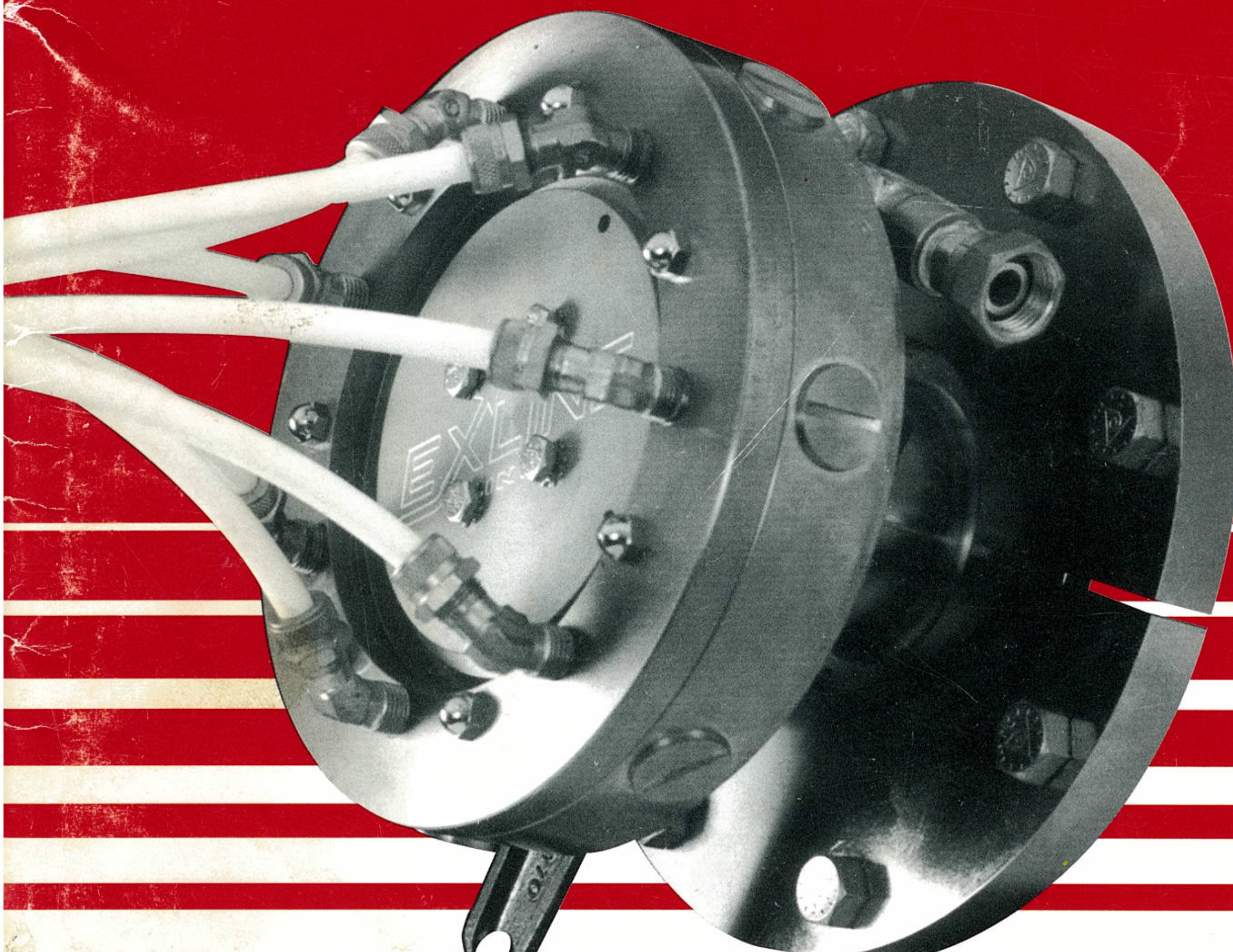
Air Start Distributor Manual



EXLINE, INC.
AIR START DISTRIBUTOR MANUAL
Patent No. 3,587,228

GMV - 10/5
Engine Type

Exline Assembly Number

311058 A
Air Start
Distributor Code

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STARTING AIR CHECK VALVE

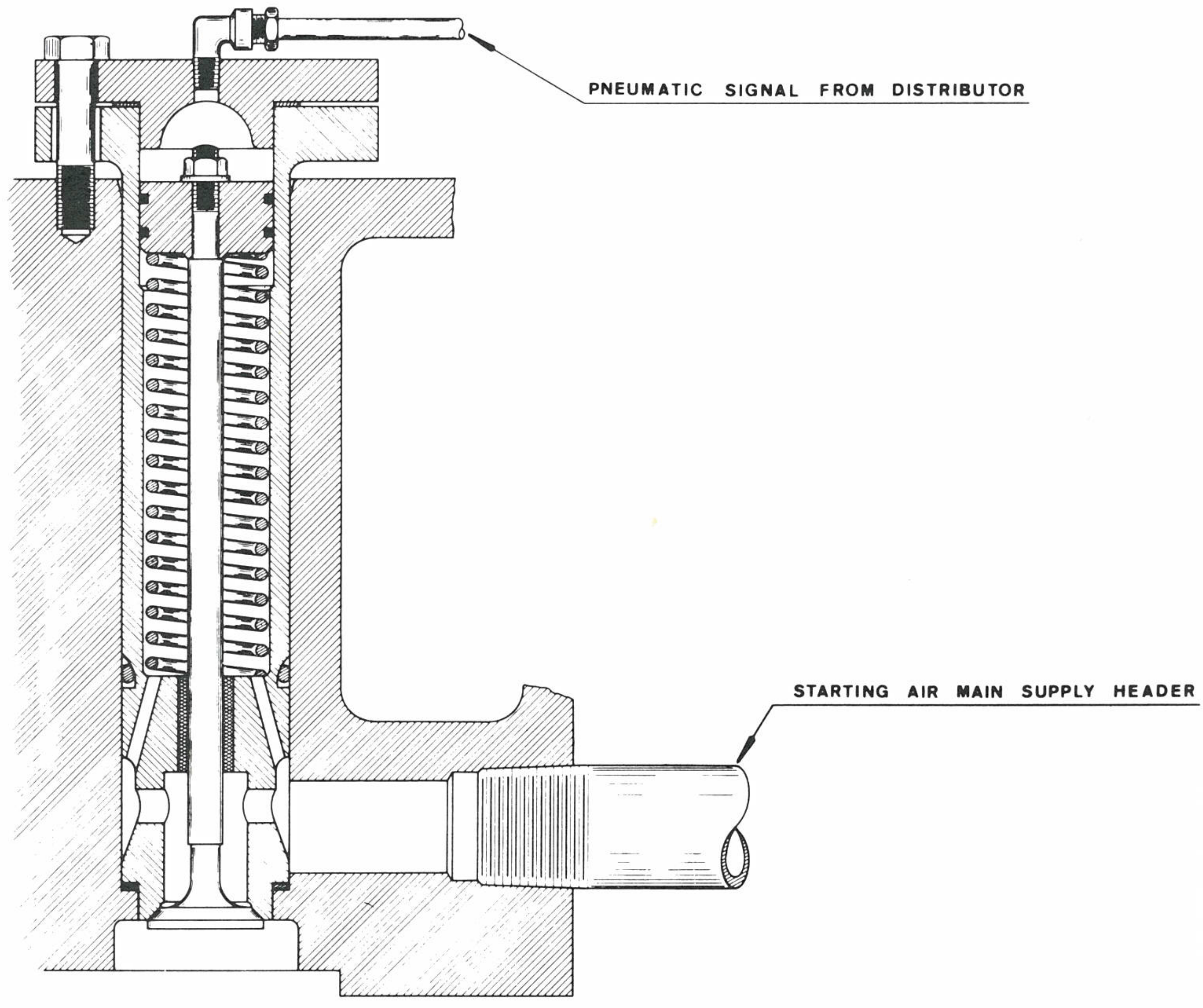


FIG. 1

PRINCIPLES OF OPERATION

This unique distributor by Exline is designed for large stationary engines which are presently equipped with, or can be equipped with, a camshaft-driven air start distributor, and engines which have power cylinder heads equipped with pneumatically operated starting air check valves (Fig. 1).

The starting air check valve receives a pneumatic signal from the air start distributor in the proper timing sequence. Upon receiving the pneumatic signal, the poppet valve opens and compressed starting air is admitted into the power combustion chamber from the main starting air header.

Fig. 2 is a typical illustration of an original equipment distributor driven by the camshaft. The distributor housing is attached in a fixed or non-movable position to the engine main frame

In this cutaway of a distributor, the arrows point to the distributor rotor or bushing that is rotated by the camshaft. The distributor rotor or bushing contains various air passage configurations, and being in constant contact with the front cover, permits an air signal to be passed at the proper time to the air start check valve. These air passage ports are located in the front cover of the distributor.

Starting air is injected into the power cylinder combustion chamber with the original equipment air start distributor and check valves. The power piston is located at or near top dead center when this occurs (Fig. 3).

Note the crank angle of the crankshaft in this illustration. The vertical arrow indicates the downward force exerted on the crankshaft power journal at the time of the initial injection of starting air. At this point, with no crankshaft rotation or momentum, the shaft "breakaway" torque applied is at minimum because of the top-dead-center crankshaft position. This method of using compressed air as a means to crank large stationary engines is the most common or accepted approach.

However, during recent years, owners and operators began the search for a more reliable way to start their engines. Present day operations demand more flexibility in use of engines, from the standpoint of starting and stopping the equipment, to maintain a more constant and controlled flow of their product. Also, many engine locations are in unattended areas and are operated by remote control. As a result, personnel are not present to "bar" or "spot" the engine to ensure a successful startup each time.

