The Locomotive BOOSTER

INSTRUCTION BOOK
No. 102-A

Franklin Railway Supply Company
Incorporated

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The Locomotive BOOSTER*

Types C-1 and C-2

Instruction Book No. 102-A

FRANKLIN RAILWAY SUPPLY COMPANY, INC.

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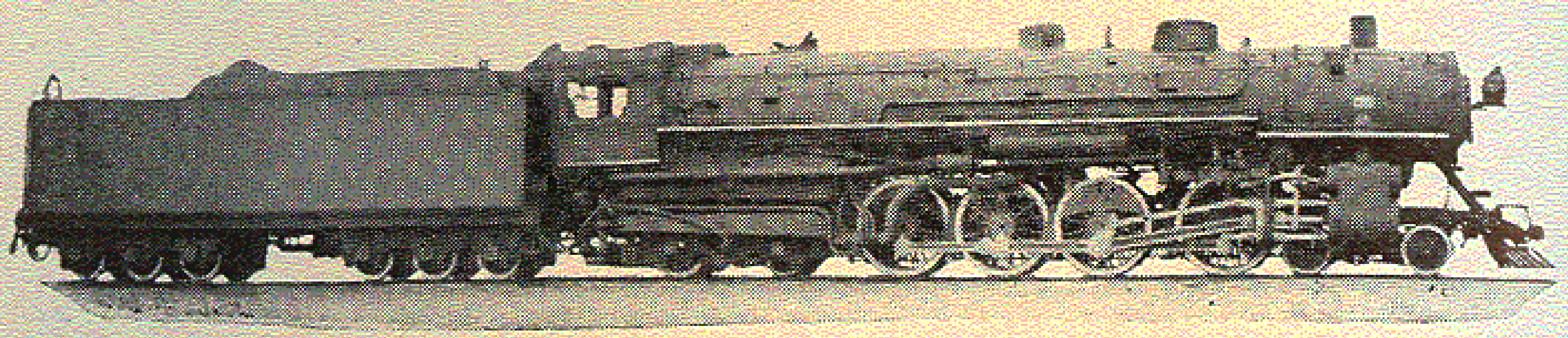

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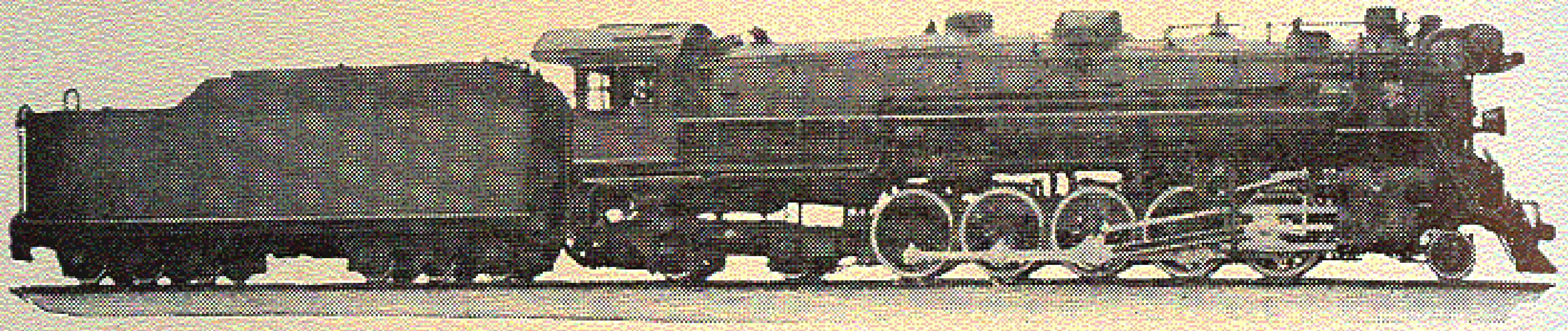

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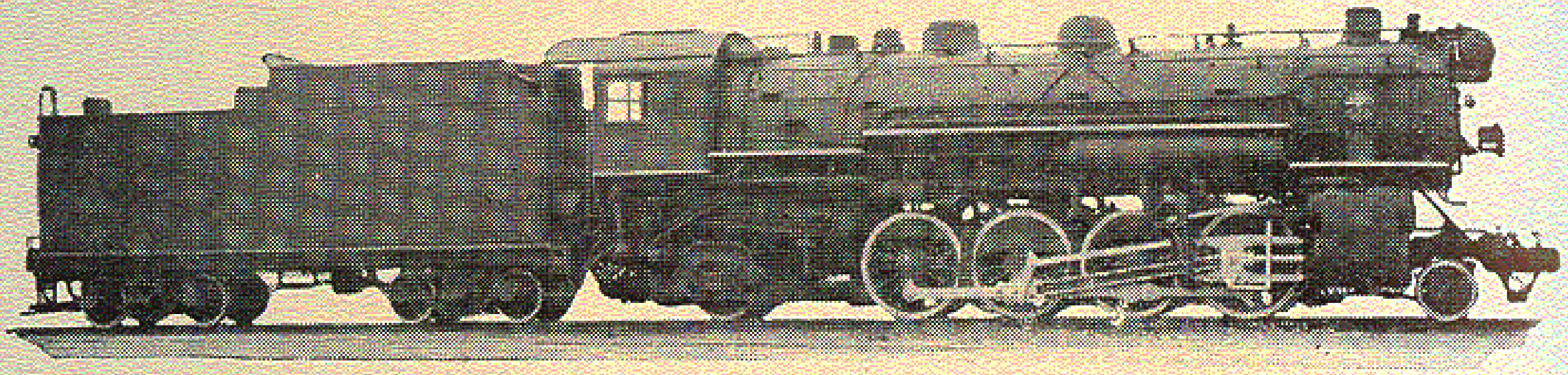

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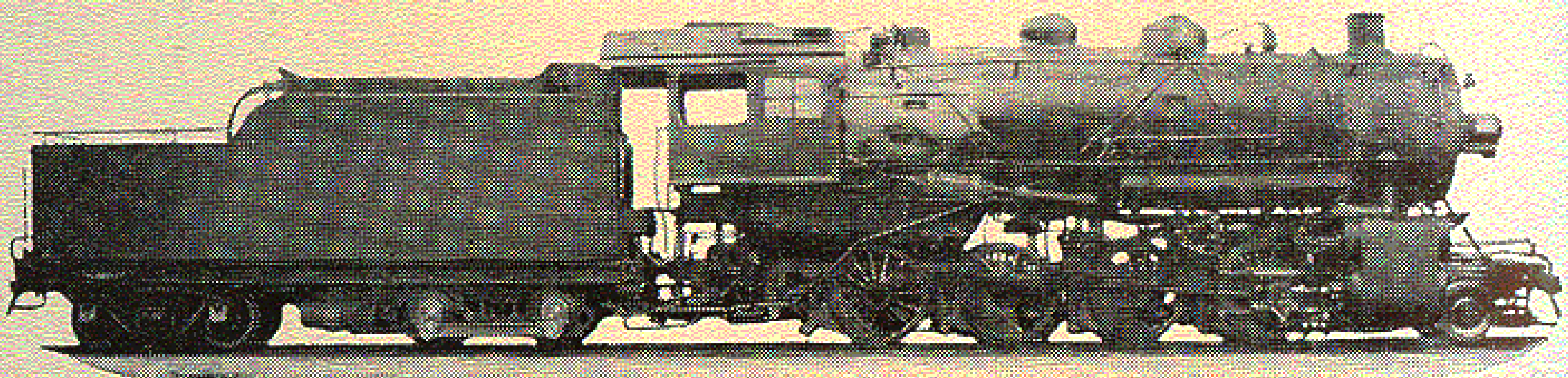

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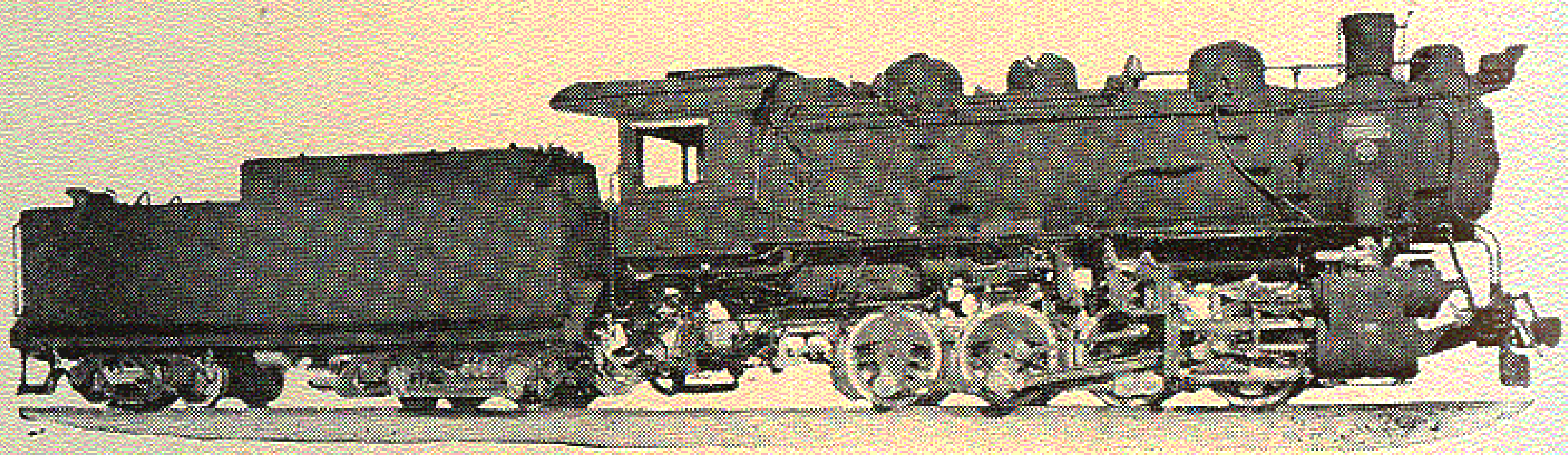

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ELEMENTS OF THE BOOSTER

Type C-2

Trailer Application

A complete Type C-2 Locomotive Booster equipment as furnished for a trailer truck application consists of the following:

Booster Engine

1 Complete Locomotive Booster
1 Complete Set Steam Inlet and Exhaust Joints

Air Control

1 Complete Throttle Valve with Operating Cylinder
1 Preliminary Throttle Valve
1 Dome Pilot Valve
1 Reverse Lever Pilot Valve
1 Timing Reservoir
1 Three-Way Cock (Cylinder Cock Cut-Out Cock)
1 Two-Way Cock (Booster Air Line Valve)
1 ½-in. Elbow
13 ½-in. Connections
4 ¾-in. Connections
3 ½-in. Couplings
3 Flexible Air Connections
1 Cradle Manifold

Miscellaneous

1 Axle Gear
1 Steam Separator
1 Steam Gauge
1 Needle Valve (Heater Valve)

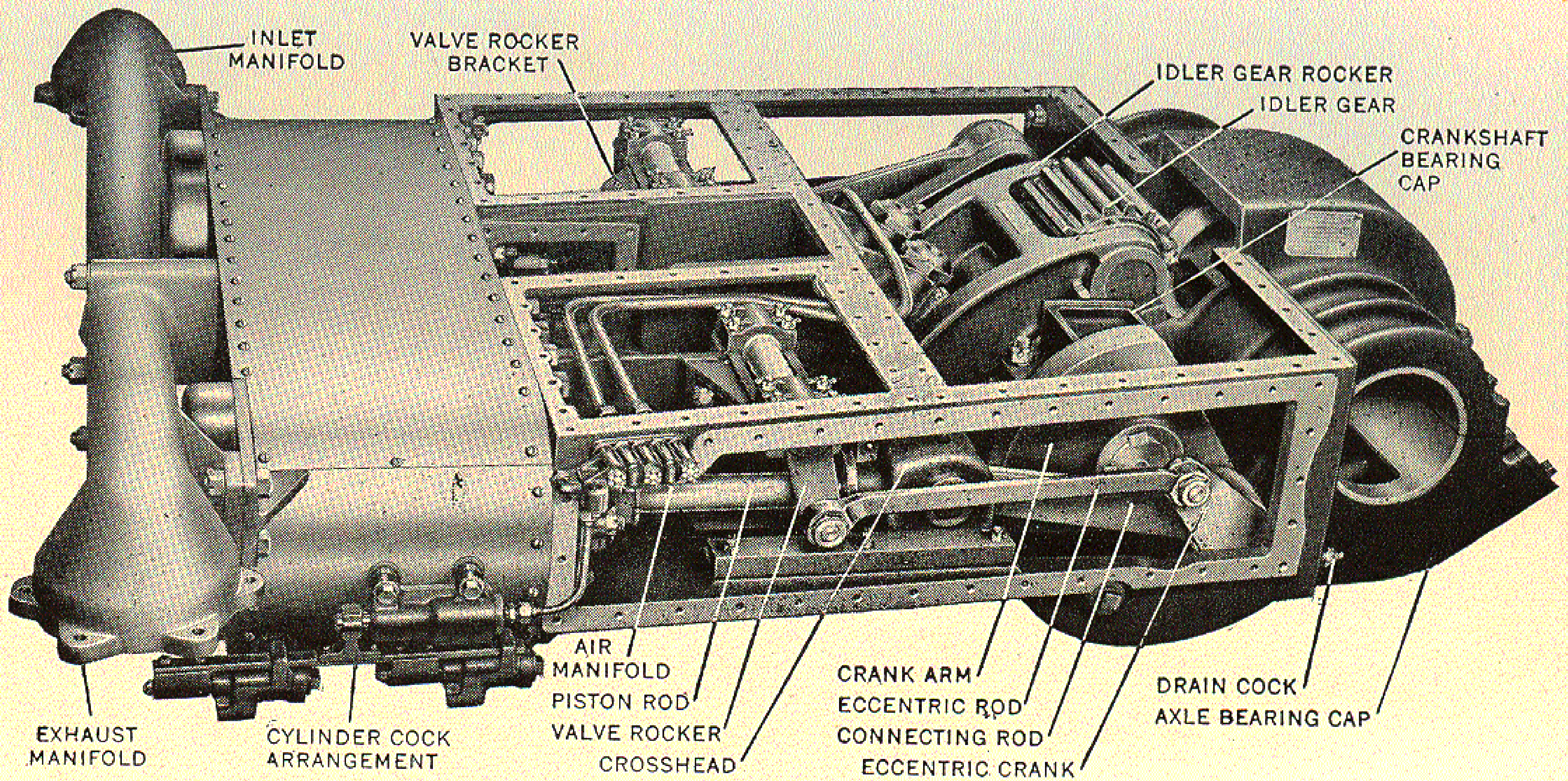


Fig. 6. Type C-2 Booster Engine; Cover Plates and Casing Top Removed

THE LOCOMOTIVE BOOSTER

For the proper use and care of The Locomotive Booster, a thorough understanding of its function is essential.

The capacity of a locomotive is limited by the load it can start. Once a load is in motion it can easily be handled at speed. It had long been recognized that some form of auxiliary power available for use at the critical moment of starting would increase the capacity of the locomotive. The need for such auxiliary power led to the development of The Locomotive Booster, which provides an additional draw bar pull not only for the critical moment of starting but also for negotiating difficult grades and meeting other emergency demands.

While the Booster conforms in design, material and workmanship to the best known practice, it must not be considered as self-maintaining and requiring no attention. It is a simple steam engine and its maintenance, lubrication and care should be the same as that accorded any other steam engine which develops its maximum power at the beginning of the operating period.

Moreover, since the control of The Locomotive Booster is semi-automatic, there is an added element which is not present in the ordinary steam engine; *i. e.,* the air-operated control system. To insure the proper functioning of the Booster, this control system should be tested and inspected for every trip of the locomotive.

If the instructions outlined in this book on Booster construction, operation and maintenance are carefully followed, there should be no difficulty in maintaining the Booster in perfect order, despite the severity of the service.

GENERAL DESCRIPTION

The Locomotive Booster, a horizontal two-cylinder steam engine, in the trailer application is mounted on the trailer truck and connected directly to the trailer axle of

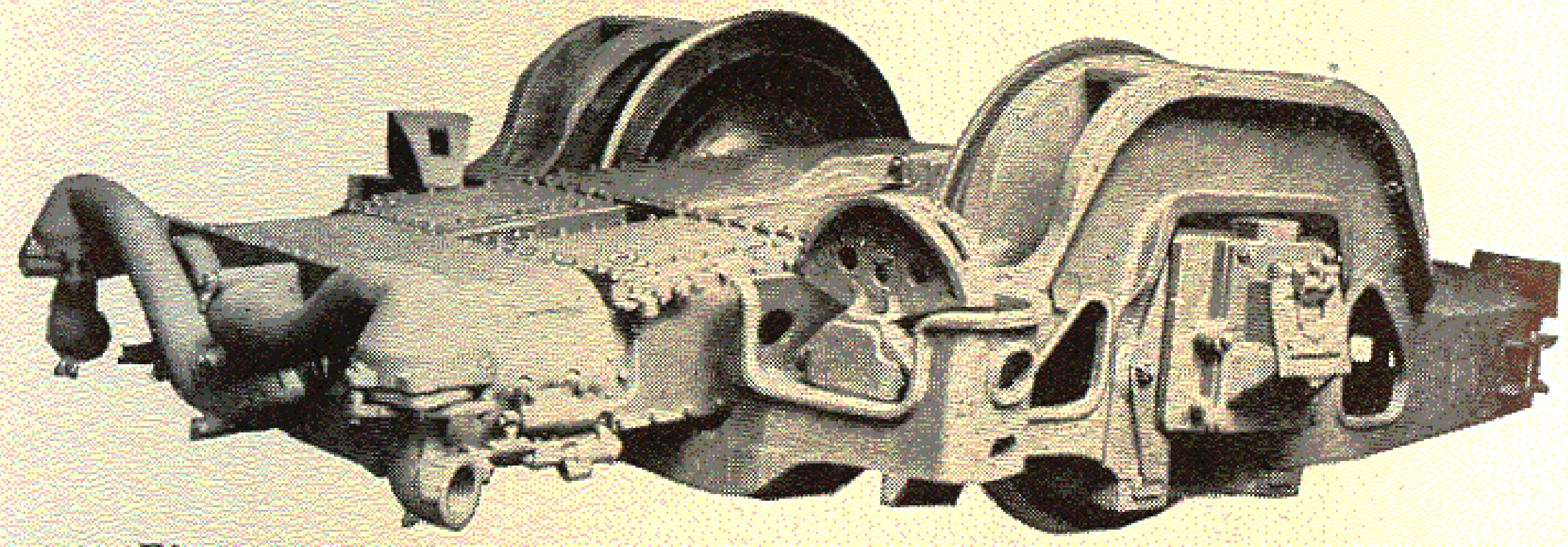


Fig. 7. Type C-2 Booster and Two-Wheel Trailer Truck

the locomotive through suitable gearing by which it may be engaged or disengaged at will.

The Booster is self-contained and has a flexible mounting in the form of a three-point suspension. The bearings

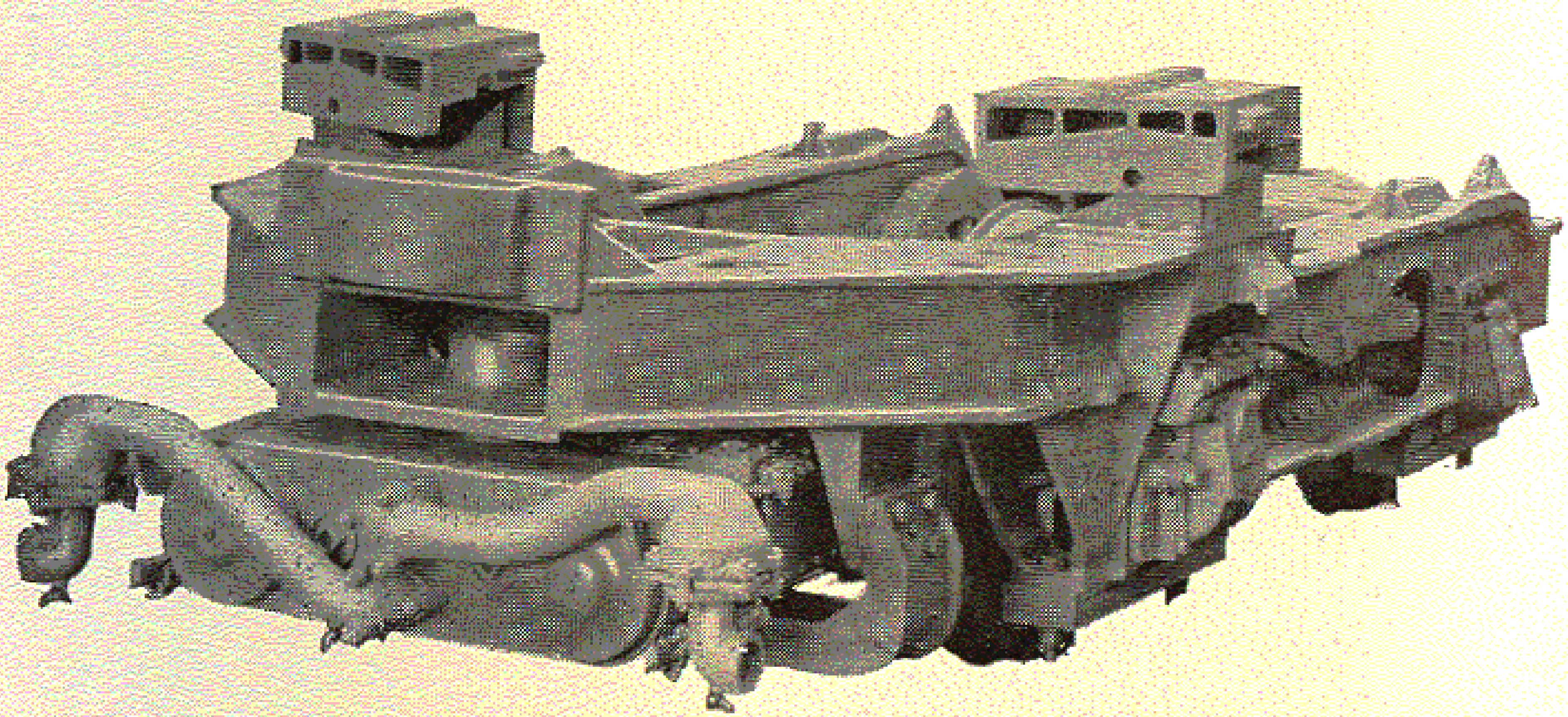


Fig. 8. Type C-2 Booster and Four-Wheel Trailer Truck

around the trailer axle are two of the points, while the third is a spherical seat at the center of the cross transom of the trailer truck frame.

In the tender application the Booster is mounted on the front tender truck and connected directly to the axle of the rear wheels by gears in the same manner as on the trailer truck.

The same Booster is used in both applications. The flexible mounting for the tender application is provided by the two bearings around the rear axle of the front truck, while the third is the spherical seat at the center of the cross transom of the tender truck frame.

While the Booster was originally designed for application to a two-wheel trailer truck, as shown in Fig. 7, it has since been applied to four-wheel trailer, Fig. 8, and four-wheel tender trucks, Fig. 9, and it is also applicable

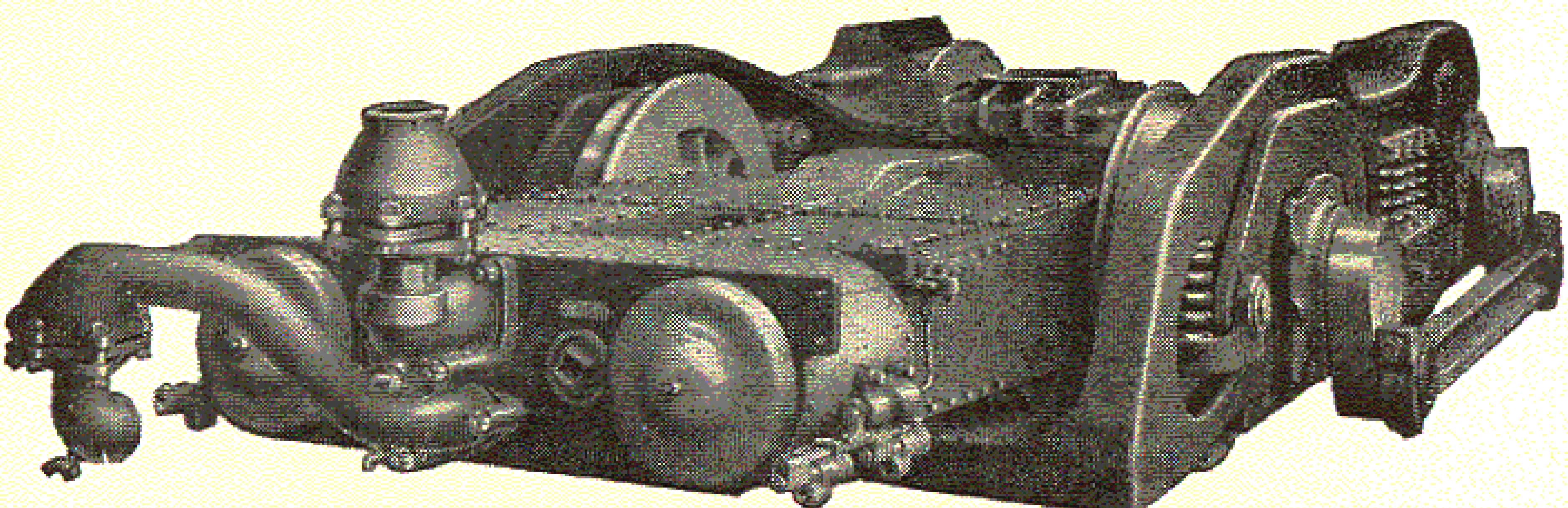


Fig. 9. Type C-2 Booster and Four-Wheel Tender Truck

to six-wheel tender trucks. In all four of the applications the construction of the Booster is identical.

The above illustrations show the Booster as applied to standard gauge locomotives. It has also been applied to two-wheel trailer locomotives of the meter gauge.

The Booster is operated by superheated steam taken from one or both steam chests of the locomotive. A complete description of the system of control, with illustrations in diagrammatic arrangement to clearly show the sequence of operations of the control parts, will be found on pages 47 to 55. See also diagram G-50055.

Briefly, the air control system functions as follows:

Superheated Application. With the idling valve in 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 throttle 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 allow the cylinder cocks to close.

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 atmosphere through ports in the reverse lever pilot valve, clutch cylinder and dome pilot valve, allowing all control parts to return to release positions with the gears out of mesh.

BOOSTER ENGINE

Type C-2

Engine Bed. The Booster engine is built upon a

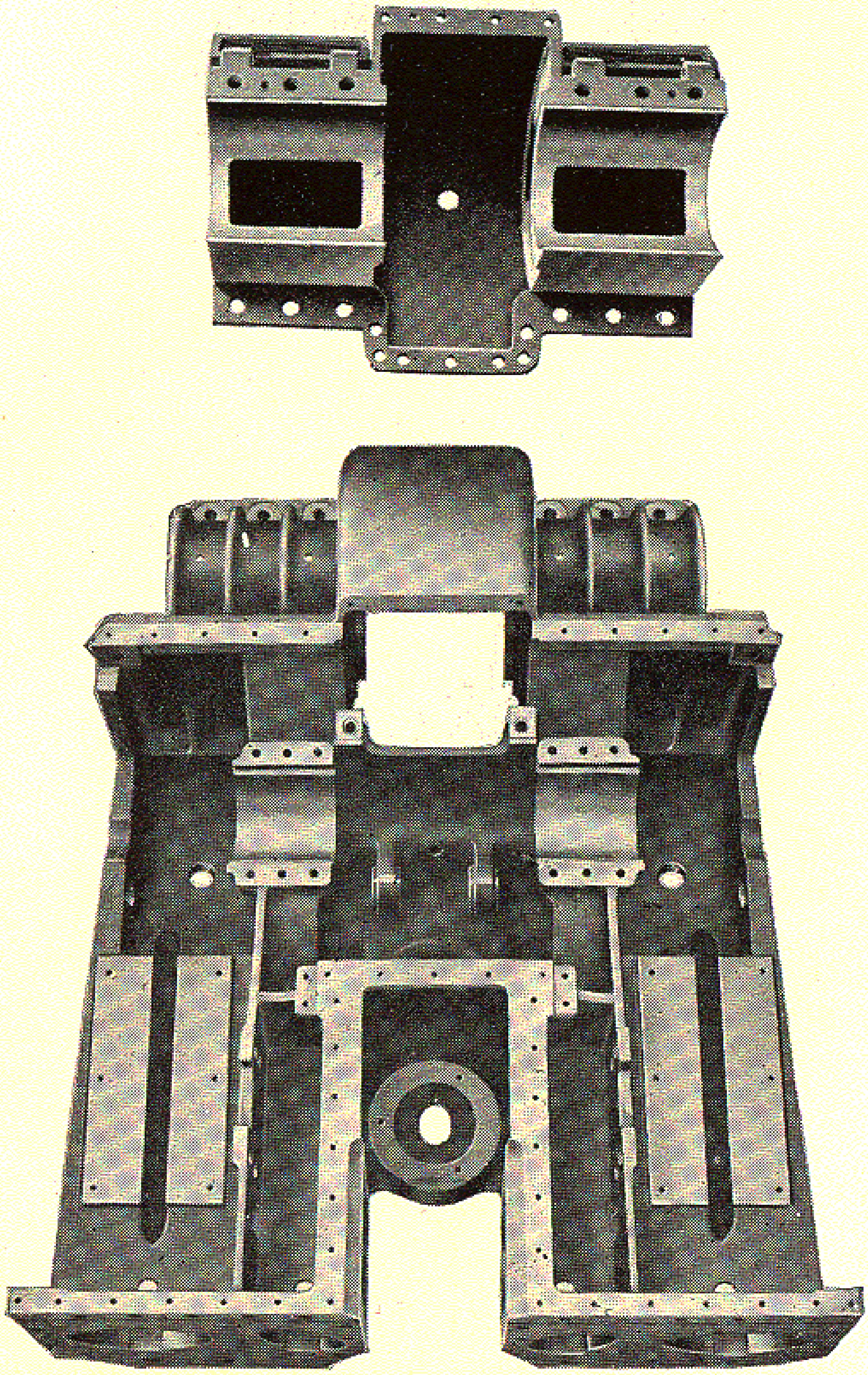


Fig. 10. Type C-2 Booster Engine Bed and Axle Bearing Cap

substantial cast-steel engine bed. The bed, with its tie bars, crossties and cover plates makes a casing in which are assembled the moving parts, consisting of the crankshaft, connecting rods, crossheads, valve gear, etc. As the casing is oil-tight the splash method of lubrication is employed.

