VICTORIAN RAILWAYS

ROLLING STOCK BRANCH

Instruction Book

ON

The Locomotive BOOSTER

The Locomotive Booster

The capacity of a Locomotive is limited by the load it can start, a greater effort being required to start the train than is necessary once the train is in motion.

The Locomotive Booster is fitted to provide auxiliary power for use at the moment of starting or at slow speed on grades and curves.

The addition of the Booster, therefore, increases the tractive effort and thereby makes possible the starting of additional loading, and to that extent increases the tonnage which can be hauled under normal conditions.

The control of the Locomotive Booster is semi-automatic and is fully described in the succeeding pages. Briefly, however, it is as follows :—

When it is necessary to use the Booster, and after the Booster has been idled and the idling valve placed in running position, the Booster Latch is raised which, making contact with the Reverse Lever Pilot Valve, sets into operation the control system of the Booster. The Booster cuts out automatically when the Reverseing Lever is notched up to a predetermined point of cut off ; or it may be cut out instantly by the enginemen knocking down the Booster Latch. This is necessary in cases of the Booster engine wheels slipping or just before coming to a stop.

There are two types of Boosters in use :—

1. Narrow Gauge type, as fitted to engine No. 110N.

2. C2 type, as fitted to X class engines.

The description of the various parts and their method of working, which is explained fully in the following pages, applies primarily to the C2 type Booster as fitted to " X " class engines, but as the Narrow Gauge type fitted to 110 " N " varies in detail only, these instructions can be regarded as applying to that type also.

A layout showing the position of the various parts comprising a Booster installation on an "X" class engine is shown in Fig. 1.

GENERAL DESCRIPTION.

The Locomotive Booster is a horizontal two cylinder steam engine mounted on the Trailing Truck and connected directly to the Trailing Truck Axle through suitable gearing by which it may be engaged or disengaged at will.

The Booster is designed for applying power to the Trailing Truck wheels in the FORWARD MOTION ONLY.

The Booster is operated by superheated steam taken from the steam chests of the Locomotive and is controlled by, and responds to, the varying openings of the Locomotive Regulator. The steam, after being used in the Booster cylinders, is exhausted either through the blast pipe or by a pipe attached to the top of the boiler behind the funnel as shown in Fig. 1. The steam pipes, both inlet and exhaust, are fitted with Ball Joints in order to obtain the necessary flexibility.

The Booster is self-contained and has a flexible mounting in the form of a three-point suspension. The bearings around the Trailing Truck axle are two of the points, while the third is a spherical seat at the centre of the cross member of the Trailing Truck Frame.

The Booster Control System is operated by air from the Main Reservoir air line.

Briefly the air control system functions as follows :—

With the Idling valve handle in the Up or "Idling" position, air from the brake valve or main reservoir is allowed to pass to and open the preliminary throttle valve which allows saturated steam to pass down the main Booster steam pipe and idle the Booster over without bringing the gears into mesh.

With the Idling valve handle in the Down or "Running" position, when the latch is raised to cut in the Booster, air passes from the brake valve or the main reservoir line through the reverse lever pilot valve and simultaneously to the clutch cylinder (which carries the idler gear into meshing position) and to the preliminary throttle valve. After the preliminary throttle valve has opened, a small amount of steam passes to the Booster engine for turning it over slowly to mesh the gears and to apply a slight torque to the trailer axle. When the gears are fully in mesh, air passes through the clutch cylinder and the two top ports of the dome pilot valve to the throttle operating cylinder which opens the Booster throttle. After the locomotive regulator has been opened and sufficient steam pressure has built up in the Booster steam inlet pipe to open the dome pilot valve, air passes also through the third port of this valve and the timing reservoir to the cylinder cock operating cylinders which close the cylinder cocks.

When the latch is knocked down to cut out the Booster, the air supply from the brake valve or the main reservoir line is cut off at the reverse lever pilot valve and the air in the entire control system is released to the atmosphhere through ports in the reverse lever pilot valve, clutch cylinder and dome pilot valve, allowing all control parts to return to release position with the gears out of mesh.

BOOSTER ENGINE.

The Booster engine is built on a steel casting which forms the three points upon which the Booster is carried and within which the principal moving parts are assembled.

Fig. 2 shows the Booster engine with cover plates and casing top removed.

The engine bed, together with the casing, frames

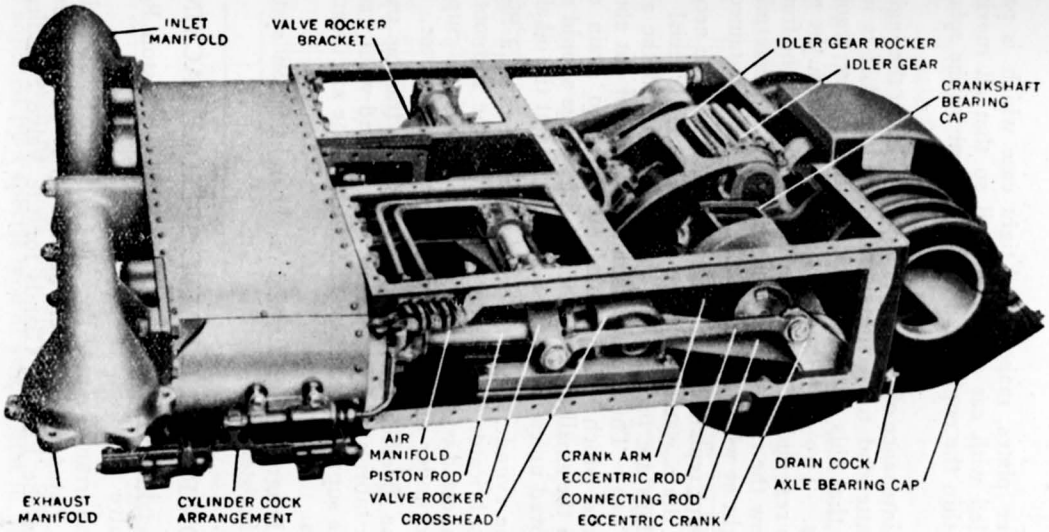


Fig. 2. *Type C-2 Booster Engine; Cover Plates and Casing Top Removed*

and cover plates, make an oil-tight case which is partially filled with car and wagon oil so that all moving parts within the engine bed are lubricated by the splash system.

Maintenance of the proper supply of oil in the engine bed is attended to at the running shed, and it is important that this should be given attention at regular intervals. Two oil filling caps are provided on the top near the rear end, and two oil overflow cocks at the front, just below the trailing axle (one on each side), determine the height at which the oil level should be maintained.

Before replenishing the oil supply, it may be necessary to drain water from the engine bed. Special oil drain plugs are provided in the crank pit and the axle bearing cap. These plugs should be screwed out about two turns which will permit any water to drain out through the small holes in them. The plugs should not be removed unless it is necessary to drain out the oil also.

The cylinders and valves are lubricated by a Sight Feed Lubricator located in the cab of the locomotive and connected with the Booster steam inlet pipe. Superheater cylinder oil must be used in this lubricator.

The Booster main bearings on the trailing truck axle are lubricated by car and wagon oil and wool waste, which is supplied and inspected through the axle bearing cap lids.

A Diagram, Fig. 20, shows the lubrication system of the Booster.

PISTON ROD AND VALVE SPINDLE PACKING.

Metallic packing is used on both the Piston Rods and Valve Spindles.

The arrangement of Packing Gland and Swab Holder for the Piston Rod is as shown in Fig. 3. The arrangement of the Packing Glands for the Valve Spindles is similar.

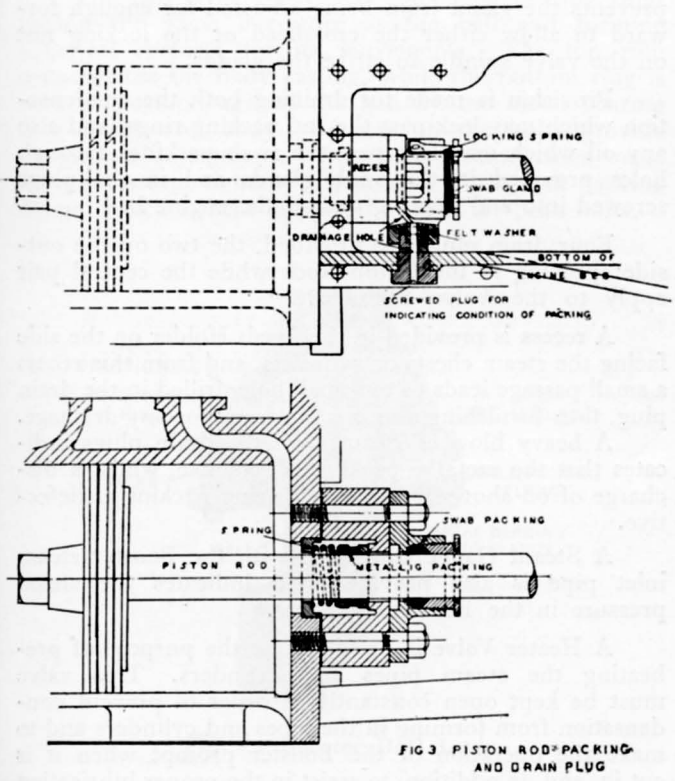


Fig. 3.—Diagram of Piston Rod Packing and Drain Plug.

The swab packings are held in place in the holders and adjusted by a special type of swab gland in the form

of a nut, screwed into the swab holder and held in adjustment by a locking spring. The locking spring prevents the gland from being adjusted far enough forward to allow either the crosshead or the locking nut on the valve spindle to strike the glands.

Provision is made for draining both the condensation which may leak past the rod packing rings, and also any oil which may leak past the swab packings through holes provided in the swab glands and in the plugs screwed into and jointing against the engine bed.