Another factor controlling the number of starting attempts, or the starting of several engines in close sequence, is the limited supply of available compressed air for starting or cranking purposes.

Because of these conditions and requirements, the need for an efficient and reliable "compressed air starting system", that uses the majority of the existing air start system, has presented itself.

TYPICAL O.E.M. START DISTRIBUTOR

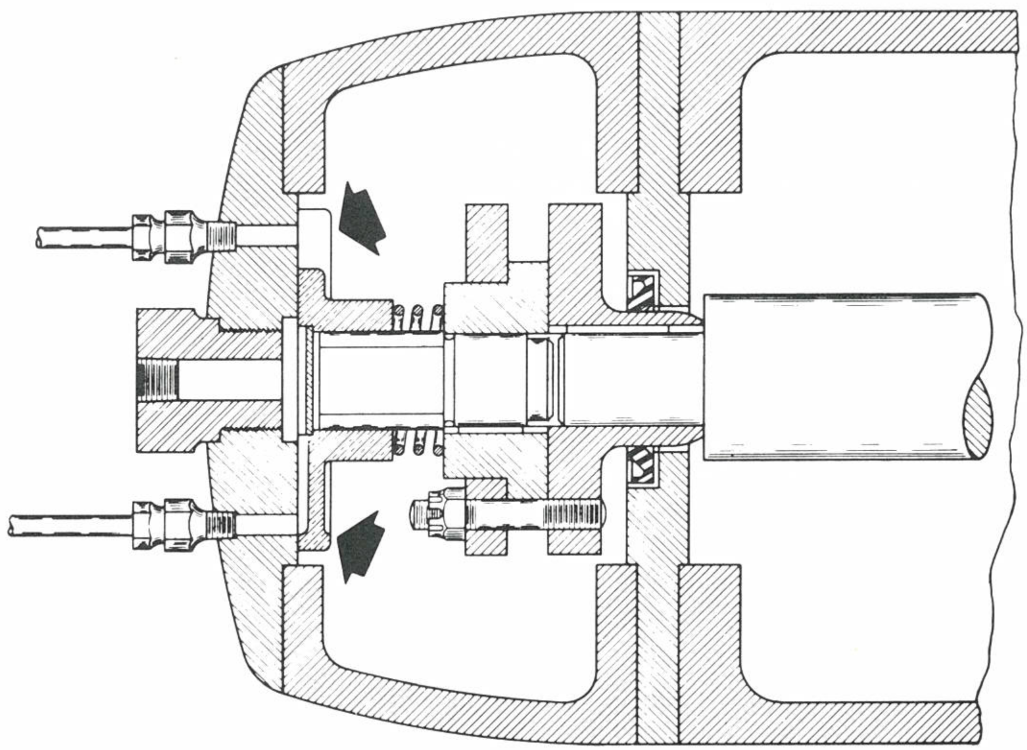


FIG. 2

ADVANCE AIR START INJECTION
HIGH EFFICIENCY
MAXIUM R.P.M.

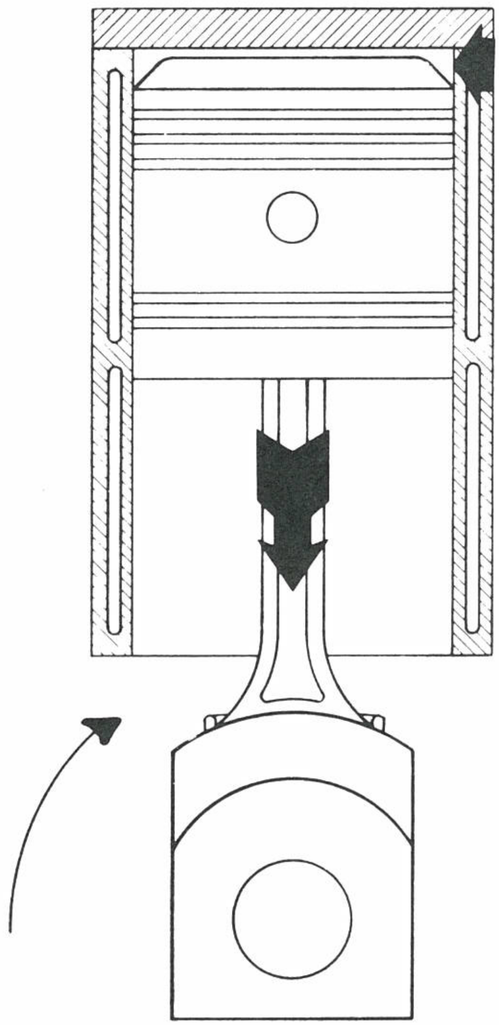


FIG. 3

After considerable study and research, it is determined the best approach is the redesign of the starting air distributor

In considering the redesign, some additional engine cranking and starting characteristic information is necessary to determine the starting sequence requirements.