The engine bed is supported by two bearings around the trailer axle and one bearing on the cross transom of the trailer truck. Between the spherical seat of the engine bed and the carbon steel wearing plate riveted

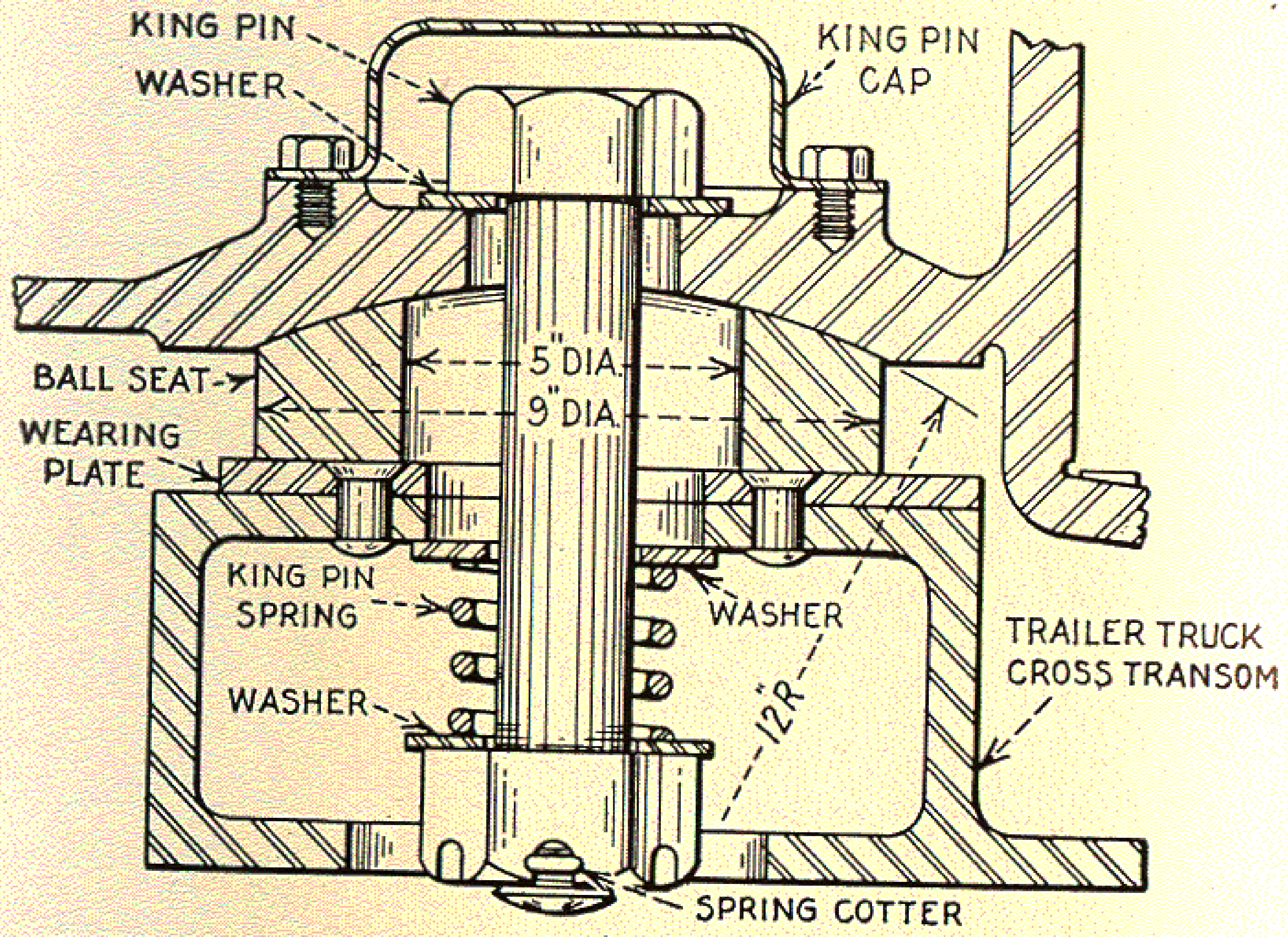


Fig. 11. Type C-2 Booster Ball Seat Arrangement

to the truck transom is placed the ball seat. This arrangement allows free movement of the Booster with the varying positions of the trailer axle.

The Cylinders, valve chambers and steam chest are made integral of special cast iron. The valve chambers are bushed in the usual way, but no bushings are used in the bores of the cylinders, which are mostly 10″ x 12″.

The front cylinder heads are cast integral with the cylinders, while the back heads are removable, copper gaskets being used to make tight joints. The entire cylinder casting is heavily lagged and jacketed, giving proper insulation and a neat appearance.

The integral front heads provide for securing the entire front face of the cylinder casting to the engine bed, making a fastening which is in direct line with the main thrust of the pistons.

The cylinder cocks are screwed into bosses on the sides

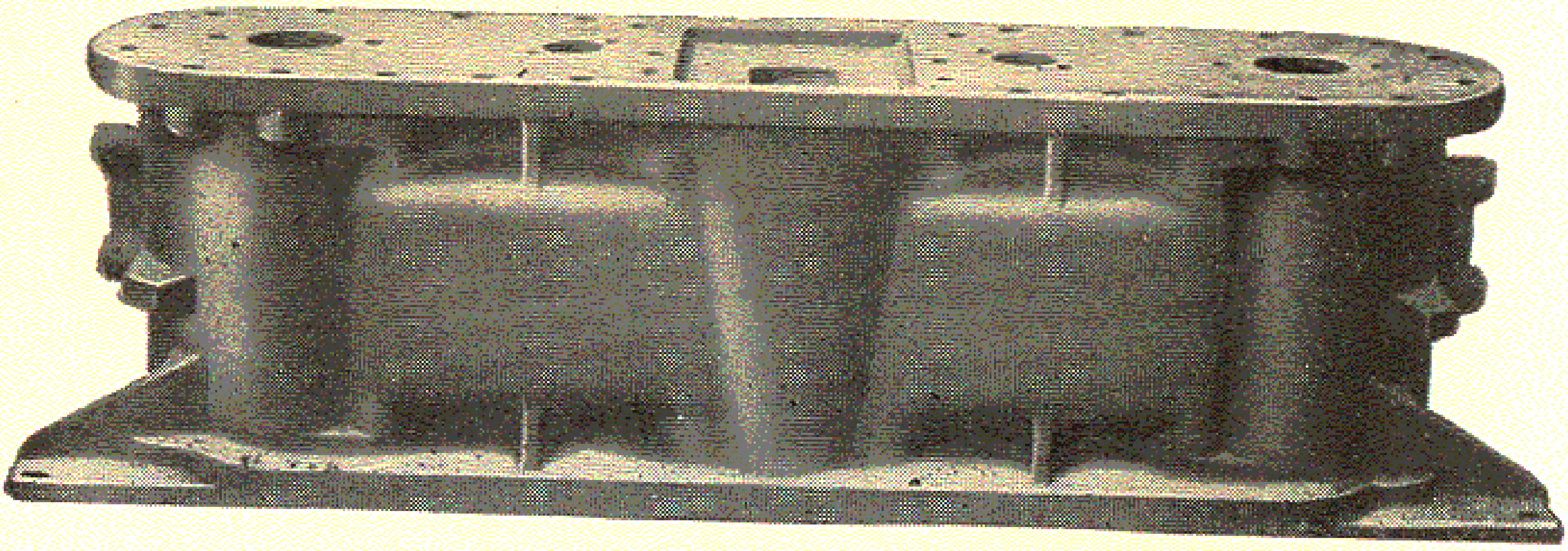


Fig. 12. Type C-2 Booster Cylinders

of the casting, the horizontal center line of the cocks being below the cylinder counterbores to provide for the necessary drainage. The cylinder cock operating cylinders are secured to bosses on the casting by tap bolts.

Pistons are of the usual design, having two snap rings. Valves are of the plug piston type, for inside admission, and have no rings. The turned down portions of the inner edges of the finished diameter surfaces of the valve provide for lengthened cut-off to facilitate starting.

Crossheads and Piston Rods. The crosshead is of cast-steel, having a babbitted face. Its ways are integral with the engine bed, the steel guides being securely bolted to the ways. The crosshead pin is of conventional design, having two tapered fits in the crosshead, and is secured against turning by a dowel. The piston rod, made of special steel and ground full length to size, has a taper fit into the crosshead against a shoulder on the rod and is secured in position by a taper key.

The Valve Gear is of the return crank type. The return or eccentric crank has an integral spindle and is secured to the integral crank pin by a four-key spline on the spindle, meshing with keyways machined in the

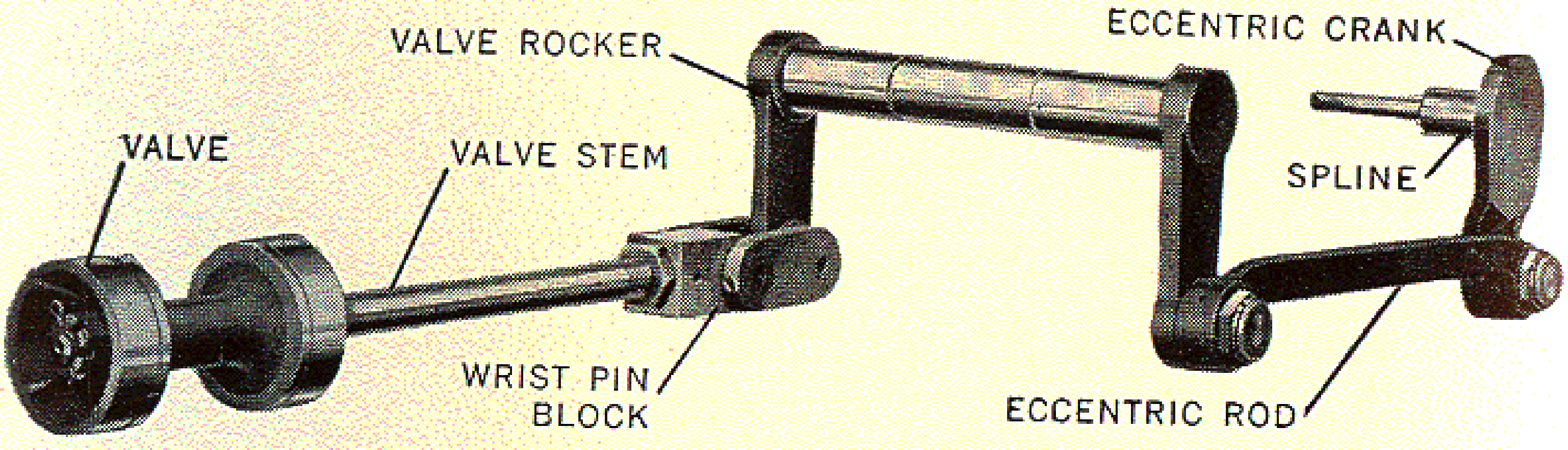


Fig. 13. Booster Valve Gear

pin. A fixed "angle of advance" or "lead angle" is therefore provided. Motion of the eccentric crank is transmitted through the eccentric rod to the valve rocker. The rocker carries the motion across the top of the piston rod to the center line of the valve stem and the valve itself. To properly set the valve, the stem can be screwed in or out of the wrist pin block. A nut locks against the block and a taper pin is fitted in a reamed hole through the block and stem to prevent turning. The method of setting valves is fully described on pages 60 to 64.

The turned down portions of the inner edges of the finished diameter surfaces of the valve provide for lengthened cut-off to facilitate starting. The principal valve dimensions are as follows:

	Long Cut-Off Valve	Limited Cut-Off Valve
Valve Travel	3¼″	$4\frac{19}{32}$″
Valve Length	7¼″	8⅜″
Valve Diameter	4.247″	4.247″
Cut-Off	App. 75%	App. 50%
Lead — Back	$\frac{5}{64}$″	$\frac{1}{16}$″
Lead — Front	$\frac{5}{64}$″	$\frac{5}{64}$″
Steam Lap — Back	¾″	$1\frac{15}{32}$″
Steam Lap — Front	¾″	$1\frac{9}{16}$″
Exhaust Lap — Back	Line and Line	$\frac{7}{32}$″
Exhaust Lap — Front	Line and Line	$\frac{15}{32}$″

The Piston Rod and Valve Stem Packings and Swabs are placed inside of the engine bed, the usual type of metallic rod packings being used.

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 rod to strike the glands.

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

The Connecting Rods, which are of exceptionally heavy cross section, are made of special steel, one-piece drop-forged and fitted with bronze bushings at both ends.

The Eccentric Rods are stamped with the words "Right" or "Left" in order to easily identify them.

The Crankshaft and Gear is a one-piece steel forging, having a raised portion at its center, into which the straight spur gear teeth are cut. The crank arms, set at 90° apart, are pressed on the ends of the shaft under heavy pressure and each is further secured by two ¾″ by 1″ keys.

The Crank Arm and Pin is made in a one-piece steel forging. The crank arms are stamped "Right" and "Left" and must be so used in order to have the keyways

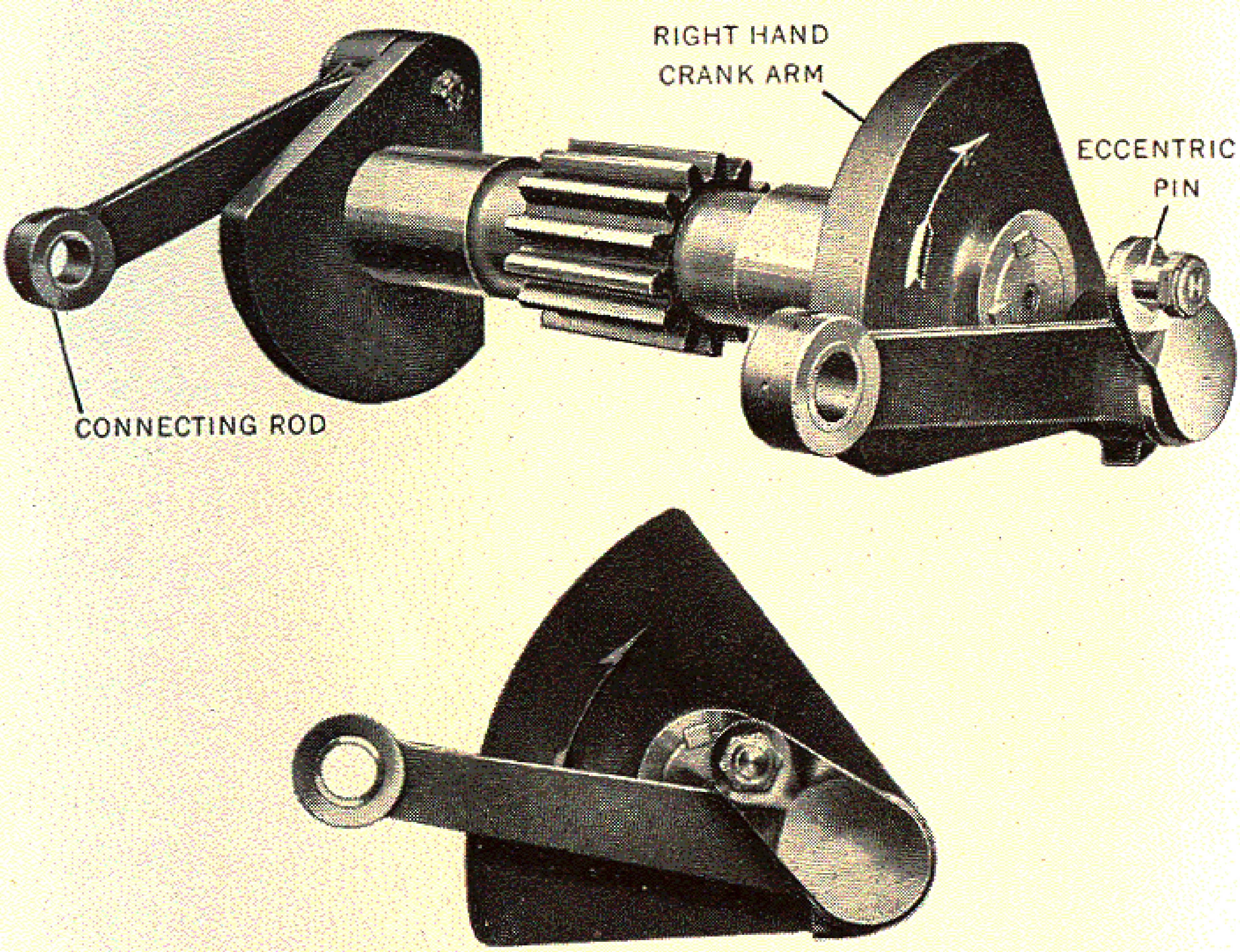


Fig. 14. Crankshaft Complete, with Connecting Rods

in the pins so placed that they will locate the eccentric cranks for the prescribed angle of advance. The arms are counter-balanced to reduce vibration to a minimum.

Instructions for pressing the crank arms on the crankshaft are given on pages 56 and 57.

Crankshaft Complete, with Connecting Rods. Fig. 14 shows these parts as they are assembled. It will be noted that the right hand crank arm leads the left one, and that the pin of the eccentric crank follows the crank pin. The direction of rotation is indicated by the arrow and the connecting rods are shown in the positions which they assume when connected to the crossheads.

Crankshaft, Idler Gear Rocker, and Gears. Since the crankshaft gear does not mesh directly with the trailer

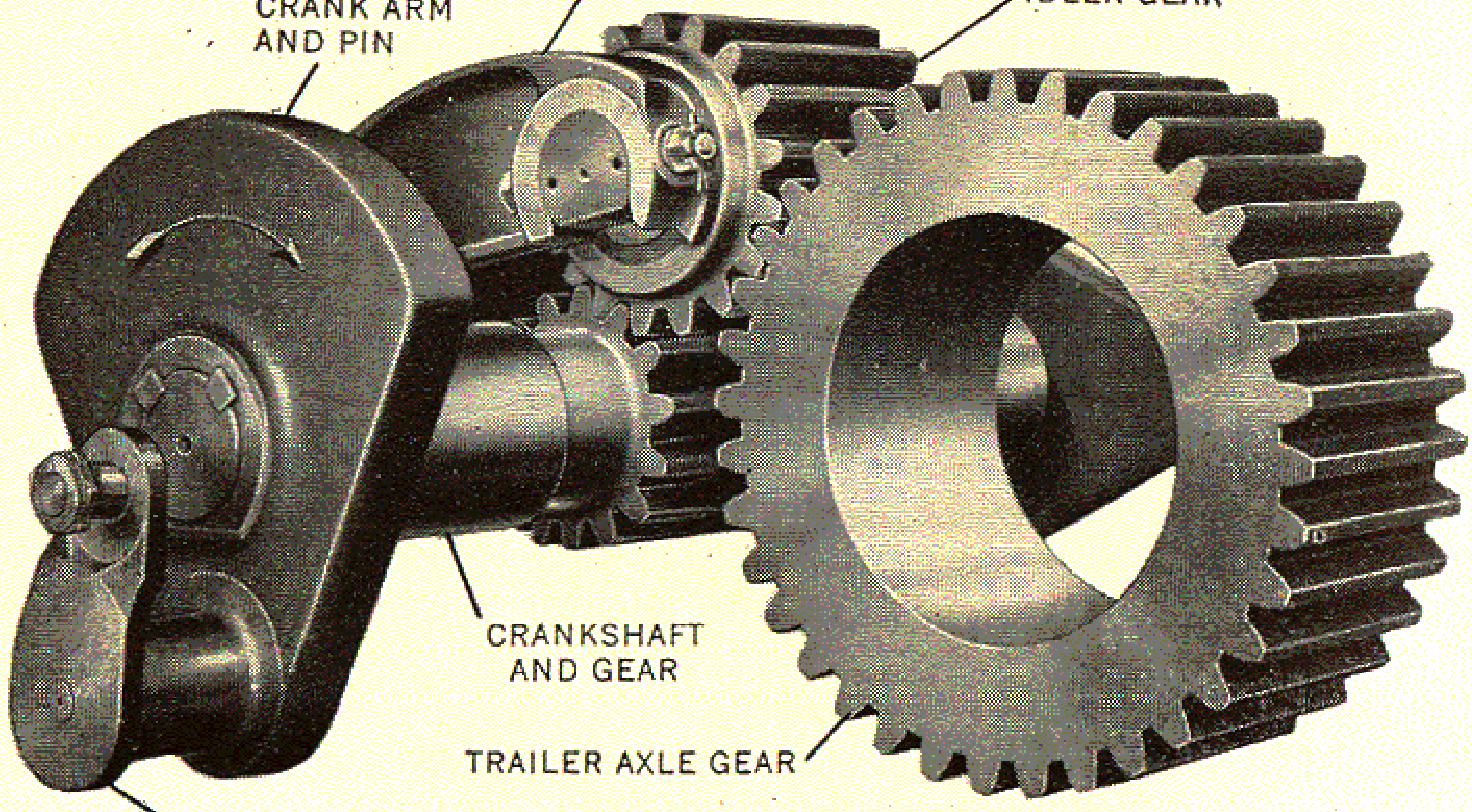


Fig. 15. Crankshaft, Idler Gear Rocker, and Gears

axle gear, a third or idler gear, is provided. It is mounted in the steel idler gear rocker, which is fulcrumed in a bracket integral with the engine bed. The idler gear is held continuously in mesh with the crankshaft gear and is carried into mesh with the trailer axle gear by the rocker, thus transmitting the power from the crankshaft to the trailer axle.

The Trailer Axle Gear is of steel and is pressed cold onto the trailer axle under a pressure of from 90 to 120 tons. No other means of securing it to the axle is necessary. The gear is centrally located on the axle and is housed by the overhang of the engine bed and the axle bearing cap.

Steam Piping. The arrangement of flexible steel

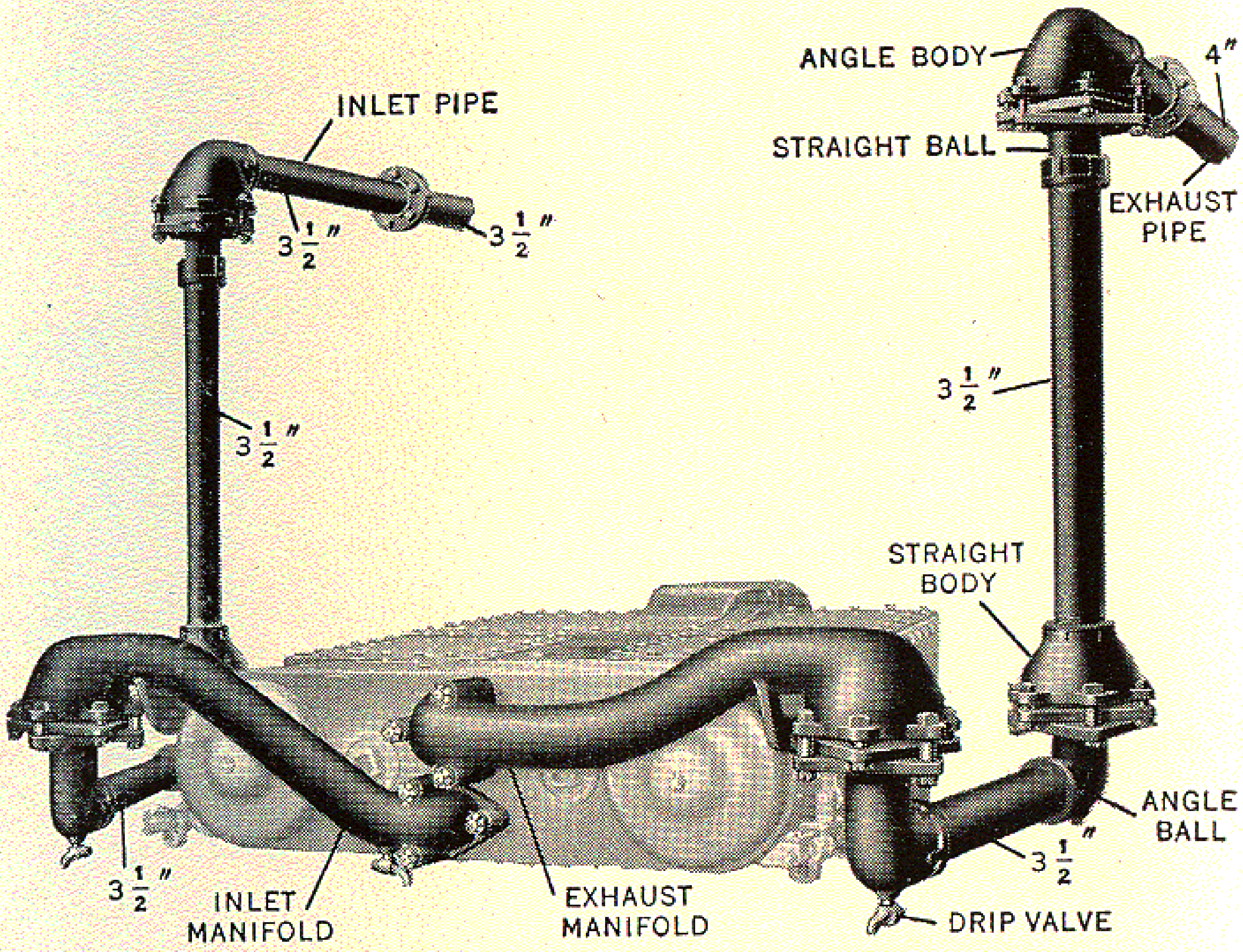


Fig. 16. Type C-2 Booster Steam Inlet and Exhaust Joints, Manifolds and Piping

piping for carrying the steam to and from the Booster cylinders is shown in Fig. 16.

The steam inlet pipe, on the left side of the locomotive, consists of a suitable run of extra heavy steel pipe with 3½" flexible joints. These joints are specially designed

Franklin Ball Joints, one with angle ball (female), the body for which is cast on the manifold; one with angle ball (female) and straight body; and one with straight ball (female) and angle body. The exhaust pipe on the right side of the locomotive is similar, using the same size joints.

The inlet pipe, as well as those portions of the exhaust pipe between the flexible joints, is 3½″ in size. The exhaust pipe ahead of the flange coupling is 4″ in size.

The connections with the fittings and the manifolds, after being tightly screwed together are further secured against loosening by brazing. To facilitate brazing and to obtain a true surface the ends of the joints and of the manifolds are machine finished.

Bronze wire, of approximately the following composition, should be used. Copper 60%; zinc 40%; manganese 0.5%; iron 1% and aluminum 0.1% maximum.

As dirty surfaces produce poor welds, it is very important that they be thoroughly clean and free of scale. The pre-heating should be uniform all around, using a long flame and raising the parts to a good spitting temperature. After pre-heating, reduce the flame length and increase the blast. As the bronze casting will come to a welding temperature before the steel, care should be taken not to make it too high, or any hotter than is necessary for the bronze wire to at once spread when a drop is melted by the torch. A flux should be used in just sufficient amount to keep the surfaces clean, but no more. As the temperature rises it will be noticed that small drops of a white silvery nature will appear on the bronze casting, which are indicative of about the temperature at which the brazing should be done. After brazing, the parts should be allowed to cool slowly and uniformly.

The inner ends of the cast iron manifolds are bolted to the face of the cylinder casting, joints being made with copper gaskets. The outer ends are bolted to integral lugs on the cylinder casting.

Suitable guide links are used to govern the movements of the middle ball joints so as to prevent interference with other locomotive parts.

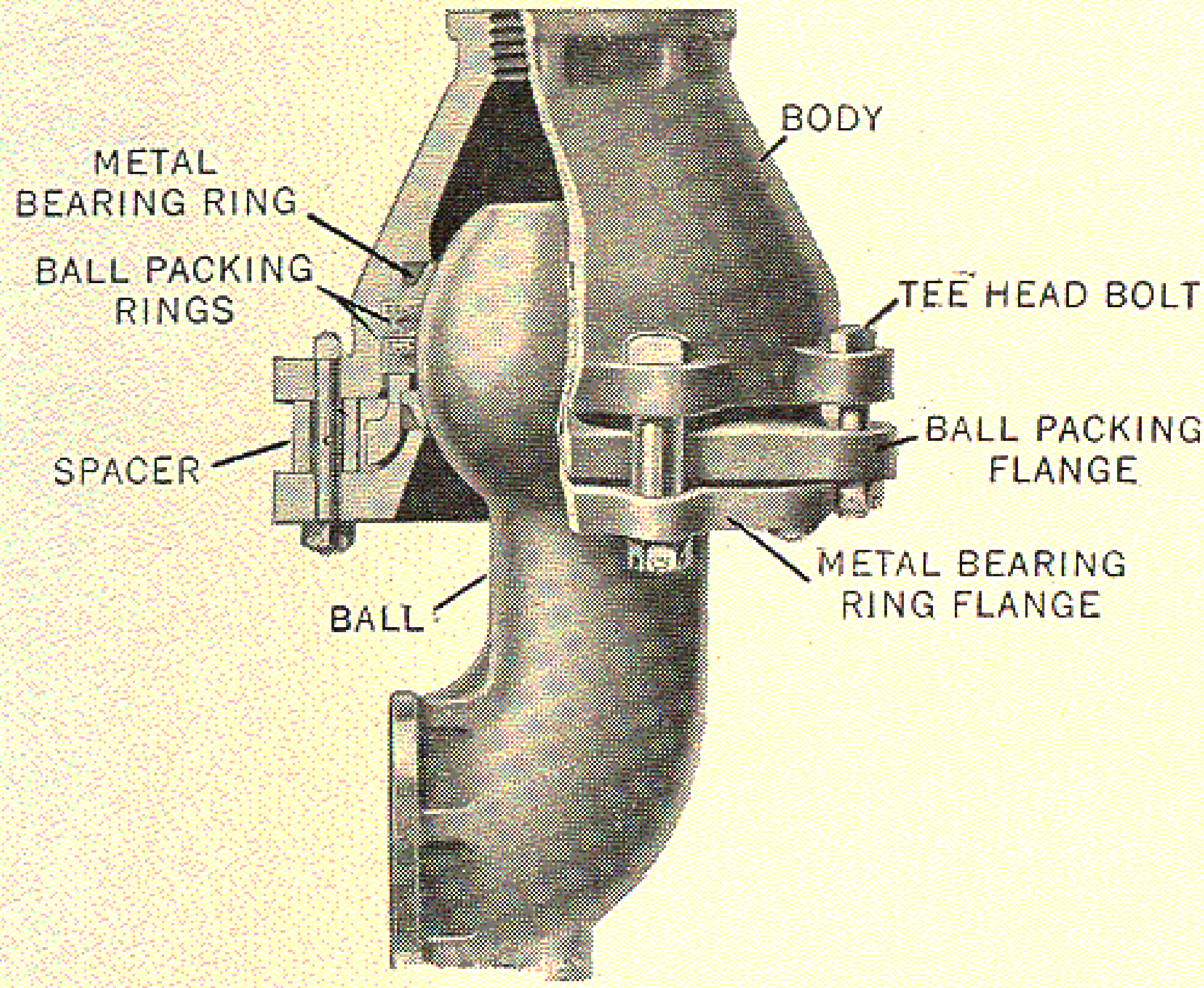


Fig. 17. Booster Ball Joint

The top ball joints must be supported by rigid clamps which will allow for the longitudinal expansion of the pipes.

Fig. 17 shows the details of a 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 the 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.

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 length of the packing ring as manufactured provides a 3/8″ opening when in position on the ball and this opening should be provided when replacing rings which have lengthened due to service.

A boss is cast on the angle ball and tapped with a standard 3/8″ 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.

All of the steam inlet pipe should be lagged with sponge felted covering 1″ thick. The exhaust pipe should be similarly lagged on passenger engines.

The steam separator should be located in the exhaust pipe and as far forward as possible to eliminate moisture from the pipe to prevent water being blown from the stack. Drainage from the separator is taken out through a check valve and pipe leading down to about the height of the engine truck. The check valve is counter-weighted so as to remain closed except when the pressure from the water and the exhaust steam is sufficient to open it.

Booster Lubrication. The engine bed, tie bars, crossties, and cover plates make an oil-tight casing which is filled with oil so that all moving parts within the engine bed may be lubricated by the splash method.

Maintenance of the proper supply of oil in the bed should be attended to at the enginehouse and it is important that this matter be given attention after each trip or

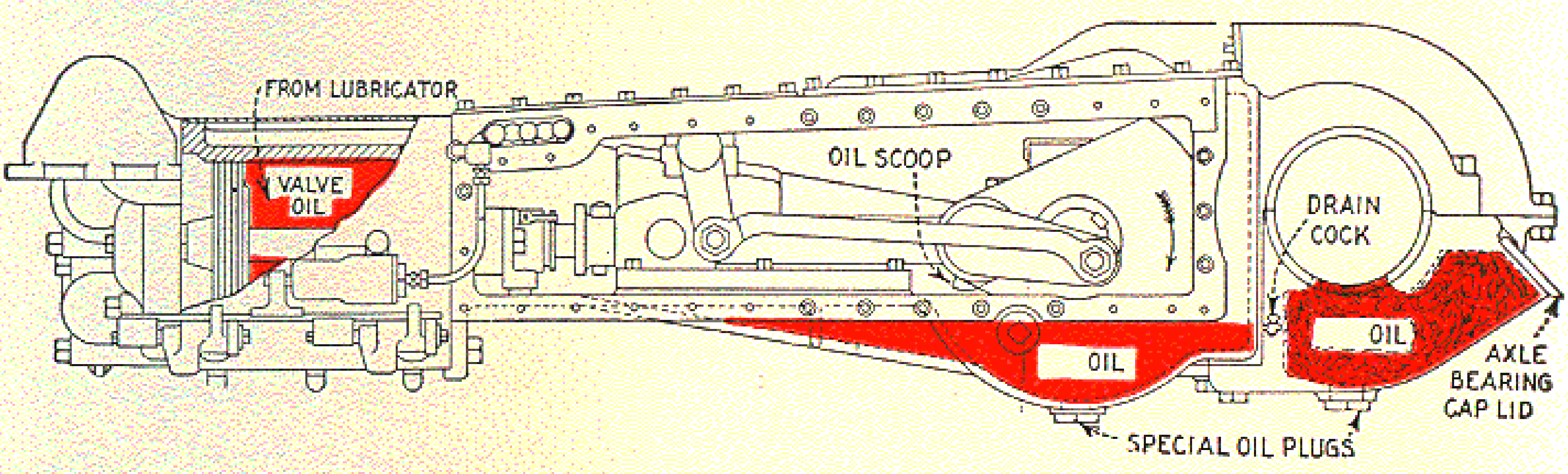


Fig. 18. Booster Lubrication Chart

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. Two oil-overflow drain cocks at the front end of the engine bed indicate the height at which the oil should be maintained. Before replenishing the oil supply, it may be necessary to drain water from the bed. The special oil plugs in the crank-pits and axle bearing cap should be backed out a turn or two which will permit the 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.