Four drain plugs are provided, the two on the outside applying to the Piston Rods while the central pair apply to the Valve Spindles.

A recess is provided in the Swab Holder on the side facing the steam chests or cylinders, and from this recess a small passage leads to the small hole drilled in the drain plug, thus furnishing a means of escape for any drainage.

A heavy blow of steam from the drain plugs indicates that the metallic packing is defective, whilst a discharge of oil shows that the swab ring packing is defective.

A Steam Gauge connected with the Booster steam inlet pipe is also provided and indicates the steam pressure in the Booster cylinders.

A Heater Valve is provided for the purpose of preheating the steam pipes and cylinders. This valve must be kept open constantly in order to prevent condensation from forming in the pipes and cylinders and to make the operation of the Booster prompt when it is cut in, and, in addition, to assist in the proper lubrication of the cylinders and valves.

STEAM PIPING AND BALL JOINTS.

In order to permit the necessary flexibility, the steam pipes, both inlet and exhaust, are fitted with Ball Joints.

Fig. 4 shows the details of the Ball Joint.

The ball is held between two metal bearing rings having the same curvature as the ball and forming spherical surfaces for its movements. The top ring rests against the body casting, while the bottom ring is held in position against the ball by the metal bearing ring flange and body. Spacers on the bolts provide for proper adjustment. Two ball packing rings make the joint steam tight by adjustment of the ball packing flange, which is held in place by three tee-head bolts.

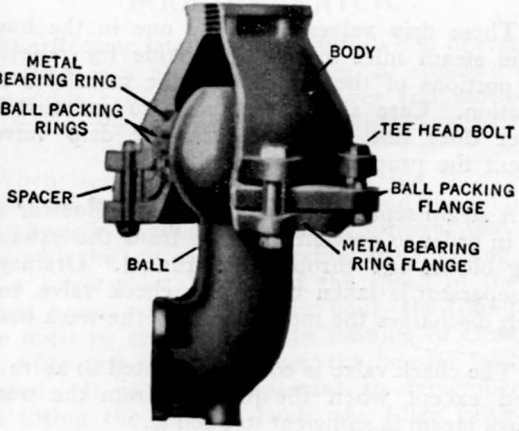


Fig. 4. Booster Ball Joint

Careful adjustment is essential to prevent leakage and at the same time to allow free movement of the ball. Adjustment should not be made when the joints are cold, but should be made after the Booster has been idled

sufficiently to HEAT THE JOINTS to the temperature they will have when the Booster is operated in service.

The packing ring is to be of such a length that an opening of $\frac{3}{8}$ in. is provided for when the packing is in position on the ball.

A boss is cast on the angle ball and tapped with a standard $\frac{3}{8}$ in. pipe tap. Automatic drip valves are screwed into these tapped holes on the balls which connect to the manifolds, while the holes are closed with pipe plugs on the balls used on the front ends of the short horizontal steam and exhaust pipes.

These drip valves, with the one in the low point of the steam inlet manifold, provide for relieving the rear portions of the piping and the manifolds of condensation. Care should be taken to see that foreign matter does not accumulate in the drip valves and prevent the proper seating of the balls.

A steam separator is located on the Booster exhaust pipe in order to prevent moisture from the exhaust pipe being blown out through the funnel. Drainage from the separator is taken through a check valve and pipe which discharges the moisture on to the track bed.

The check valve is counterweighted so as to remain closed except when the pressure from the water and exhaust steam is sufficient to open it.

A drain pipe is also provided on the Booster steam pipe. It is situated just behind the smoke box and leads from the Booster steam pipe to the steam chest.

A cylinder cock cut-out cock, located in the cab, is provided so that the cylinder cocks may be opened by hand after they have been closed automatically by air pressure in the control system.

BOOSTER CONTROLS.

The compressed air for the Booster controls is taken from the main reservoir and is used to perform three operations—engage the gears, open the preliminary and main throttles and close the cylinder cocks.

The various devices by which this is accomplished are explained in detail in the following pages, and a study of the operation of each separate part of the control system should be made before attempting to become familiar with the system as a whole.

BOOSTER LATCH.

The Booster latch, which controls the operation of the Booster, is a hinged latch (Fig. 5) attached to the indicator block of the reversing lever and moves with the block as the engine is notched up.

When it is necessary to operate the Booster, and provided the booster has been idled, and the engine reversing lever is in such a position in foregear that it will engage with the lug on the operating shaft leading to the Reverse Lever Pilot Valve and the speed of the train is not in excess of 12 miles per hour, the Idling valve handle must be returned first to running or close position. After this has been done, the booster latch may be raised. It is most important to remember that before lifting the Booster latch, the Idler valve must be cut out. If this is not done, the Locking Device in the Reverse Lever pilot valve will prevent the operation of the Booster.

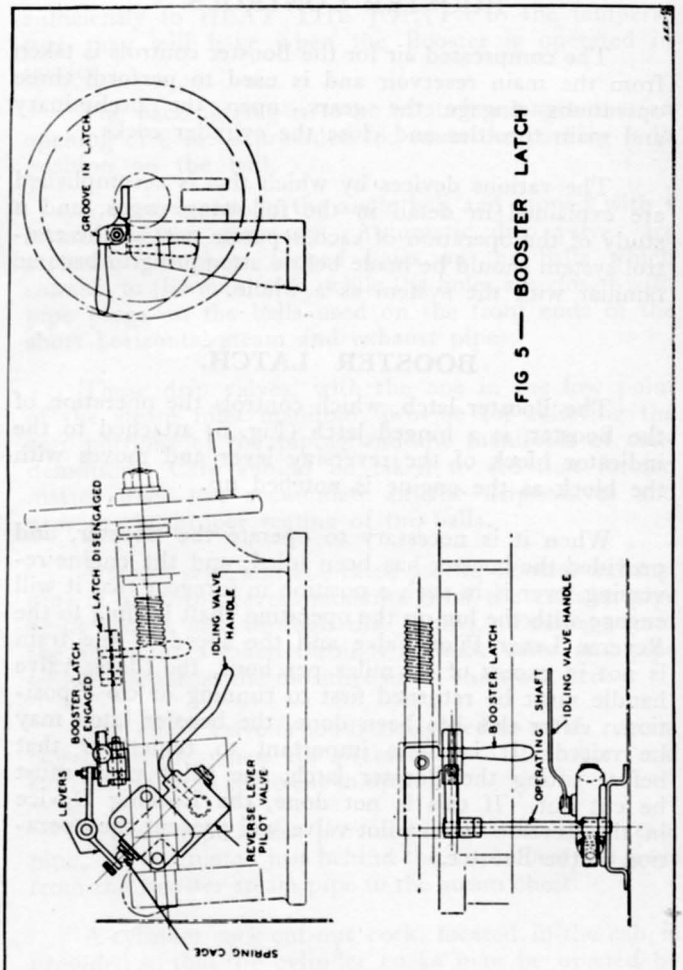


Fig. 5.—Booster Latch.

The lifting of the Booster latch causes the lever and shaft connected to the spring cage of the reverse lever pilot valve (Fig. 6) to come into contact with the grooved portion of the top of the Booster latch. The lever then operates the spring cage and air is admitted to the control system and the Booster becomes engaged.

The latch automatically falls back when the reversing lever, in the action of notching up, reaches the predetermined point of cut off. The latch must be knocked down when the speed exceeds 20 miles per hour, as this is the maximum speed at which the Booster is allowed to operate.

REVERSE LEVER PILOT VALVE.

The Reverse Lever Pilot valve (Fig. 6) situated against the side ofthe cab on the left hand side is operated by raising or lowering the Booster latch.

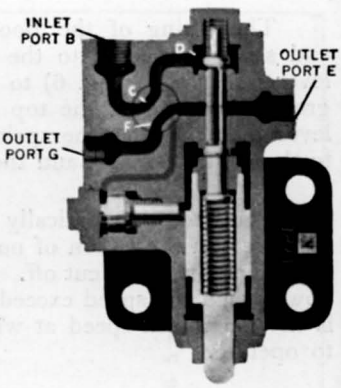
The purpose of the reverse lever pilot valve is to :

(a) Admit a supply of air into the control system of the Booster when the latch is raised.

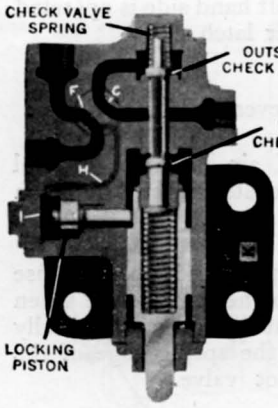
(b) Shut off the air supply and open release port A, Fig. 6, to the atmosphere when the latch is manually or automatically disengaged from the spring cage of the reverse lever pilot valve.

(c) Provide for idling the Booster from the cab by means of the Idling valve which is incorporated in the body of the pilot valve.

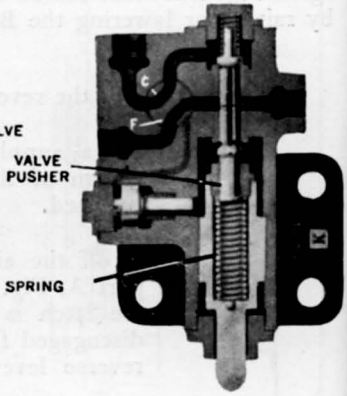




Application



Idling



Release

Fig. 6. *Type C-2 Booster Reverse Lever Pilot Valve*

The words " Idling Valve " are cast on the handle and the words " Running Position " and " Idling Position " are cast on the body as shown in Fig. 6. The sectioned views show the positions of the several parts when the valve is set for idling, application or release.

When there is air pressure on the reverse lever pilot valve, the indicator block of the reversing lever, Fig. 5, must be in or near the corner in the forward position, and the idling valve must be in the running position, Fig. 6, in order to raise the latch.