Fig. 4 is an illustration of the procedure used to calculate "breakaway" torque. It is a typical drawing of an engine flywheel using an air jack and compressed air. A hand-operated air valve applies the compressed air and an air gauge in the system shows the air pressure that is applied to the jack cylinder. The point of application of the jacking force is kept as near to the flywheel's horizontal centerline as possible to minimize angular error. Slowly applied air pressure at the jack cylinder is recorded just as the crankshaft flywheel begins to rotate.

Using this pressure reading and the following formula: pressure applied times the area of the jack piston (in square inches) times the radius of the flywheel (in feet) equals the breakaway torque (in foot pounds) needed to rotate the crankshaft (T = P*A*R).

The graph in Fig. 5 represents the "breakaway" torque of a typical 10-cylinder engine with four angle-mounted compressors pressurized to 800 psig.

Referring to the graph, you will note that at one point the "breakaway" torque required to crank the engine is approximately 13,400 foot pounds.

The redesigned air start system for this type engine must meet the minimum "breakaway" torque requirements to assure a reliable crankshaft rotation for startup.

Fig. 6 is an illustration of the crankshaft journal on the power stroke. Since a fixed maximum pressure limits the starting air available to the starting system, it is necessary to approach other areas of the air starting system the need to increase "breakaway" torque. The most logical area is after-top-dead-center starting air injection.

In other words, admitting starting air pressure into the power combustion chamber as the piston is on its downward stroke. This takes advantage of the crank angle to increase the "breakaway" torque.

The graph in Fig. 7 illustrates "torque produced" information using after top dead center air injection. The calculations were obtained from the same typical 10-cylinder, 4-compressor engine previously discussed.

The dotted line running vertically through the center represents the maximum torque required for crankshaft "breakaway" during startup. The first diagonal line on the left represents air injection at 20 degrees after top dead center.

Note that in order to develop "maximum breakaway torque required" it is necessary to have available 250 psig of starting air pressure. However, with the use of any air pressure supply, this 250 psig starting air pressure is a diminishing figure; therefore, we can not be assured of a positive crankshaft rotation each time a start is attempted.

PROCEDURE USED TO OBTAIN BREAKAWAY TORQUE

1. ATTACH AIR PIPING AND GAUGE TO BARRING JACK AS PER SKETCH.
2. POSITION JACK NEAR THE HORIZONTAL CENTERLINE TO MINIMIZE ANGULAR ERROR.
3. INCREASE AIR PRESSURE TO JACK SLOWLY UNTIL FLYWHEEL JUST BREAKS AWAY (RECORD BREAKAWAY PRESSURE).
4. CALCULATE THE REQUIRED BREAKAWAY TORQUE FROM FORMULA.

T = RAP:

LETTER "T" = BREAKAWAY TORQUE (FT. LB)

LETTER "R" = RADIUS OF FLYWHEEL (FEET)

LETTER "A" = AREA OF JACK PISTON ($IN.^2$)

LETTER "P" = AIR PRESSURE AT JACK (PSIG)