The Booster cylinders and valves are lubricated with valve oil from an extra feed on the main locomotive lubricator or from a separate lubricator in the cab.

The lubricator line has a $\frac{1}{16}''$ choke bushing where it enters the Booster steam inlet pipe.

The main bearings on the trailer axle are lubricated through the dope-packed axle bearing cap in the same manner as car journals. The wool waste, soaked in oil, should not be packed too tightly or in such amounts that no space remains for the oil. Should the trailer axle bearings heat in service they may be repacked or oiled through the two axle bearing cap lids.

BOOSTER CRANKCASE LUBRICANT

Specification

1. Flash Point (Degrees F.)	Not less than 340
2. Viscosity (100 Degrees F.)	Not more than 1225
3. Viscosity (210 Degrees F.)	Not less than 60
4. Viscosity (280 Degrees F.)	Not less than 41
5. Pour (Degrees F.)	Not greater than +5
6. Reaction	Neutral

IMPORTANT—THE LUBRICANT MUST SEPARATE EASILY FROM WATER.

The above specifications can be met by oils furnished by most of the oil companies, typical examples being the following:

1. Standard Oil of Indiana—No. 2528
2. Standard Oil of New Jersey—Aracar No. 70
3. Sinclair Oil Co.—Garnet "DD"
4. Texas Oil Co.—Texayce RB-1559
5. Socony Vacuum Oil Co.—SV-406.11

Reclaimed oil should never be used for Booster crankcase lubrication.

BOOSTER CONTROL
Type C-2

The Booster Latch, when used on a locomotive equipped with the Precision Power Reverse Gear, is secured to an extension arm of the indicator block passing through the cover plate of the bracket. The reverse lever pilot valve is fastened to the forward end of the indicator

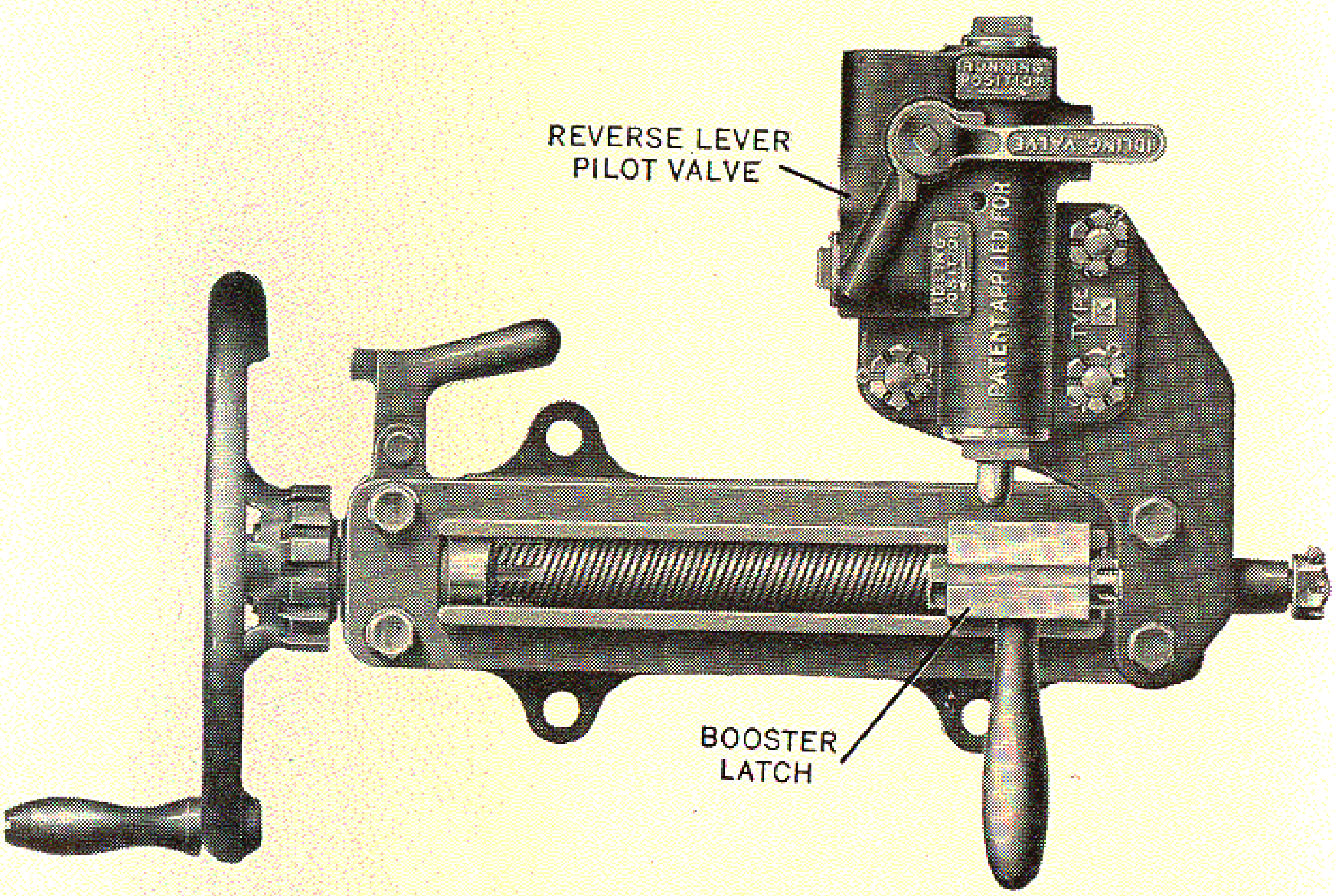
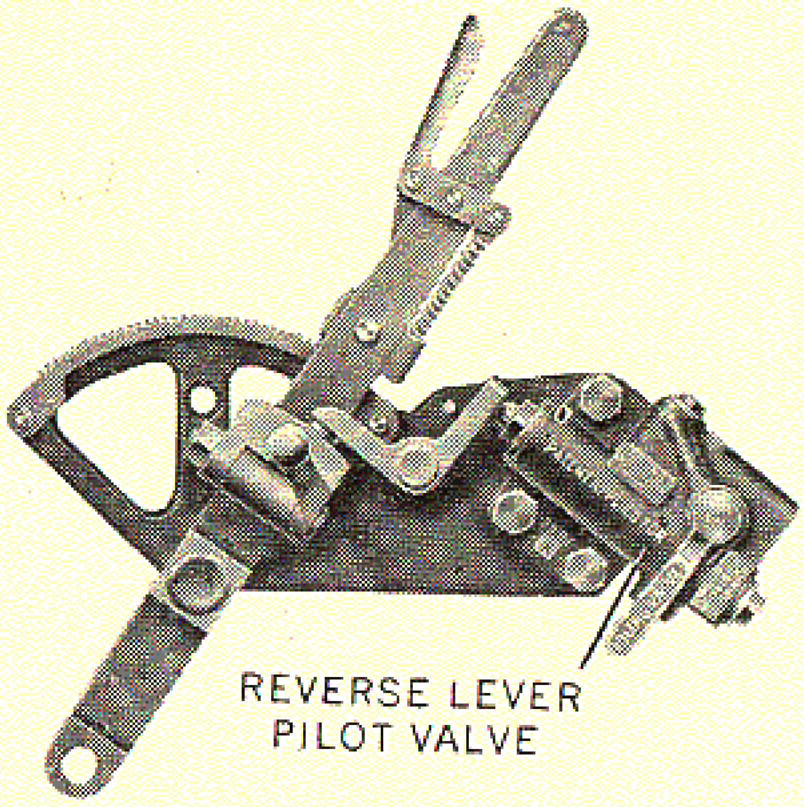


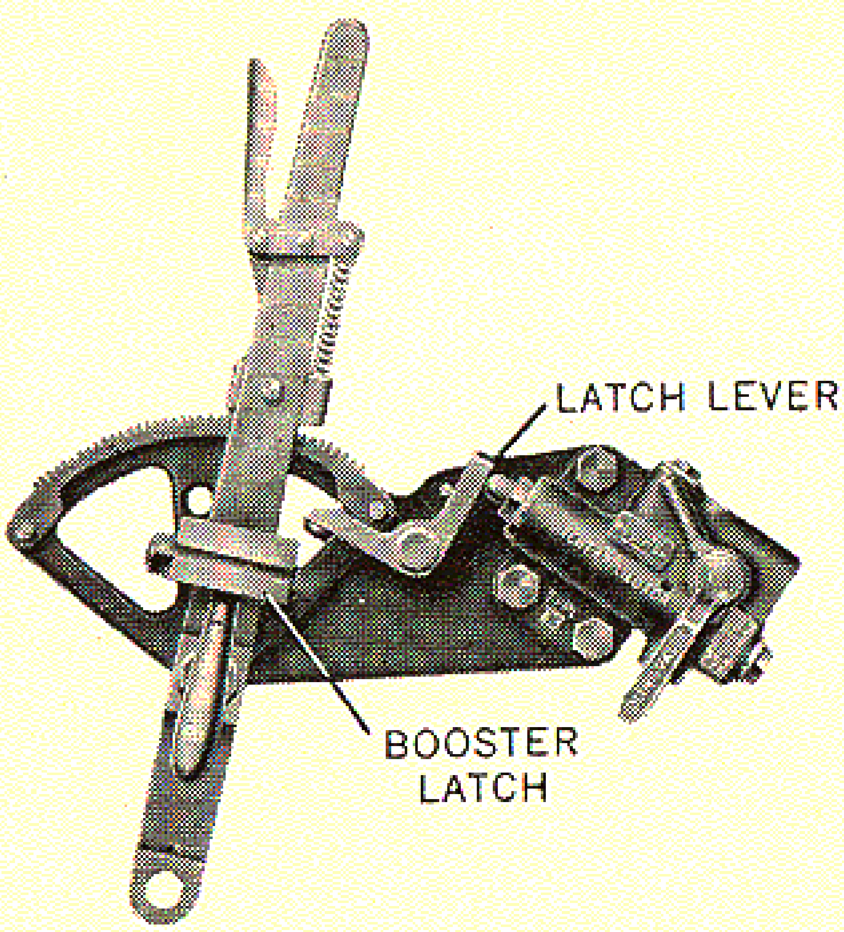
Fig. 19. Booster Latch as used with Precision Gear

bracket on a steel plate, which arrangement requires that the indicator block be in or near the corner in the forward position in order to engage the Booster latch to move the spring cage of the reverse lever pilot valve.

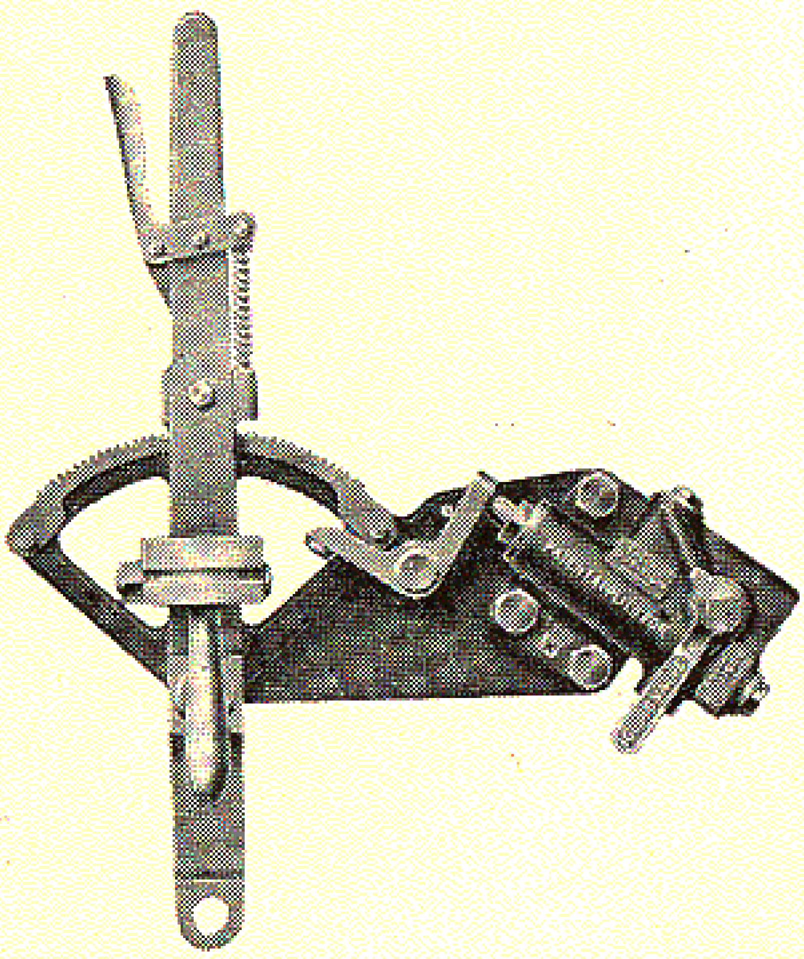
When the Booster latch is used on a locomotive equipped with the Ragonnet Power Reverse Gear, the latch is fulcrumed on the reverse lever. To the forward end of the quadrant is fastened a steel plate which carries the reverse lever pilot valve and provides a support for the pin of the latch lever. This arrangement also requires that the reverse lever be in or near the corner in the



Lever in Corner
Booster Cut In



Lever at 66% Cut-Off
Booster Cut Out



Lever on Center
Booster Cut Out

Fig. 20. Booster Latch as used with Ragonnet Gear

forward position in order to engage the Booster latch and latch lever, which latter moves the spring cage of the reverse lever pilot valve.

When the Precision Gear indicator block is moved back or when the Ragonnet Gear reverse lever is "hooked up", in either case to a point where the Booster latch, or the latch lever, will not engage with the spring cage of the reverse lever pilot valve, the latch drops down, automatically releasing the air in the control system and disengaging the Booster.

The above mentioned point of disengagement of the latch or latch lever, for the long cut-off engine is about 66% locomotive cut-off; and for the limited cut-off engine about 55% cut-off; meaning 66% and 55% of the locomotive piston stroke.

The latch, or the latch lever, may be disengaged from the spring cage at any time by knocking down the latch.

It is important, when fitting the jaws of the Booster latch over the boss on the reverse lever or over the extension of the indicator block, that the latch will drop down by gravity when the reverse lever or the indicator block is moved back out of contact with the spring cage of the reverse lever pilot valve.

The Reverse Lever Pilot Valve is operated by raising or lowering the Booster latch. Its purpose 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. 21, 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.

The words "Idling Valve" are cast on the handle and

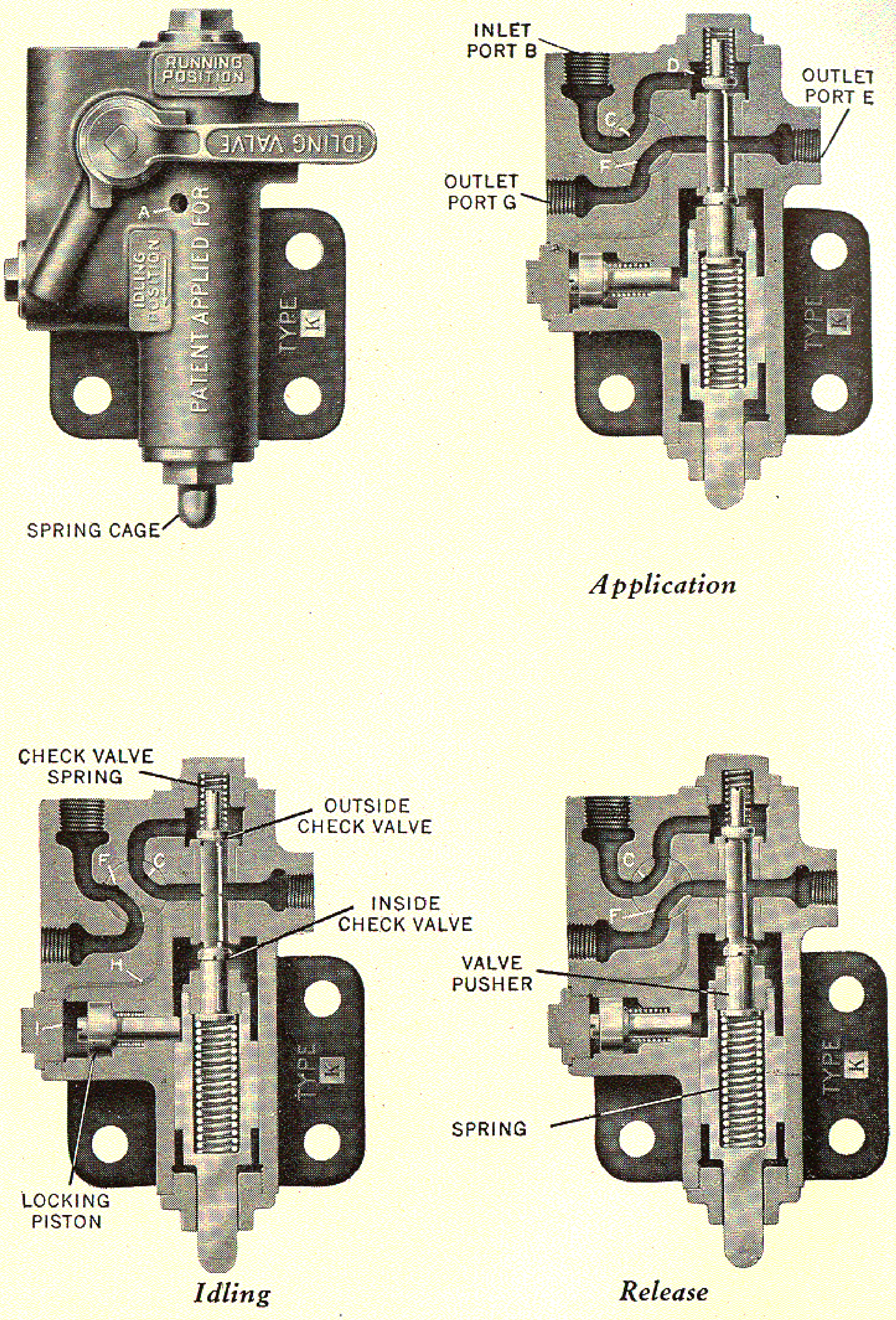


Fig. 21. Type C-2 Booster Reverse Lever Pilot Valve

the words "Running Position" and "Idling Position" are cast on the body as shown in Fig. 21. 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 reverse lever, Fig. 20, or the block of the Precision Power Reverse Gear indicator, Fig. 19, must be in or near the corner in the forward position and the idling valve must be in the running position, Fig. 21, in order to raise the latch.

Application. Idling Valve in Running Position. When the 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 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 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 in 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. 21, provides for conveniently idling the Booster from the cab. When the idling valve is placed in idling position, the locking feature makes it impossible to cut in the Booster while it is idling.

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-house 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.

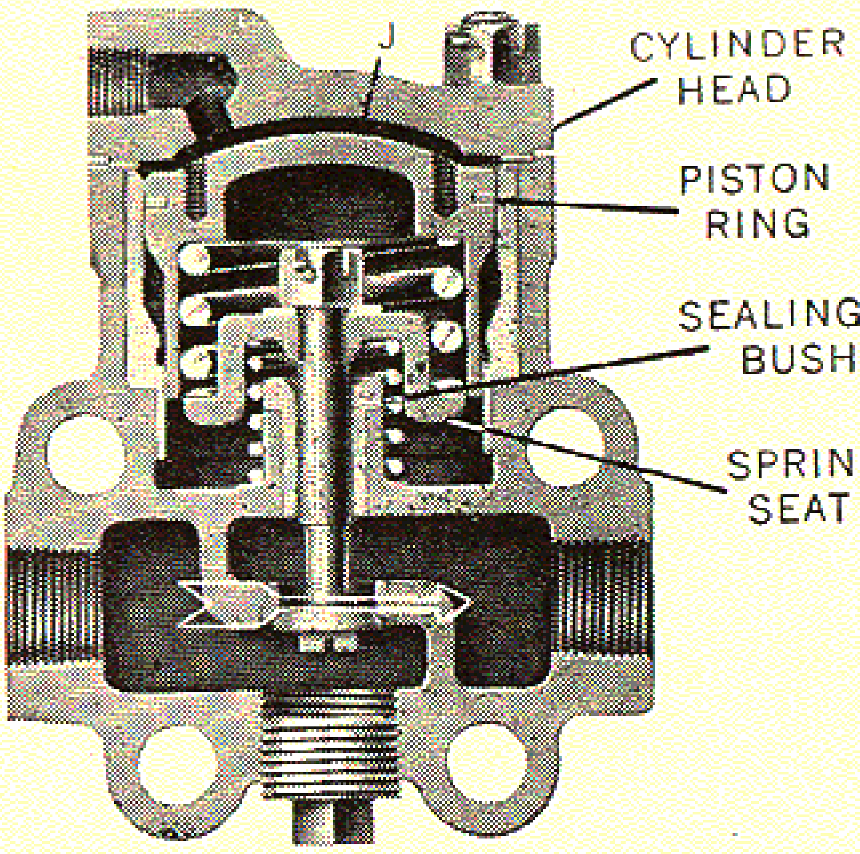
Another advantage from idling is gained by having lubricated the valves and cylinders before the Booster goes into regular service operation.

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:

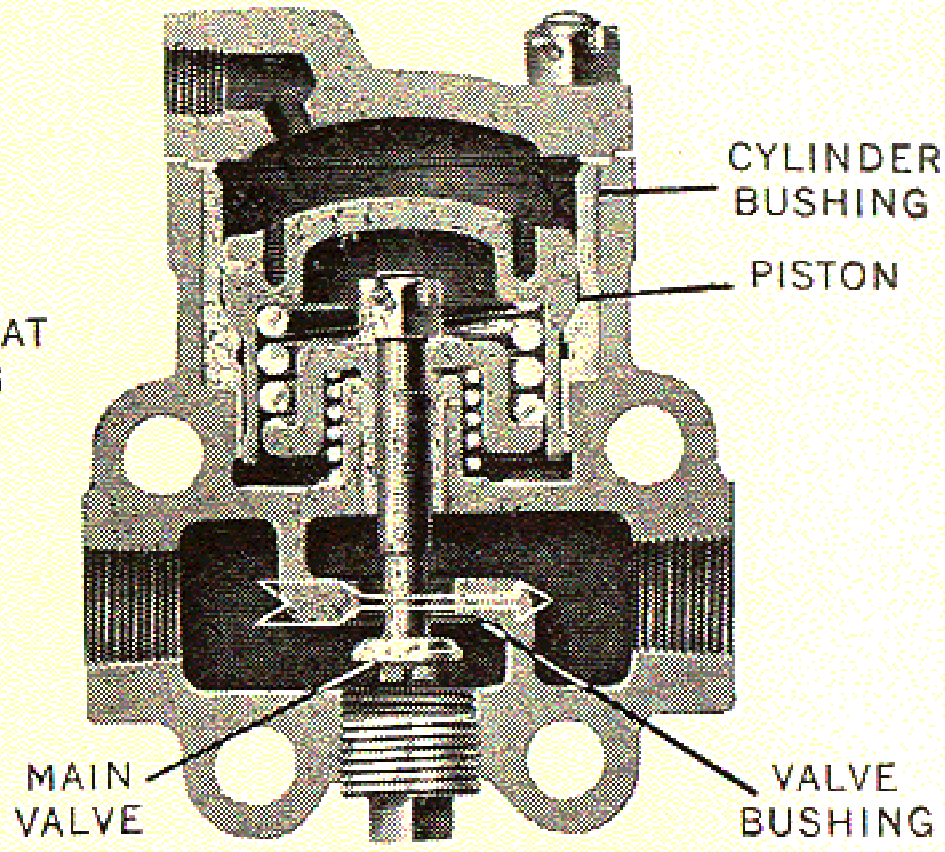
(a) For turning the Booster over, so that the idler gear and trailer axle gear will match, permitting the idler gear to be pulled down completely into mesh by the action of tooth pressure when locomotive is stationary.

(b) For turning the Booster over, at a speed in excess of the speed of the trailer 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-



Release



Application

Fig. 22. Type C-2 Booster Preliminary Throttle Valve

liminary throttle valve, Fig. 22. 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, 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.

The size of choke varies according to boiler pressure to insure proper idling speed. At boiler pressure the Booster should idle at 375 R.P.M. The size of choke for different boiler pressures is:

Boiler Pressure	*Size of Choke*
200 lbs. or under	5/8"
201 lbs. to 250 inclusive	9/16"
251 lbs. to 274 inclusive	1/2"
275 lbs. to 299 inclusive	7/16"
300 lbs. to 350 inclusive	3/8"

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 a bronze ring, moves in a bronze bushing. The jointing 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.

The valve bushing of special heat treated steel, and the sealing seat bushing of stainless steel, provide renewable seats for the main valve and the spring seat.

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. When separate valves are shipped this port is closed by a pipe plug which must be removed before operating the valve.

Since the limits are necessarily close, great care is taken in the manufacture. 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 use of large stillson wrenches should be avoided and care should be taken not to clamp the parts too tightly in vises.

The preliminary throttle valve must be installed on a bracket, secured to the boiler, in the preliminary steam line and higher than the steam turret when possible, so that the steam will pass through it in the direction of the arrow cast upon the body.

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. 23 shows the release position of the clutch cylinder, the idler gear being out of mesh with the trailer axle gear; while Fig. 24 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 gears 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.

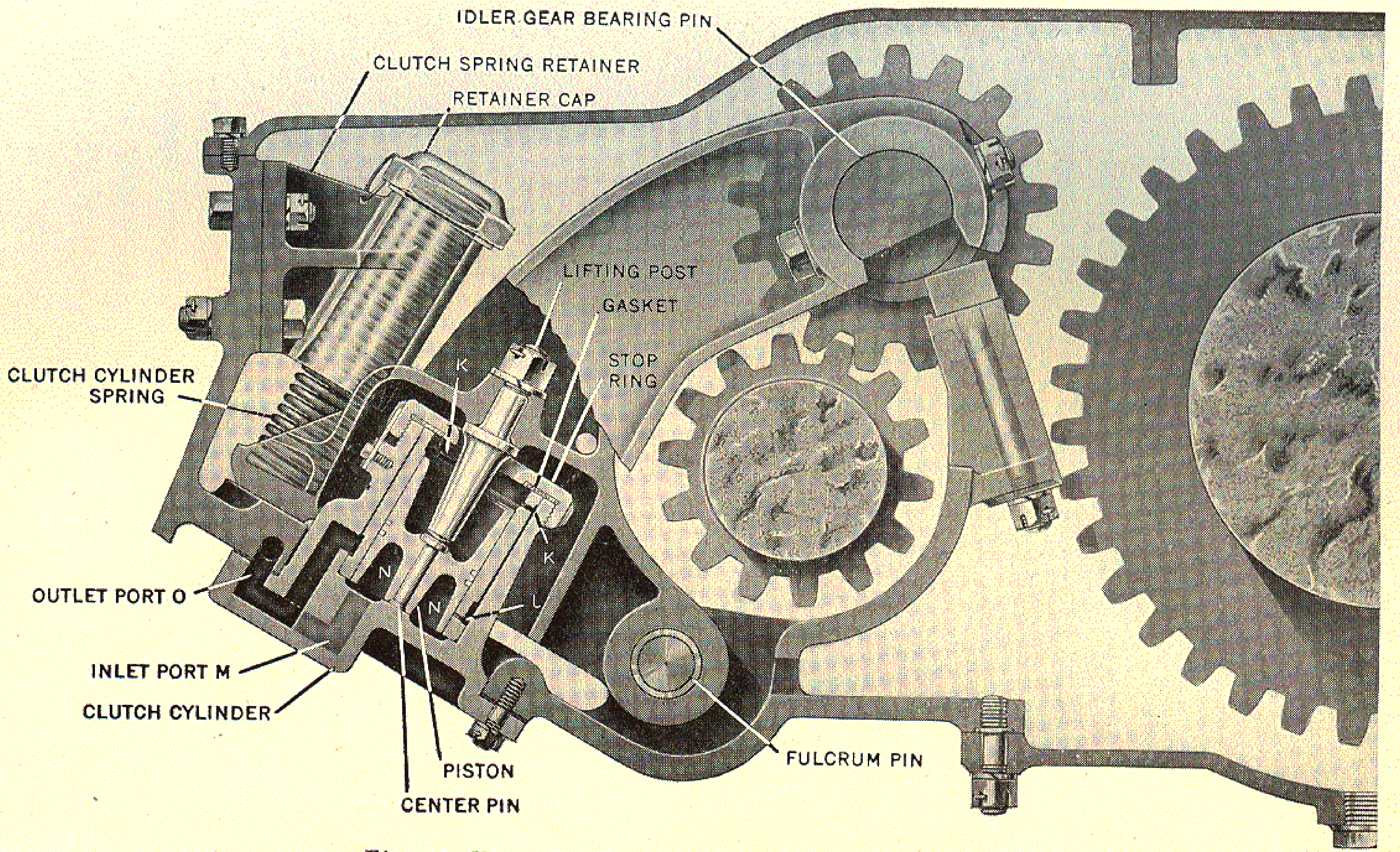


Fig. 23. Type C-2 Booster Clutch Cylinder; Release

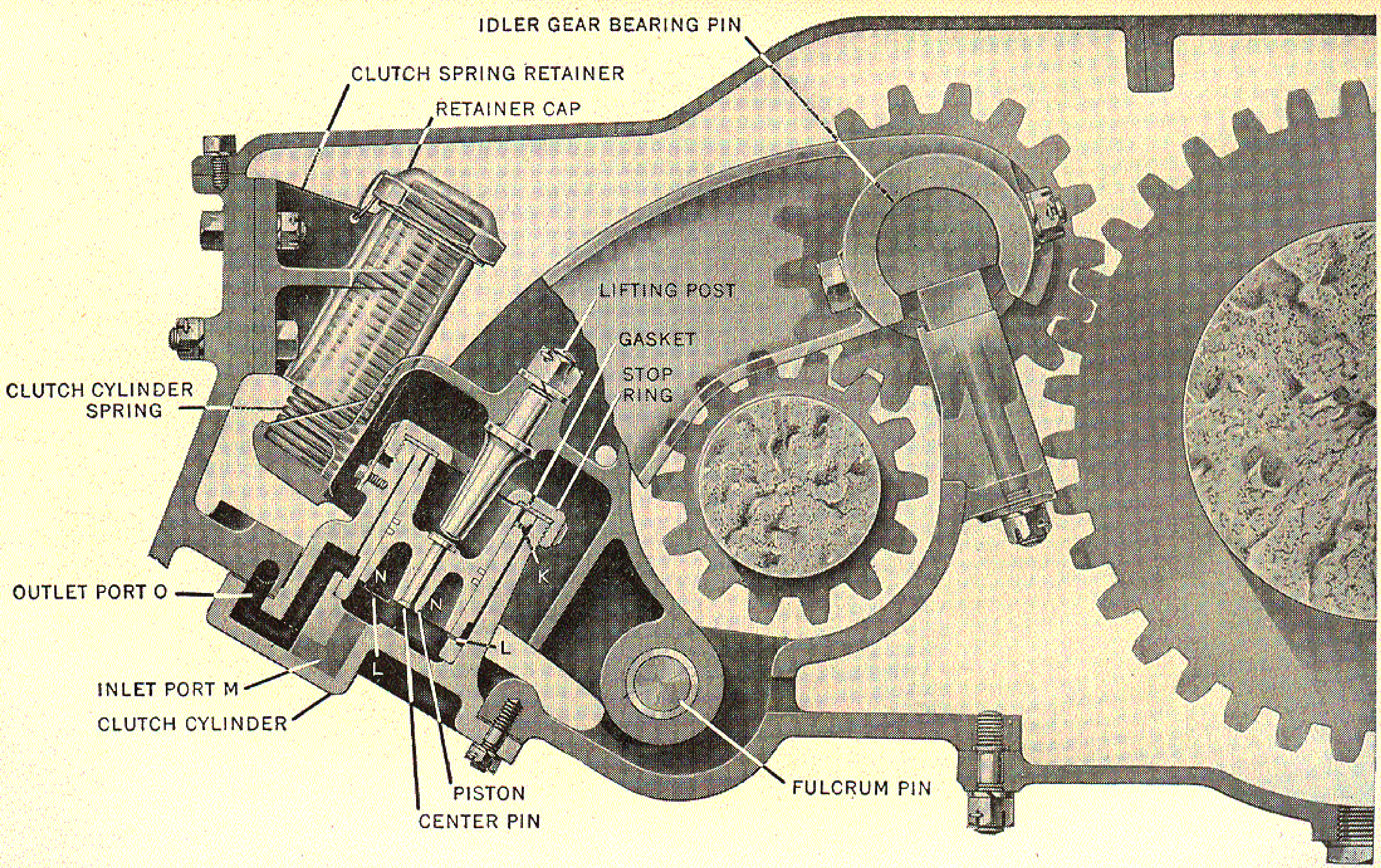


Fig. 24. Type C-2 Booster Clutch Cylinder; Application

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 center 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 $\frac{1}{16}''$ to $\frac{1}{8}''$ clearance between the center 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 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 $\frac{1}{16}''$ to $\frac{1}{8}''$ clearance between the center 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. 23, the springs hold the back stops of the rocker against a machined pad on the engine bed. When in application position, Fig. 24, 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. 25, above the outside check valve, and through outlet port Q to the throttle operating cylinder to open the Booster throttle. After the locomotive throttle 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 springs to return the piston to release position. The check valve

