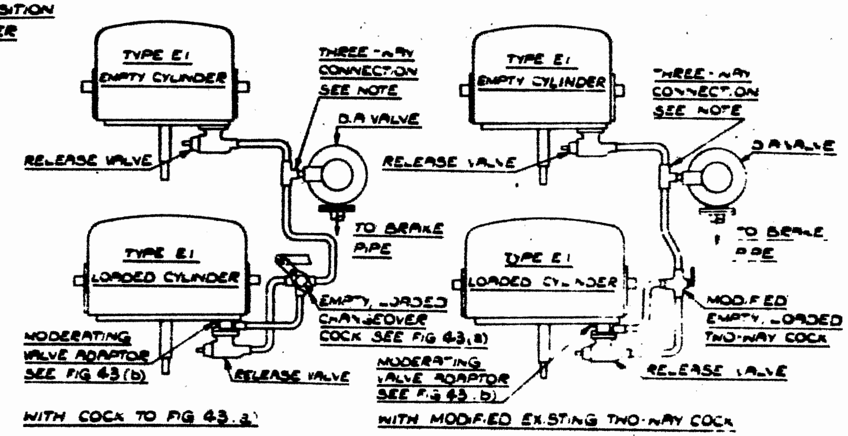


FIG. 43(b) MODERATING VALVE ADAPTOR.



NOTE - WHEN MODERATING VALVE BODY IS USED, BALL TO BE REMOVED.

FIG. 43(c) ALTERNATIVE BRAKE PIPEWORK LAYOUTS.

EMPTY/LOADED CHANGEOVER GEAR

FIG. 43(a, b & c)

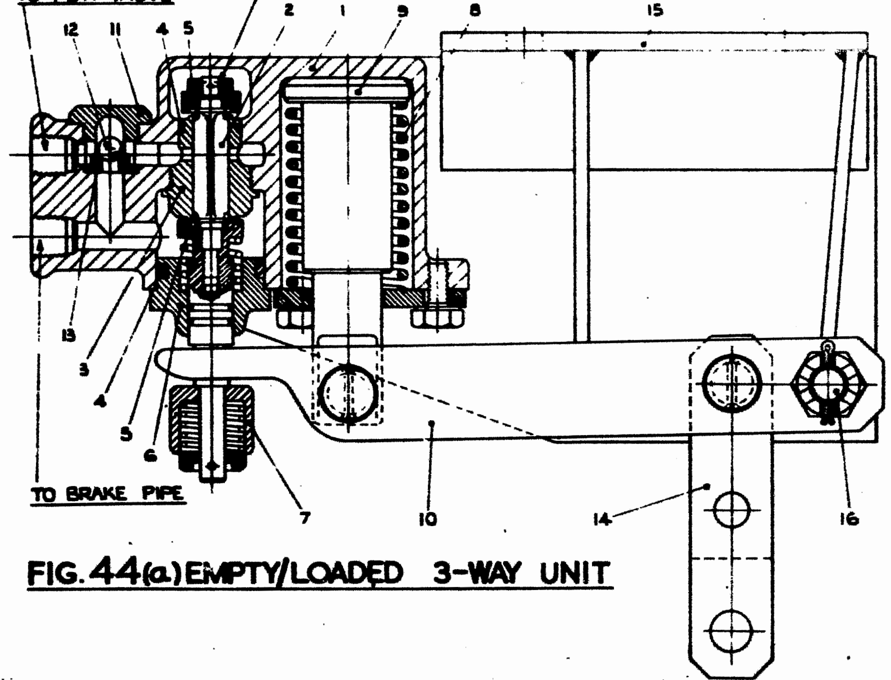
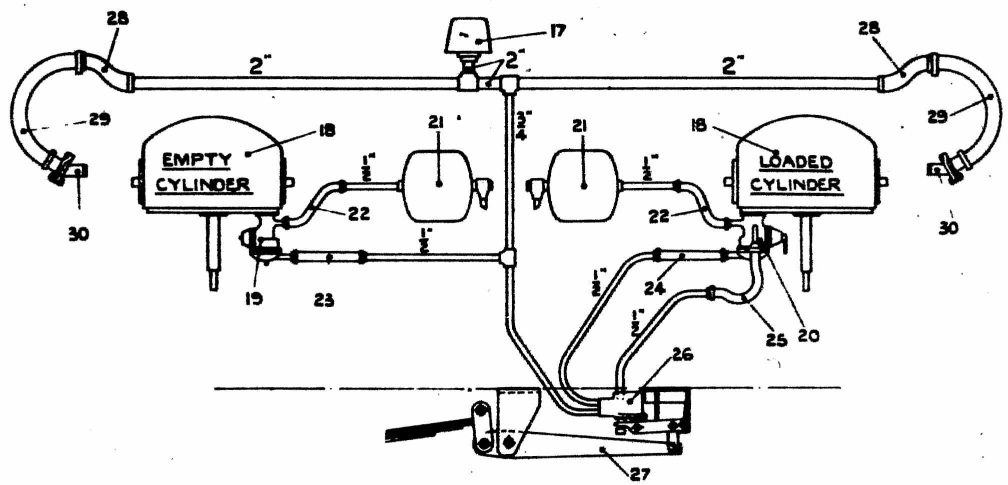