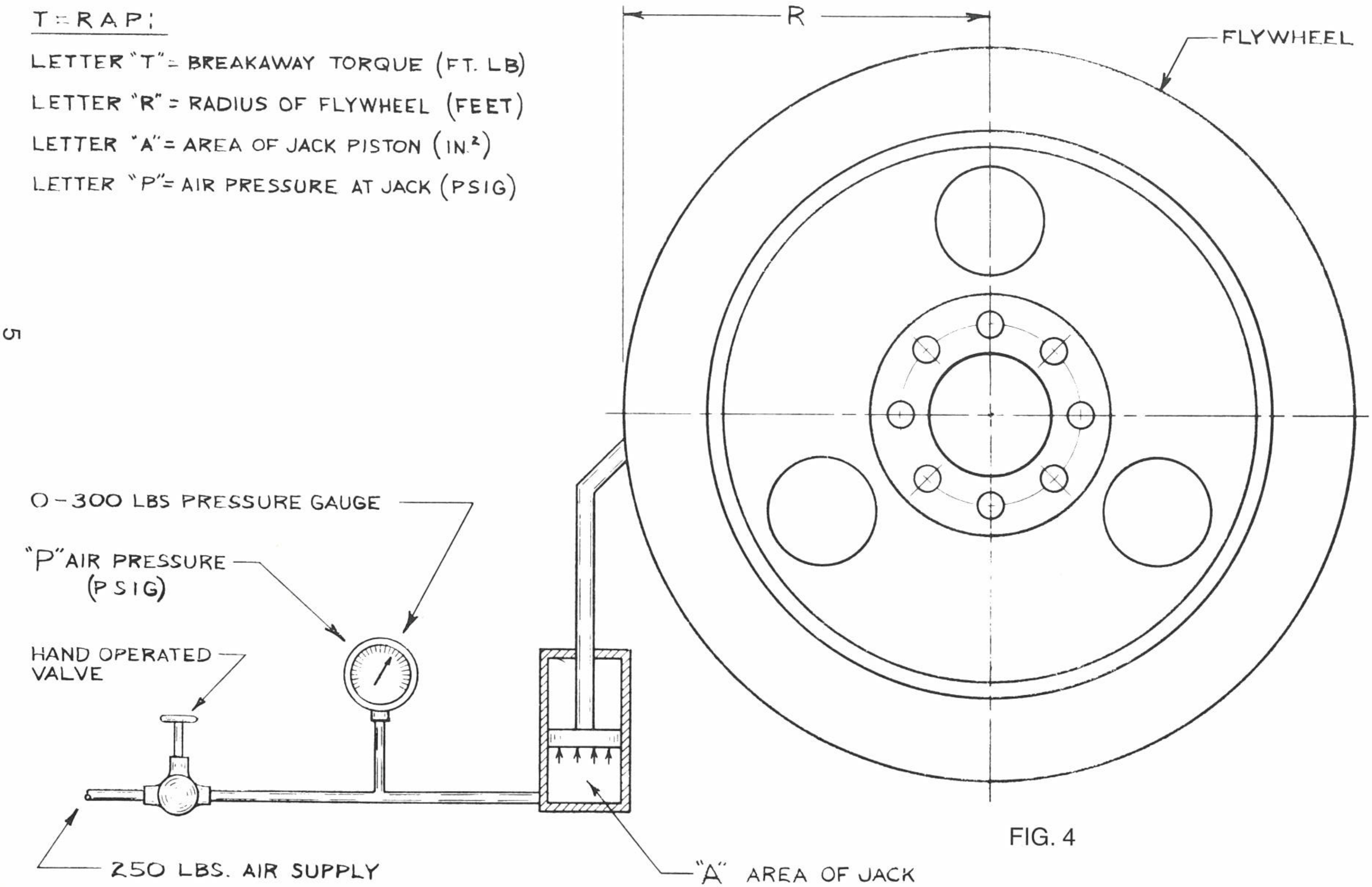
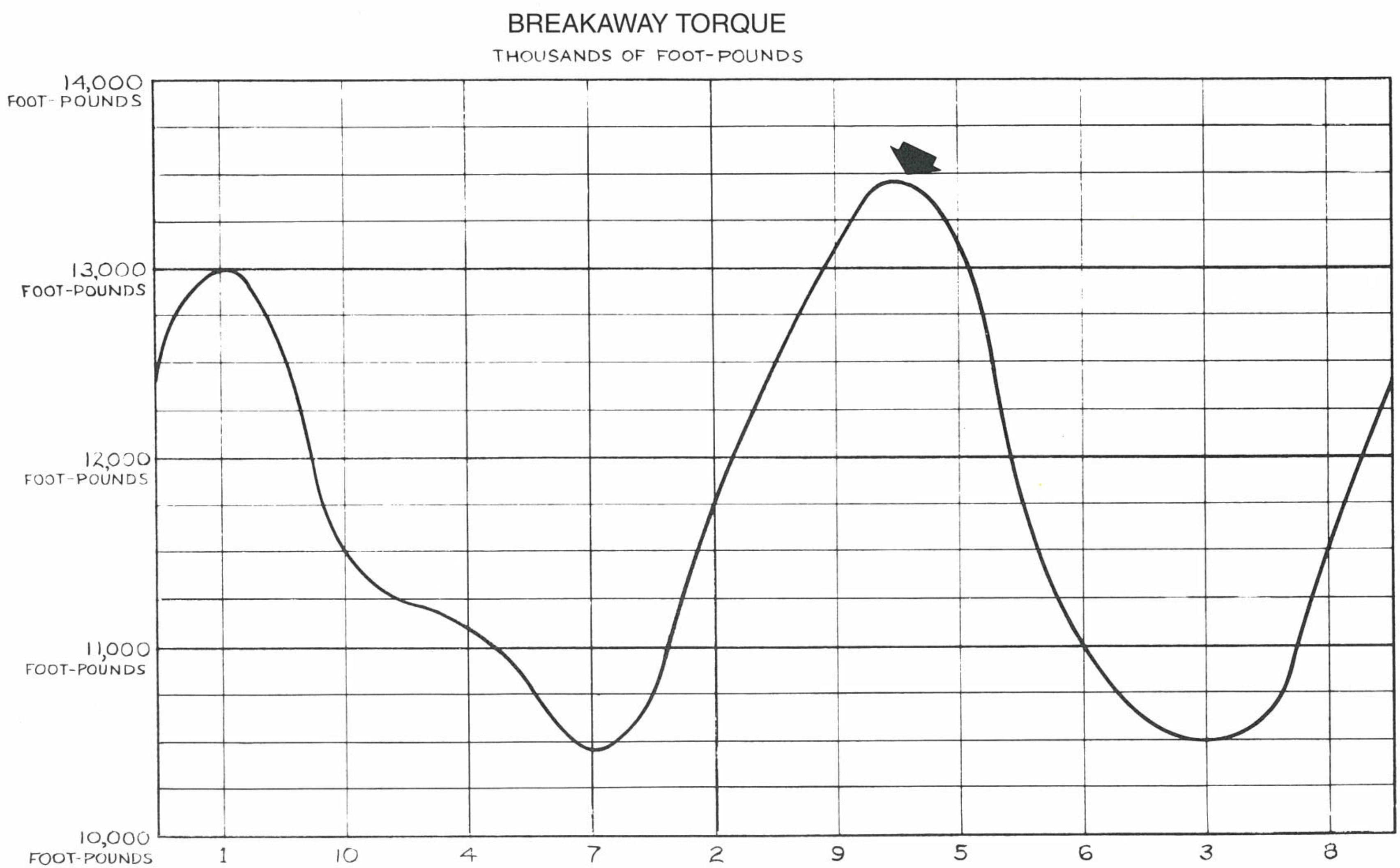