Application.—Idling Valve in Running Position.—When the Booster latch is raised the spring cage is moved, causing the inside check valve to close, thus preventing communication with the atmosphere through release Port A. Simultaneously the outside check valve is opened and main reservoir pressure flows through inlet Port B, Port C in the plug of the Idling valve, to chamber D, and to outlet Port E ; also through Port F in the plug to outlet Port G.

Release.—Idling Valve in Running Position.—When the latch is manually or automatically disengaged from contact with the spring cage, the valve pusher spring returns the spring cage to its release position. The check valve spring closes the outside check valve, shutting off the flow of air from the main reservoir, and opens the inside check valve, which latter allows the air in the lines to the preliminary throttle valve and to the clutch cylinder to exhaust to the atmosphere through release Port A.

Idling.—Idling Valve in Idling Position.—When the Idling valve is placed in the idling position, communication with chamber D above the outside check valve is shut off, as will be noted in the illustration. It will also be noted that Port F in the plug of the Idling

valve allows the main reservoir pressure to flow directly from inlet Port B to outlet Port G. Air also flows from Port F through the small port in the plug and Port H in the body of the valve into chamber I back of the locking piston. The piston then moves to its seat, carrying the end of its stem over the shoulder of the spring cage, which prevents movement of the cage by the latch should an attempt be made to cut in the Booster while it is idling.

When the Idling valve is placed in running position, the air chamber I flows through Port H and exhausts to the atmosphere through the small port in the plug of the Idling valve. The locking piston spring moves the piston and its stem back to release position.

The purpose of the valve pusher and spring is to prevent a positive pressure of the valve pusher retaining nut against the head of the inside check valve and also to make close adjustment of the Booster latch unnecessary.

As noted above, the Idling valve must be in running position in order to raise the latch to operate the Booster in the normal manner.

The Idling valve, which is incorporated in the body of the reverse lever pilot valve, as shown in Fig 6, provides for conveniently idling the Booster from the cab. NO ATTEMPT MUST BE MADE TO CUT THE BOOSTER IN WHEN THE IDLING VALVE HANDLE IS IN THE "IDLING POSITION."

The primary purpose of the Idling valve is to provide a means for warming the Booster cylinders and pipes and freeing them of water prior to cutting in the Booster.

The Booster should be idled for two or three minutes, after which it may be cut in upon placing the Idling valve in running position and raising the latch.

It is advantageous to idle the Booster at every opportunity before cutting in. This is very evident at times when the locomotive has been standing in the engine-shed or when starting the train from the terminal or station stops, but it may not be considered as important at other points on the run, such as when approaching a grade. It is particularly advantageous at this time, since the quick response with full Booster power is wanted when it is cut in. This is obtained if the Booster has been idling while approaching the grade, as the cylinders and pipes will have been warmed and the steam from the preliminary throttle valve will be sufficient to turn the Booster over fast enough to allow the gears to mesh properly at the running speed of the locomotive when the Booster is cut in.

Another advantage from idling is gained by having lubricated the valves and cylinders before the Booster goes into regular service operation.

The Preliminary Throttle Valve is designed to admit a limited amount of steam to the Booster cylinders when the latch is raised. This valve provides :

(a) For turning the Booster over, so that the Idler gear and trailing truck axle gear will match, permitting the Idler gear to be pulled down completely into mesh by the action of tooth pressure when locomotive is stationary.

(b) For turning the Booster over, at a speed in excess of the speed of the trailing truck axle gear, when the locomotive is moving in the forward direction at a

speed not in excess of 12 m.p.h., thus providing sufficient tooth pressure to pull the Idler gear completely into mesh.

(c) A safe means of idling the Booster for inspection.

Air is piped directly from the outlet port G of the reverse lever pilot valve to the cylinder head of the pre-

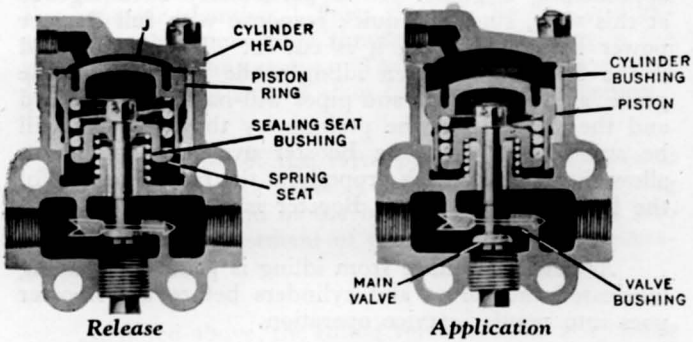


Fig. 7. Type C-2 Booster Preliminary Throttle Valve

liminary throttle valve, Fig. 7. Steam passes through the body of the valve in the direction of the arrow.

When the latch is raised, air flows to chamber J, forcing the piston down to its seat in the cylinder bushing, compressing the two springs and carrying the sealing valve of the spring seat to its seat. The main valve is opened against the steam pressure, in which position it will remain as long as the latch is raised, or when the Idling valve is in the idling position.

After leaving this valve the steam passes through a choke, having a $\frac{1}{2}$ in. drilled hole, at the Booster steam inlet pipe. This choke serves to throttle the steam admitted to the Booster, to provide for the operations outlined in paragraphs a, b and c.

When the latch is manually or automatically disengaged from the spring cage of the reverse lever pilot valve, air pressure on the piston is released to the atmosphere through release port A in the reverse lever pilot valve and the piston is returned to its release position by the large spring, while the small spring closes the main valve which shuts off the supply of preliminary steam to the Booster.

The bronze piston, fitted with bronze ring, moves in a bronze bushing. The joining surface on the piston seals against the seat in the bushing, thus preventing escape of air which may leak past the ring. The two tapped holes in the piston provide for its easy removal.

A small port in the front of the valve body allows any steam which may leak past the sealing valve of the spring seat to exhaust to the atmosphere, thus providing for the correct operation of the valve.

It is of utmost importance when assembling, that the parts be kept free from dirt, scale, etc., and that the main valve and the spring seat are true and in line.

The Clutch Cylinder is operated by air pressure to carry the Idler gear into position for meshing with the axle gear and out of mesh with the axle gear.

Fig. 8 shows the release position of the clutch cylinder, the idler gear being out of mesh with the trailer axle gear ; while Fig. 9 shows the application position, the idler gear being in mesh with the axle gear.

The clutch cylinder operates to :

(a) Carry the Idler gear into position for meshing

with the axle gear, close ports K in the cylinder bushing to the atmosphere, and to open ports L in the bushing to allow the air to pass to the throttle operating cylinder after the Booster latch has been raised. The action of tooth pressure, proportional to the power of the Booster, holds the gear in mesh without further assistance from the clutch cylinder.

(b) Allow the clutch cylinder springs to return the rocker and Idler gear to release position and open ports K to the atmosphere when the latch is manually or automatically disengaged from the spring cage of the reverse lever pilot valve.

With the Idling valve in running position, when the latch is raised, the air flows directly from the reverse lever pilot valve through the line and the front hole of the air manifold and to the clutch cylinder through inlet port M in the engine bed and the clutch cylinder, into chamber N under the piston. The air pressure forces the piston upward, making contact between the hardened steel centre pin and the Idler rocker lifting post, compressing the two clutch cylinder springs and moving the rocker and the Idler gear forward to the position from which the Idler gear is pulled into mesh with the axle gear. At this position the upward movement of the piston ceases as its top makes a seal with the gasket in the stop ring, thereby closing ports K and preventing escape to the atmosphere of any air which may leak past the piston rings. The rocker and gear, however, continue to move as the idler gear pulls itself fully into mesh with the axle gear and against the rocker stops. This additional movement of the gear and rocker provides from $\frac{1}{16}$ in. to $\frac{1}{8}$ in. clearance between the centre pin and the lifting post, so that the piston is held against the gasket by pressure of air only and is not affected by the action of the gears when the Booster is in operation.

When the piston has completed its movement, the ports L in the lower part of the bushing are uncovered