FIG. 44(a) EMPTY/LOADED 3-WAY UNIT

DESCRIPTION

1 VALVE BODY
2 VALVE
3 VALVE SEATING
4 SEALING RINGS
5 VALVE SEAT
6 VALVE SPINDLE GUIDE
7 OVER-RIDE BOX & SPRING
8 BALANCING SPRING
9 PLUNGER
10 VALVE OPERATING LEVER
11 BALL VALVE CAGE
12 BALL VALVE
13 BALL VALVE SEAT
14 CONNECTING LINK
15 VALVE CARRIER BRACKET
16 FULCRUM PIN

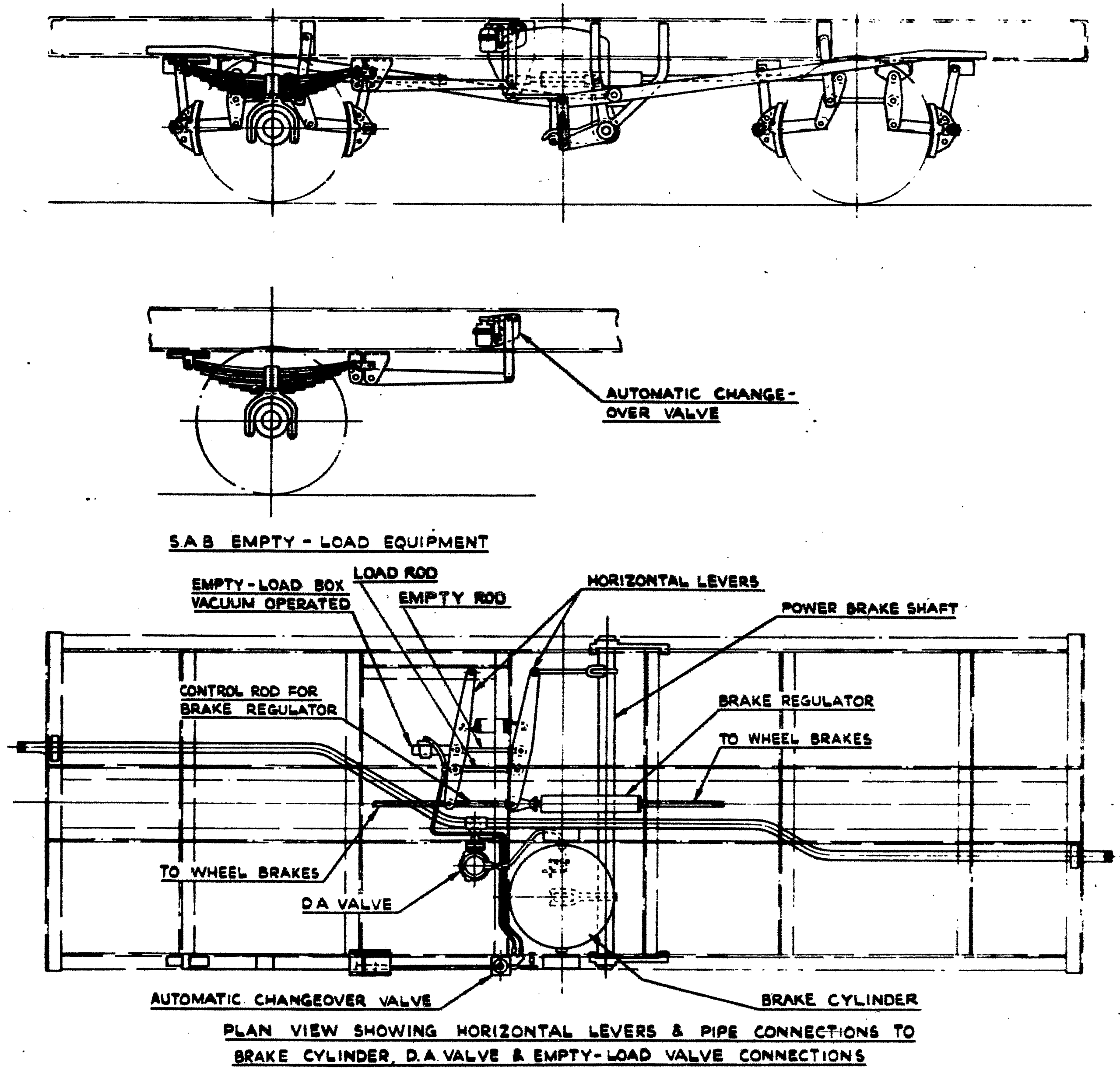


17 ACCELERATOR VALVE
18 BRAKE CYLINDER TYPE E.I
19 FDA VALVE (EMPTY)
20 FDA VALVE (LOADED)
21 INSHOT CHAMBER
22 5/8" HOSE & CLIPS (BRAKE CYL. TO INSHOT CH)
23 5/8" HOSE & CLIPS (FDA VALVE TO BRAKE PIPE)
24 5/8" HOSE & CLIPS (FDA VALVE TO 3-WAY VALVE)
25 5/8" HOSE & CLIPS (FDA VALVE TO 3-WAY VALVE)
26 EMPTY/LOADED 3-WAY UNIT
27 EMPTY/LOADED WEIGHING LEVER
28 2" CAST IRON BEND
29 2" HOSE COUPLING & CLIPS
30 2" DUMMY COUPLING & CARRIER