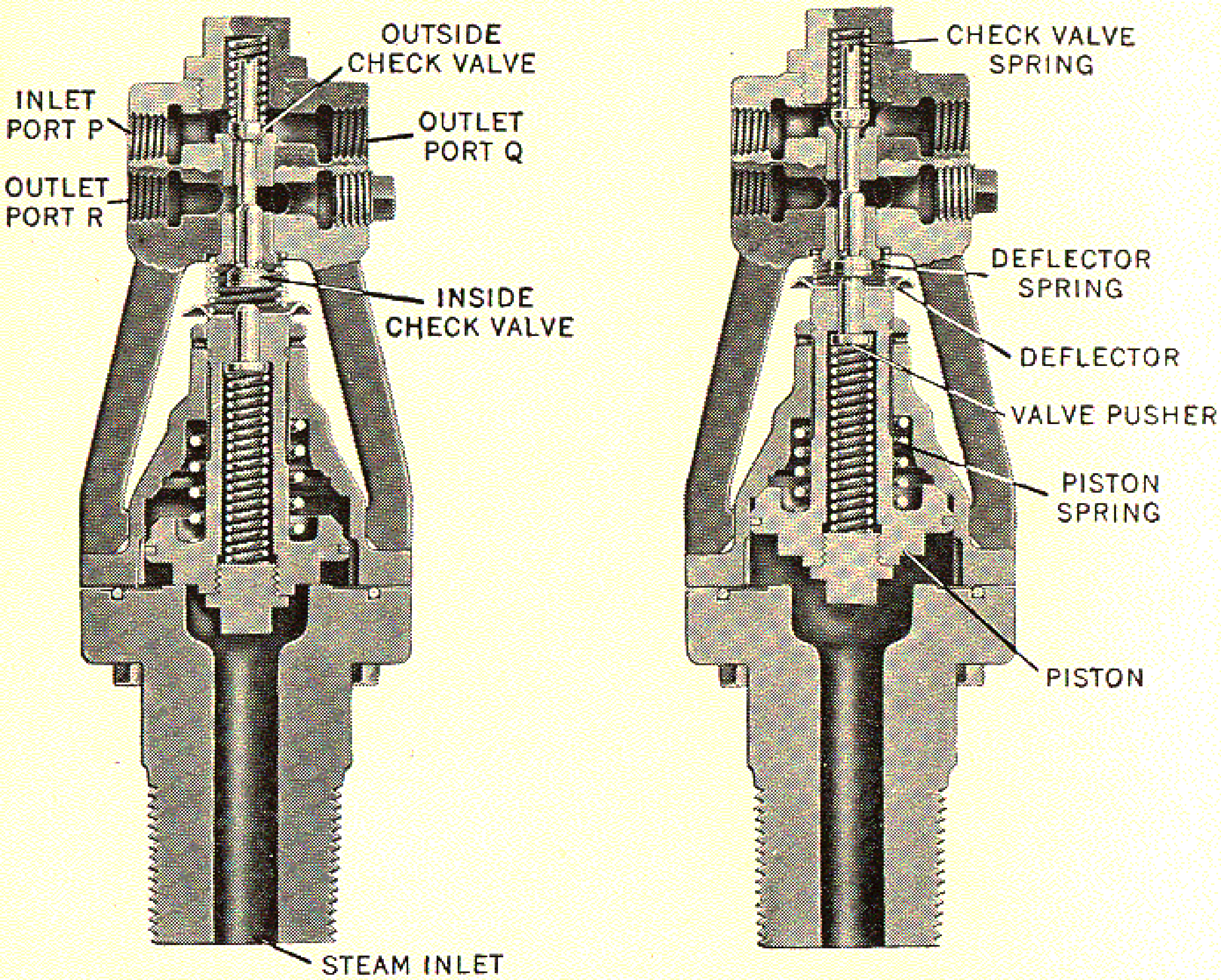


Fig. 25. Dome Pilot Valve

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 lines to the timing reservoir and the cylinder cock operating cylinders 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 fourth port in the valve, which is shown plugged in Fig. 25, may be used instead of the port marked R if the piping arrangement makes it desirable.

The Booster Throttle Valve controls the supply of steam to the inlet pipe. There are two designs—one conforms with loccmotive throttle valve practice in having

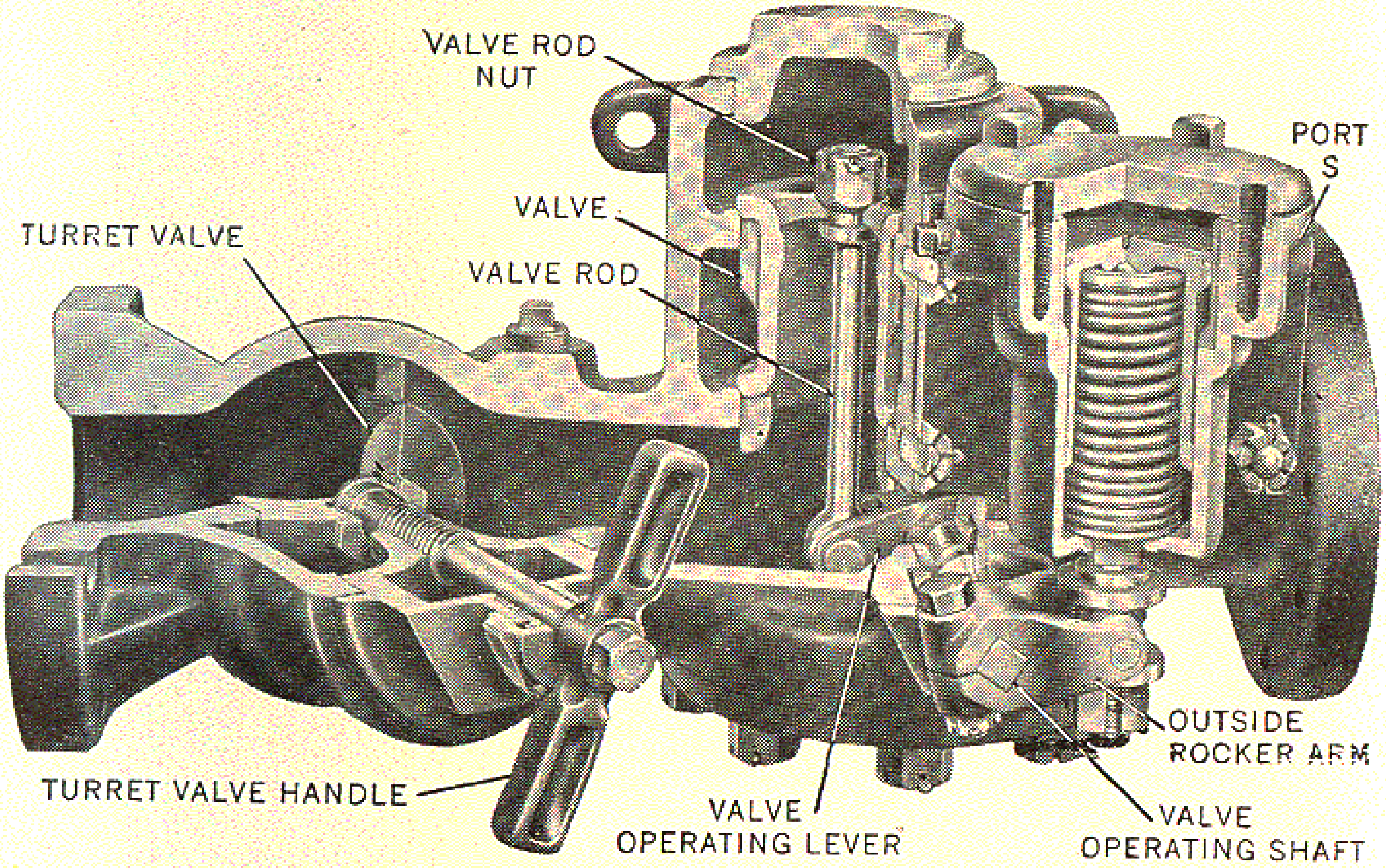


Fig. 26. Booster Throttle Valve and Operating Cylinder

two seats. 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 other is of the single seated type and is firmly held on its seat by the inlet pressure and unbalanced area. When the throttle operating cylinder acts to open the throttle, the pilot valve is lifted from its seat and relieves the pressure from the top of the main valve. Further movement of the valve operating shaft lifts the main valve and carries it to its full open position.

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 $\frac{1}{64}''$ clearance to permit the valve to properly seat itself.

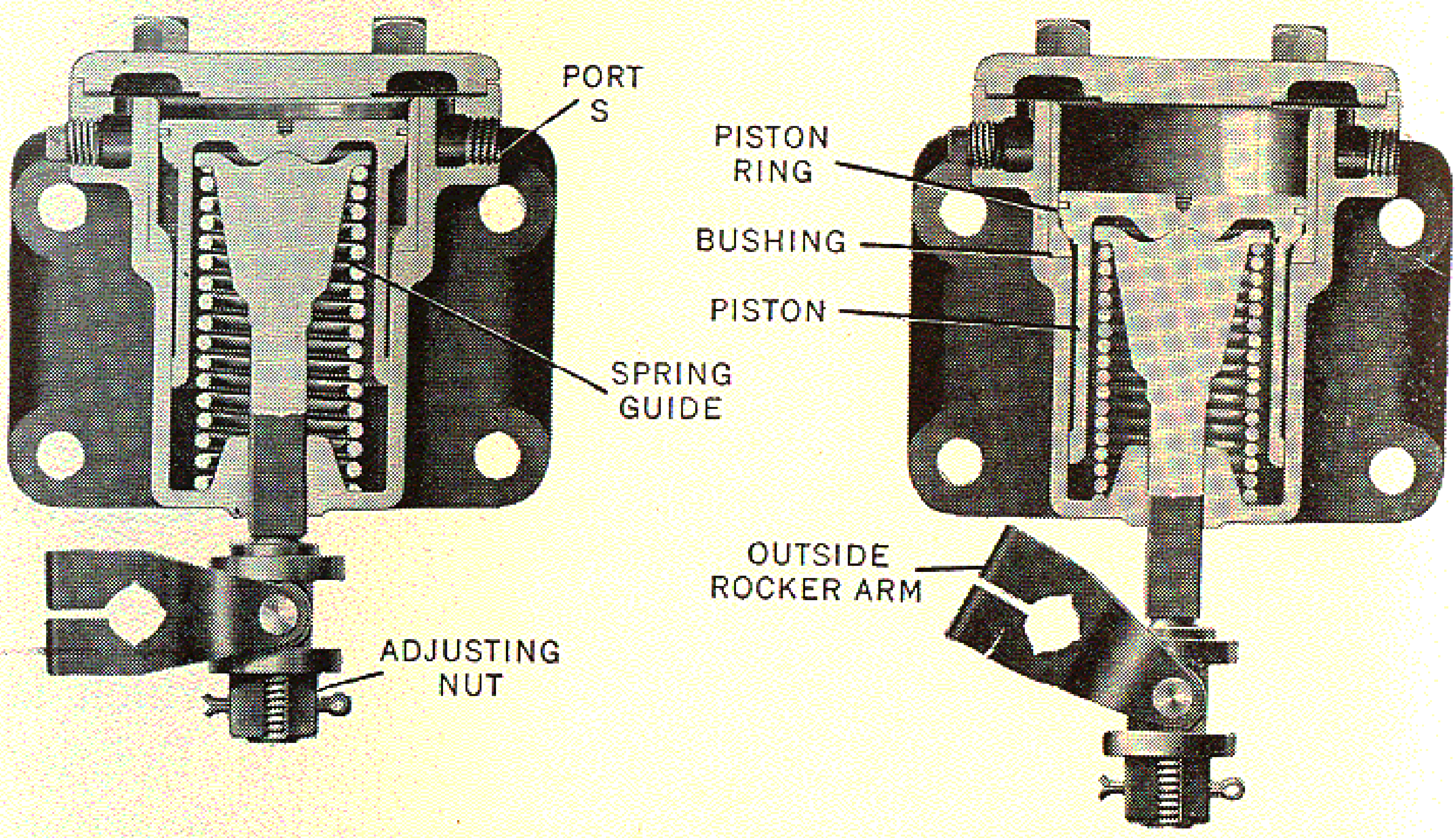
The Throttle Valve Operating Cylinder, which is bolted to the throttle valve body, opens the Booster throttle through pressure of air and closes it by action of the spring.

(a) When air is admitted through port S, Fig. 27, 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 5/8″ 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.



Release ***Application***

Fig. 27. Booster Throttle Valve Operating Cylinder

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.*

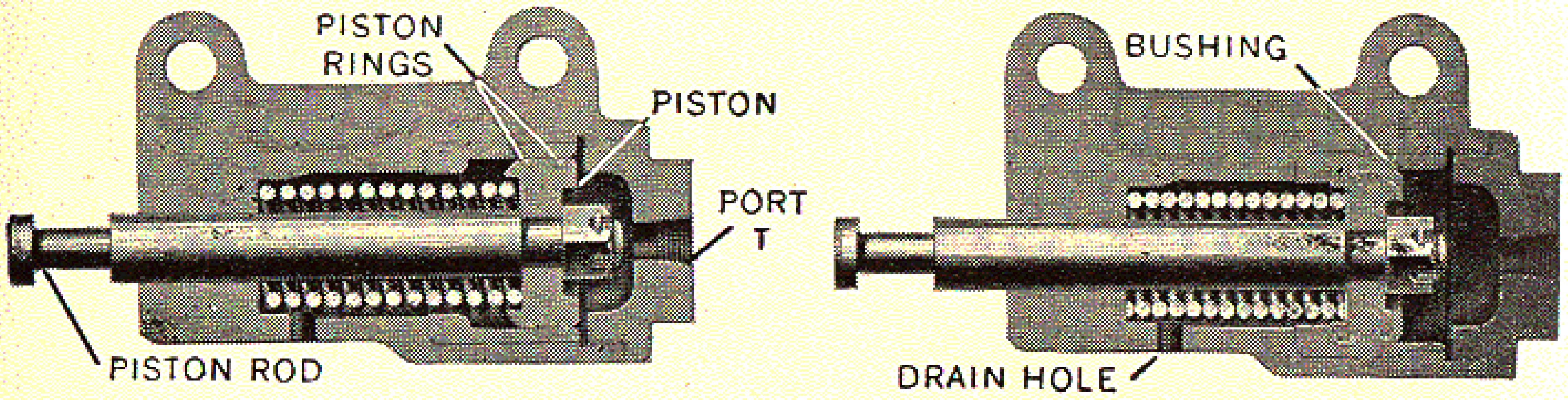
To *Increase* the valve lift, screw the adjusting nut *Downward.*

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 cylinders.

(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. 29, 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.



Release *Application*

Fig. 28. Type C-2 Booster Cylinder Cock Operating Cylinder

In allowing the cylinder cocks to close, the air enters through port T, Fig. 28, 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 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 past the rings and also provides a stop to limit the travel of the operating rod on the closing stroke.

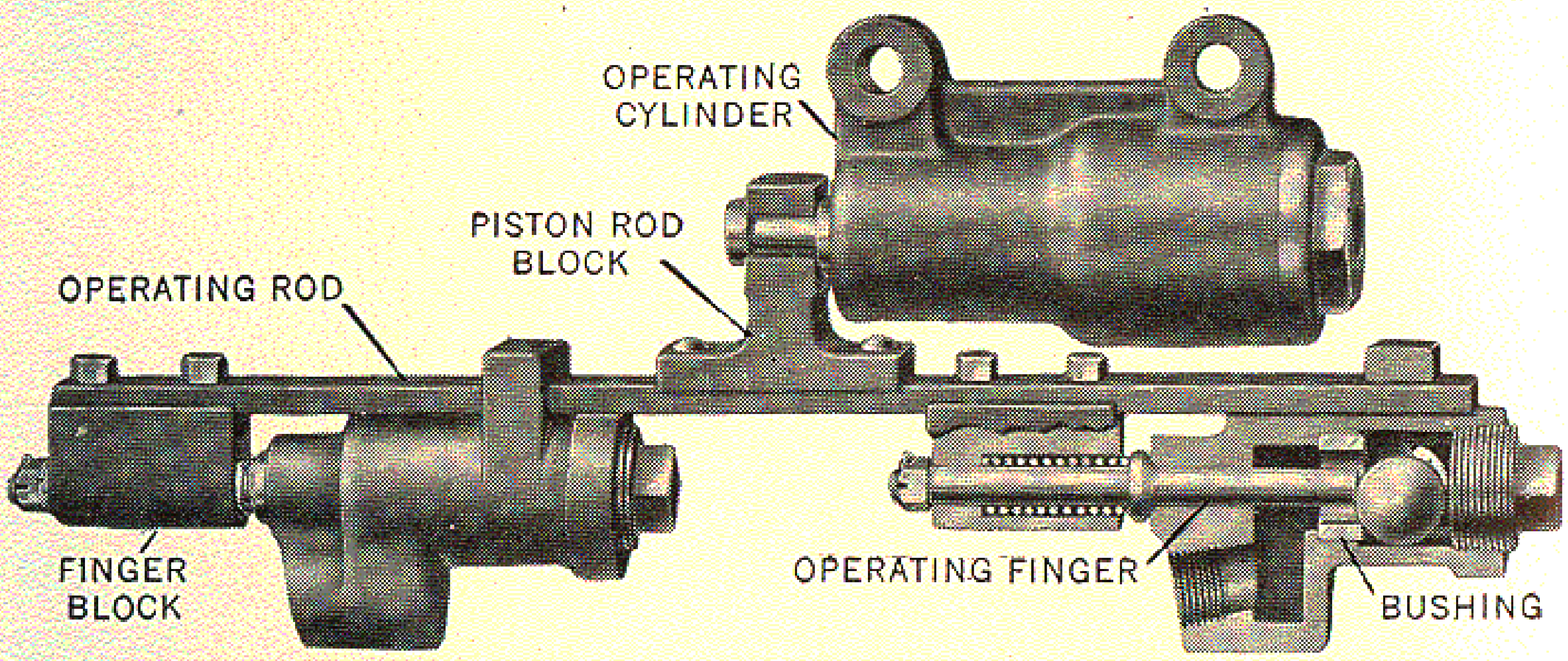


Fig. 29. Type C-2 Booster Cylinder Cock Operating Arrangement

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.

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 operating cylinders are interchangeable to either side of the Booster. The cylinder cocks are rights and lefts and are not interchangeable to opposite sides of the Booster, but are interchangeable front and back on the same side. The discharge is directed toward the rear

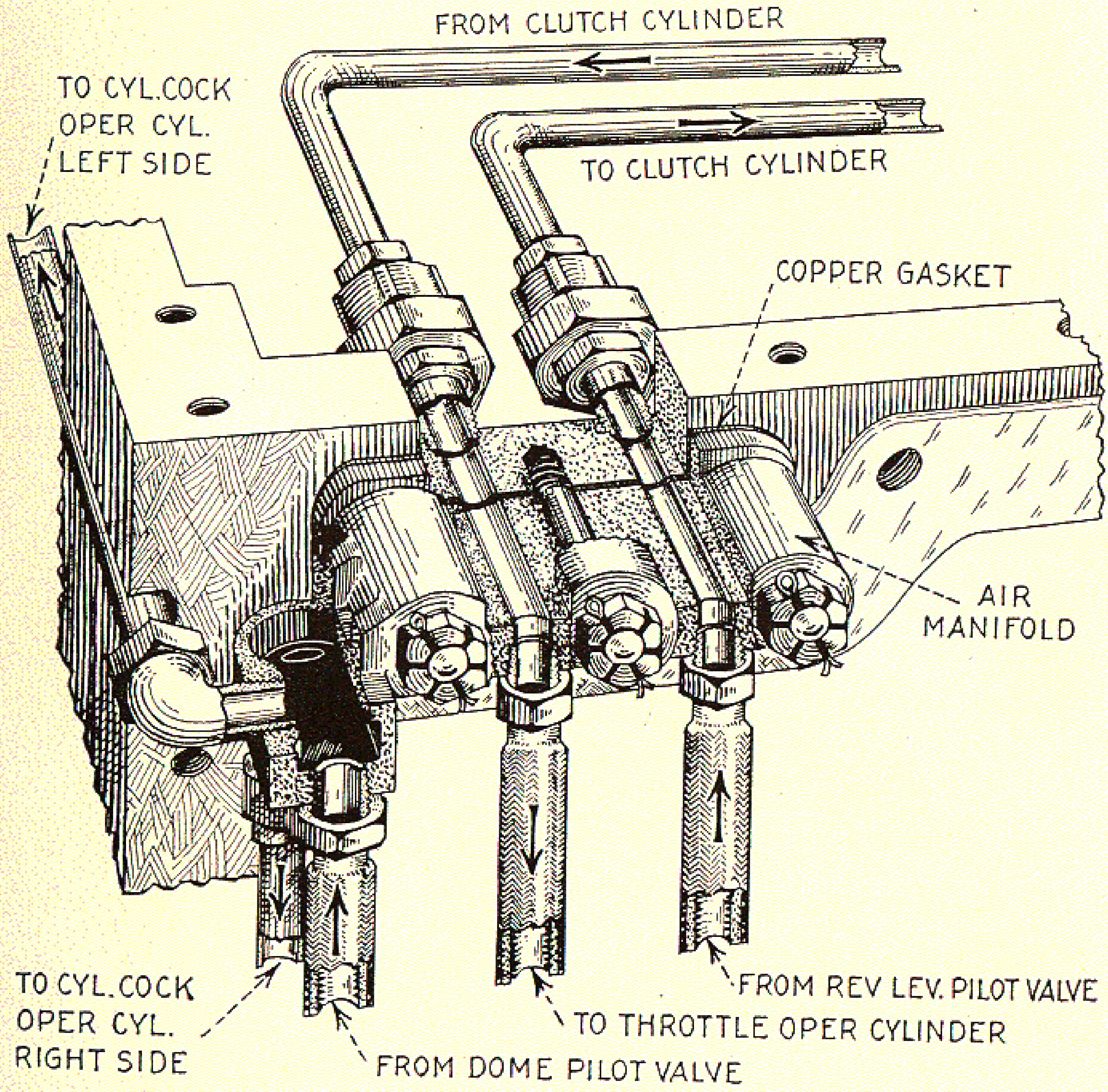


Fig. 30. Type C-2 Booster Air Manifold, Showing Flexible Air and Piping Connections

of the locomotive and the openings are tapped for possible piping to any desired point.

The cylinder cock arrangements, being located on the sides of the cylinders, are placed so as to be protected by the truck cross transom and the cylinders.

The Air Manifold, secured on 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. 30 shows the location of the manifold; the ports to which the integral couplings of the flexible air connections are screwed, and the ports to which the air piping connections are made for the clutch cylinder and the cylinder cock operating cylinders.

CONTROL SYSTEM FOR SUPERHEATED STEAM

Type C-2 Booster

A study of the operation of each separate part of the control system, given on pages 24 to 46, should be made before attempting to familiarize oneself with the system as a whole.

The Booster control system is operated by air from the main reservoir through the brake pipe or a main reservoir pipe. The operation of the Booster, after the latch has been raised, is automatic.

Superheated steam for the Booster is supplied from one or both steam chests of the locomotive to the Booster throttle valve. Therefore, the Booster is controlled by and responds to the varying openings of the locomotive throttle. Exhaust steam from the Booster is carried forward on the right side by a pipe leading from the Booster exhaust manifold, and is disposed of either to the atmosphere or into the main engine exhaust, depending upon the application.

The preliminary throttle valve, located outside of the cab near the steam turret, supplies steam for idling the Booster and also for turning it over slowly to assist in the proper meshing of the gears. As only a small amount of steam is necessary, a choke is used where the preliminary steam line enters the inlet pipe.

The preliminary throttle valve body is usually drilled and tapped for a small heater choke with $\frac{1}{16}''$ orifice. This choke always permits a small quantity of steam to the Booster at all times for heating the pipes and cylinders, although some applications have a heater valve for this purpose and is arranged either in a by-pass around the preliminary valve or on a line tapped into the steam turret or the blower line.

The steam gauge and lubricator pipes are tapped into the Booster steam inlet pipe through welded saddles. It is important that the lubricator pipe be applied to the inlet pipe back of the gauge pipe, to prevent any possibility of the oil plugging the choke of the gauge pipe, Figs. 35 and 36.

SEQUENCE OF OPERATIONS
(Superheated Steam)
Type C-2 Booster

The air control arrangements, Figs. 31, 32, 33 and 34, 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. 31, with the air, in red, held above the outside check valve of the reverse lever pilot valve. In Figs. 32, 33 and 34, 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 system and the successive changes of the parts from release to application positions is given in the following paragraphs.

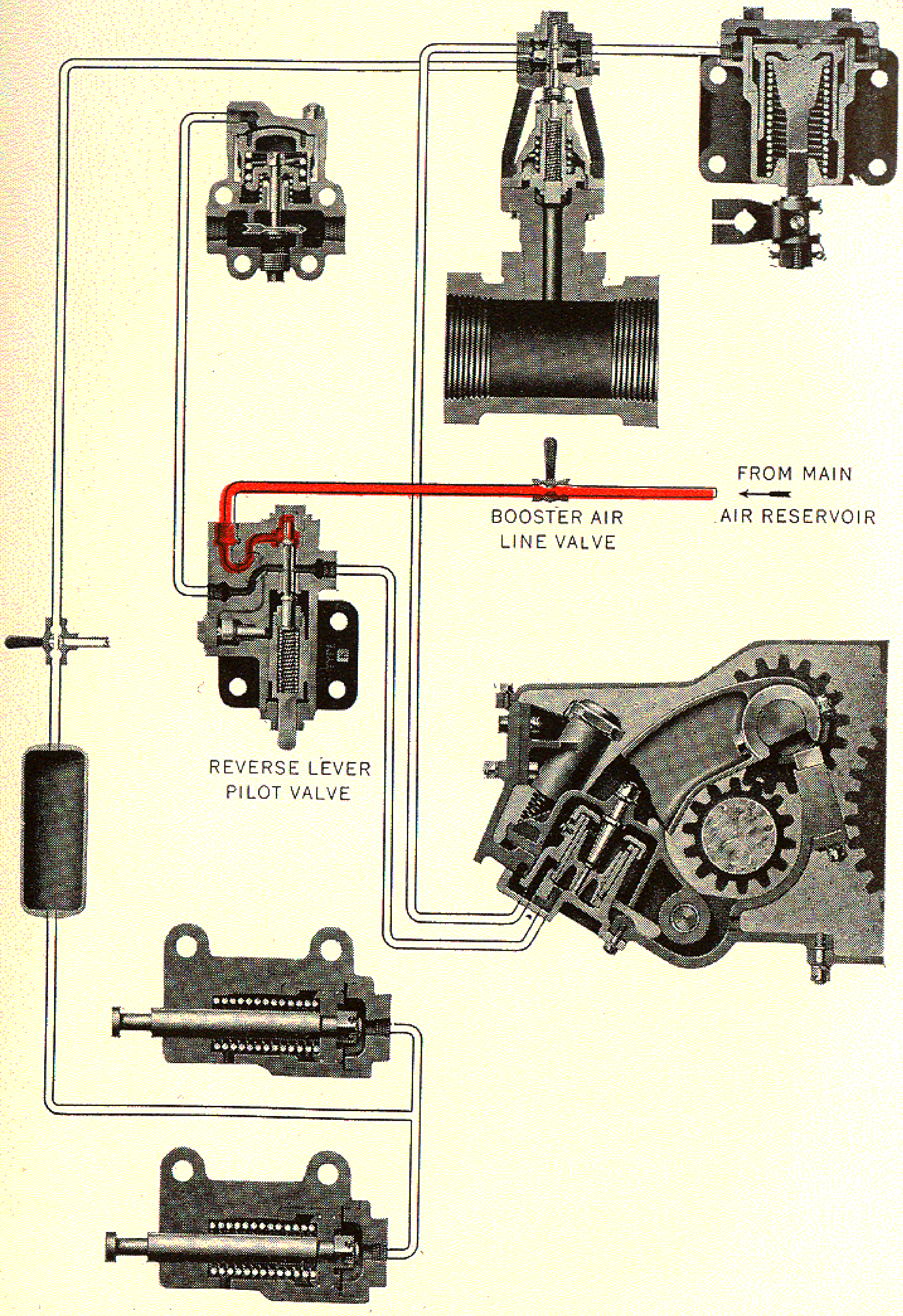


Fig. 31. All Control Parts in Release Positions. Air Held at Reverse Lever Pilot Valve

For the applications where either the Booster slip control valve or Booster exhaust check valve, or both are installed, see Diagram G-50055 for the additional operating information required. Also for the diaphragm valve attached to the cylinder cock timing reservoir and the Booster inlet check valve.

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. 31. 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. 32. When the reverse lever, or the block of the Precision Power Reverse Gear indicator, is in or near the corner in the forward position and the Booster latch is raised, the spring cage of the reverse lever piolt 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. 33. The preliminary throttle valve has opened to allow a small amount of steam to pass through the choke at the steam inlet pipe to the Booster engine 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

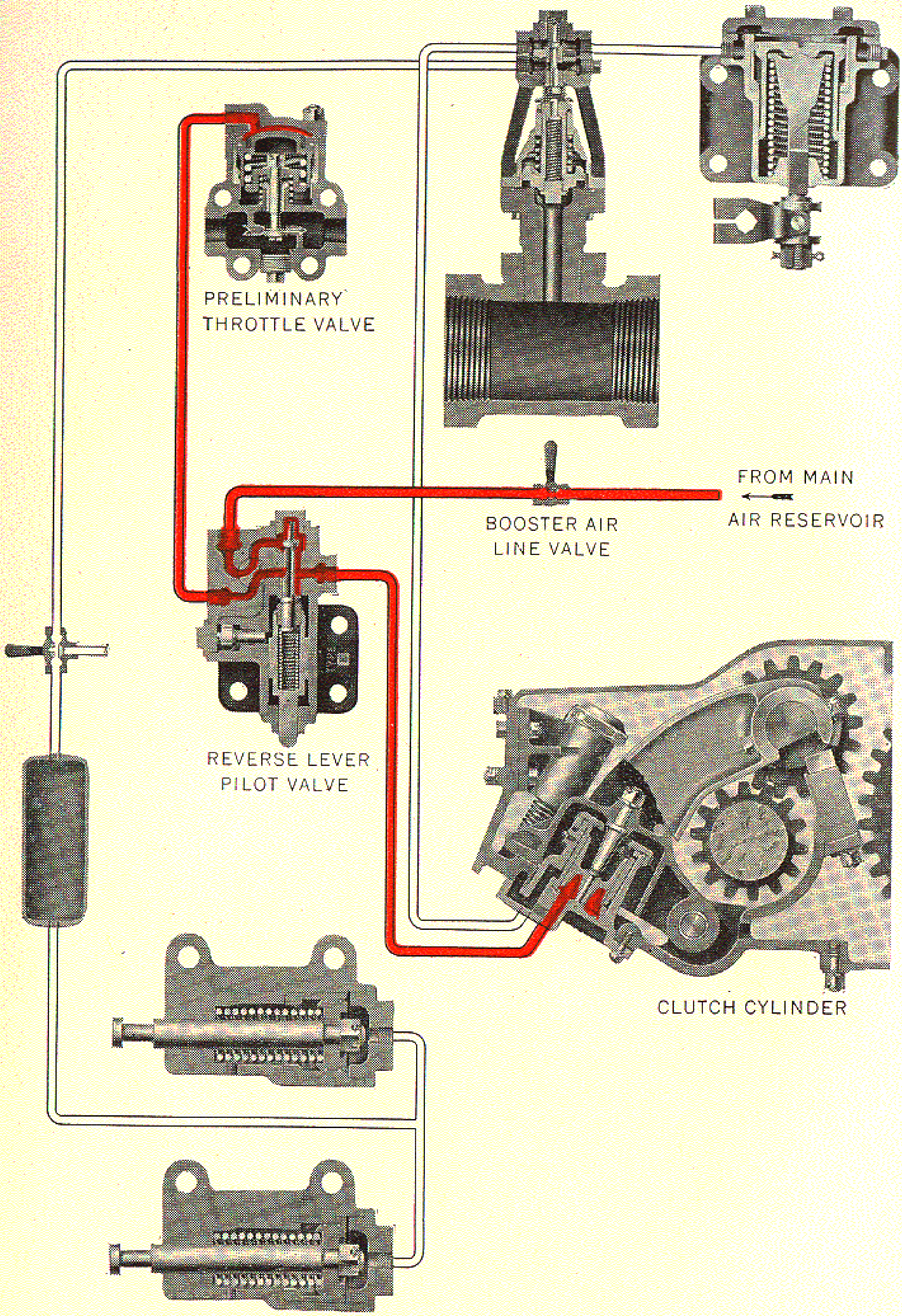


Fig. 32. Reverse Lever Pilot Valve Has Been Operated. Air Has Reached Preliminary Throttle Valve and Clutch Cylinder

clutch cylinder and the two top ports of the dome pilot valve above its outside check valve to the throttle operating cylinder.