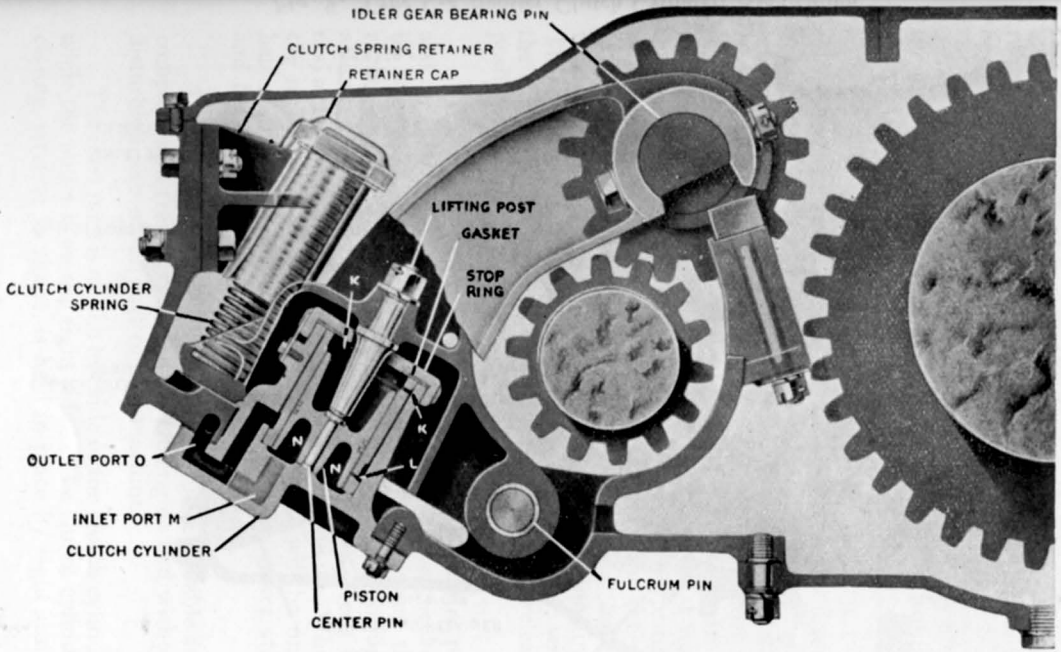
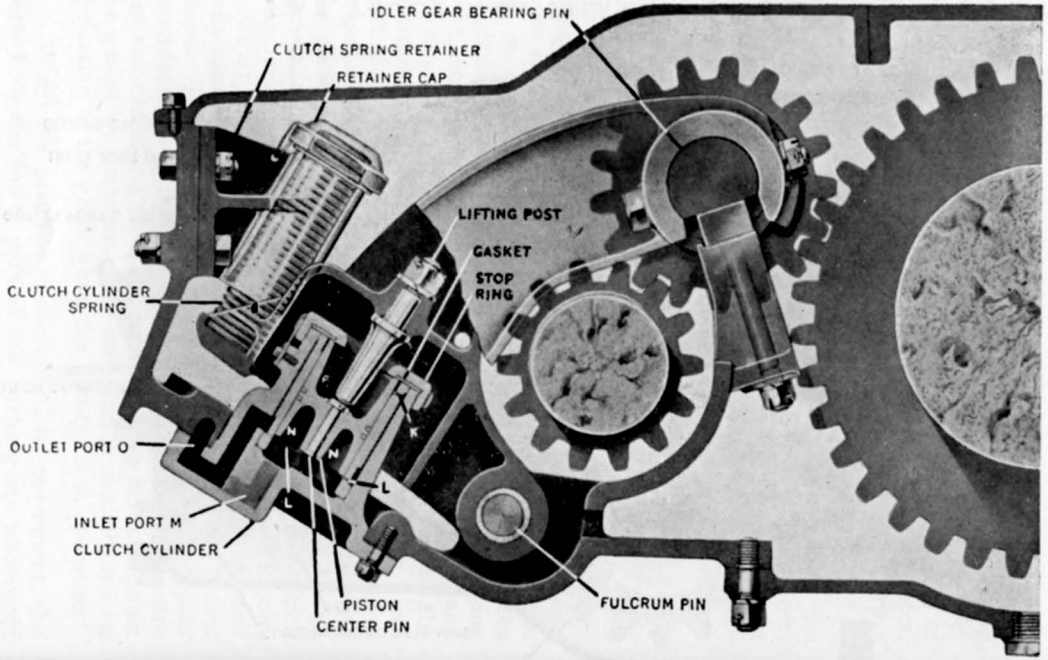


Fig. 8. Type C-2 Booster Clutch Cylinder; Release


IDLER GEAR BEARING PIN
CLUTCH SPRING RETAINER
RETAINER CAP
LIFTING POST
GASKET
STOP RING
CLUTCH CYLINDER SPRING
OUTLET PORT O
INLET PORT M
CLUTCH CYLINDER
PISTON CENTER PIN
FULCRUM PIN
O
M
N
K
L

and the air then passes through outlet port O and the two top ports of the dome pilot valve to the throttle operating cylinder.

If there is a leakage of air past the piston rings after the piston has sealed against the gasket, it passes through the ports in the upper part of the bushing and to outlet port O.

When the latch is manually or automatically disengaged from contact with the spring cage of the reverse lever pilot valve, the air in chamber N under the piston is released to the atmosphere through release port A in the reverse lever pilot valve. This release of air from the chamber N allows the piston to break its seal with the gasket in the stop ring, through action of the springs, thus providing an escape to the atmosphere, for the air in the line to the dome pilot valve, through the central turned-down section of the clutch cylinder bushing. The clutch cylinder springs then return the rocker, with the Idler gear and the clutch cylinder piston, to release position.

The $\frac{1}{16}$ in. to $\frac{1}{8}$ in. clearance between the centre pin and the lifting post is very important and can be checked by admitting air to the clutch cylinder and forcing the rocker backward to a point where the lifting post, through action of the springs, causes the piston to just break its seal against the gasket, indicated by leakage of air. When the rocker is in this position, the clearance will be one-half of the distance between the top of the rocker stop and flat face of the Idler gear bearing pin.

The " underside " clutch cylinder is removable as a complete unit from the bottom of the engine bed without disturbing any other part of the machine.

The inlet port is on the left side of the clutch cylinder while the outlet is on the right side. The clutch cylinder casting, circular in shape, is held in place by eight studs.

The rear stud, between the air ports, is longer than the others and makes it impossible to place the clutch cylinder in a wrong position. The air piping connects to ports drilled in the engine bed, which match with similar ports through the flange of the clutch cylinder. Care must be taken to see that the gasket is properly applied so as not to blank off the air ports.

The clutch spring retainer, bolted to the engine bed, houses two springs which rest in the integral shoes of the Idler gear rocker, while the top ends are held by retainer caps. Any possible backing off of the caps is prevented by wire locks to the retainer casting.

When the clutch cylinder is in release position, Fig. 8, the springs hold the back stops of the rocker against a machined pad on the engine bed. When in application position, Fig. 9, the springs are compressed and the flat ends of the Idler gear bearing pin are held against the rocker stops.

The Dome Pilot Valve, which is screwed into either a tee or a welded saddle on the Booster steam inlet pipe behind the Booster throttle valve, acts to delay the closing of the cylinder cocks for from five to seven seconds after sufficient steam pressure has built up in the steam inlet pipe to operate the dome pilot valve.

(a) Air passes to inlet port P, Fig. 10, above the outside check valve, and through outlet port Q to the throttle operating cylinder to open the Booster throttle. After the locomotive regulator has been opened and sufficient steam pressure has built up in the steam inlet pipe to overcome the piston and deflector springs, the piston moves to its seat in the piston cage and the valve pusher closes the inside check valve, thus preventing communication with the atmosphere past this valve. Simultaneously the outside check valve is opened and air passes through a small drilled hole in the outside check valve bushing, to outlet port R.

(b) When the Booster throttle has closed, due to release of the air pressure in the throttle operating cylinder, the steam pressure on the dome pilot valve piston is removed, allowing the piston and deflector

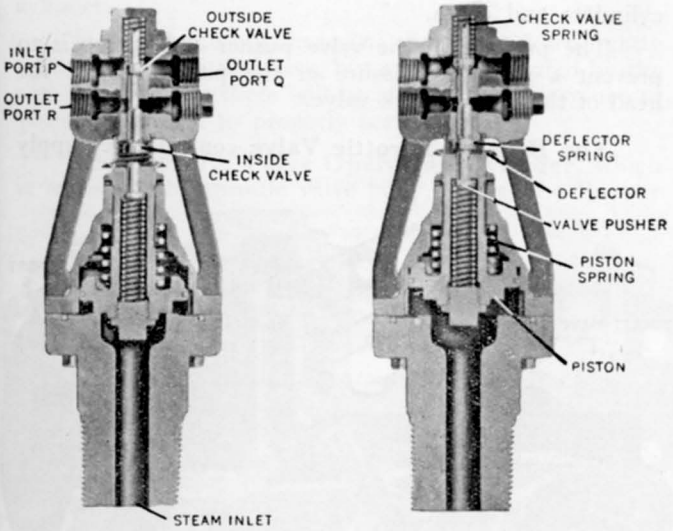


Fig. 10. Dome Pilot Valve

springs to return the piston to release position. The check valve spring closes the outside check valve, which shuts off the passage of air through the drilled hole in the bushing, and opens the inside check valve which allows the air in the cylinder cock operating cylinders to exhaust to atmosphere past the inside check valve.

The function of the small drilled hole in the outside check valve bushing is that of delaying the passage of air into the line to the timing reservoir and the cylinder cock operating cylinder for from five to seven seconds after the operation of the dome pilot valve or for sufficient time to blow all of the water from the Booster cylinders and pipes.

The purpose of the valve pusher and spring is to prevent a positive pressure of the piston against the head of the inside check valve.

The Booster Throttle Valve controls the supply

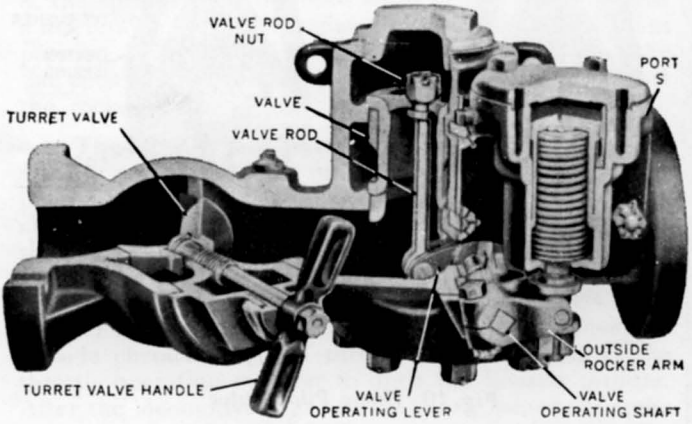


Fig. 11. Booster Throttle Valve and Operating Cylinder

of steam to the inlet pipe. The top seat, being larger than the bottom one, gives a slightly unbalanced valve which will remain closed under pressure of the steam passing through the cored openings to the chamber above the valve.

The turret valve, which is incorporated in the body of the throttle valve on the steam side, affords a means of shutting off the steam supply by hand when desired.

The throttle valve rod connects with the valve operating lever, inside of the body, and through the operating shaft, with the outside rocker arm of throttle operating cylinder.

The valve rod nut should not be pulled down tightly against its seat in the valve, but should be located by the cotter pin so that there will be about $\frac{1}{64}$ in. clearance to permit the valve to properly seat itself.