FIG. 4



TYPICAL TEN CYLINDER ENGINE WITH FOUR ANGLE MOUNTED COMPRESSORS PRESSURED TO 800 PSIG.

FIG. 5

RETARDED AIR START INJECTION
HIGH TORQUE
NO DEAD SPOTS

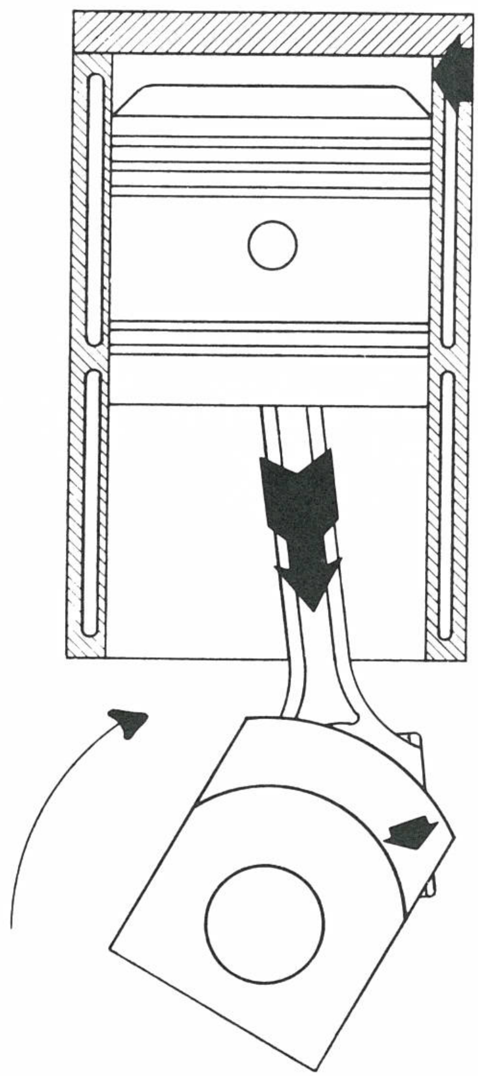


FIG. 6

TORQUE PRODUCED BY ONE 16 INCH CYLINDER AS A FUNCTION OF STARTING AIR PRESSURE AND TIMING

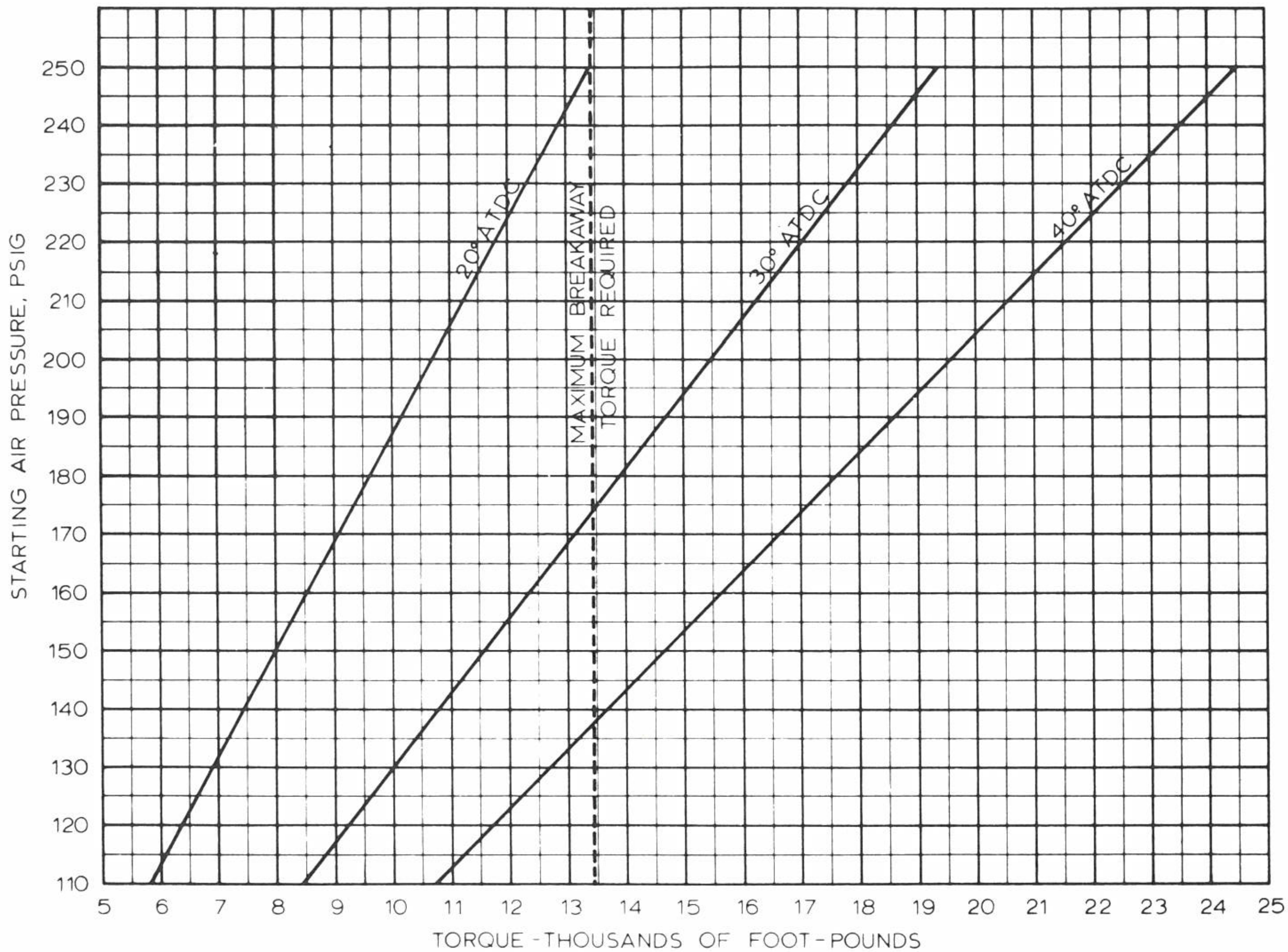


FIG. 7

The center diagonal line represents air injection at 30 degrees after top dead center. Notice that the diagonal line crosses the dotted line at approximately 175-psig starting air pressure.

Injection at this point would ensure a crankshaft "breakaway" roll for engine startup with as low as 175-psig starting air.

Continuing these projections, observe where the right-hand diagonal line that represents starting air injection at 40 degrees after top dead center crosses the dotted line. Maximum breakaway torque with as low as 140-psig starting air pressure is achieved. This late air injection gives reliability for rotating the crankshaft at startup; but due to the large volume of compressed air that would be consumed it is not feasible to consider this configuration. Also, cranking rpm would be greatly diminished.

This information shows the solution to obtaining maximum "breakaway" torque is starting air injection after top dead center (Fig. 8-B). But, as stated in the preceding paragraph, late air injection consumes large quantities of starting air and Continued use of starting air in this mode would not be practical or economical.

However, referring to Fig. 8-A, we know the most economical use of starting air, once the crankshaft has started turning, is near top dead center injection of starting air.

Since "after top dead center" and "top dead center" air injection is beneficial in certain phases of the starting cycle (Fig. 8-A and Fig. 8-B), both are incorporated in the design of the Exline variable injection air start distributor.

With the variable injection distributor control, Exline is able to use after top dead center air injection to achieve a "reliable" - "high torque" - "no dead spot" crankshaft breakaway roll. As soon as the crankshaft is turning the air injection point is changed to a near top dead center position which gives maximum crankshaft rpm and more economical use of the starting air.

The Exline air start distributor, featuring variable injection control, is designed to replace the original equipment distributor on large stationary engines. It is driven by the camshaft and mounted to the engine main frame with a special mounting adaptor plate
which is designed to let the distributor housing be rotated from one air injection point to another, relative to the crank angle of the crankshaft. An air cylinder that pushes or pulls an arm attached to the distributor shaft housing rotates the housing.

Because the distributor housing is designed to rotate, flexible pneumatic tubing is used from the distributor to the existing tubing that carries the pneumatic signal to each starting air check valve.

Exline air start distributors are custom-manufactured for each engine that is started with an air injection starting system.

ADVANCE AIR START INJECTION
HIGH EFFICIENCY
MAXIUM R.P.M.