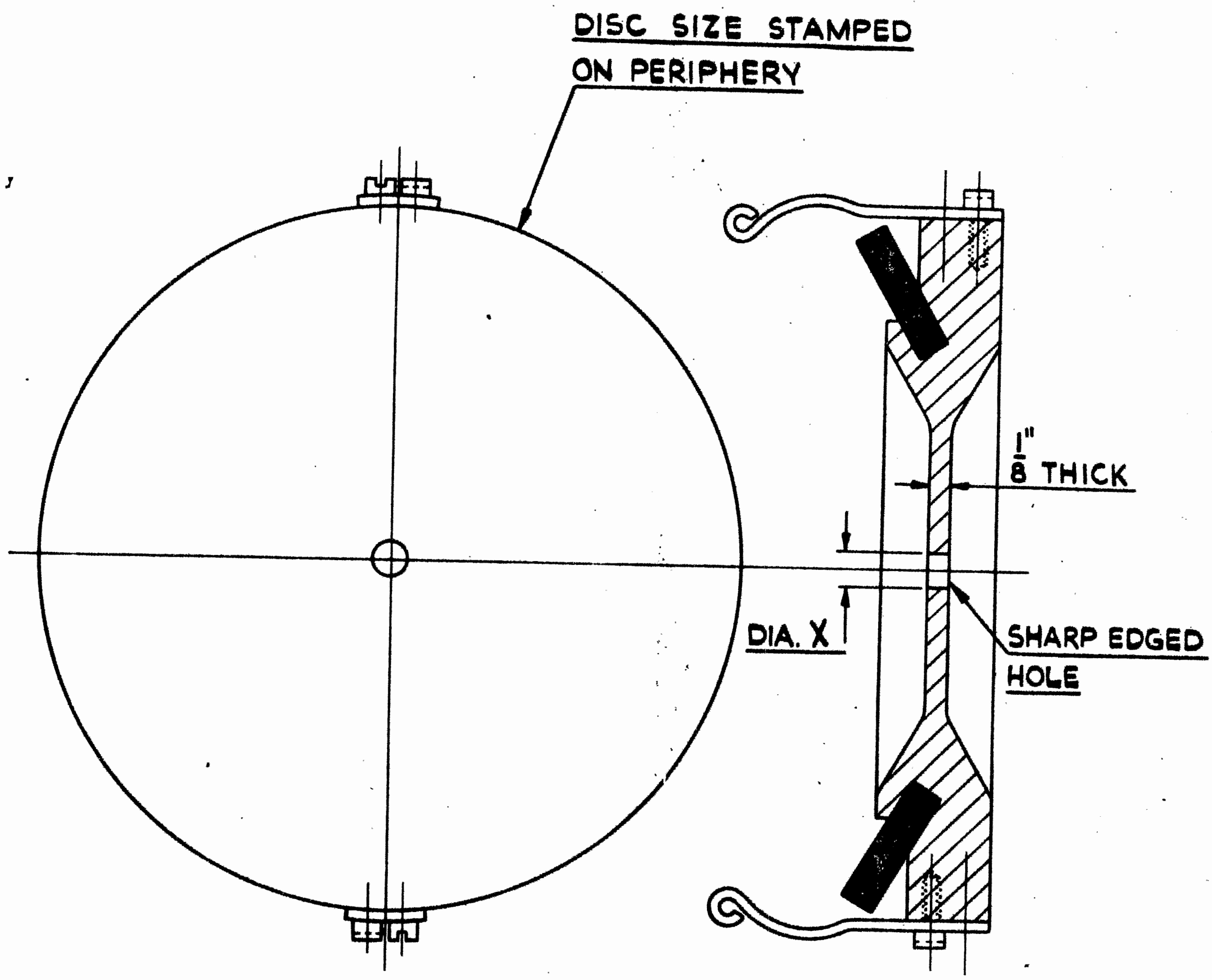
FIG. 44(b) BRAKE PIPEWORK LAYOUT AND EMPTY/LOADED LEVERAGE SYSTEM

AUTOMATIC EMPTY/LOADED CHANGEOVER SYSTEM (G.