The Throttle Valve Operating Cylinder, which is bolted to the throttle valve body, opens the Booster

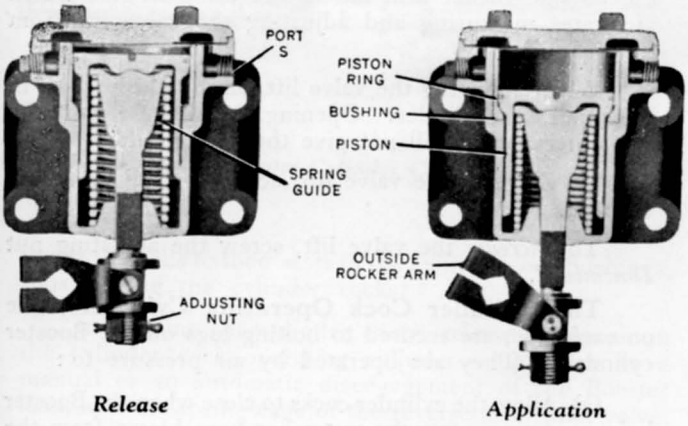


Fig. 12. Booster Throttle Valve Operating Cylinder

throttle through pressure of air and closes it by action of the spring.

(a) When air is admitted through port S, Fig. 12, at the top of the body and in the cylinder head, it forces the

piston down until the piston and bushing seats are in contact. Escape of air is thus prevented, although there may have been a leakage past the piston ring. The spring guide is carried down with the piston, compressing the spring and moving the end of the outside rocker arm downward, thus opening the throttle valve.

(b) When air is released, the spring carries the piston and the end of the outside rocker arm upward, thus closing the throttle valve.

The spring guide has a spherical surface contact with the piston, which permits free piston movement.

The proper throttle valve lift is $\frac{5}{8}$ in. and is governed by the travel of the piston. The valve operating lever and the outside rocker arm are of the same length, which facilitates measuring and adjusting the valve lift from the outside.

When adjusting the valve lift, air should be used in the operating cylinder. Opening the throttle valve by any other means will not give the correct lift.

To *Decrease* the valve lift, screw the adjusting nut *Upward.*

To *Increase* the valve lift, screw the adjusting nut *Downward.*

The Cylinder Cock Operating Cylinders, one on each side, are secured to bolting lugs on the Booster cylinders. They are operated by air pressure to :

(a) Allow the cylinder cocks to close when the Booster is in operation, after the water has been blown from the pipes and cylinder .

(b) Open the cylinder cocks when the Booster is not in operation.

Each operating cylinder is provided with a compact operating rod arrangement, as shown in Fig. 14, for two cylinder cocks. The operating rod connects with the

piston rod through the piston rod block and with the cylinder cocks through the two finger blocks carrying the operating fingers.

In allowing the cylinder cocks to close, the air enters through port T, Fig. 13, in the cylinder head, forcing the piston backward. This movement continues until the bevel face of the piston joints against the seat in the bushing. The operating fingers, secured to the finger blocks, release the ball valves. The steam pressure then

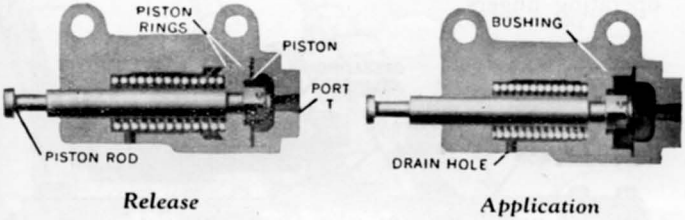


Fig. 13. Type C-2 Booster Cylinder Cock Operating Cylinder

forces the balls to their seats in the cylinder cock bushings, thus closing the cylinder cocks.

In opening the cylinder cocks, release of the air in the cylinder cock operating cylinder—due either to a manual or an automatic disengagement of the Booster latch and the spring cage of the reverse lever pilot valve, or to an opening of the cylinder cock cut-out cock to the atmosphere—allows its spring to force the piston and the operating fingers forward to unseat the ball valves against the steam pressure, thus opening the cylinder cocks.

This forward movement of the piston continues until the integral valve on the rear finger seals against the seat

on its cylinder cock. The valve on the front finger seals against its seat due to pressure of the spring in the counterbored portion of the front finger block.

The piston is fitted with two rings. The seat in the bronze bushing prevents escape of the air which may have leaked pass the rings and also provides a stop to limit the travel of the operating rod on the closing stroke. The travel on the opening stroke is limited by the integral valves of the rear fingers which seal against the seats of the cylinder cocks, as do those of the forward fingers, thus preventing the discharge of steam around the operating fingers.

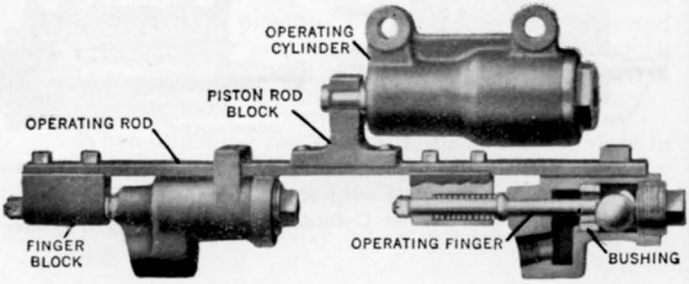


Fig. 14. *Type C-2 Booster Cylinder Cock Operating Arrangement*

There is a separate piping connection to the air manifold for each cylinder. The drain hole into the spring space provides for escape of air or moisture which may have leaked past the rings before the bevel face of the piston has jointed against the seat in the bushing.

The Air Manifold, secured to the back end of the right tie bar of the Booster on three studs, provides a single jointing point with the Booster for the three flexible air connections from the cradle manifold on the locomotive.

A copper gasket, between the finished surfaces of

the air manifold and the tie bar, prevents air leakage where the two air ports through the manifold meet those through the tie bar.

Fig. 15 shows the location of the manifold ; the ports to which the integral couplings of the flexible air connec-

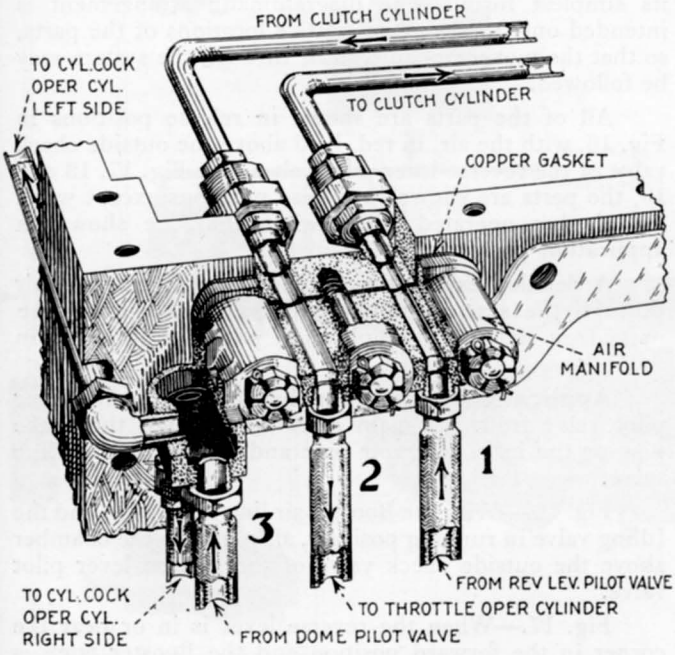


Fig. 15. *Type C-2 Booster Air Manifold, Showing Flexible Air and Piping Connections*

tions are screwed, and the ports to which the air piping connections are made for the clutch cylinder and the cylinder cock operating cylinders.

SEQUENCE OF OPERATIONS
(Superheated Steam).
Type C2 Booster.

The air control arrangements, Figs. 16, 17, 18 and 19, show the control parts only and illustrate the system in its simplest form. The diagrammatic arrangement is intended only to show the relative locations of the parts, so that the movements of the air through the system may be followed.

All of the parts are shown in release positions in Fig. 16, with the air, in red, held above the outside check valve of the reverse lever pilot valve. In Fig. 17, 18 and 19, the parts are shown in release positions except when the air has operated them, when they are shown in application positions.

A detailed explanation of the movement of the air through the sysem and the successive changes of the parts from release to application positions is given in the following paragraphs.

Application.—Air is supplied to the reverse lever pilot valve from the main reservoir through the brake pipe or the main reservoir pipe and the Booster air line valve.

Fig. 16.—With the Booster air line valve open and the Idling valve in running position, air passes to the chamber above the outside check valve of the reverse lever pilot valve.

Fig. 17.—When the reverse lever is in or near the corner in the forward position and the Booster latch is raised, the spring cage of the reverse lever pilot valve is moved, causing the inside check valve to open. Reservoir air then passes simultaneously to the preliminary throttle valve and to the clutch cylinder.