Fig. 34. 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 throttle. After the locomotive throttle 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 engineman may do so by opening the cylinder cock cut-out cock to atmosphere.

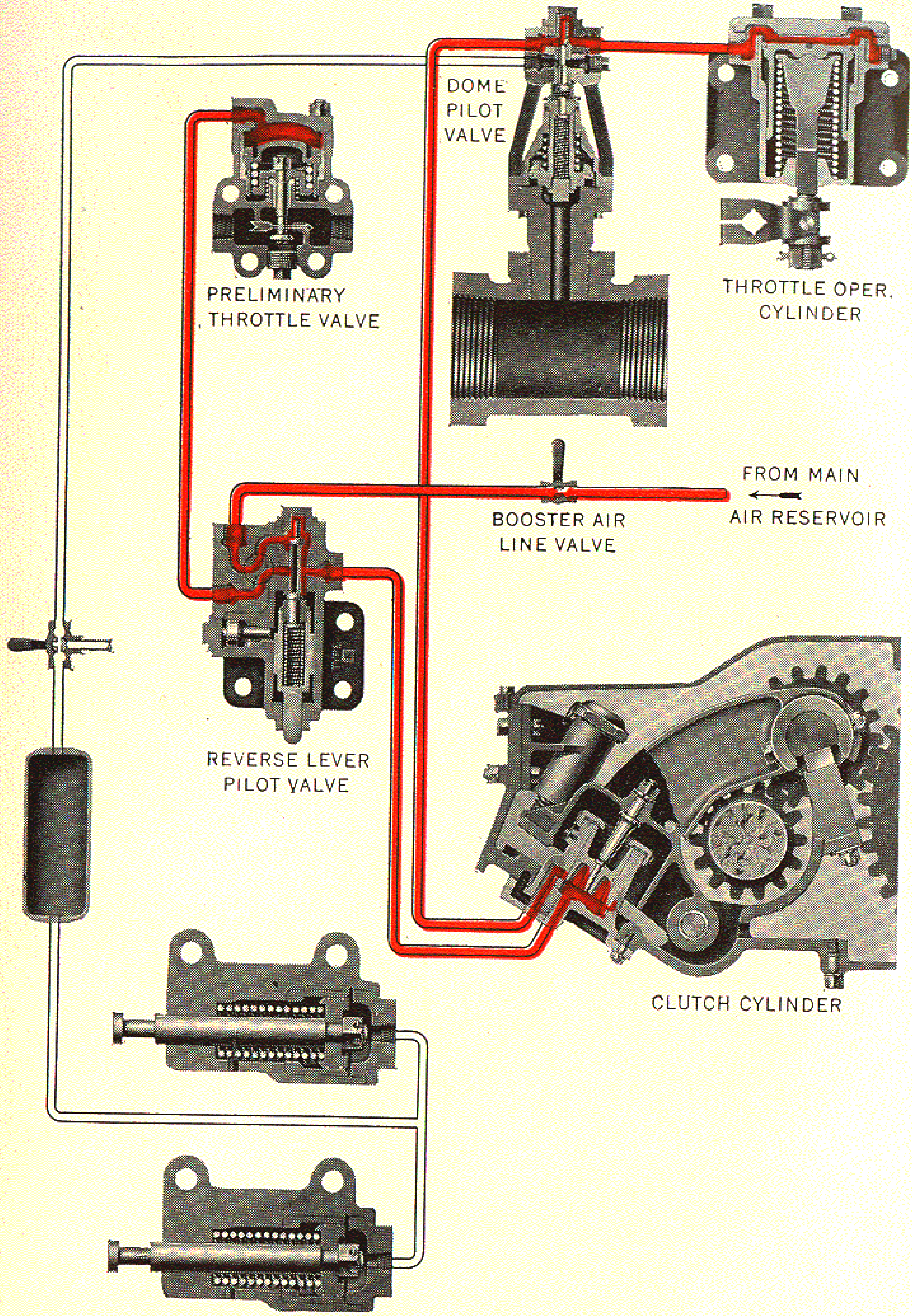


Fig. 33. Preliminary Throttle Valve and Clutch Cylinder Have Operated. Air Has Reached Throttle Operating Cylinder

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.

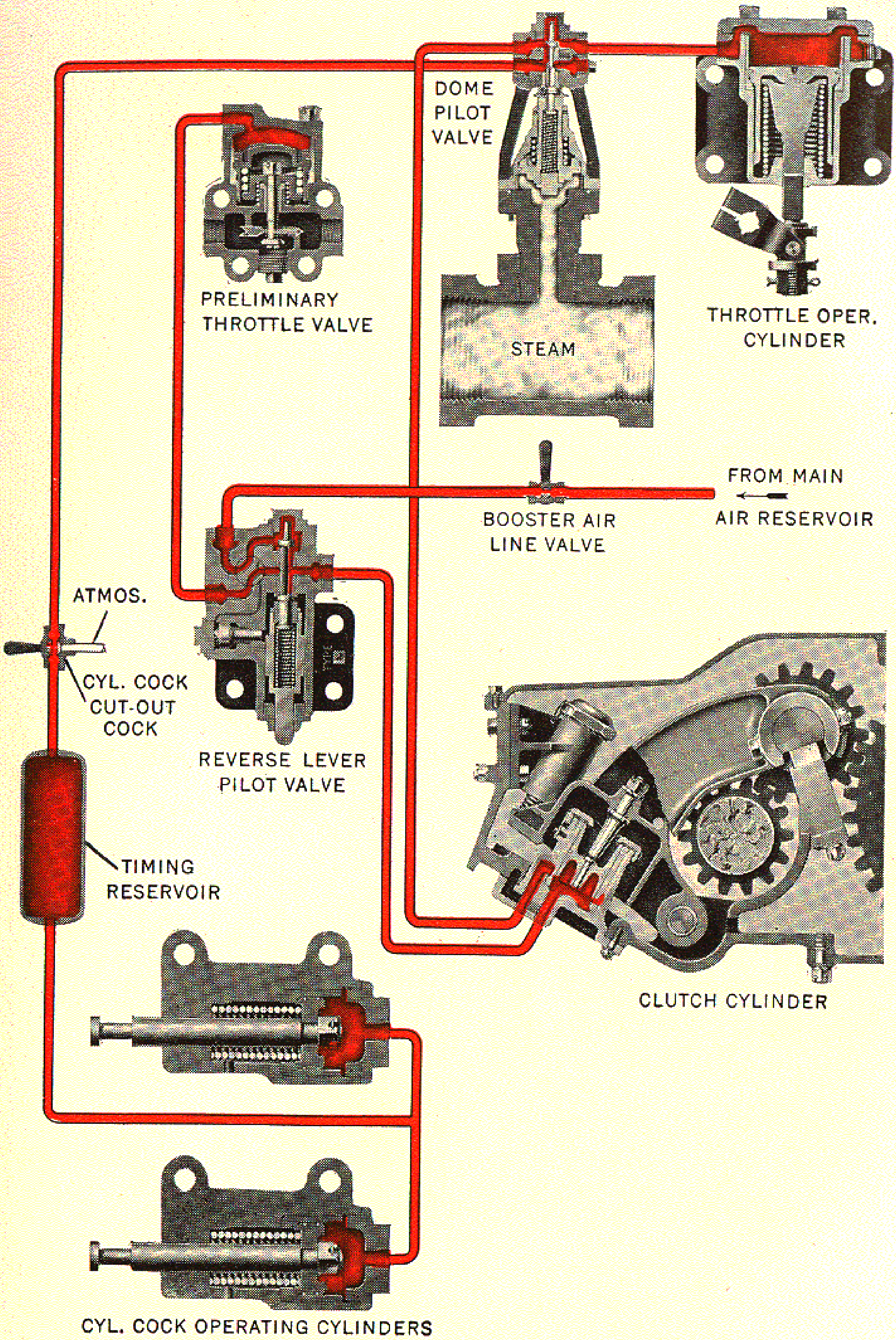


Fig. 34. Throttle Operating Cylinder and Dome Pilot Valve Have Operated. Air Has Reached and Operated Cylinder Cock Operating Cylinders

INSTRUCTIONS FOR PRESSING ON CRANK ARMS

Particular care should be exercised in doing this work and the procedure as outlined below should be followed:

(1) Examine the ends of the crankshaft to see that the outer ends are rounded with an oil stone so as to facilitate entering in the crank arms. Examine edges of the keyways to see that they are smooth to prevent burrs picking up.

(2) Examine the crank arm bores and remove all burrs. Particular attention should be given to the inside edges of the bore (straight face side), which should be filed bevel to prevent sharp edges from riding in the fillet of the crankshaft, which would cock the crank arm when forced home against the shoulder. Particular attention should also be paid to the edges of the keyways, which should be slightly beveled to prevent cutting.

(3) The outer surface of the ends of the crankshaft and the bore of the crank arm should be smeared with a very thin coat of white lead and machine oil.

(4) Level up the crankshaft in the wheel press and set the crank arm square with the shaft. The table or arm of the press must be furnished with square blocks to prevent the crankshaft from twisting when under pressure. If not square, shim arms, using a square at different points for checking.

(5) The crankshaft should be forced into the crank arm at a pressure of from 18 to 20 tons. A dummy key, having a tapped hole in one end for removal, should be used in one keyway as a guide. After the arm is properly

home, hard against the shoulder of the shaft, one of the keys can be forced in place while the parts are in the wheel press. In the event that the second keyway is slightly offset, the necessary offset key should be used. Keys should not fit hard on top and bottom, as this is liable to throw the crank pin out of true. **This Is Very Important.** Drive the keys home hard.

(6) After both crank arms have been pressed on and the keys fitted, the crank pins should be tested for true alignment with the crankshaft. This is best done by placing the crankshaft on a surface table. A standard indicator should preferably be used, but a surface gauge may suffice. Try each pin in two positions at right angles. Pins should not be out more than .002″ in length in either direction. **Check Only Against the 6″ Diameter Bearing On the Shaft. Do Not Use the Shaft Centers or Faces of the Crank Arm.**

(7) A standard engine lathe may be used in making the test for true alignment of the pins, provided that extraordinary care is used in checking the shaft. The tail stock of the lathe may be high or low, so that the necessary allowances must be made for this condition. In the event that the pins are out of true, a slight peening on the high side will stretch the metal in the direction desired.

(8) Local heating of the metal around the crankshaft bore of the crank arm will tend to stretch the metal permanently and prevent making a correct job.

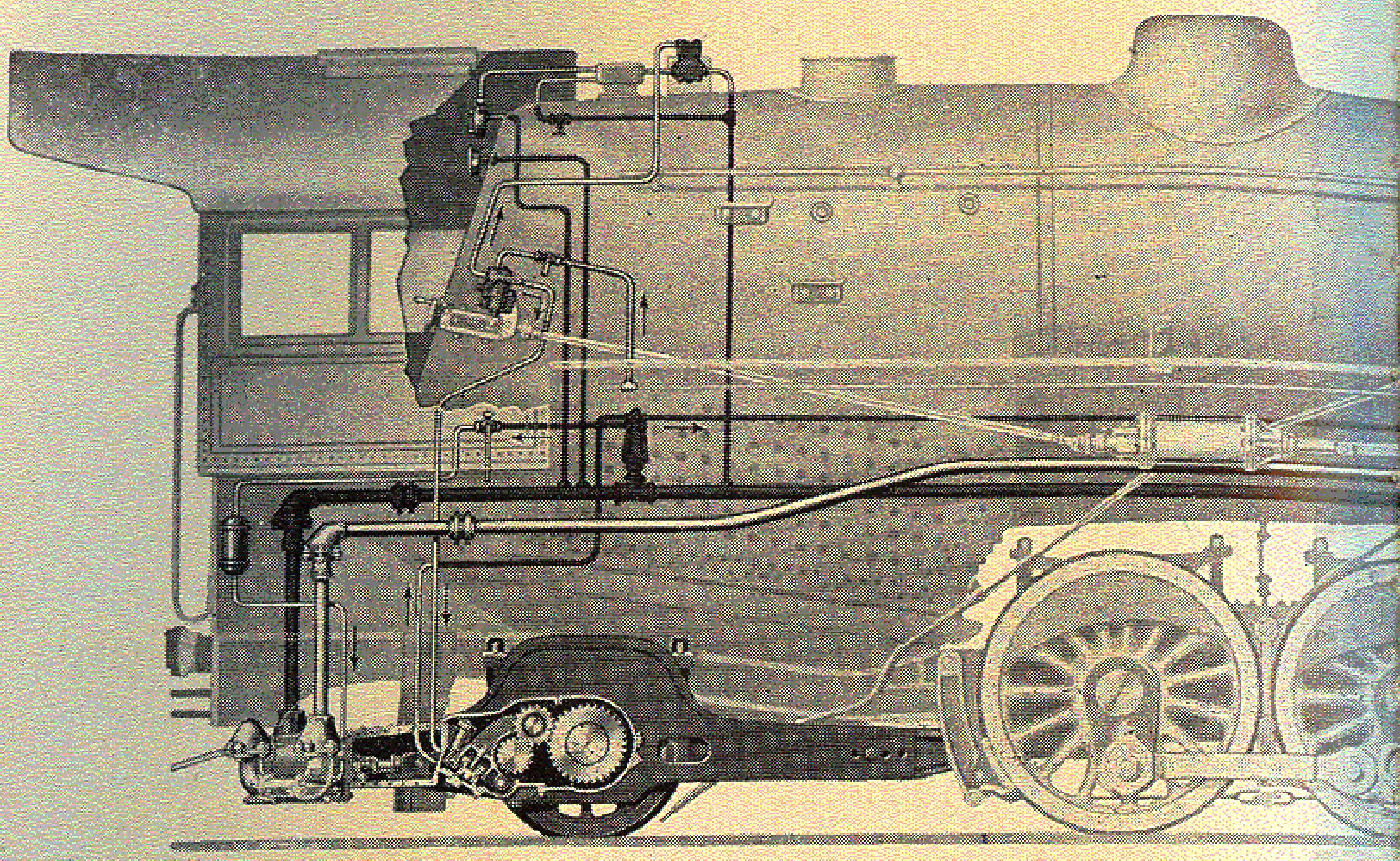


Fig. 35. Typical Type C-2

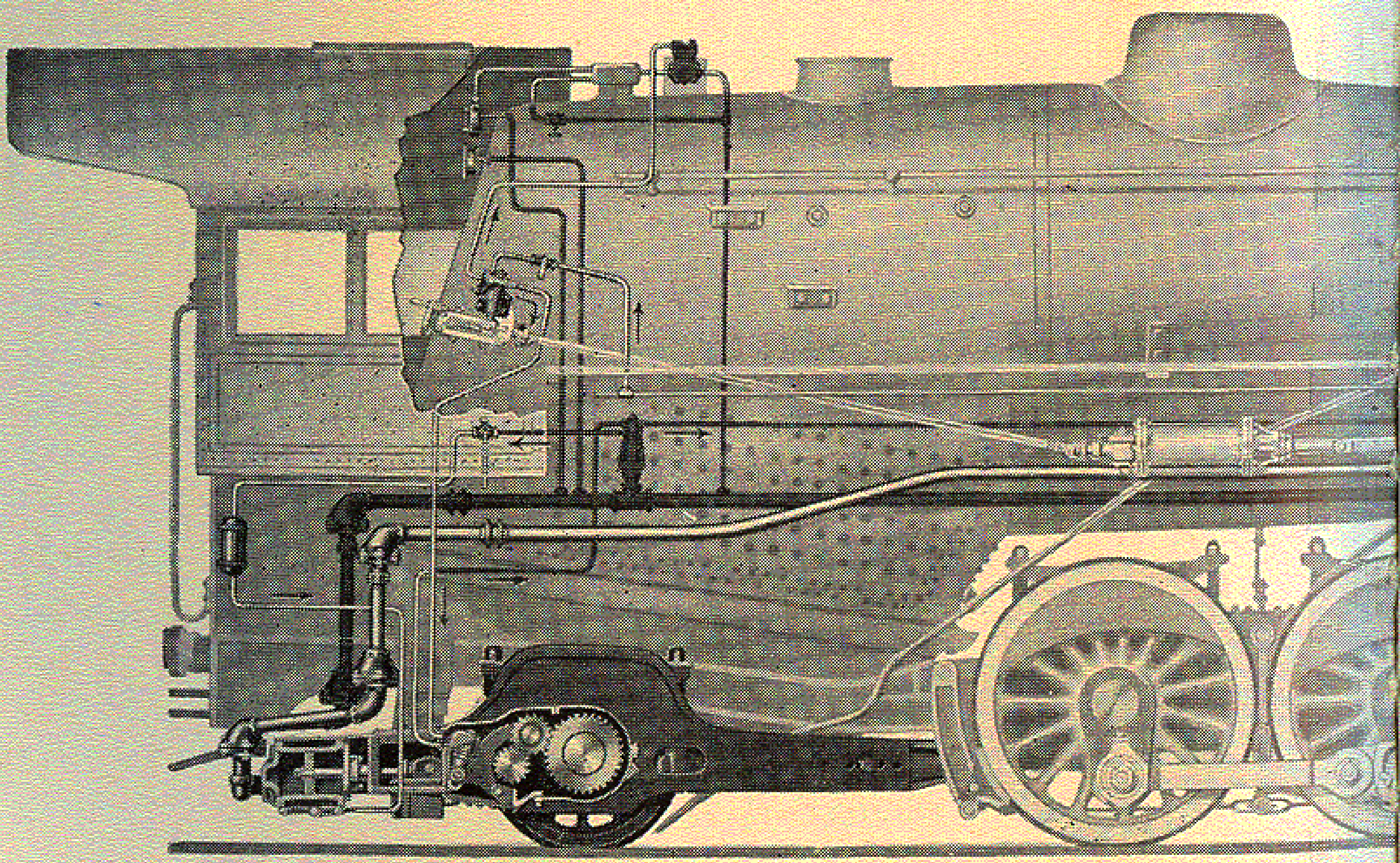
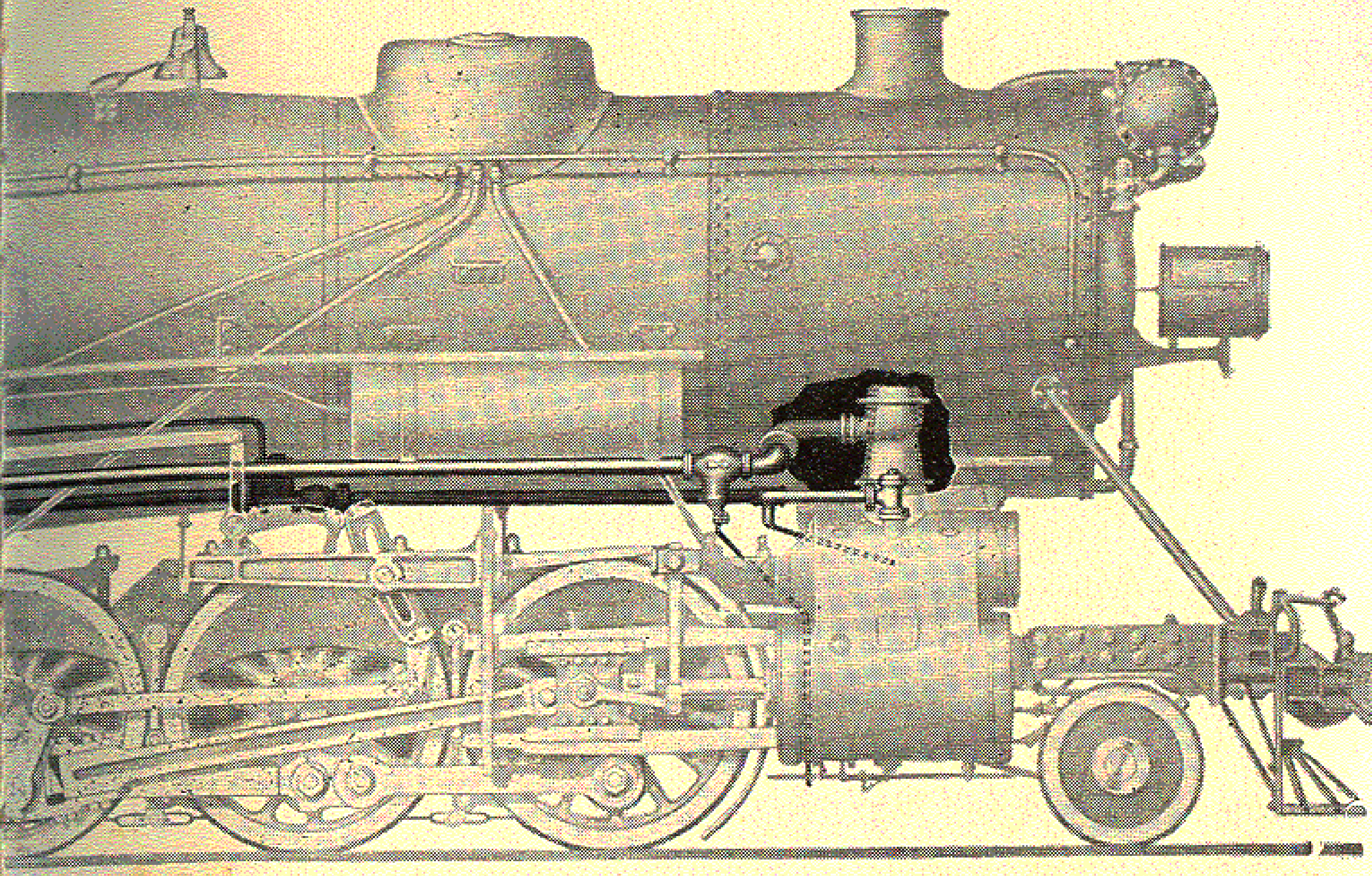
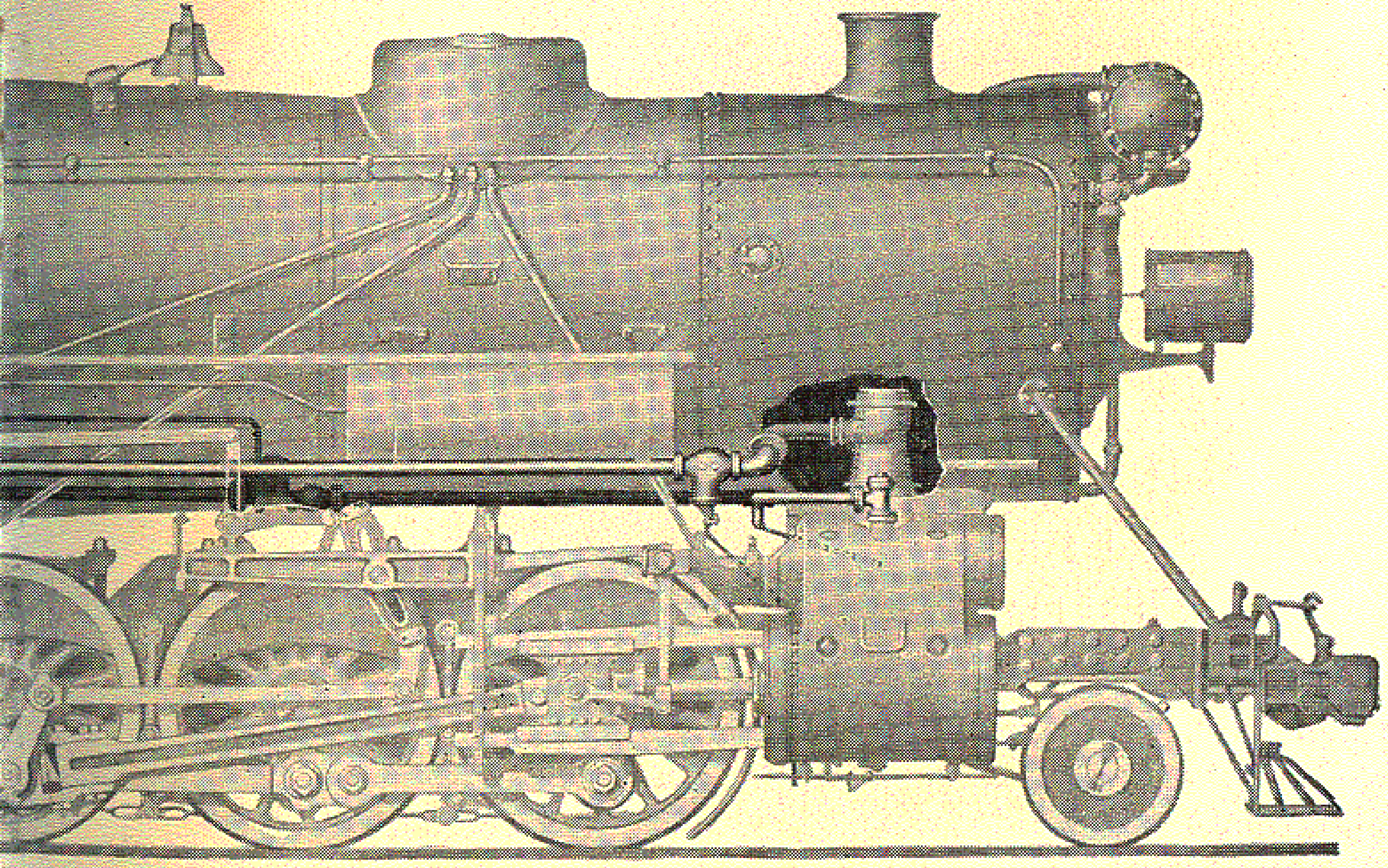


Fig. 36. Typical Type C-1



ooster-Equipped Locomotive



ooster-Equipped Locomotive

(a) For the long cut-off valve, subtract one quarter of the amount of over-travel from the dimension $3^{35}/_{64}''$ as shown in Fig. 38 when the crank pin is on the back dead center.

(b) For the limited cut-off valve, subtract one third

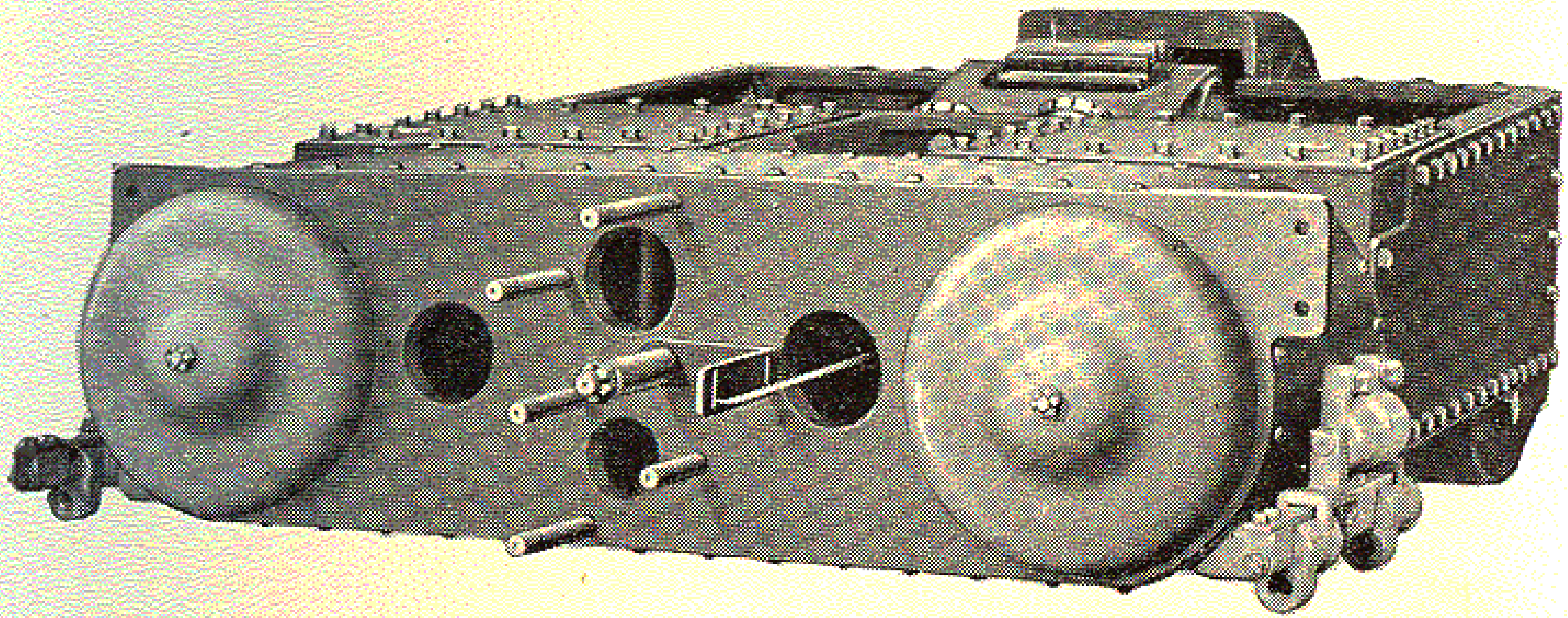


Fig. 40. Method of Locating Exact Valve Travel

of the amount of over-travel from the dimension $2\frac{5}{16}''$ as shown in Fig. 39 when the crank pin is on the back dead center.

In case the valve under-travels more than $\frac{1}{8}''$ allowable, as noted above, proceed as follows:

(c) For the long cut-off valve, add one quarter of the amount of under-travel to the dimension $3^{35}/_{64}''$ as shown in Fig. 38 when the crank pin is on the back dead center.

(d) For the limited cut-off valve, add one third of the amount of under-travel to the dimension $2\frac{5}{16}''$ as shown in Fig. 39 when the crank pin is on the back dead center.

In the manufacture of the large connecting rod bushing, all dimensions are accurately maintained, including the outside diameter of the flange. The vertical distance from the crosshead ways to the top edge of the flange of the large connecting rod bushing, when the crank pin is on the back dead center, is 5½″. This dimension is shown on the detail drawing of the gauge, Fig. 41. A portion of the crosshead guide has been cut away in Fig. 37 to illustrate the position of the gauge, which should be held vertically on the outside crosshead way between the connecting and eccentric rods.