& C.)

FIG. 44(a & b)



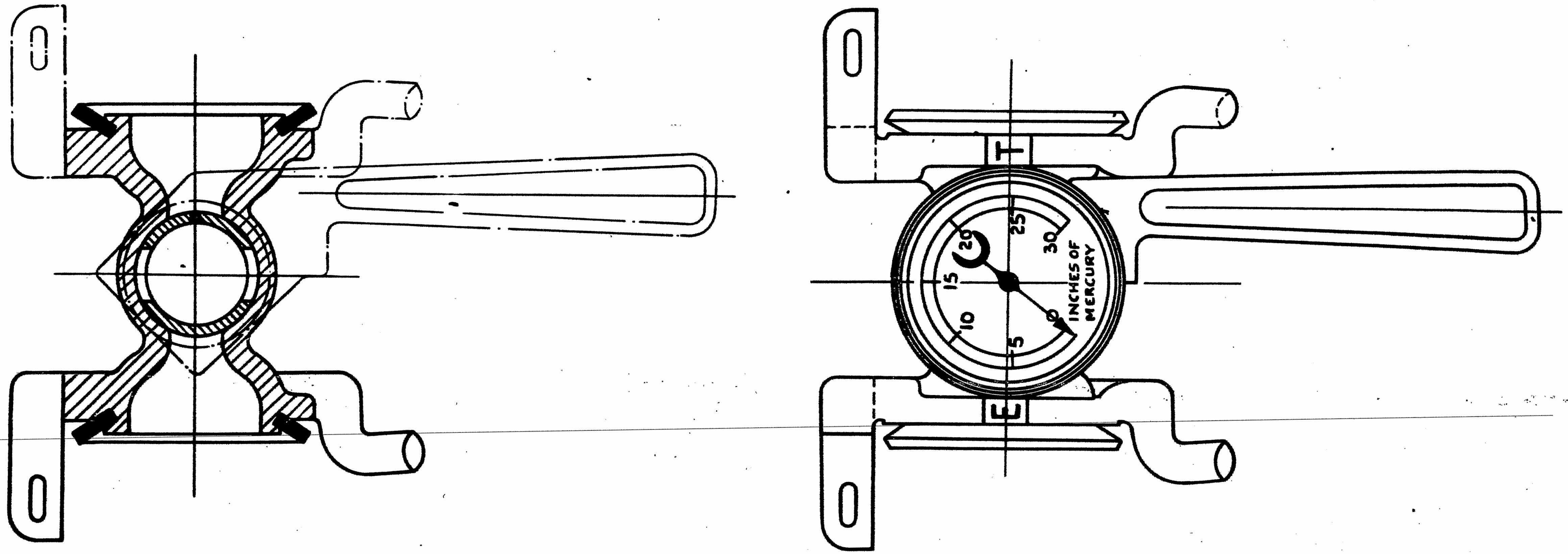
BRAKE ARRANGEMENT, S.A.B. BRAKE WAGON FIG. 45.