Fig. 18.—The preliminary throttle valve has opened to allow a small amount of steam to pass through the $\frac{1}{2}$ in. choke at the steam inlet pipe to the Booster engine

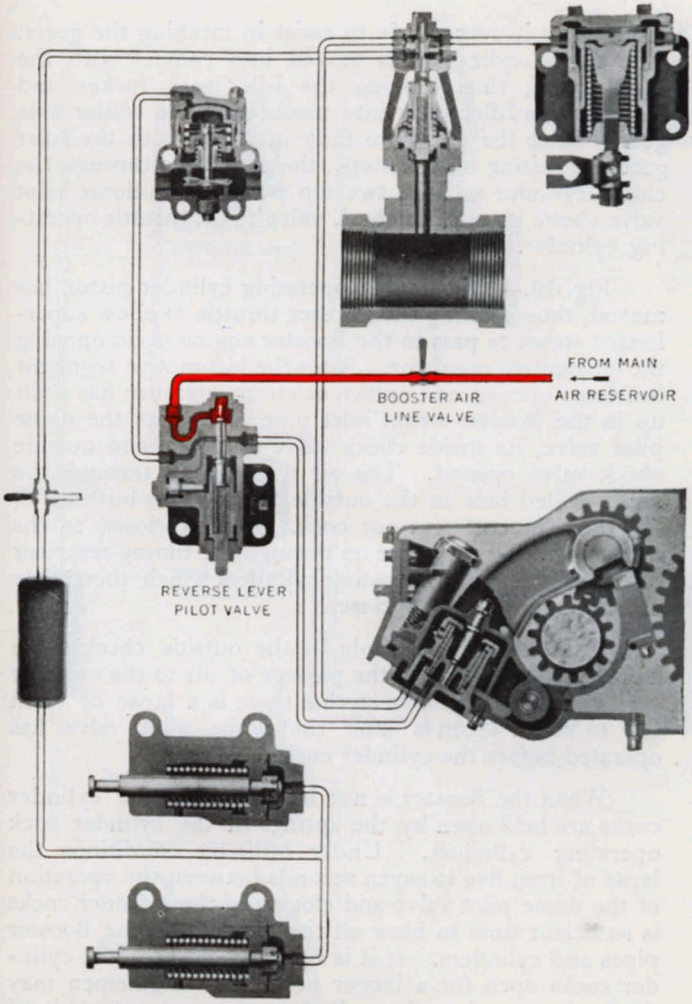


Fig. 16. **All Control Parts in Release Positions. Air Held at Reverse Lever Pilot Valve**

for turning it over slowly to assist in meshing the gears. The clutch cylinder has moved into contact with the lifting post, thus moving the Idler gear rocker and carrying the Idler gear into mesh with the trailer axle gear. After the gears are fully in mesh, with the Idler gear pin resting on the stops, the air passes through the clutch cylinder and the two top ports of the dome pilot valve above its outside check valve to the throttle operating cylinder.

Fig. 19.—The throttle operating cylinder piston has moved, thus opening the Booster throttle to allow superheated steam to pass to the Booster engine upon opening the locomotive regulator. After the locomotive regulator has been opened and sufficient steam pressure has built up in the Booster steam inlet pipe to operate the dome pilot valve, its inside check valve is closed and outside check valve opened. The air then passes through the small drilled hole in the outside check valve bushing to the cylinder cock cut-out cock. If it is closed to the atmosphere the air passes on through the timing reservoir to the cylinder cock operating cylinders which then allow the cylinder cocks to close.

The small drilled hole in the outside check valve bushing serves to delay the passage of air to the cylinder cock operating cylinders so that there is a lapse of from five to seven seconds after the dome pilot valve has operated before the cylinder cocks are closed.

When the Booster is not in operation, the cylinder cocks are held open by the springs in the cylinder cock operating cylinders. Under ordinary conditions the lapse of from five to seven seconds between the operation of the dome pilot valve and closing of the cylinder cocks is sufficient time to blow all the water from the Booster pipes and cylinders. If it is necessary to keep the cylinder cocks open for a longer period the enginemen may do so by opening the cylinder cock cut-out cock to atmosphere.

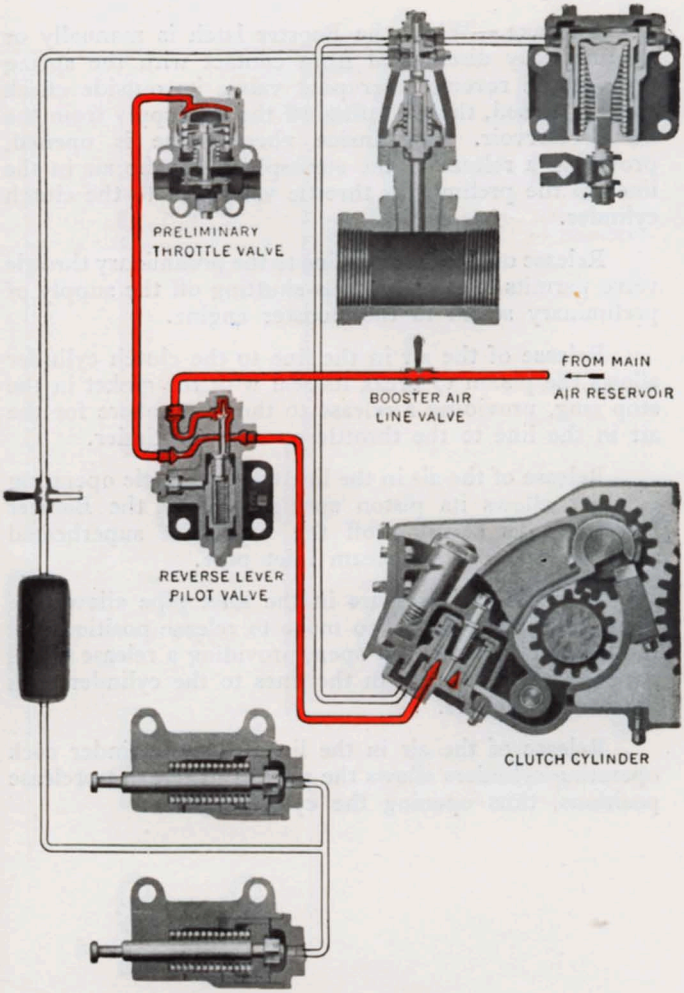


Fig. 17. Reverse Lever Pilot Valve Has Been Operated. Air Has Reached Preliminary Throttle Valve and Clutch Cylinder

Release.—When the Booster latch is manually or automatically disengaged from contact with the spring cage of the reverse lever pilot valve, its outside check valve is closed, thus shutting off the air supply from the main reservoir. The inside check valve is opened, providing a release to the atmosphere for the air in the lines to the preliminary throttle valve and to the clutch cylinder.

Release of the air in the line to the preliminary throttle valve permits it to close, thus shutting off the supply of preliminary steam to the Booster engine.

Release of the air in the line to the clutch cylinder allows the piston to break its seal with the gasket in the stop ring, providing a release to the atmosphere for the air in the line to the throttle operating cylinder.

Release of the air in the line to the throttle operating cylinder allows its piston spring to close the Booster throttle, thus shutting off the supply of superheated steam to the Booster steam inlet pipe.

Reduction of pressure in the inlet pipe allows the dome pilot valve piston to move to release position and the inside check valve to open, providing a release to the atmosphere for the air in the lines to the cylinder cock operating cylinders.

Release of the air in the lines to the cylinder cock operating cylinders allows the pistons to return to release positions, thus opening the cylinder cocks.

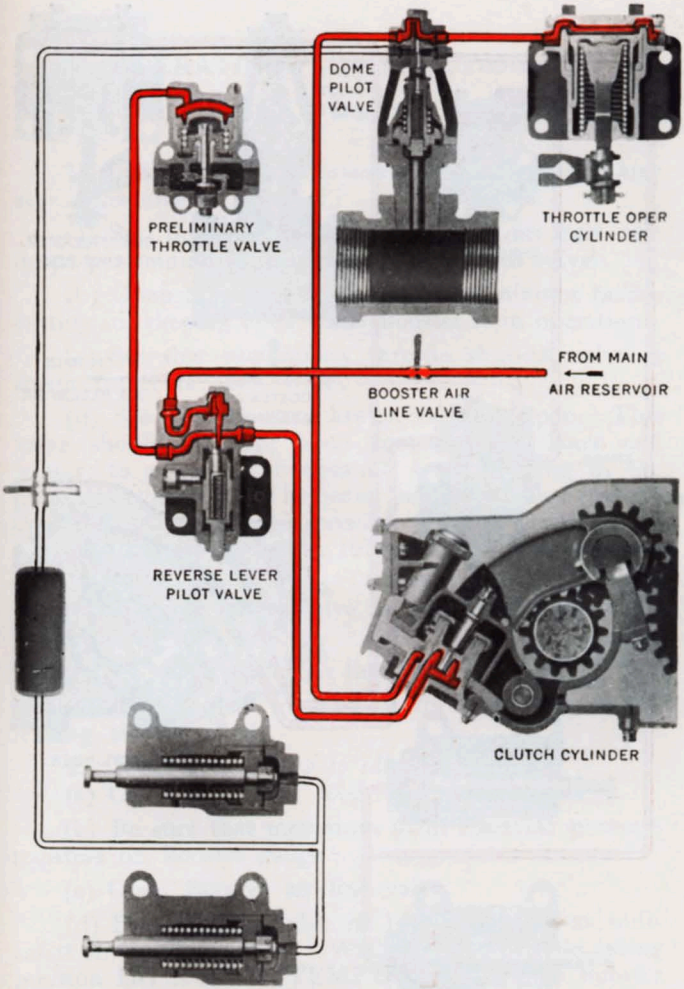


Fig. 18. Preliminary Throttle Valve and Clutch Cylinder Have Operated. Air Has Reached Throttle Operating Cylinder