With the crank pin considerably below its dead center,

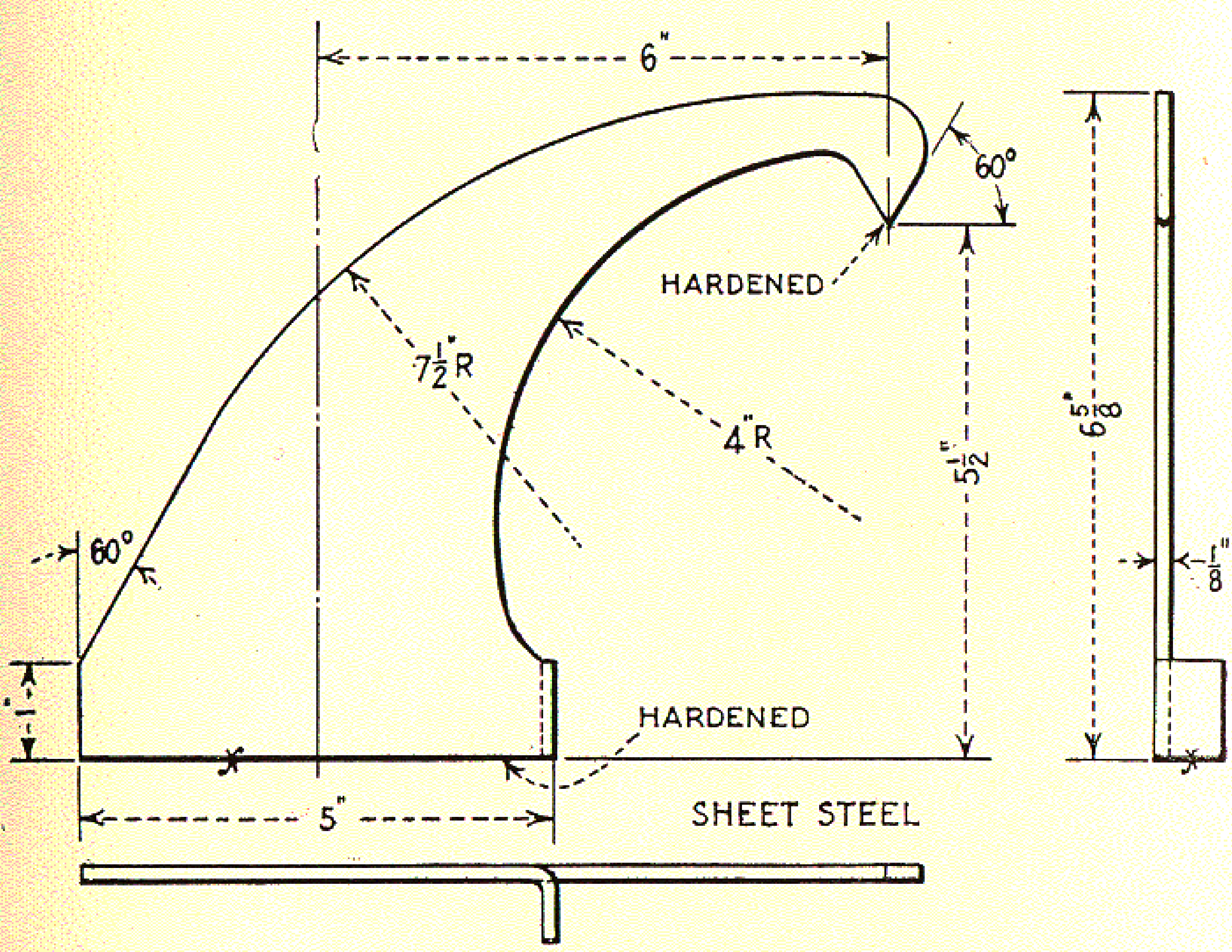


Fig. 41. Valve Setting Gauge

turn the Booster over in the forward direction until the top of the bushing flange comes into contact with the gauge point, as shown in Fig. 37. This places the crank pin on the back dead center.

It is now possible to properly locate the valve, which may be done by loosening the lock nut, removing the taper pin, and screwing the valve stem in or out of the wrist pin block until the valve is located as shown in either Fig. 38 or Fig. 39, making allowance for any over-travel or under-travel as outlined above.

The following is the essential data pertaining to valve setting:

Booster runs in forward motion only.

		Long Cut-Off Valve	Limited Cut-Off Valve
Valve Travel		3¼″	$4\frac{19}{32}$″
Valve Length		7¼″	8⅜″
Valve Diameter		4.247″	4.247″
Cut-Off		App. 75%	App. 50%
Lead	Back	$\frac{5}{64}$″	$\frac{1}{16}$″
	Front	$\frac{5}{64}$″	$\frac{5}{64}$″
Steam Lap	Back	¾″	$1\frac{15}{32}$″
	Front	¾″	$1\frac{9}{16}$″
Exhaust Lap	Back	Line and Line	$\frac{7}{32}$″
	Front	Line and Line	$\frac{15}{32}$″
Ecc. Rod Length, C to C		23″	23″
Ecc. Crank Length, C to C		$5\frac{11}{32}$″	$4\frac{11}{16}$″

INSTRUCTIONS FOR DETERMINING ROCKER STOP HEAD HEIGHT

When the idler gear is properly in mesh with the trailer axle gear, the distance between the center of the idler gear bearing pin and the center of the trailer axle is 13.281″. The height of the rocker stop head, against which the idler gear bearing pin rests when the gears are in mesh, determines the position of the idler gear. Due to the fact that a number of tolerances cause slight variations in the various adjacent surfaces, and also due

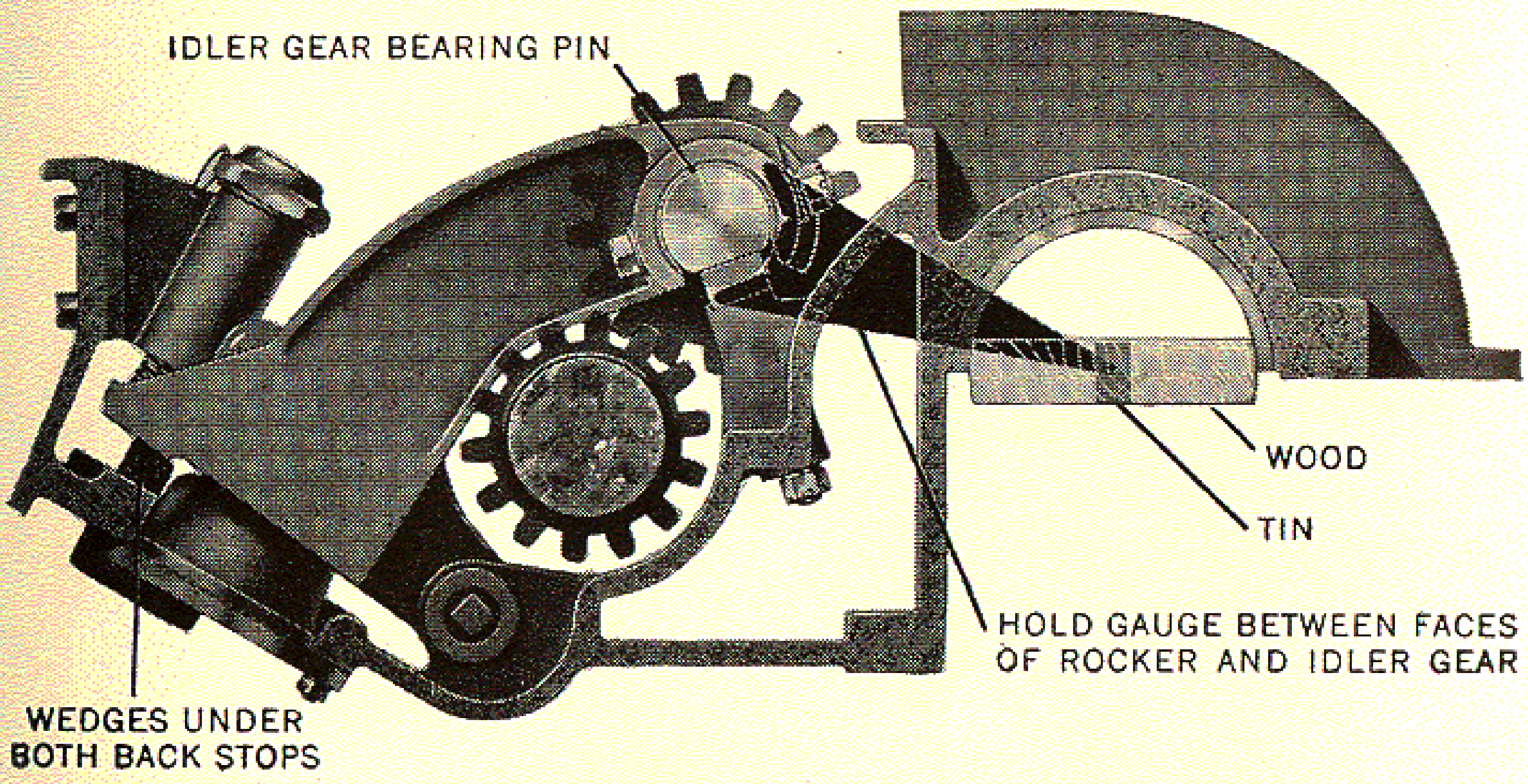


Fig. 42. Gauge in Position on Tye C-2 Booster

to natural wear after the Booster has been in service, it is not possible to furnish the rocker stops with a standard height of head. To meet this condition the stops are furnished with additional metal to allow for proper fitting to maintain the 13.281″ dimension noted above.

Fig. 42 shows the gauge in position on the Type C-2 Booster. The detail dimensions of the gauge are given in Fig. 43. The ends should be hardened. It is very important that the 11.295″ dimension (which is 13.281″ minus one-half the diameter of the idler gear bearing pin) be exact to properly locate the idler gear bearing pin at 13.281″ from the center of the trailer axle.

This gauge is to be used to determine the proper rocker stop head height when installing new stops or when checking stops in Boosters in service. The work is to be done after the Booster is removed from the locomotive

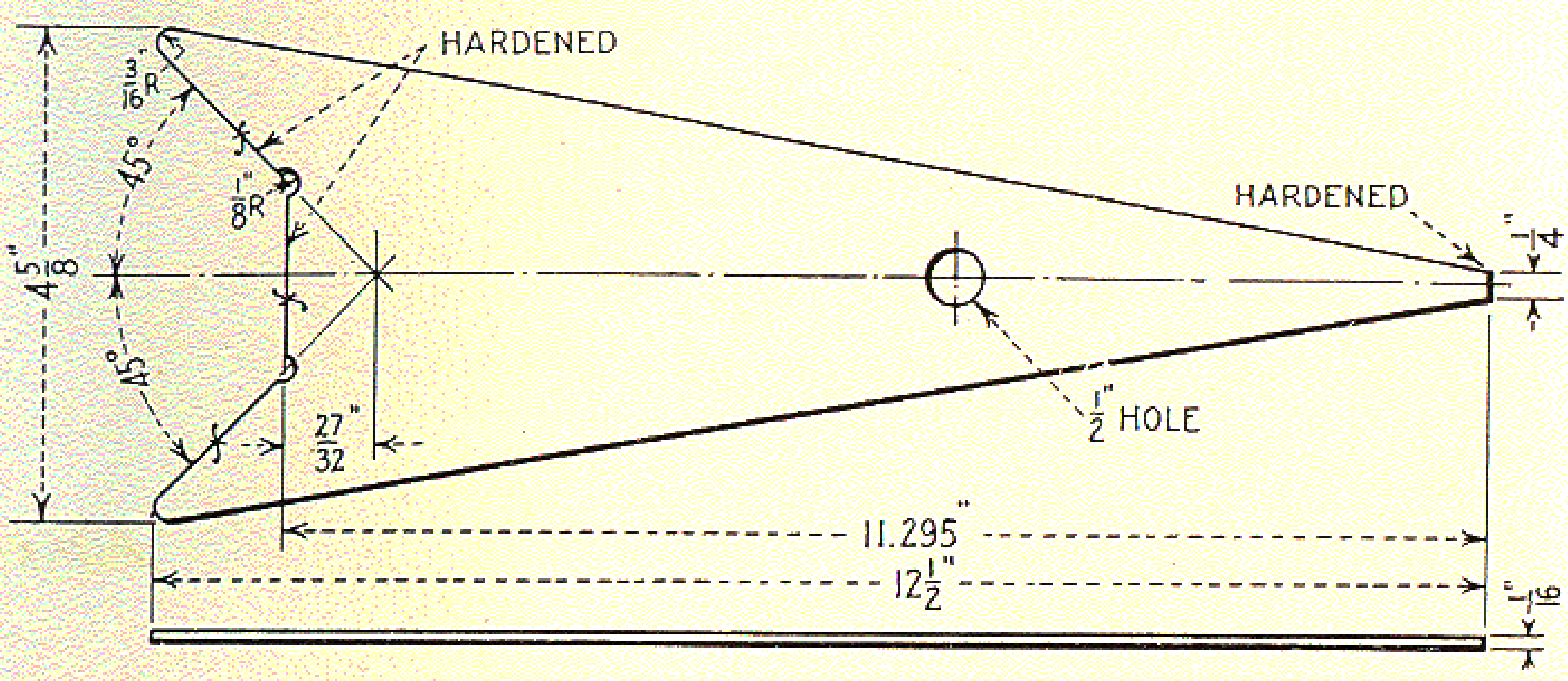


Fig. 43. Gauge for Types C-1 and C-2 Booster

but **Before** the Booster is disassembled, with the exception of the removal of the front casing top.

Following is the procedure for use of this gauge:

(a) Set a piece of hard wood in each of the axle bearing bushings, at the inside ends, with the face flush with those of the flanges on the bushings.

(b) Locate the centers of the bushing bores by punch marks on pieces of tin fastened to the wood strips.

(c) Place wedges under both back stops of the idler gear rocker.

(d) Hold the gauge in position, as shown in Fig. 42, with the vertical face against the idler gear bearing pin, between maces of the rocker and of the idler gear. Then drive the wedges in until the small end of the gauge lines up with the center of the axle bearing bushing. There is $\frac{1}{32}''$ clearance between the 45° surfaces of the gauge and the pin, so that the vertical surface only will bear against the pin.

(e) If the rocker stop heads are worn and need replacing, the height of the heads on the new stops will be the thickness of the old ones plus the distance between the old stops and the flats on the pin. This distance can be measured with a thickness gauge.

(f) Then transfer the gauge to the other side of the idler gear, using the center in the other bushing, so that a check can be made on both sides.

(g) Remove the rocker and gear and the stops and have the heads of the new stops machined to the required height. **Allowing** $\frac{1}{64}''$ additional metal for fitting after the stops and rocker are placed in position.

(h) Make a final check, using the gauge, after the new stops are in place and the idler gear bearing pin held down against the stops.

Although the illustration shows the gauge as used on the Type C-2 Booster the same gauge may be similarly used on the Type C-1 Booster.

The same method of determining the rocker stop head height may be used on the Type C Booster, except that 11.545″ should be used in place of the 11.295″ dimension for the Types C-1 and C-2 Boosters, as shown in Fig. 43.

Fig. 43A shows the gauge necessary when idler gear is fitted with roller bearings.

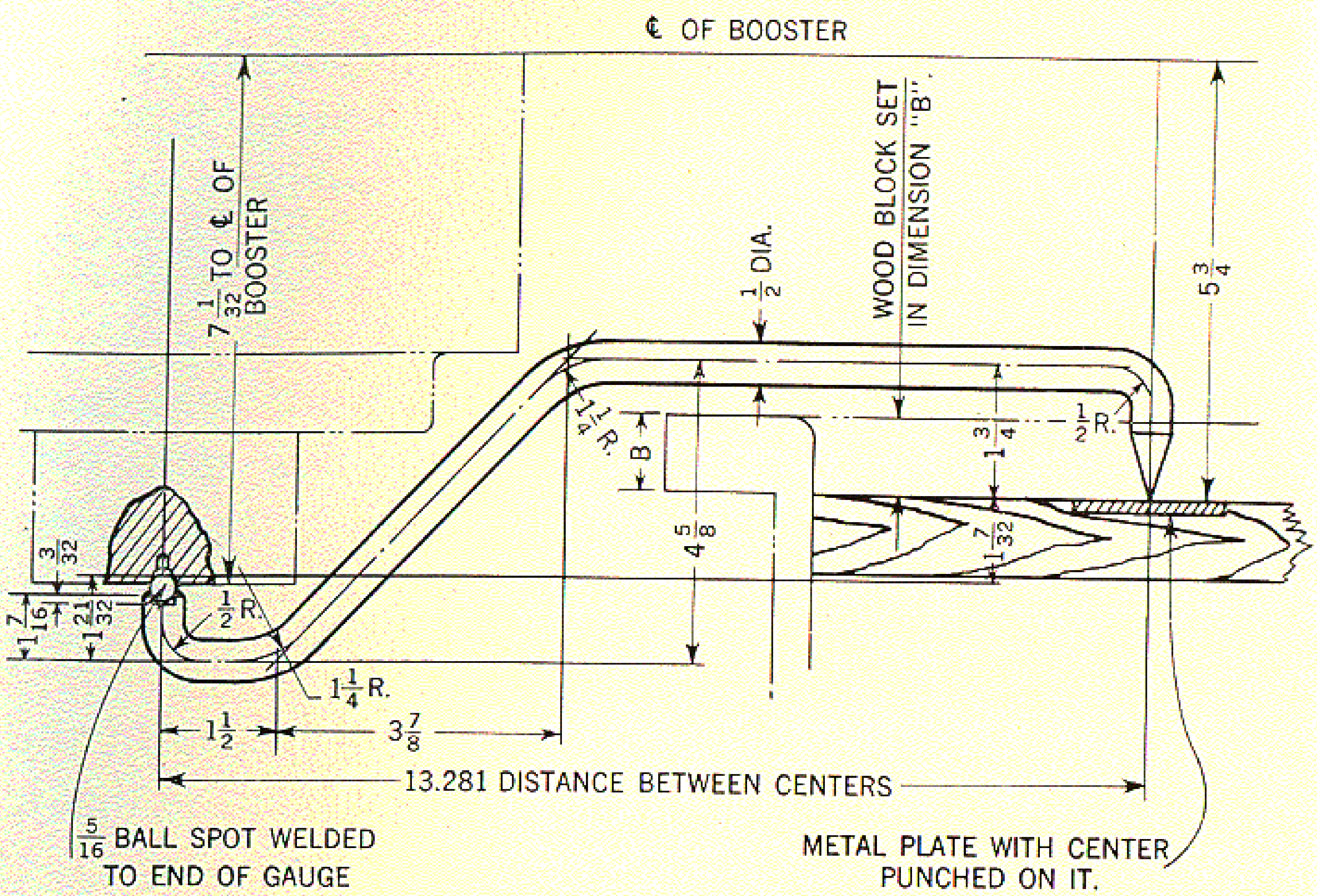


Fig. 43A

OPERATING INSTRUCTIONS

Type C-2 Booster

1. **What should 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, if one is installed. This valve should be kept open constantly, summer and winter, to prevent condensation from forming in the pipes and cylinders and possible freezing in extremely cold weather. 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. This will prevent movement of the spring cage by the latch should an attempt be made to cut in the Booster while it is idling.

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

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

The Booster should always be idled before cutting it in on the road. **This is Very Important.**

4. **Should the Booster be used when the train might be started without it?**

Yes. Always use the Booster to start the train, whether a full train or not, as it will enable road speed to be reached in a shorter time.

5. **If the Booster idles at high speed when locomotive throttle 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.

(f) The pipe plug in the atmosphere port of the preliminary throttle valve may not have been removed. (See Preliminary Throttle Valve, page 32.)

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 21 M. P. H.

12. What should be done to prevent slipping of trailer wheels at starting?

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

13. What should be done if trailer wheels slip?

Booster latch should be knocked down at once and not raised again until slipping has stopped.

(a) If equipped with slip control valve, depress slip control valve handle only until slipping of the Booster driven wheels has stopped.

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 when locomotive is backing up?**

The Booster should not be left in gear 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.

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. To conform with general locomotive practice the handle of this cock should be turned lengthwise of the pipe to open the cylinder cocks when the Booster is cut in.

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. Maintenance of the proper supply of oil in the bed should be attended to at the enginehouse. Should the trailer axle bearings heat in service they may be repacked with wool waste, soaked in oil, through the two axle bearing cap lids. (See Booster Lubrication, page 22.)

DAILY TERMINAL MAINTENANCE

Type C-2 Booster

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

   On the arriving track 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 an inspector should do 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.

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 leakage from the piston rod or valve stem packings through the holes in the plugs in the engine bed.

(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 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 proper speed.

5. **If the Booster continues to idle after idling valve has been placed on 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 cocks fail 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 throttle 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 cock operating cylinders for leaks.

(e) Examine Booster cylinder cack 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 an other quarter and try cylinder cocks again.

(i) Do not make any changes, such as enlarging the hole in dome pilot valve bushing.

7. **During the arriving track 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 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) Set locomotive brakes.

(d) See that Booster cylinder cock cut-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 checking 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 enginehouse 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 to idle the Booster.

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

(a) The proper lift is ⅝″ for the double seated throttle and $1\frac{5}{16}$″ for the single seated throttle valve, 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 should be done to insure proper lubrication of the Booster?**

(a) It is important that the maintenance of the proper supply of 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 valve oil from an extra feed on the main locomotive lubricator or 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 $\frac{1}{16}''$ choke bushing where the lubricator line enters the Booster steam inlet pipe.

(d) The main bearings on the trailer axle are lubricated by the dope-packed axle bearing cap in the same manner as car journals. The wool waste, soaked in oil, should not be packed too tightly or in such amounts that no space remain for the oil. (See Booster Lubrication, page 22.)

ELEMENTS OF THE BOOSTER
Type C-2
Tender Application

A complete Type C-2 Locomotive Booster equipment as furnished for a tender truck application consists of the following:

Booster Engine

1 Complete Locomotive Booster
1 Complete Set Steam Inlet and Exhaust Joints
1 Truck

Air Control

1 Complete Throttle Valve with Operating Cylinder
1 Inlet Check Valve
1 Preliminary Throttle Valve
1 Dome Pilot Valve
1 Reverse Lever Pilot Valve
1 Timing Reservoir
1 Three-Way Cock (Cylinder Cock Cut-Out Cock)
1 Two-Way Cock (Booster Air Line Valve)
1 ½-in. Elbow
19 ½-in. Connections
4 ¾-in. Connections
3 ½-in. Couplings
6 Flexible Air Connections
3 Cradle Manifolds
3 Sleeves (Flexible Air Conn.)
3 Nuts (Flexible Air Conn.)
3 Gaskets (Flexible Air Conn.)

Miscellaneous

1 Axle Gear.
1 Steam Gauge
*1 Butterfly Exhaust Valve
*1 Needle Valve (Heater Valve)

*(Only when needed)

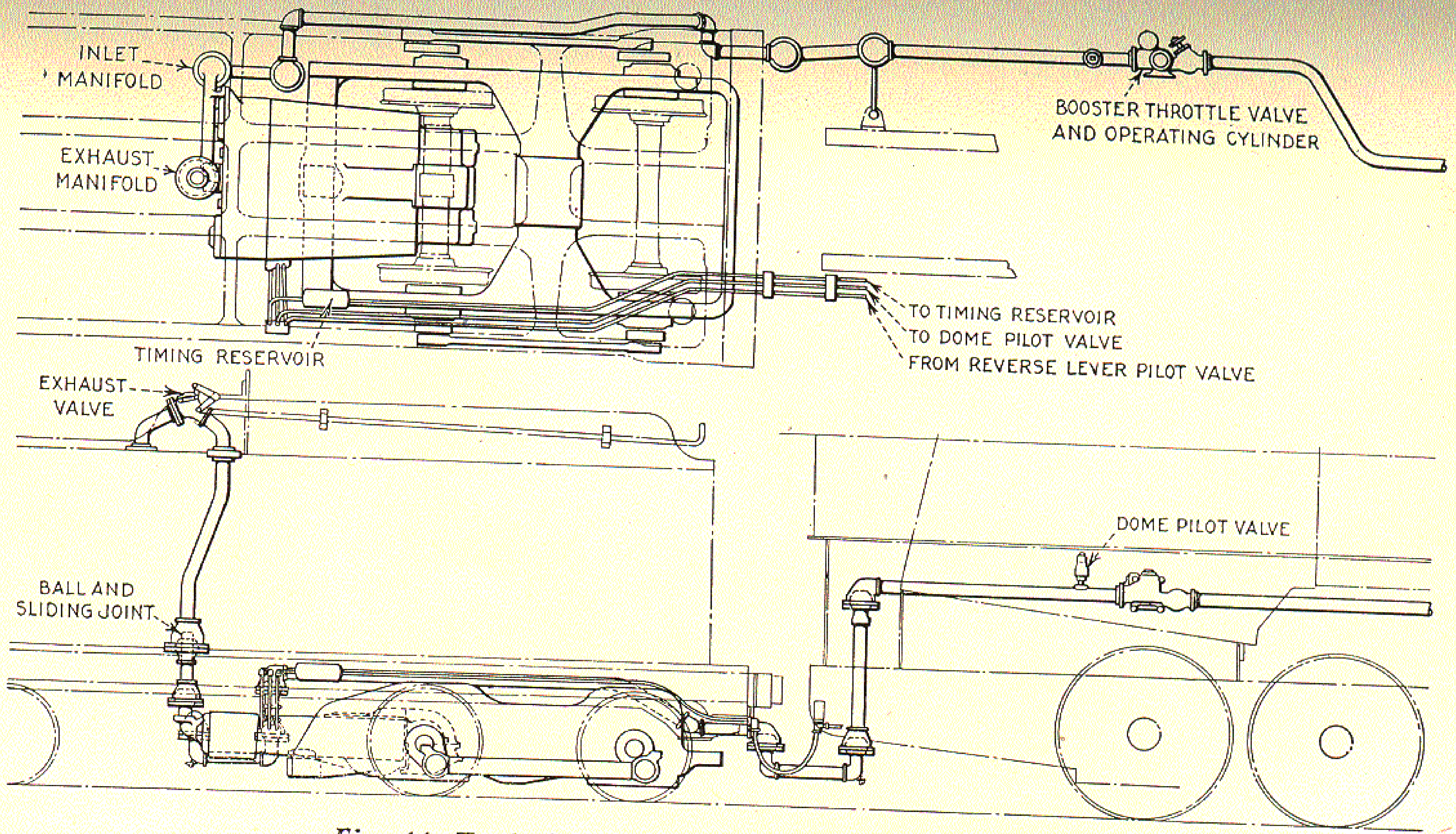


Fig. 44. Typical Locomotive Booster Tender Application

GENERAL DESCRIPTION

Tender Application

The construction of the Booster as well as its air control equipment is the same as in the trailer application, except that two additional cradle manifolds and three additional flexible air connections are necessary. This provides for the same Booster being used on the tender of one locomotive or on the trailer of another locomtive.

Fig. 4 shows a tender application of The Locomotive Booster to a 2-8-0 freight locomotive and Fig. 5 a similar application to a 0-8-0 switching locomotive. Fig. 9 shows the Booster in position on a four-wheel tender truck.

Fig. 44 shows a typical application. The steam inlet pipe is run along the outside of the tender frame, left side, to a connection with the steam inlet manifold of the Booster in a manner similar to that of the trailer application. Exhaust steam is carried up from the exhaust manifold through the water compartment of the tender to the exhaust valve, which discharges it on top of the water. The manually operated valve of the exhaust valve provides for directing the steam to the atmosphere when desired. The ball and sliding joint connection of the exhaust pipe to the bottom of the tender provides for the lateral and vertical movements of the Booster and of the tender frame.

The steam inlet piping is drained by automatic drip valves.

The air control piping is run along the inside of the tender frame, right side, to a connection with a cradle manifold on the tender frame and to the air manifold on the Booster.

The Booster is mounted on the front tender truck and connected directly to the axle of the rear wheels by gears in the same manner as the trailer Booster. The flexible mounting is provided by two bearings around the rear axle of the front truck, the third being the spherical seat at the center of the cross transom of the one-piece tender truck frame.

The tender load is transmitted to the axle driving boxes through equalizers supported on springs. The equalizer rigging carries a greater portion of the tender load to the rear, or driven, axle.

Side rod cranks are pressed on the axles and further secured by keys. Both pairs of wheels are connected by side rods, which makes available the resistance of the front wheels when there is a tendency of the rear wheels to slip. The side rods are counterbalanced by weights cast in the wheel centers. This enables the driving box cellars to be removed for repacking without disturbing the binders.

Some Booster tender trucks are equipped with Roller Bearings.

ELEMENTS OF THE BOOSTER

Type C-1

Trailer Application

A complete Type C-1 Locomotive Booster equipment as furnished for a trailer truck application consists of the following:

Booster Engine

1 Complete Locomotive Booster
1 Complete Set Steam Inlet Joints
1 Complete Set Exhaust Joints

Air Control

1 Complete Throttle Valve with Operating Cylinder
1 Preliminary Throttle Valve
1 Dome Pilot Valve
1 Reverse Lever Pilot Valve
1 Timing Reservoir
1 Three-Way Cock (Cylinder Cock Cut-Out Cock)
1 Two-Way Cock (Booster Air Line Valve)
14 Connections
2 Elbows
4 Tees
3 Flexible Air Connections
1 Cradle Manifold

Miscellaneous

1 Axle Gear
1 Steam Separator
1 Steam Gauge
1 Needle Valve (Heater Valve)

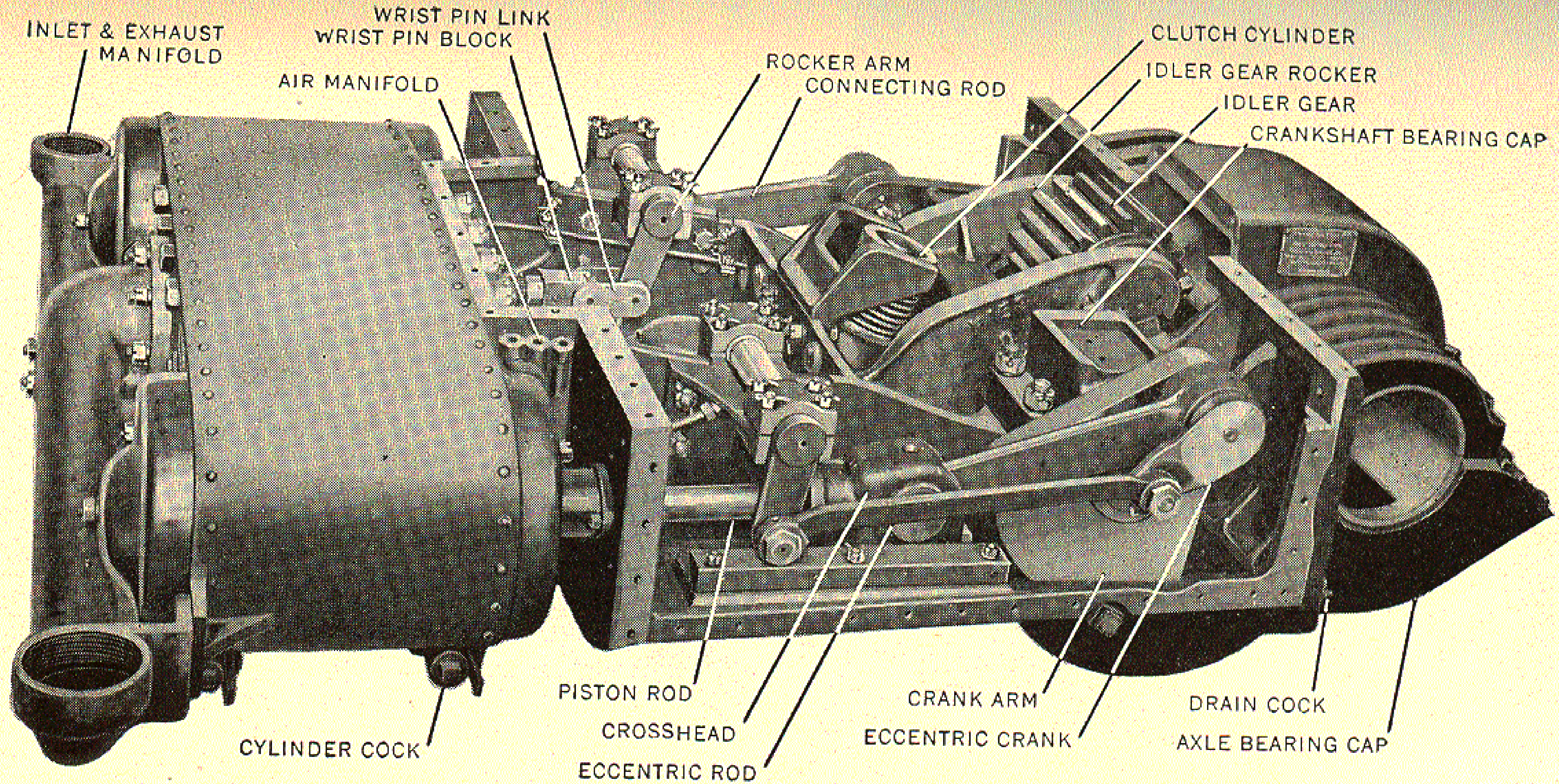


Fig. 45. Type C-1 Booster Engine: Cover Plates and Casing Top Removed.