USE OF DISC		DIA. X
V.B. TEST IN SERVICE (V.B. REG. Nº 10)	SCHEDULE OF STANDARD EXAMINATIONS	
LOCO. EXHAUSTER OR STEAM LOCO. SMALL EJECTOR	EXHAUSTER AT MAINTAINING SPEED OR SMALL EJECTOR. DIESEL M.U. TRAINS	3/16"
STEAM LOCO. WITH SINGLE EJECTOR	EXHAUSTER/S AT RELEASING SPEED OR LARGE EJECTOR	1/4" (DISC PAINTED RED)

LEAK DISCS

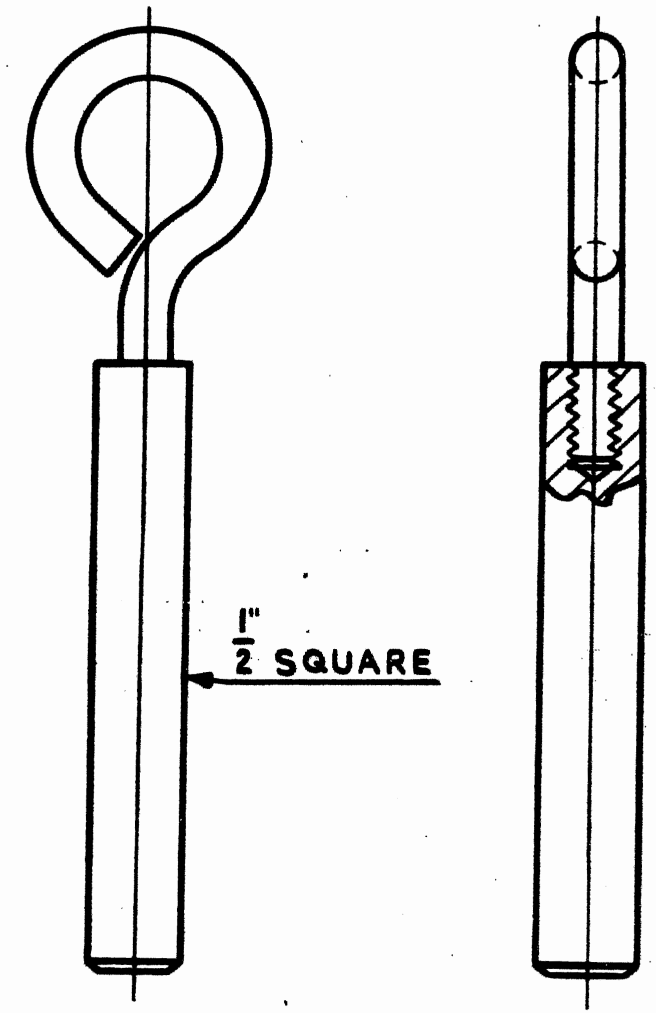
FIG. 47



VACUUM TEST COCK.