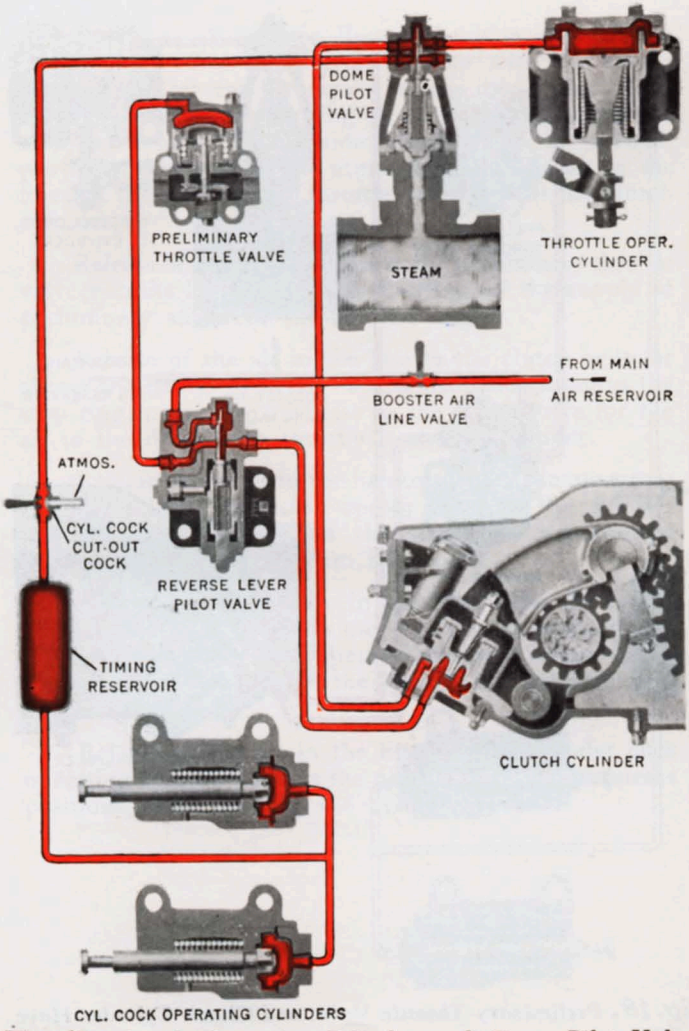


Fig. 19. Throttle Operating Cylinder and Dome Pilot Valve Have Operated. Air Has Reached and Operated Cylinder Cock Operating Cylinders

OPERATING INSTRUCTIONS.

Type C2 Booster.

1. *What should a locomotive crew do when taking over locomotive at terminal?*

(a) Set Booster lubricator feed for at least two drops per minute to lubricate cylinders and valves.

(b) Open lubricator feed about two minutes before cutting in, keeping open while Booster is in operation.

(c) See that preliminary throttle shut-off valve at steam turret is open wide.

(d) See that Booster heater valve is open. This valve should be kept open constantly, summer and winter, to prevent condensation from forming in the pipes and cylinders. The heater valve also makes prompt operation of the Booster possible when it is cut in, as well as to assist in proper lubrication of the cylinders and valves.

(e) See that turret valve in Booster throttle valve is open.

(f) See that Booster air line valve is open.

(g) Idle Booster for two or three minutes before leaving the terminal.

2. *What is necessary to idle the Booster?*

(a) Open lubricator feed.

(b) Be sure that maximum main reservoir pressure registers on Booster gauge.

(c) Open Booster air line valve.

(d) Place Idling Valve in Idling position as indicated on handle of valve. While the handle is in Idling position DO NOT ATTEMPT to RAISE the Booster Latch as the Spring Cage is locked in place and the Reverse Lever Pilot Valve cannot be operated.

(e) Idle Booster for two or three minutes, after which the Idling valve should be placed in running position.

3. *At what time should the Booster be idled on the road ?*

The Booster should always be idled before cutting it in on the road, especially on grades, and cut in after the speed has reduced to 12 m.p.h. or less. **This is very Important.**

4. *What test must be made by the Driver before leaving the Depot to be positive that the Booster air control system will function properly ?*

A standing test must be made with a boiler pressure of not less than 175 lbs. and a main reservoir pressure of at least 80 lbs., the standing test being carried out in the following manner :—

(a) Apply locomotive brakes.

(b) Place the reversing screw nut in fore position to enable Booster latch to engage pilot valve.

(c) Close locomotive release cocks.

(d) Open locomotive regulator fully so as to ensure that there is at least 150 lbs. pressure in the steam chest. If a back pressure gauge is fitted it must show 150 lbs. pressure.

(e) Raise Booster latch so as to engage pilot valve.

(f) When the above test is carried out, provided the steam and air pressure are at least those set out above, the Booster release cock should close properly after the lapse of the usual time, i.e., 5 to 7 seconds.

(g) If the Booster cylinder cocks do not close it indicates that there is trouble in the air control system, caused probably by the clutch cylinder stop ring gasket being defective.

5. *If the Booster idles at high speed when locomotive regulator is opened, although Idling valve is in running position and latch down, what is the probable cause?*

Booster throttle valve may be stuck open or may not be seating properly. Close turret valve in Booster throttle valve. Do not use the Booster again until trouble is corrected.

6. *If latch is raised and the Booster does not respond, what are some of the more common causes?*

(a) Turret valve in Booster throttle valve may not be open.

(b) Preliminary throttle shut-off valve at steam turret may not be open.

(c) Booster air line valve may not be open.

(d) Main reservoir pressure may be too low.

(e) Booster may be cold, or cylinders and valves may need lubricating.

7. *Why should preliminary throttle shut-off valve at steam turret be kept open wide?*

Because the preliminary steam is required for turning the Booster over to permit proper meshing of the gears when the Booster is cut in.

8. *If latch is knocked down when locomotive is in motion, but gears do not disengage, even though little or no steam pressure shows on Booster gauge, what should be done?*

This indicates that either preliminary throttle valve or Booster throttle valve may be stuck open or leaking.

(a) If trouble is in preliminary throttle valve, close shut-off valve at steam turret.

(b) If trouble is in Booster throttle valve, close turret valve.

(c) If in doubt, close both and do not attempt to use the Booster until the trouble is corrected.

9. *After knocking down latch, if considerable pressure still shows on Booster gauge, what should be done?*

Close turret valve in Booster throttle and shut-off valve at steam turret, and report the trouble on arrival at terminal. Do not attempt to use the Booster in this condition.

10. *Should the Booster be cut in at any speed?*

The Booster should never be cut in at speeds above 12 m.p.h. The small amount of steam admitted to the cylinders through the preliminary throttle valve and choke will not turn the Booster over fast enough to permit correct meshing of gears at speeds higher than 12 m.p.h. and damage may result if it is attempted.

11. *What is the highest speed at which the Booster should be used?*

The Booster should not be used at speeds higher than 20 m.p.h.

12. *What should be done to prevent slipping of trailing truck wheels at starting?*

Sand should be dropped before coming to a stop so that it will be under the trailing truck wheels at starting.

13. *What should be done if trailing truck wheels slip?*

Booster latch should be knocked down at once and not raised again until slipping has stopped. Sand must not be used while the trailing truck wheels are slipping owing to danger of stripping Booster gears.

14. *Should the Booster be cut out before bringing a locomotive to a stop?*

Yes. Always cut out the Booster before coming to a stop. This permits the gears to disengage.

15. *Should the Booster be left in gear or idled when locomotive is backing up?*

The Booster is designed for use in **Forward**

Motion Only and it should not be left in gear, or even idled, while backing up.

16. *May slack be taken with the Booster gears engaged?*

When reverse lever is pulled back, latch will disengage automatically and after hand on Booster gauge has dropped to zero, slack may be taken in the usual way and without damage to the Booster, providing locomotive is moved backward **slowly** and for only a short distance.

17. *If locomotive is brought to a stop with the Booster cut in and it is necessary to back up, what must be done to disengage the gears?*

(a) Knock down latch, move locomotive ahead a few feet and gears will disengage. The Booster must always be disengaged before attempting to back up.

(b) In many cases, such as a sudden stalling of the train on a steep grade, the engineman may not have time to knock down the latch. Where it is impossible to move locomotive ahead, or cut locomotive from the train, it is permissible to move backward **slowly** for a short distance with the gears engaged. The gears being in mesh would be indicated by the noise from the suction of air through the Booster Cylinder Cocks.

18. *If cylinder cocks fail to close after the Booster is cut in, what are some common causes?*

(a) Cylinder cock cut-out cock may not be closed to atmosphere to provide for the air passing from dome pilot valve to cylinder cock operating cylinders.

(b) The small drilled hole through the bushing in dome pilot valve may be closed by dirt or scale.

(c) Leakage in air lines to cylinder cock operating cylinders, or a bad leak in any part of the control system.

(d) Some part of the cylinder cock operating rigging may be binding.

19. *What is the purpose of the cylinder cock cut-out cock?*

To provide a means by which cylinder cocks may be opened by hand after they have been closed automatically by air pressure in the control system.

20. *What would cause a continuous hobnobbing of the gears when locomotive is in motion and the Booster is cut in?*

(a) A closed preliminary throttle shut-off valve at steam turret.

(b) Insufficient steam from the preliminary throttle valve, due to its having failed to open.

(c) A cold Booster which has not been properly idled.

21. *What would cause a continuous hobnobbing of the gears when locomotive is in motion and the Booster is not cut in?*

Breakage of the clutch cylinder springs, a very unlikely condition, or backing off of clutch spring retainer caps would cause this hobnobbing. Booster should be reported for repairs.

22. *After dumping ashpan on the road, what precaution should be observed?*

Locomotive should be moved so that the Booster will not remain over the hot cinders, as the heat may deteriorate gaskets or cause other damage.

23. *What parts are to be oiled by the enginemen before leaving terminal?*

It is important that the engine crew see that the Booster lubricator is filled and set for about two drops per minute. Maintanance of the proper supply of oil in the bed will be attended to at the shed. Should the trailing track axle bearings heat in service they may be repacked with wool waste, soaked in car oil, through the two axle bearing cap lids. Drivers, however, must inspect the trailing truck axle bearings in order to see that the bearings are properly lubricated and that the oil sump test cocks are showing oil.

SHED INSPECTIONS.

Type C2 Booster.

1. *Where and when should the Booster be inspected and tested?*

On the arriving road and as quickly as possible after arrival. Sufficient steam is usually available at that time to complete the proper test and to make note of work to be done.

2. *What is the first thing that should be done to inspect and test a Booster-equipped locomotive on the arriving track?*

(a) Close turret valve in Booster throttle valve.

(b) With a small wrench, work rocker arm on Booster throttle valve to see that it is perfectly free, and that the spring takes the rocker home with good force.