GENERAL DESCRIPTION

In the following pages relative to the Type C-1 Booster, reference is made to only those parts which differ from the similar parts used in the Type C-2 Booster itself or its air control system.

In some cases it is possible to replace Type C-1 Booster and air control parts with those of the Type C-2. Such

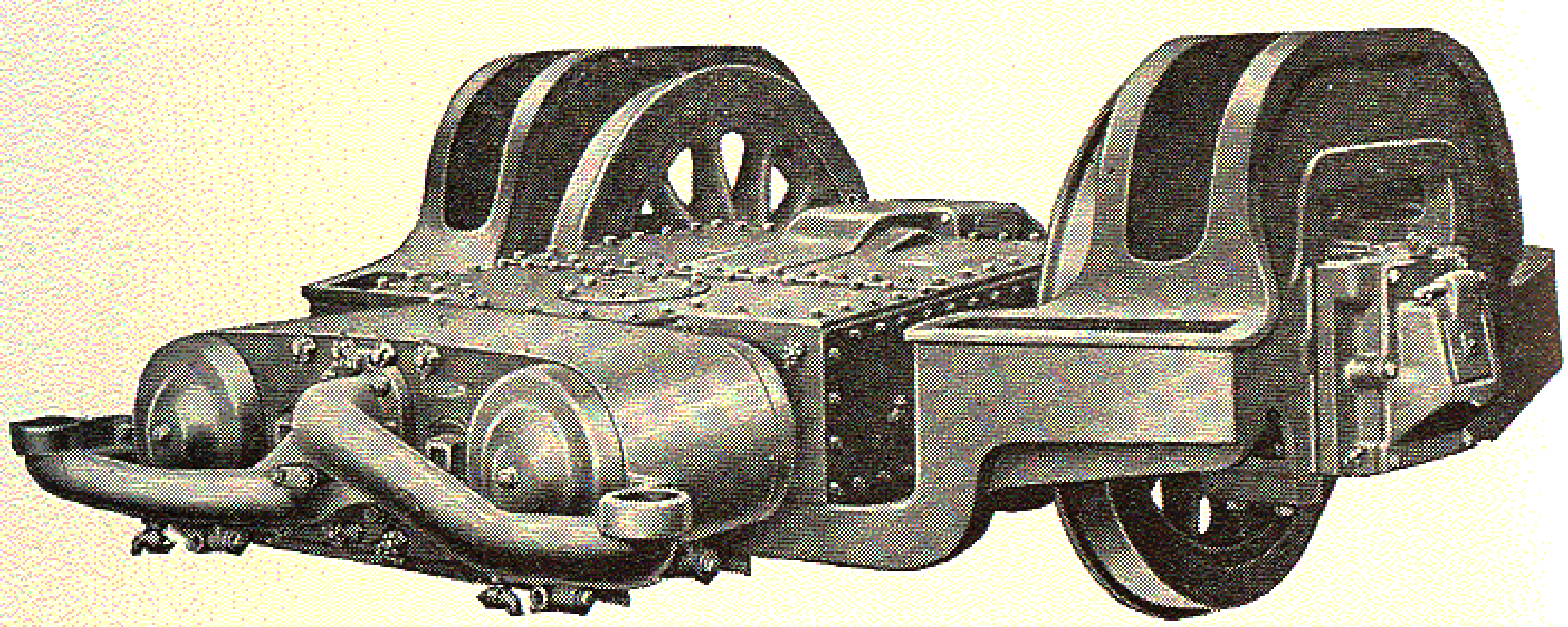


Fig. 46. Type C-1 Booster and Two-Wheel Trailer Truck

information as is necessary in connection with these replacements is given in the descriptions which follow.

Fig. 46 shows the Type C-1 Booster as applied to a two-wheel trailer truck. The general description of the Booster, as given on pages 8 to 10 applies to this type also.

BOOSTER ENGINE
Type C-1

Engine Bed. The engine bed, Fig. 47, is of a slightly

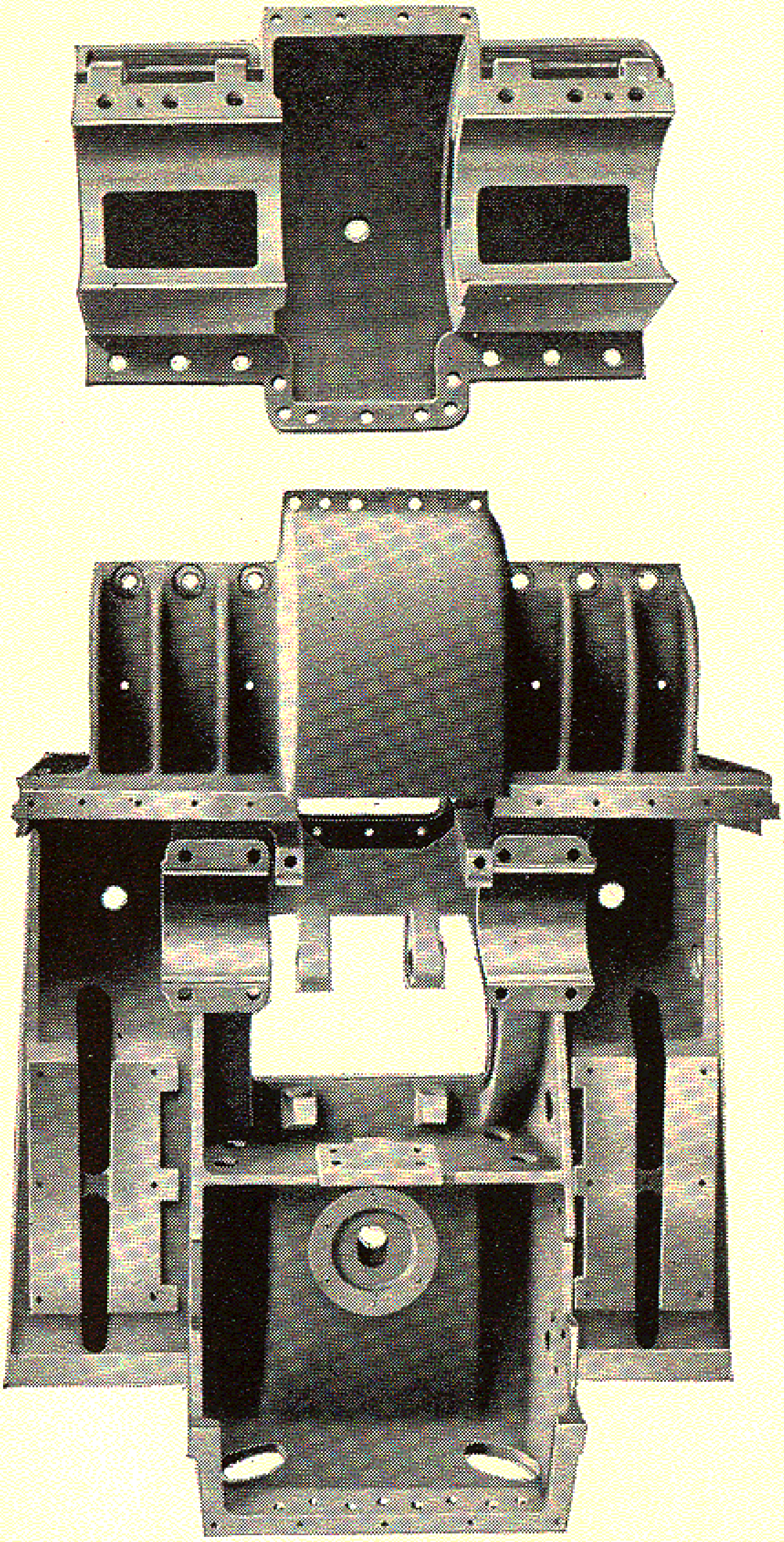


Fig. 47. Type C-1 Booster Engine Bed and Axle Bearing Cap

different design from the similar part shown in Fig. 10

for the Type C-2 Booster. The description of the Type C-2 parts given under this heading applies to the Type C-1 parts also.

The ball seat arrangement, Fig. 11, is the same in both types of Boosters, except that a gasket is necessary under the king pin cap on the Type C-1 Booster.

The Cylinders, valve chambers and steam chest of the

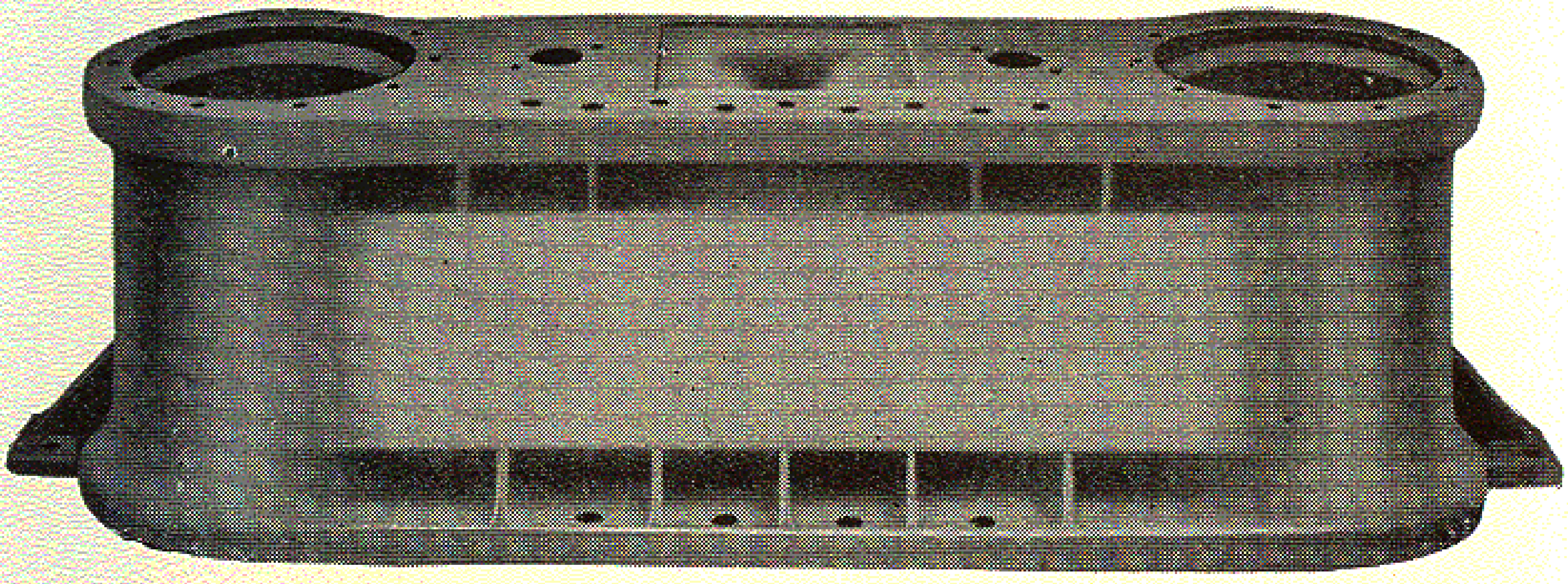


Fig. 48. Type C-1 Booster Cylinders

Type C-1 Booster are made integral of special cast iron. The valve chambers are bushed in the usual way, but no bushings are used in the bores of the cylinders, which are 10″ x 12″.

The cylinder heads, front and back, are removable, copper gaskets being used to make tight joints. The entire cylinder casting is heavily lagged and jacketed, giving proper insulation and a neat appearance.

The pistons and the valves, and the principal valve dimensions are the same as on the Type C-2 Booster, as given on page 15.

Piston Rod and Valve Stem Packings and Swabs. The usual type of metallic rod packings are used.

The piston rod swab packing is held in place in the swab cup against the end cover plate. Provision is made for draining any condensation which may leak past the rod packing rings or oil past the swab packings through a hole in the swab cap.

The valve rod swab packing is held in place in the stuffing box gland and adjusted against the swab packing gland by nuts on studs extending into the cylinder casting. Provision is made for draining possible condensation or oil leakage through a pipe from the stuffing box gland to a tee in the engine bed.

Crankshaft, Idler Gear Rocker, and Gears. These assembled parts are the same as those shown in Fig. 15 for the Type C-2 Booster, with the exception of the idler gear rocker. While this part performs the same function in both types of Boosters, it is not interchangeable, although the other parts are interchangeable.

Steam Piping. The arrangement of flexible piping for the Type C-1 Booster cylinders is shown in Fig. 49.

The steam inlet pipe, on the left side of the locomotive, consists of a suitable run of extra heavy steel pipe with three 3″ flexible joints. These flexible joints are specially designed Franklin Ball Joints, one with angle body and straight ball (female), one with straight body and angle ball (female), and one with angle body and straight ball (male). The exhaust pipe on the right side of the locomotive is similar except that the joints are 3½″.

The connections with the fittings and the manifold, after being tightly screwed together, are further secured against loosening by brazing. To facilitate brazing and to obtain a true surface the ends of the joints and of the manifold are machine finished. An approximate specification for the bronze wire and instructions for doing this brazing work are given on page 19.

The cast iron manifold is bolted at its center to the face of the cylinder casting, the joint being made with a copper gasket. The ends of the manifold are secured to integral lugs on the cylinder casting.

Suitable guide links are used to govern the movements of the middle ball joints so as to prevent interference with

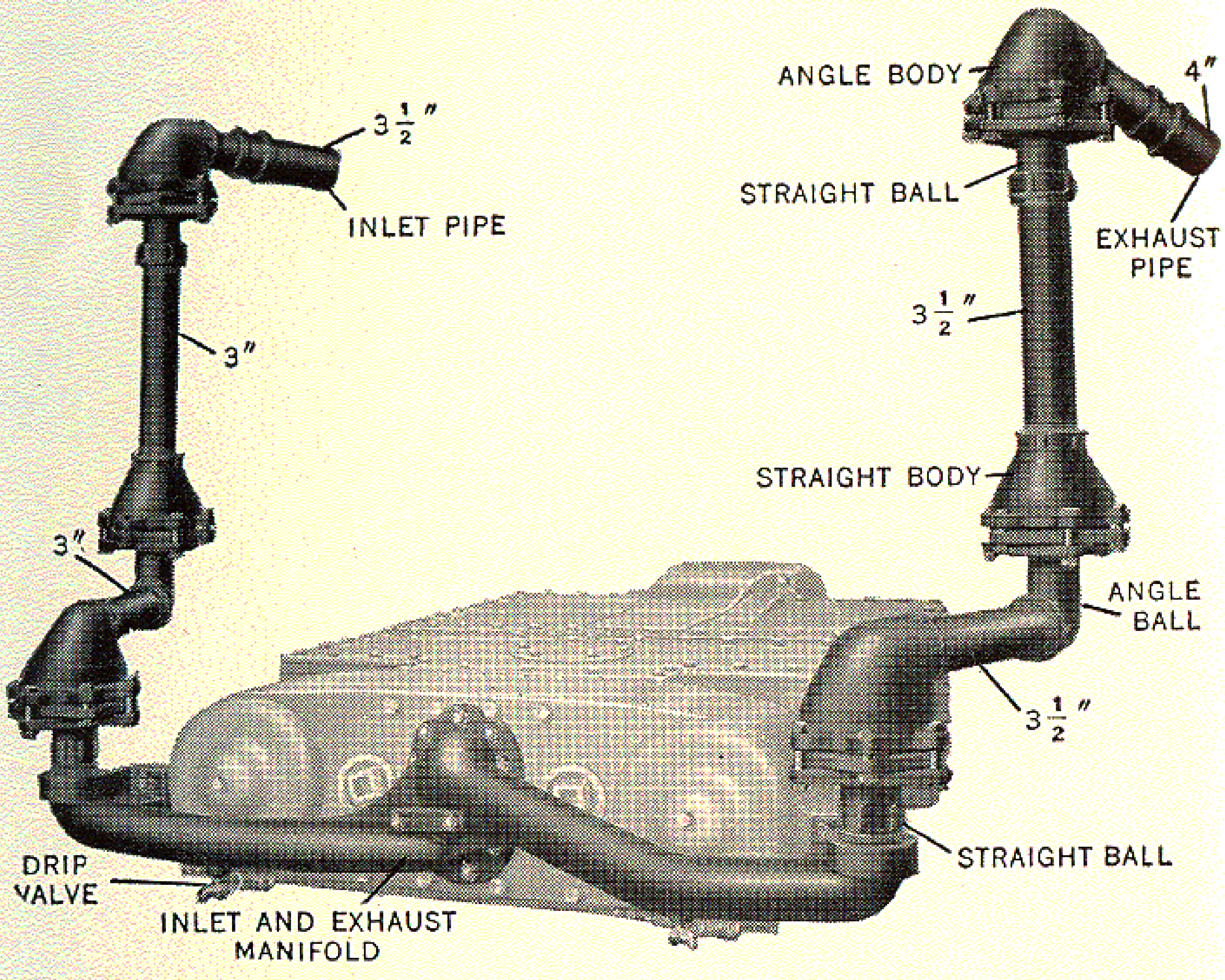


Fig. 49. Type C-1 Booster Steam Inlet and Exhaust Joints, Manifold and Piping

other locomotive parts. The top ball joints must be supported by rigid clamps which will allow for the longitudinal expansion of the pipes.

A complete description of the ball joints with the method of adjustment, the inlet and exhaust pipe lagging and the steam separator are given on pages 20 and 21.

BOOSTER CONTROL
Type C-1

The Booster Latch. The description of the operation of the latch as given in connection with the Type C-2 Booster control applies equally as well to the Type C-1 Booster, with the exception of the references to the idling valve which is a part of the reverse lever pilot

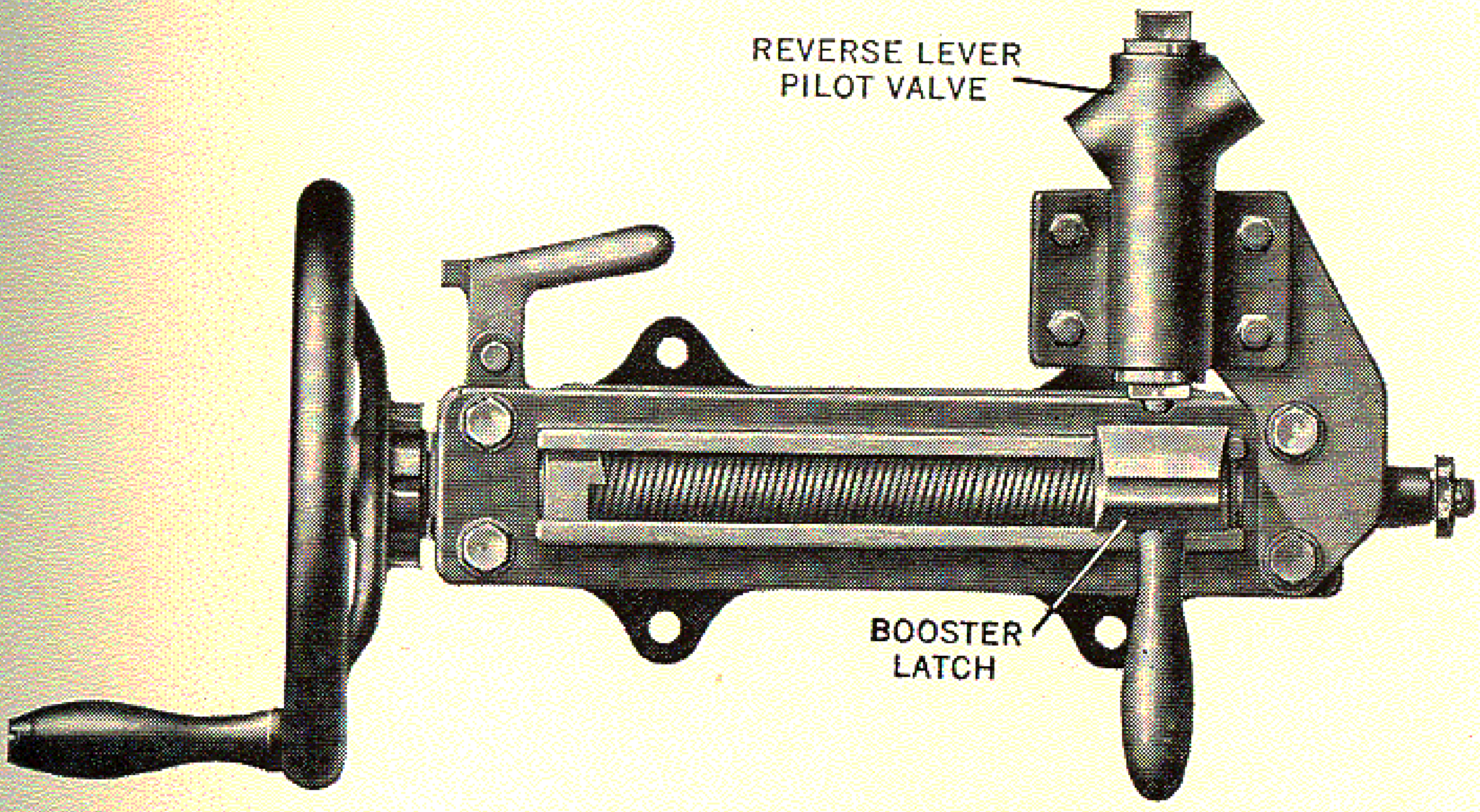


Fig. 50. Booster Latch as used with Precision Gear

valve. The illustrations of the latch as used with the Precision gear, Fig. 50, and as used with the Ragonnet gear, Fig. 51, differ from the similar illustrations, Figs. 19 and 20, only as regards the type of reverse lever pilot valve shown.

The Reverse Lever Pilot Valve, the release position of which is shown in Fig. 52, is operated by raising or lowering the Booster latch in the same manner and for the same purposes as is the improved valve used with the Type C-2 Booster.

The Type C-1 Booster valve, however, requires the use of the separate idling valve in the air line to the clutch cylinder, while the Type C-2 Booster valve includes the idling valve, as shown in Fig. 21.

When the reverse lever, Fig. 51, or the block of the

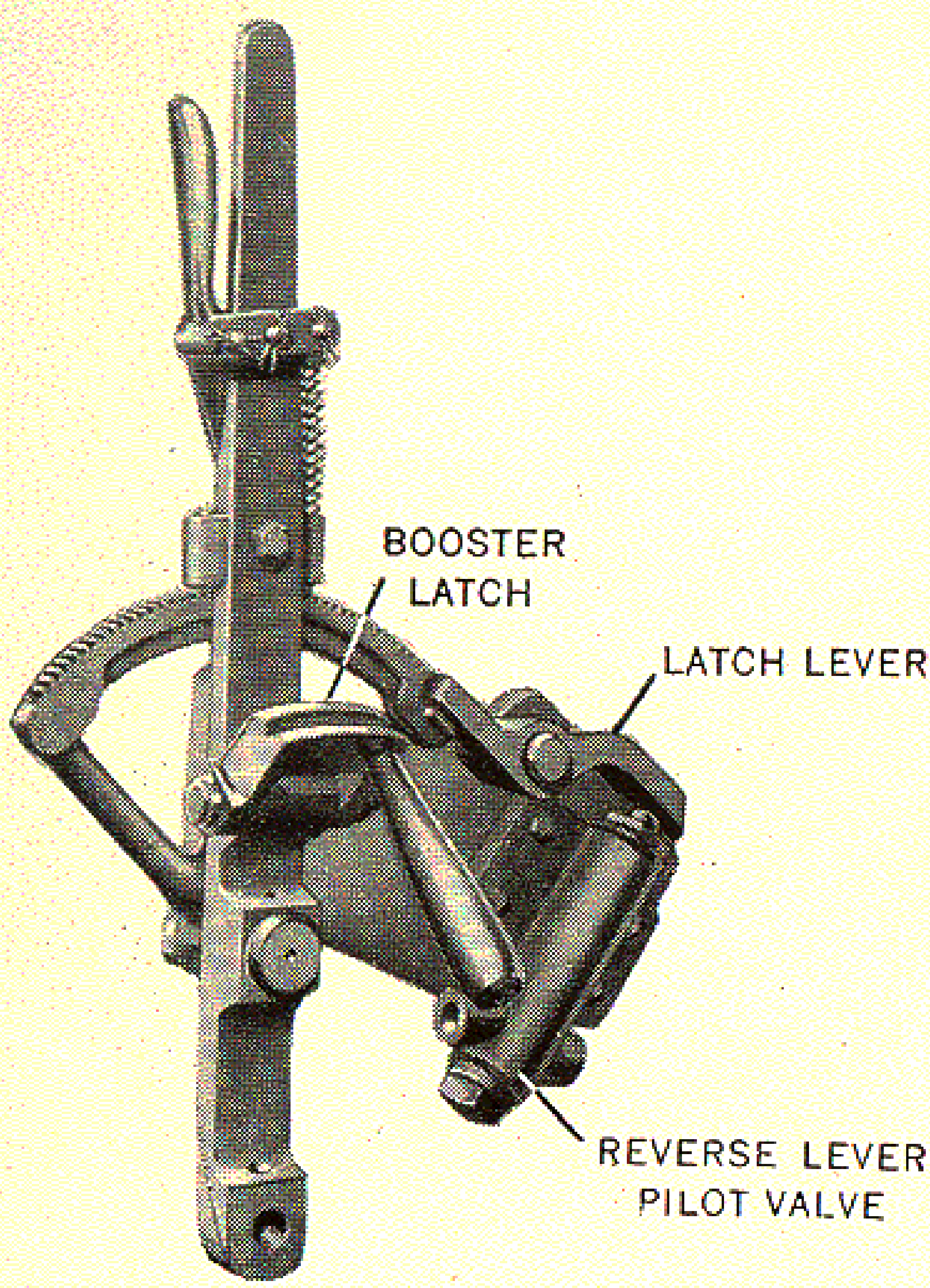


Fig. 51. Booster Latch as used with Ragonnet Gear

Precision Power Reverse Gear indicator, Fig. 50, is in or near the corner in the forward position and the 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, Fig. 52. Simultaneously the outside check valve is opened and main reservoir pressure flows through inlet port B and to outlet port C.

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 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.

The purpose of the valve pusher and valve pusher spring is to prevent a positive pressure of the valve

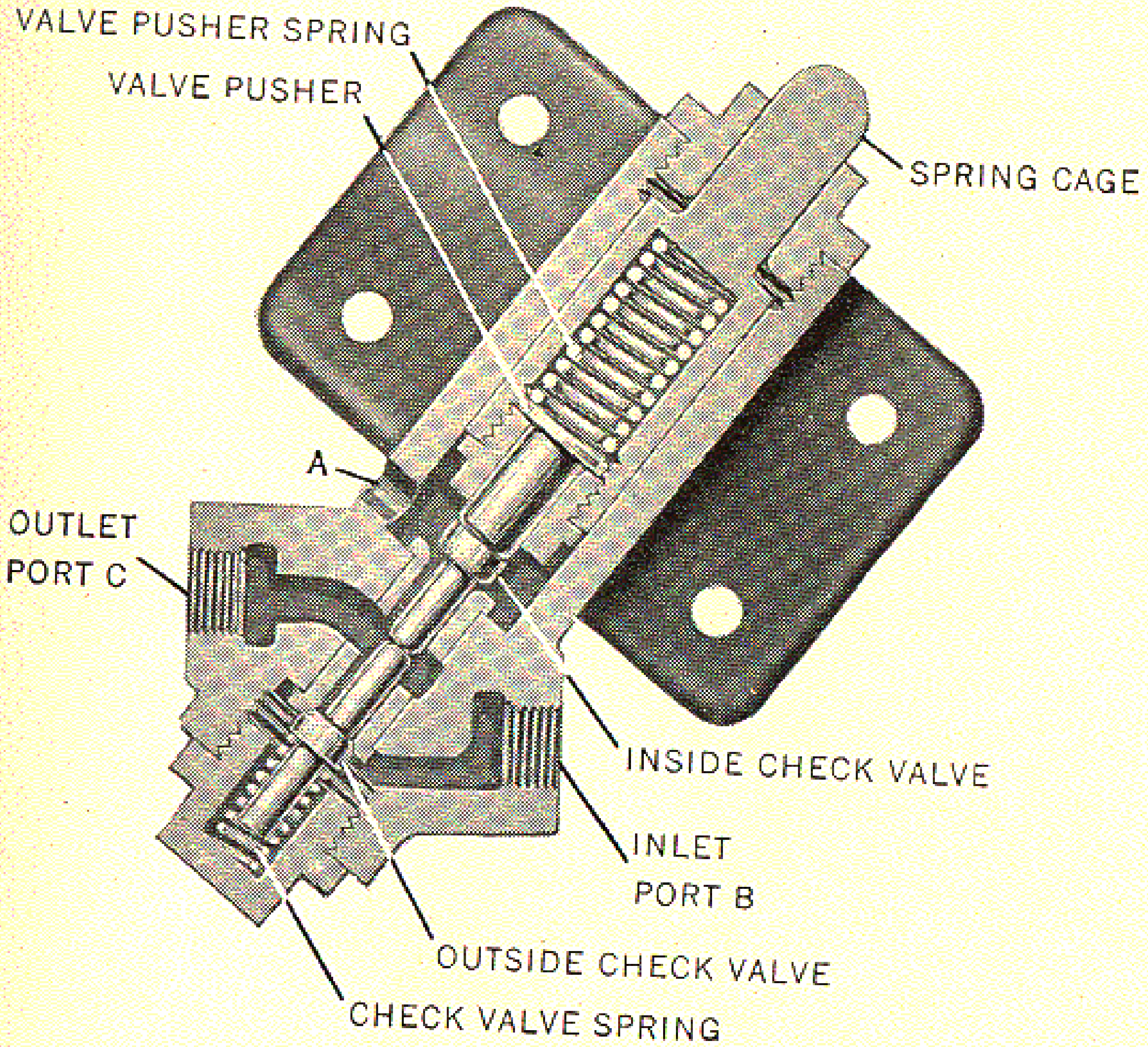


Fig. 52. Type C-1 Booster Reverse Lever Pilot Valve; Release

pusher retaining nut against the head of the inside check valve and also to make close adjustment of the Booster latch unnecessary.

The reverse lever pilot valve shown in Fig. 52 may be replaced by the valve shown in Fig. 21, in which case the separate idling valve should be removed from the line to the clutch cylinder, since the idling valve is incorporated in the body of the pilot valve shown in Fig. 21.

The Idling Valve used with the Type C-1 Booster air control system, a simple two-way cock in the line to the clutch cylinder, serves the same purpose as the idling valve which is incorporated in the body of the reverse lever pilot valve used with the Type C-2 Booster control.

When this improved reverse lever pilot valve, Fig. 21, is used with the Type C-1 Booster air control, the separate idling valve should be removed from the line to the clutch cylinder, since the idling valve is incorporated in the body of the pilot valve shown in Fig. 21.