FIG. 48

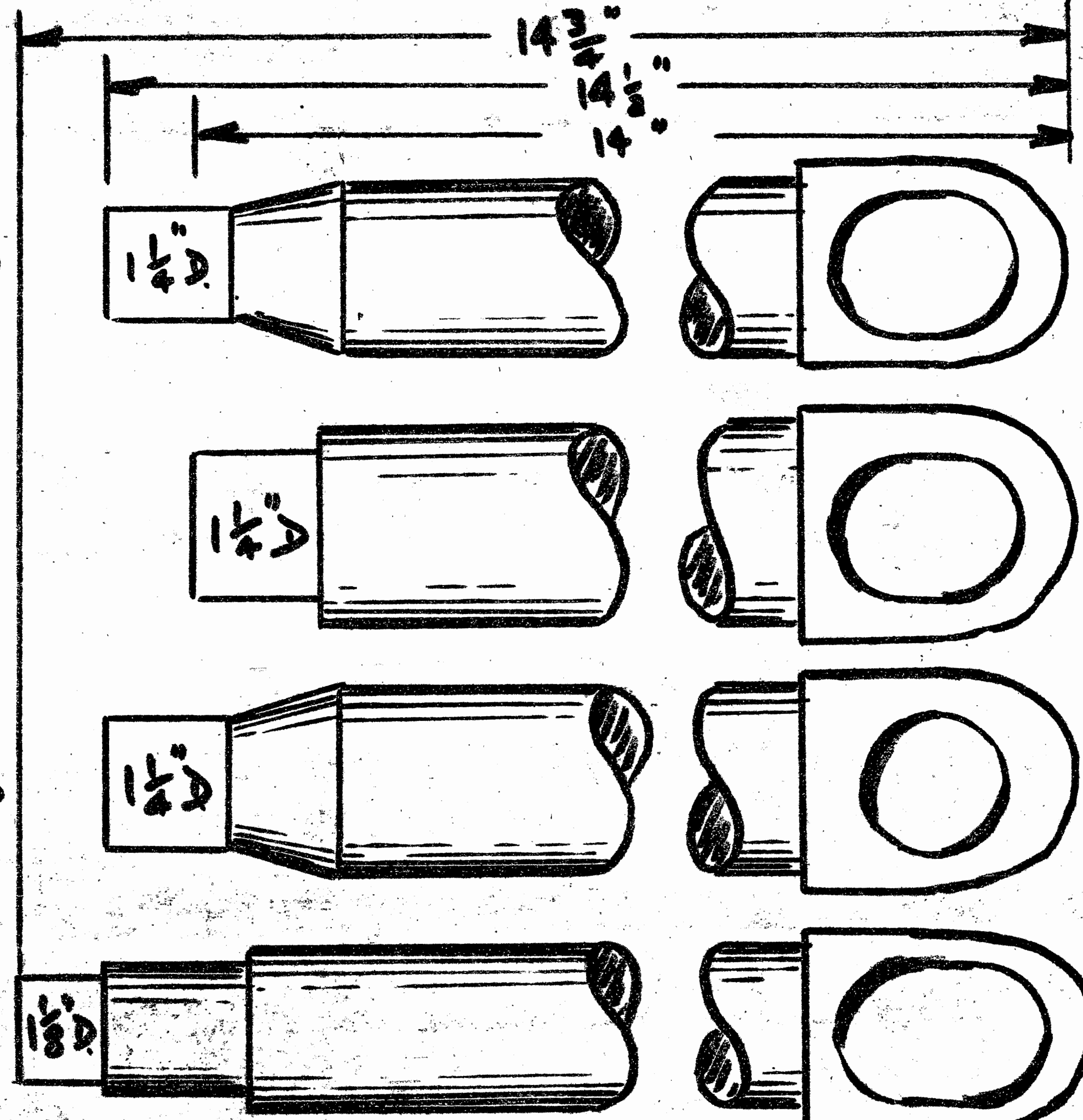
FIG. 48



BRAKE ADJUSTMENT GAUGE.

FIG. 49

FIG. 49



18/43761 22" SL/BAND

19/67700 'C' TYPE R/RING

18/~~43761~~ 47361 18" SL/BAND

19/67701 'E' TYPE R/RING

IDENTIFICATION OF VACUUM CYLINDER PISTON RODS