(c) Open turret valve in Booster throttle valve.

3. *What is the next operation?*

(a) Open Booster lubricator feed.

(b) Start air pump and wait until maximum main reservoir pressure registers on gauge.

(c) See that preliminary throttle shut-off valve at steam turret is open wide.

(d) See that Booster air line valve is open.

(e) Place Idling valve in idling position and idle the Booster. The idling speed, depending upon the boiler pressure, should be about as follows :—

190 lbs. ... 264 R.P.M.
200 ,, ... 324 ,,

4. *While the Booster is idling, what inspection should be made?*

(a) Test lines to preliminary throttle valve and to brake pipe or to main reservoir for leaks at connections

and also at points where Booster air lines come into contact with other locomotive parts. Constant vibration will "saw" copper pipes and cause leaks.

(b) See that there is no oil or steam leakage from the piston rod or valve stem packings through the holes in the plugs in the engine bed.

A leakage of oil indicates that the swab packing in the Piston Rods or Valve Spindles is defective. A blow of steam indicates defective Metallic Packing.

(c) See that Booster cylinder cocks are open.

(d) Note the operation of the Booster. If, after warming up, it is running smoothly you may assume that the parts are O.K., including the idler gear which is constantly in mesh with the crankshaft gear.

(e) Be sure that the Booster idles at about the speed noted in paragraph (e) under Question 3. The small amount of steam passing through the preliminary throttle valve and the $\frac{1}{2}$ in. choke at the Booster steam inlet pipe will operate the Booster at about this speed. If it runs much slower at the noted boiler pressure, preliminary throttle valve or its shut-off valve at steam turret should be inspected. Under no conditions should the $\frac{1}{2}$ in. choke be altered.

5. *If the Booster continues to idle after Idling valve has been placed in running position, what is the possible cause and remedy* ?

(a) Possibly the preliminary throttle valve has not closed, as it should after placing Idling valve in running position, thus allowing steam to continue going to the Booster. Leakage through the valve would have the same effect.

(b) Examine chokes in oil line to Booster both at lubricator and at steam inlet pipe. These may have been omitted or have been steam cut which would allow sufficient steam to go to the Booster cylinders to idle it.

(c) Close preliminary throttle shut-off valve at steam turret and remove preliminary throttle valve.

(d) Remove cylinder head, piston, bottom plug and valve. The valve and seat may need regrinding. The steel bushing provides a removable seat if necessary to replace it. If the valve stem is binding in the guide, due to dirt or scale, it should be removed and cleaned. If the stem has been cut it should be dressed down with fine emery cloth. Be sure that the parts are free from dirt and do not use oil of any kind when reassembling them.

(e) Open preliminary throttle shut-off valve at steam turret.

6. *If cylinder cock fails to close, what should be done ?*

(a) Be sure that cylinder cock cut-out cock is closed to atmosphere.

(b) Examine dome pilot valve. See that the small hole through bushing is open. When latch is raised to cut in the Booster and the locomotive regulator has been opened, air should pass through the small hole in bushing and through the valve, cylinder cock cut-out cock and timing reservoir, to cylinder cock operating cylinders.

(c) Examine timing reservoir for leaks.

(d) Examine cylinder cocks operating cylinders for leaks.

(e) Examine Booster cylinder cock rigging for bent operating rods or loose connections.

(f) See that the plugs are in cylinder cocks. These may back out and the ball valves become lost.

(g) Go over entire line for leaks.

(h) Move locomotive ahead so as to place the Booster on another quarter and try cylinder cocks again.

(i) Do not make any changes, such as enlarging the hole in dome pilot valve bushing or cutting down the stem of check valve. This is most important.

7. *During the arriving road test, if gears do not go into mesh when latch is raised, what should be done?*

(a) See that maximum main reservoir pressure registers on gauge.

(b) See that Booster air line valve and preliminary throttle shut-off valve at steam turret are open.

(c) See that spring cage of reverse lever pilot valve is moved far enough to fully open outside check valve and close inside check valve.

(d) Go over air line to clutch cylinder, including flexible hose, for leaks.

(e) Thoroughly blow all dirt from top of Booster to prevent it from falling into bed.

(f) Remove an oil-filling plug in back top cover plate and note if air blows with force through the opening. If so, it indicates either that there is a loose connection or broken pipe leading to the clutch cylinder inside the engine bed.

(g) Remove clutch cylinder and test it with not less than 70 lbs. air pressure for leaky gasket.

(h) Remove front casing top to see if the trouble is in clutch cylinder piping or at connections.

8. *What will permit a constant escape of air through release port "A" of reverse lever pilot valve while latch is raised? How can this be remedied?*

(a) The spring cage may not be moved far enough to completely close the inside check valve. This can be remedied by building up and filing groove in the latch to give the spring cage its proper travel. When the latch lever is used it may be bent or built up to obtain the same result.

(b) The bolts holding the pilot valve or the bracket may have worked loose, allowing the pilot valve to raise.

9. *If gears do not come out of mesh after latch has been knocked down and locomotive moved ahead, what should be done* ?

(a) See if preliminary throttle shut-off valve is leaking.

(b) See if booster throttle valve is leaking or stuck open due to dry or dirty condition of the operating cylinder. This should be corrected by soaking the ring loose in the groove, and cleaning the piston and cylinder and applying a thin coating of brake cylinder compound to the cylinder and piston.

(c) Thoroughly blow all dirt from top of Booster to prevent it from falling into bed.

(d) Remove front casing top to see that clutch spring retainer caps are tight and properly secured against turning by wire locks.

(e) See if clutch cylinder springs are broken.

10. *How may steam inlet pipe, Booster throttle, ball joints and air lines be tested for leaks* ?

(a) Close turret valve in Booster throttle valve.

(b) See that preliminary throttle shut-off valve at steam turret is open wide.

(c) Apply locomotive brakes.

(d) See that Booster cylinder cock cut-out cock is closed to atmosphere.

(e) By means of a copper wedge between inside check valve and valve pusher of dome pilot valve, raise outside check valve.

(f) Place Idling valve in running position and raise latch.

Reservoir pressure will now build up in Booster air lines. After cylinder cocks have closed, the steam through the preliminary throttle valve will build up in steam inlet pipe back of turret valve in Booster throttle valve to about 25 lbs. less than boiler pressure. All

Booster air lines and steam inlet pipe being under pressure, the desired test may be made. The above outlined operation is safe, since the Booster will not start the locomotive against its brakes.

If any one of the control parts does not operate in its proper sequence, it indicates an obstruction in the air line, which can be located by disconnecting flexible air connections, one at a time, from the air manifold.

11. *If necessary to idle the Booster in engine shed when locomotive is dead, how can this be done?*

(a) Close turret valve in Booster throttle valve.

(b) Remove drip valve in inlet manifold and connect air hose from another engine or from shed air line so as to idle the Booster.

12. *What is the proper Booster throttle valve lift? How is the adjustment made?*

(a) The proper lift is $\frac{5}{8}$ in., and it is governed by the travel of the piston in the throttle valve operating cylinder.

(b) Adjustment is made by screwing adjusting nut upward or downward. To *Decrease* the lift, screw nut *Upward*. To *Increase* the lift, screw nut *Downward*.

13. *What is the cause of the Booster coming into mesh when the Idling valve is placed in idling position?*

The spring at the back of the idling plug cock that keeps it up to its face will most likely be found broken. This allows the plug to become slack and the air to escape down through port E, as shown in Fig. 5, to the clutch cylinder, thereby putting the gears into mesh.

14. *What should be done to insure proper lubrication of the Booster?*

(a) It is important that the maintenance of the proper supply of car and wagon oil in the engine bed be given attention after each trip, or as often as is necessary to maintain the proper supply. Two oil-filling plugs are placed at the back outside corners of the back top

cover plates. The two oil overflow drain cocks at the front end of the engine bed indicate the height at which the oil should be maintained.

(b) Before replenishing the oil supply, it may be necessary to drain water from the bed. The special oil plugs in the crankpits and axle bearing cap should be backed out a turn or two which will permit water to drain out through the small holes in the plugs. Do not remove the plugs unless it is necessary to drain out the oil also.

(c) The Booster cylinders and valves are lubricated with superheater valve oil from a separate lubricator in the cab. The necessary inspection should be made to insure proper operation of the lubricator and supply of oil to the Booster through the $\frac{1}{16}$ in. choke bushing where the lubricator line enters the Booster steam inlet pipe.

(d) The main bearings on the trailing truck axle are lubricated by the dope-packed axle bearing cap in the same manner as car journals. The wool waste, soaked in car and wagon oil, should not be packed too tightly or in such amounts that no space remains for the oil.

PERIODICAL EXAMINATION OF BOOSTER.

In addition to the examination of the Booster and fittings at the Workshops, the Booster truck and fittings must be examined at periods as set out hereunder :—

" B " Examination—2,000 miles.

Trailing truck casting.

" C " Examination—every 8,000 miles.

Booster release cocks and operating cylinder.

Clean and examine.

Drip valves on ball joint elbows.

Lubricator : Test lubricator and examine choke valves for correct opening.

Flexible air and piping connections.

Reverse screw pilot valve and latch : Clean and examine all valves and springs of pilot valve and examine button and latch for wear.

Preliminary throttle valve : Remove cover and plugs, clean and examine valve ring and springs.

Dome pilot valve : Clean and examine valve ring and springs and clean out 1/32 in. hole in check valve bush.

Booster turret valve : Examine valve and gland packing.

Booster throttle valve : Examine valve. The valve rod nut should not be pulled down tightly against its seat in the valve but should be located by the cotter pin so that there will be about 1/64 in. clearance to permit the valve to properly seat itself.

Throttle valve operating cylinder : Examine piston ring and spring and check valve for correct lift.

Heater valve : Examine valve.

Booster clutch cylinder.

Remove, examine, and clean.