The Preliminary Throttle Valve, the release position of which is shown in Fig. 53, as used with the Type C-1

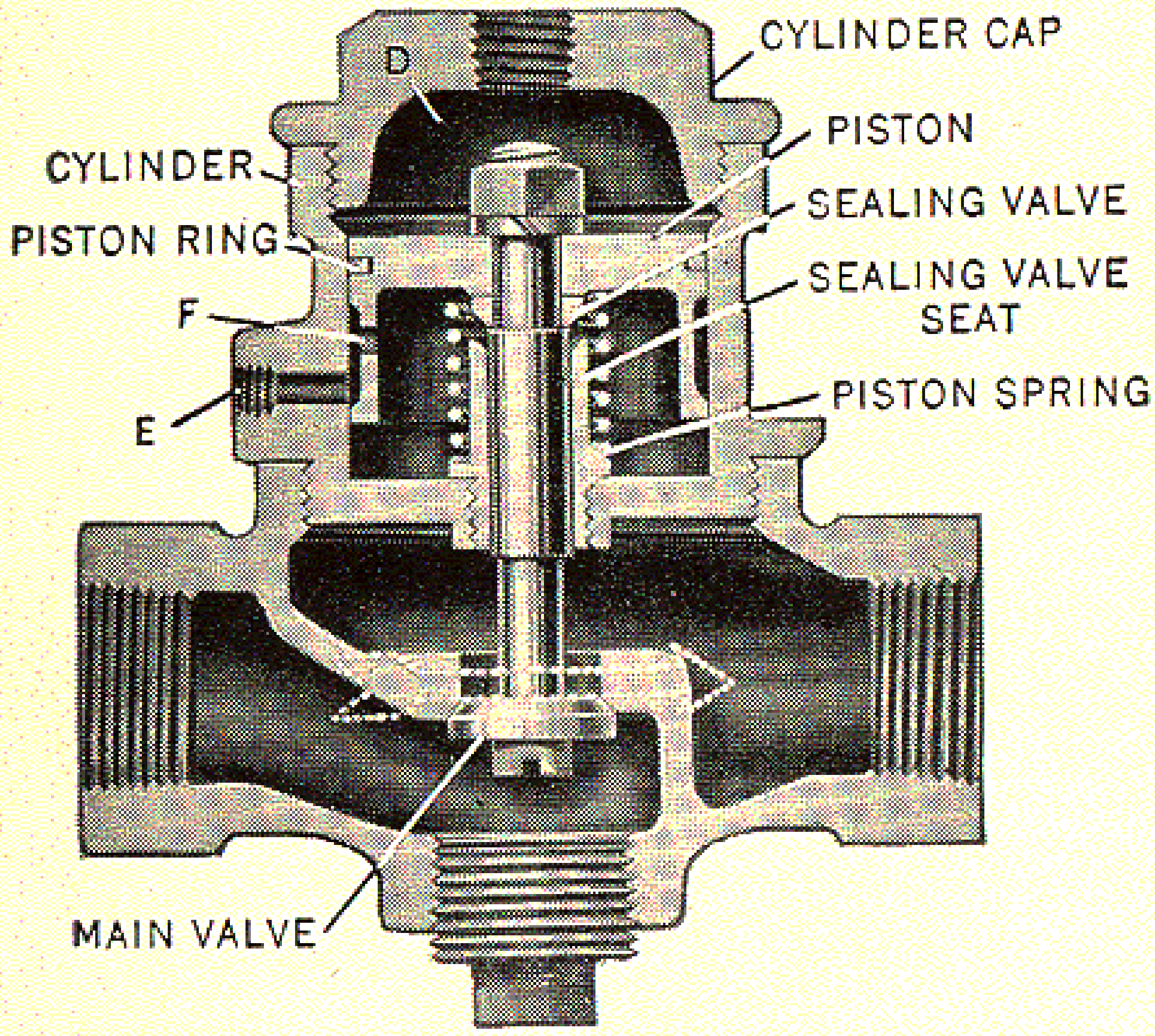


Fig. 53. Type C-1 Booster Preliminary Throttle Valve; Release

Booster air control, operates in the same general manner for the same purposes as does the improved valve used with the Type C-2 Booster control, Fig. 22.

Since the design of this valve differs from that of the improved one, the description of its operation is given here. Air is piped directly from the outlet port C of the reverse lever pilot valve, Fig. 52, to the cylinder cap of the preliminary throttle valve. Steam passes through the body of the valve in the direction of the arrow.

When the latch is raised, air flows to chamber D, forcing the piston down and carrying the sealing valve to its seat. The piston spring is compressed and the main valve is opened ⅛" against the steam pressure, in which position it will remain as long as the latch is raised.

After leaving this valve the steam passes through a choke, having a ½" 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 on pages 30 and 31.

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 reverse lever pilot valve, and the piston is returned to its release position, carrying the main valve to its seat and thus shutting off the supply of preliminary steam to the Booster.

The main valve, sealing valve and seat are made of Monel metal to resist the corrosive action of the steam, while the other parts are made of bronze. Since the limits are necessarily close, great care is taken in the manufacture. It is of utmost importance when assembling that the parts be kept free from dirt, scale, etc., and that the main valve, sealing valve seat and piston are true and in line. The use of large stillson wrenches should be avoided and care should be taken not to clamp the parts too tightly in vises.

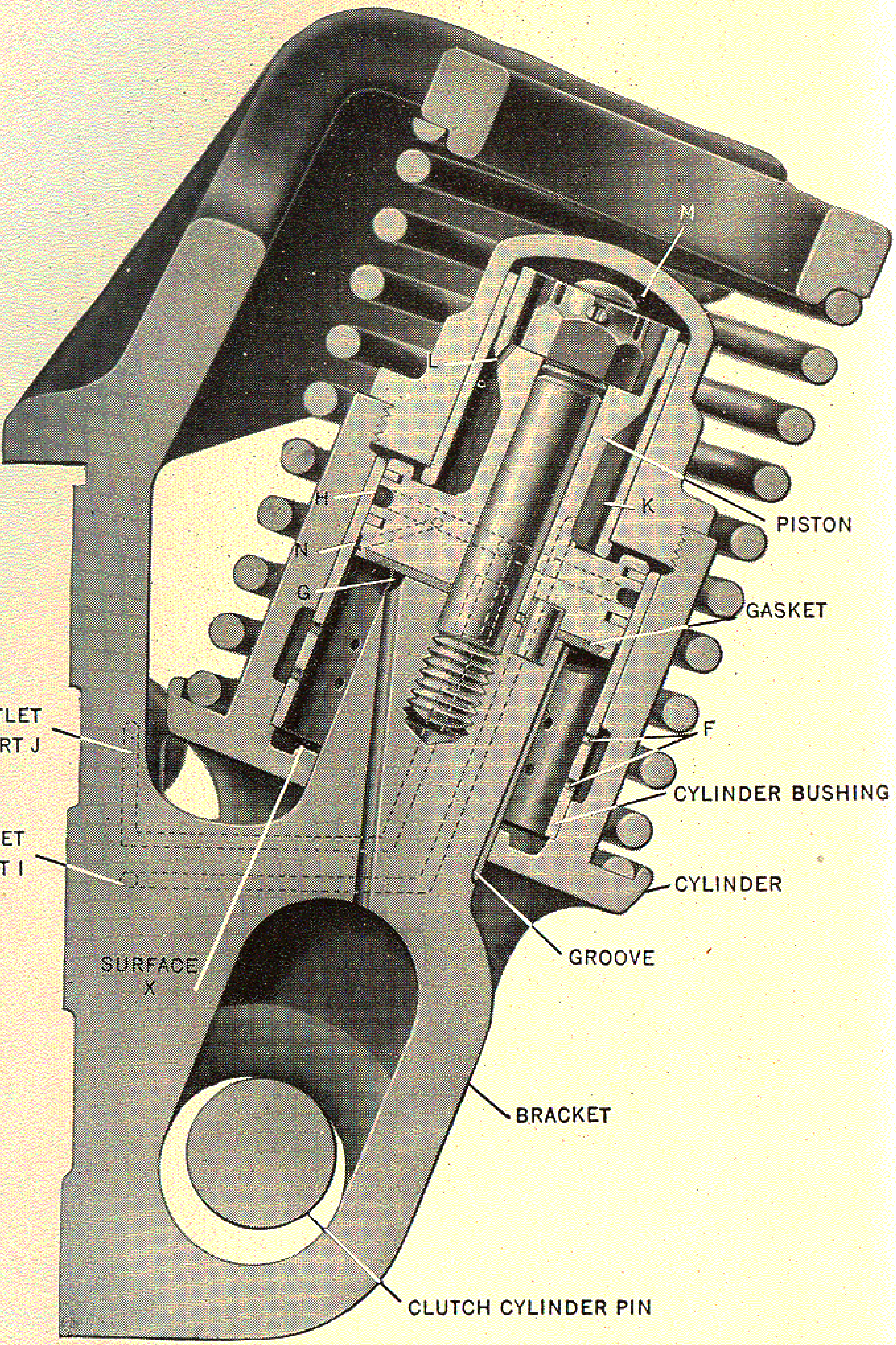


Fig. 54. Type C-1 Booster Clutch Cylinder; Release

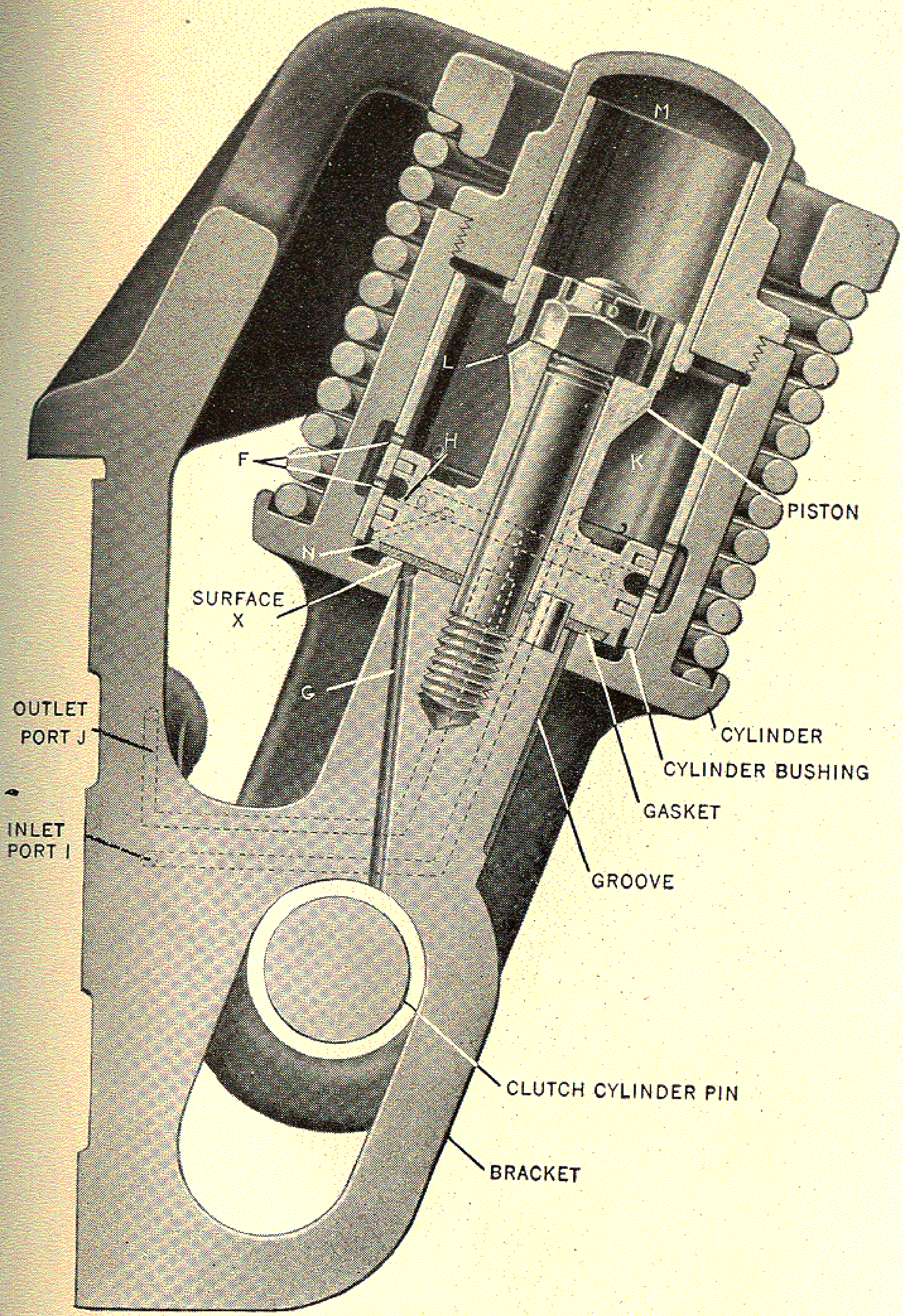


Fig. 55. Type C-1 Booster Clutch Cylinder; Application

Ports E in the cylinder and F in the piston allow any air which may leak past the piston ring and steam which may leak past the sealing valve to exhaust to the atmosphere, thus providing for the correct operation of the valve. When separate valves are shipped, port E is closed by a pipe plug which must be removed before operating the valve.

The preliminary throttle valve must be installed in the preliminary steam line and higher than the steam turret when possible, so that the steam will pass through it in the direction of the arrow cast upon the body.

The improved valve shown in Fig. 22 may be used in connection with the Type C1 Booster air control.

The Clutch Cylinder is pin-connected to the idler gear rocker and is operated by air pressure. Its purpose is to carry the idler gear into position for meshing with the axle gear and out of mesh with the axle gear.

In order to easily understand the operation of this part, it must be remembered that the clutch cylinder piston is rigidly connected to the bracket and that it does not move. When air pressure is admitted to chamber K, Fig. 54, page 100, as later described, it passes through port L, and moves the cylinder upward. A thorough understanding of the fact that the cylinder moves (not the piston) is essential to the proper understanding of the clutch cylinder operation. Fig. 54 shows the release position of the clutch cylinder when the idler gear is out of mesh with the trailer axle gear, while Fig. 55, page 101, shows the application position, when the idler gear is in mesh with the axle gear.

The clutch cylinder functions to:

(a) Carry the idler gear into position for meshing with the axle gear, close port G in the bracket to the atmosphere and open ports F 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 gears in mesh without further assistance from the clutch cylinder.

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

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 to the clutch cylinder through inlet port I in the bracket and piston, into chamber K, through port L and into chamber M above the top of the piston. The piston being rigidly connected to the bracket—as previously explained—the air pressure forces the cylinder upward, compressing the spring 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 cylinder ceases as surface X of the cylinder makes a seal with the gasket on the underside of the piston, thereby closing port G and preventing escape to the atmosphere of any air which may leak past the lower piston ring. 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 the 1/8″ clearance between the clutch cylinder pin and its hole in the cylinder casting, so that the surface X of the cylinder 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 cylinder has completed its movement, the ports F in the lower part of the bushing are uncovered and the air then passes around the top piston ring into groove H and down through the piston and to outlet port J.

If there is a leakage of air past the lower piston ring after surface X has sealed against the gasket, it passes through port N in the piston and to outlet port J.

When the latch is manually or automatically disengaged from contact with the spring cage of the reverse lever pilot valve, air in chambers K and M above the piston is released to the atmosphere through port A in the reverse lever pilot valve. This release of air from chambers K and M allows the cylinder to break its seal with the gasket, due to action of the spring, thus providing an escape to the atmosphere, through groove H, port N, port G and the grooves in the bracket, for the air in the line to the dome pilot valve. The clutch cylinder spring then returns the rocker, with the idler gear and the clutch cylinder, to release position.

The 1/8" clearance between the clutch cylinder pin and its hole in the cylinder casting is very important and can be checked by admitting air to the clutch cylinder and forcing the rocker backward to a point where, through action of the spring, surface X just breaks its seal against the gasket, indicated by the 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 the flat face of the idler gear bearing pin.

When the clutch cylinder is in release position, Fig. 54, the spring holds the back stops of the rocker against the machined pads on the engine bed. When in application position, Fig. 55, the spring is compressed and the flattened ends of the idler gear bearing pin are held against the rocker stops.

The Dome Pilot Valve as used with the Type C-1 Booster air control operates in the same manner for the same purpose as does the improved valve used with the Type C-2 Booster control.

The difference between the two valves consists in the outside check valve of the Type C-2 valve having a solid stem which is a running fit in the bushing, and the bushing having a small drilled hole through which the air passes after the check valve has been raised due to the steam pressure in the Booster steam inlet pipe. This drilled hole acts to delay the passage of the air to the timing reservoir and cylinder cock operating cylinders, which function is performed by the small drilled hole through the valve of the cylinder cock line check valve with the Type C-1 Booster air control.

The dome pilot valve of the Type C-1 control may be replaced by the improved valve shown in Fig. 25, in which case the cylinder cock line check valve must be removed from the line to the cylinder cock operating cylinder, since its function is provided for in the small drilled hole in the outside check valve bushing of the improved valve, shown in Fig. 25.

The Cylinder Cock Operating Cylinder, the release position of which is shown in Fig. 56, is fastened to the underside of the Booster cylinders and is 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 cylinders.

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

The operating cylinder is provided with an operating

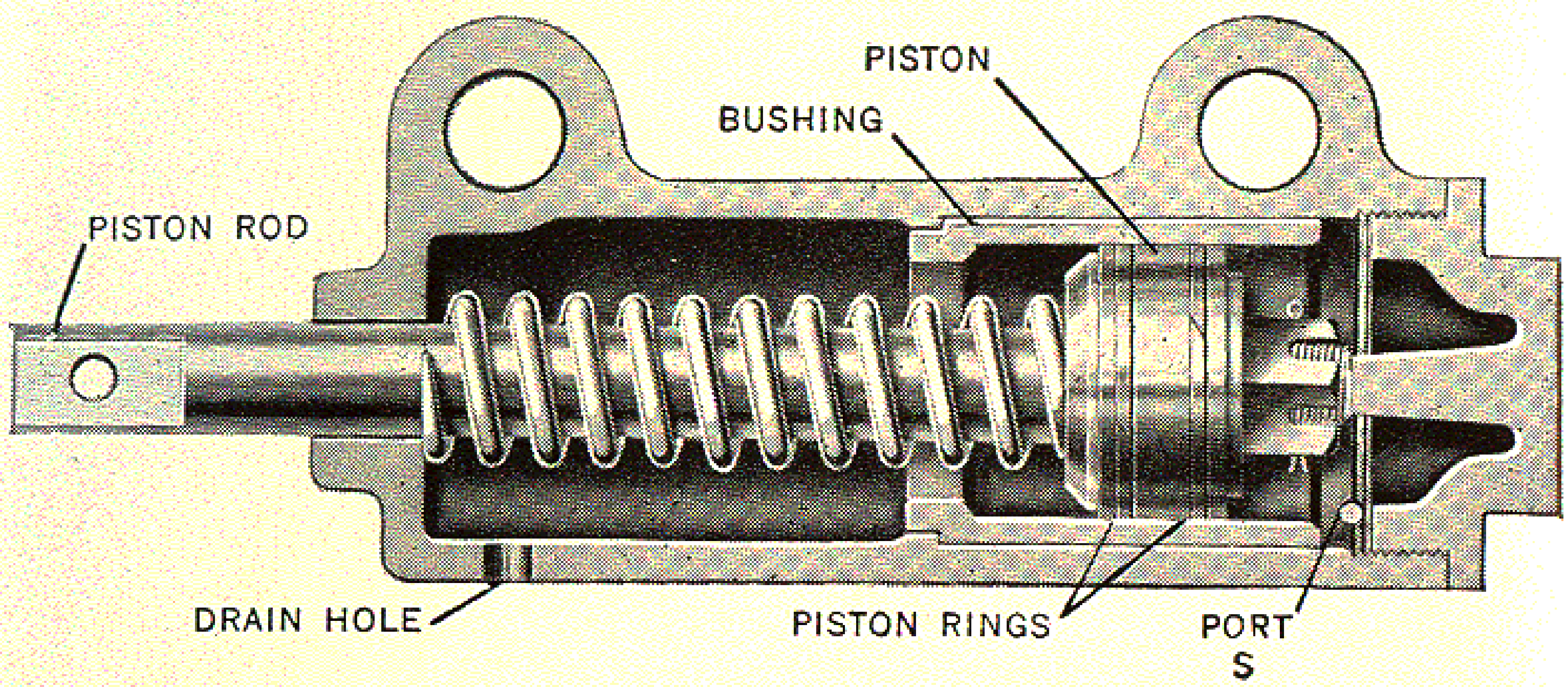


Fig. 56. Type C-1 Booster Cylinder Cock Operating Cylinder; Release

rod arrangement, Fig. 57, for four cylinder cocks. The operating rods connect with the piston through the oper-

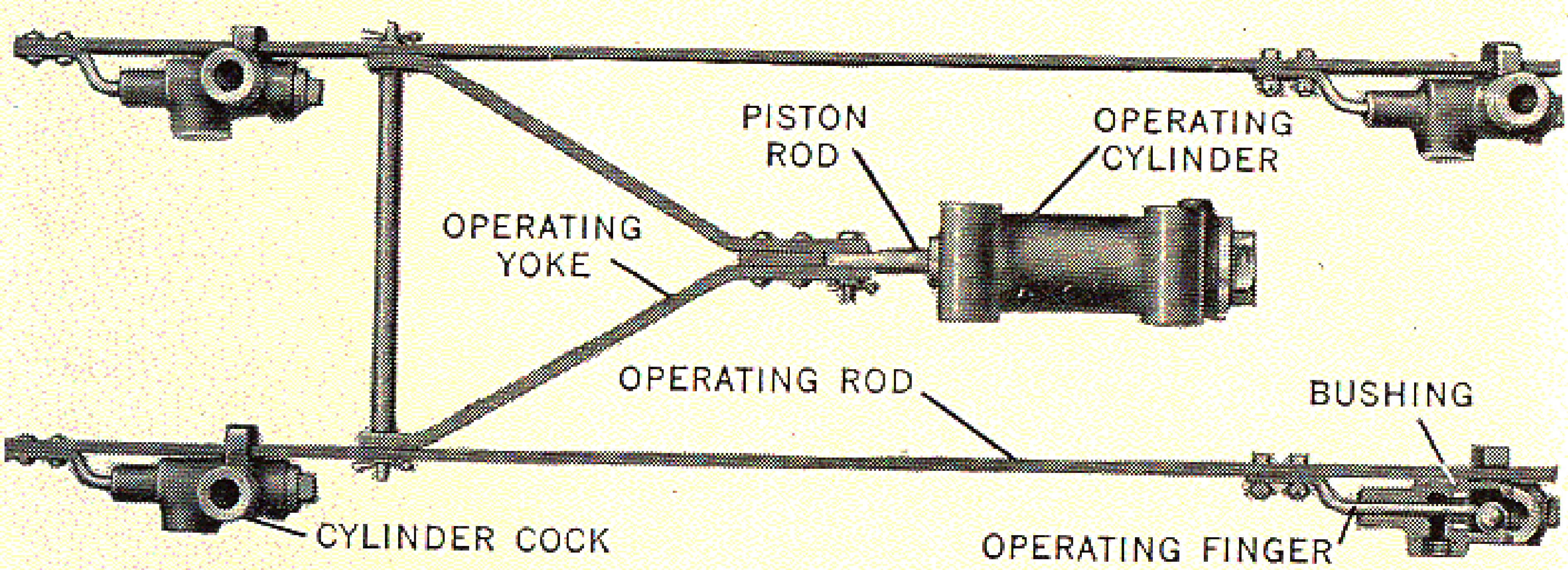


Fig. 57. Type C-1 Booster Cylinder Cock Operating Arrangement

ating yoke and with the cylinder cocks through the operating fingers.

In allowing the cylinder cocks to close, the air enters through port S at the cylinder head, forcing the piston to the left. This movement continues until the bevel face of the piston joints against the seat in the bushing. The operating fingers, secured to the operating rods, release the ball valves. The steam pressure forces the balls to their seats, 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 the spring to force the piston, and the operating fingers, to the right to unseat the ball valves against the steam pressure, thus opening the cylinder cocks.

This movement of the piston to the right continues until the end of the piston rod strikes the stop of the cylinder head.

The piston is fitted with two rings. The seat in the bronze bushing prevents escape of the air which may have leaked past the rings and also provides a stop to limit the travel of the operating rods on the closing stroke. The travel on the opening stroke is limited by the stop of the cylinder head.

The drain hole in the spring space of the operating cylinder provides for escape of the 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 right back end of the Booster engine bed on two tap bolts, 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

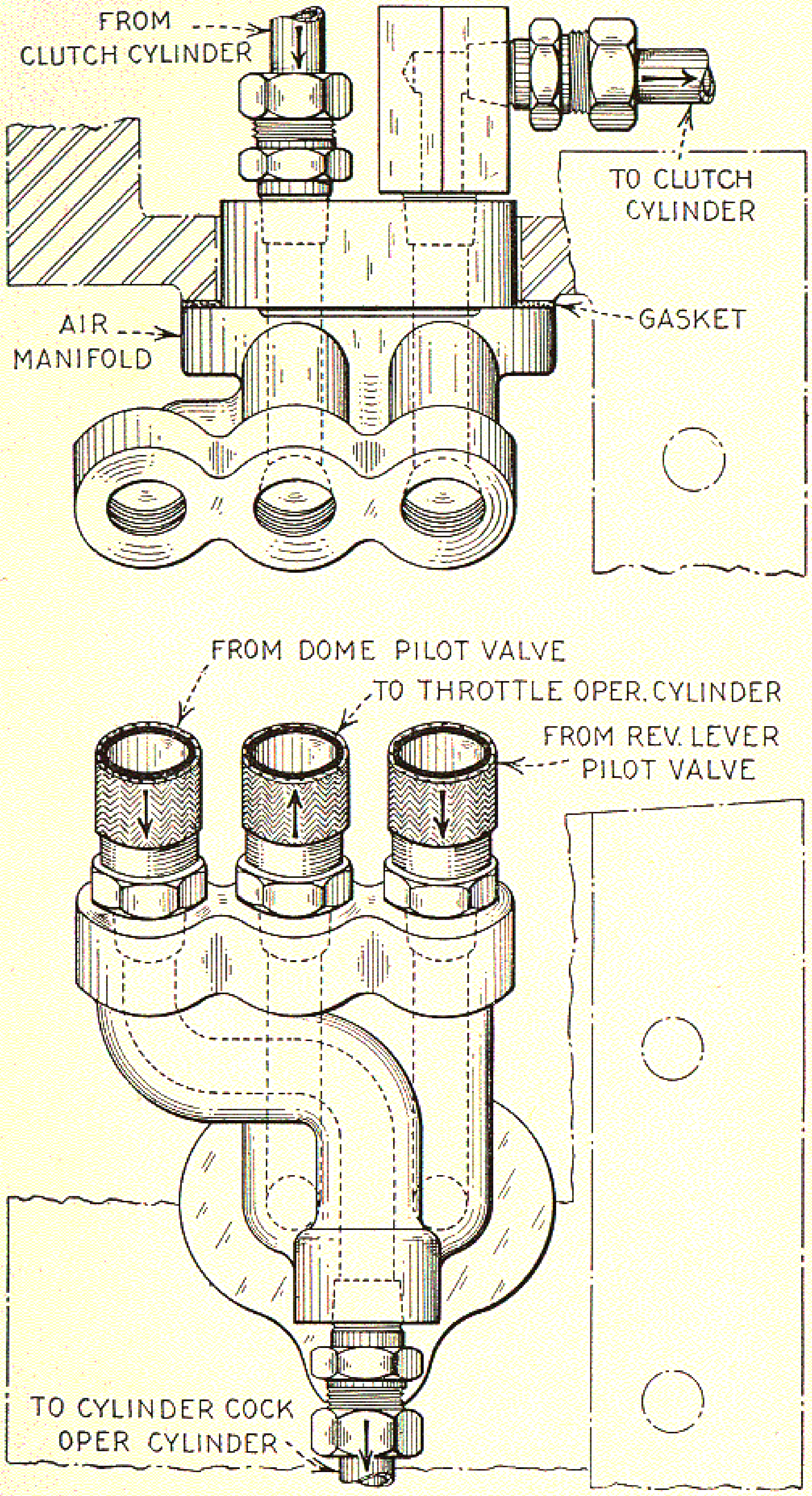


Fig. 58. Type C-1 Booster Air Manifold, Showing Flexible Air and Piping Connections

air manifold and the engine bed, prevents oil leakage where the extension of the manifold passes through the wall of the bed.

Fig. 58 shows the location of the manifold; the ports to which the integral couplings of the flexible air connections are screwed; and the ports to which the air piping connections are made for the clutch cylinder and the cylinder cock operating cylinder.

CONTROL SYSTEM FOR SUPERHEATED STEAM

Type C-1 Booster

The instructions given under this heading, pages 47 and 48, for the Type C-2 Booster apply equally as well for the Type C-1 Booster.

SEQUENCE OF OPERATIONS

(Superheated Steam)

Type C-1 Booster

The instructions given under this heading, pages 48 to 54 for the Type C-2 Booster apply to the Type C-1 Booster, except as noted in the following:

The diagrammatic arrangement illustrations, Figs. 31, 32, 33 and 34, illustrating the Type C-2 control system, is practically the same as in the Type C-1 control system, except that the improved parts are shown, and that the separate idling valve and the cylinder cock cut-out cock are not shown.

References to the idling valve being in the running position in the Type C-2 instructions, while referring to the valve which is incorporated in the body of the improved reverse lever pilot valve, Fig. 21, apply as well to the separate idling valve used on a Type C-1 Booster control with the reverse lever pilot valve shown in the Fig. 52.

References to the clutch cylinder in the Type C-2 instructions apply to the improved clutch cylinder. However, the action of the air produces the same results in so far as the meshing of the gears is concerned. The movement of the air through the Type C-1 clutch cylinder and its operation is given in detail on pages 102 to 105.

References to the dome pilot valve in the Type C-2 instructions, while referring to the improved valve with the small drilled hole in the outside check valve bushing, apply as well to the dome pilot valve which does not have this drilled hole in the bushing. In case of the latter valve, the air is delayed in its passage to the cylinder cock operating cylinder by the small drilled hole through the valve of the cylinder cock line check valve. The dome pilot valve used with the Type C-1 air control may be replaced by the improved valve shown in Fig. 25, in which case the cylinder cock line check valve must be removed from the line to the cylinder cock operating cylinder, since its function is provided for in the small drilled hole in the outside check valve bushing of the improved valve.

References to the cylinder cock operating cylinders in the Type C-2 instructions apply to the improved arrangement using two operating cylinders. However, the action of the air produces the same results in so far as the opening and closing of the cylinder cocks is concerned.

The action of the air in the Type C-1 cylinder cock operating cylinder and its operation is given in detail on pages 105 to 107.

OPERATING INSTRUCTIONS

Type C-1 Booster

The Question and Answers given under this heading for the Type C-2 Booster, pages 69 to 75, may be made to apply to the C-1 Booster by replacing the same numbered questions or lettered answers in the Type C-2 instructions by the ones given below.

2. What is necessary to idle the Booster?

(d) Close idling valve to prevent the air from going to the clutch cylinder to mesh the gears.

(e) Raise latch and idle Booster for two or three minutes, after which the latch should be knocked down before opening the idling valve.

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

(f) The pipe plug in the atmosphere port of the preliminary throttle valve may not have been removed. (See Preliminary Throttle Valve, page 98.)

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

(b) The small drilled hole through the valve of the cylinder cock line check valve at timing reservoir may be closed by dirt or scale.

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

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

Breakage of the clutch cylinder spring, a very unlikely condition, or breakage of the spring seat. Booster should be reported for repairs.

DAILY TERMINAL MAINTENANCE

Type C-1 Booster

The Questions and Answers given under this heading for the Type C-2 Booster, pages 76 to 83, may be made to apply to the Type C-1 Booster by replacing the same numbered questions or lettered answers in the Type C-2 instructions by the ones given below.

3. **What is the next operation?**

(e) Close idling valve in air line to clutch cylinder and idle the Booster. Idling speed, depending upon the boiler pressure, should be about as noted in paragraph (e), Question 3, page 76.

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

(b) See that there is no oil leakage from the piston rod swab cup or from the valve stem stuffing box gland through the tee in the engine bed.

5. **If the Booster continues to idle after latch is knocked down, what is the possible cause and remedy?**

(a) Possibly the preliminary throttle valve has not closed, as it should after knocking down the latch, thus allowing steam to continue going to the Booster.

Leakage through valve would have same effect. (d) Remove cylinder cap, bottom plug and the valve. The valve and seat may need regrinding. 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.

6. **If cylinder cocks fail to close, what should be done?**

(b) See that the small hole through the valve of the cylinder cock line check valve is open. When latch is raised to cut in the Booster, and the locomotive throttle has been opened, air should pass through the small hole in the valve of the cylinder cock line check valve and the timing reservoir to the cylinder cock operating cylinder.

(d) Examine cylinder cock operating cylinder for leaks.

(i) Do not make any changes, such as enlarging hole in valve of the cylinder cock line check valve.

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

(f) Remove plug of oil-filling street elbow in the side plate of Booster 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; that the piston stud or a piston ring is broken; or that the gasket is worn out.

(g) Remove front casing top to see if the trouble is in clutch cylinder. If so, it should be removed complete for repairs and thoroughly tested with not less than 70 lbs. air pressure for leaky gasket.

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

(d) Remove front casing top to see if the clutch cylinder spring or spring seat is broken. These may be replaced without removing the clutch cylinder.

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

(f) Close idling valve.

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

(b) Remove drip valve in inlet side of inlet and exhaust manifold and connect air hose to idle Booster.

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

(a) It is important that the maintenance of the proper supply of 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 street elbows are placed at the back ends of the side 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.