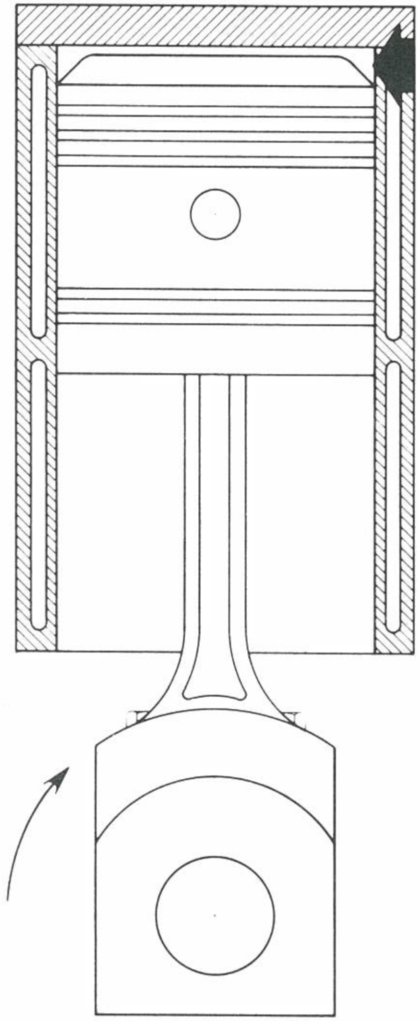


FIG.8A

RETARDED AIR START INJECTION
HIGH TORQUE
NO DEAD SPOTS

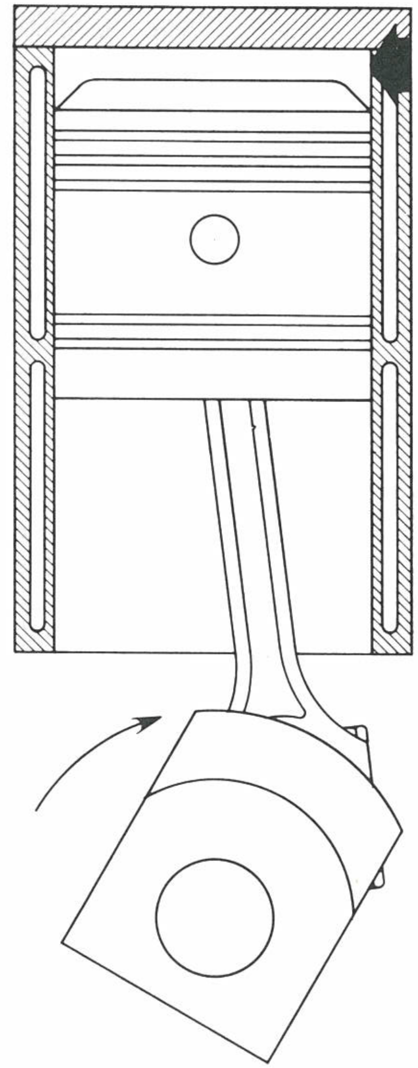


FIG.8B

Distributor cams within the distributor housings are specially designed for the correct timing of the radially positioned poppet valves located in the valve housings. The poppet valves are positioned to coincide exactly with the firing angles of the engine on which it is being installed.

Referring to the cutaway illustration in Fig. 9, we can point out the components that make up the Exline air start distributors. Starting with the lower right reference arrow and moving CCW we see first the camshaft, next the shaft housing, next the valve housings, and finally the front cover.

In Fig. 10, starting with the lower right reference arrow and moving CW, we see first, the camshaft ball bearing. While there is only one shown, there are two bearings used in the shaft housing to support the camshaft. Next, we see the cam itself. Note that it has two cam lobes. This is because the illustration we are using consists of two valve housings. The next arrow points to the adjustable length push rod. Note the coil spring installed below the hex portion of the push rod and the valve housing. The final components are the sliding vent valve, the poppet valve, and the valve cap.

In Fig. 11, one push rod and valve assembly is in contact with the lobe of the cam. The other push rods and valve assemblies (not shown) are positioned inward, toward the camshaft in the closed position. They are held in the closed position by the starting air pressure, which has been admitted into the distributor housing at the beginning of the starting sequence. That one valve is held off its valve seat by the cam, as illustrated by the arrows, indicating upper or outward movement. It has also moved the sliding vent valve to a closed position. Starting air pressure that has been admitted into the distributor, indicated by the arrows in Fig. 12, flows past the valve, through the air passages in the valve housings, and out from the distributor through the front cover discharge ports. This starting air signal continues on, through the tubing to the air start check valve located on the power cylinder.

Refer to the valve housing and push rod in Fig. 13. Note the cam has rotated to a position where the poppet valve has closed on its seat and the push rod is off-cam. Closing off the supply pressure has stopped the pneumatic signal to the cylinder. Air pressure still remaining in the check valve air chamber and the pneumatic lines must be vented before the check valve on the cylinder will close.

Venting occurs as the push rod falls off-cam and the sliding vent valve moves down the stem of the poppet valve and the valve guide in the valve housing. Use Fig. 14 and follow the arrows that indicate the vent flow path. From top left, the cylinder check valve's air pressure, reversing itself, flows back through the front cover outlet ports and back through the area under the closed poppet valve. The next arrow indicates the sliding vent valve, having been forced down by starting air supply, allows the continued flow of pressure to continue out through the push rod chamber and vent to atmosphere through the exhaust port, indicated by the third arrow, in the front cover. The venting to atmosphere of the cylinder check valve air allows the cylinder check valve to close and stop the flow of starting air into the power cylinders.

VALVE AND SHAFT HOUSING CUTAWAY

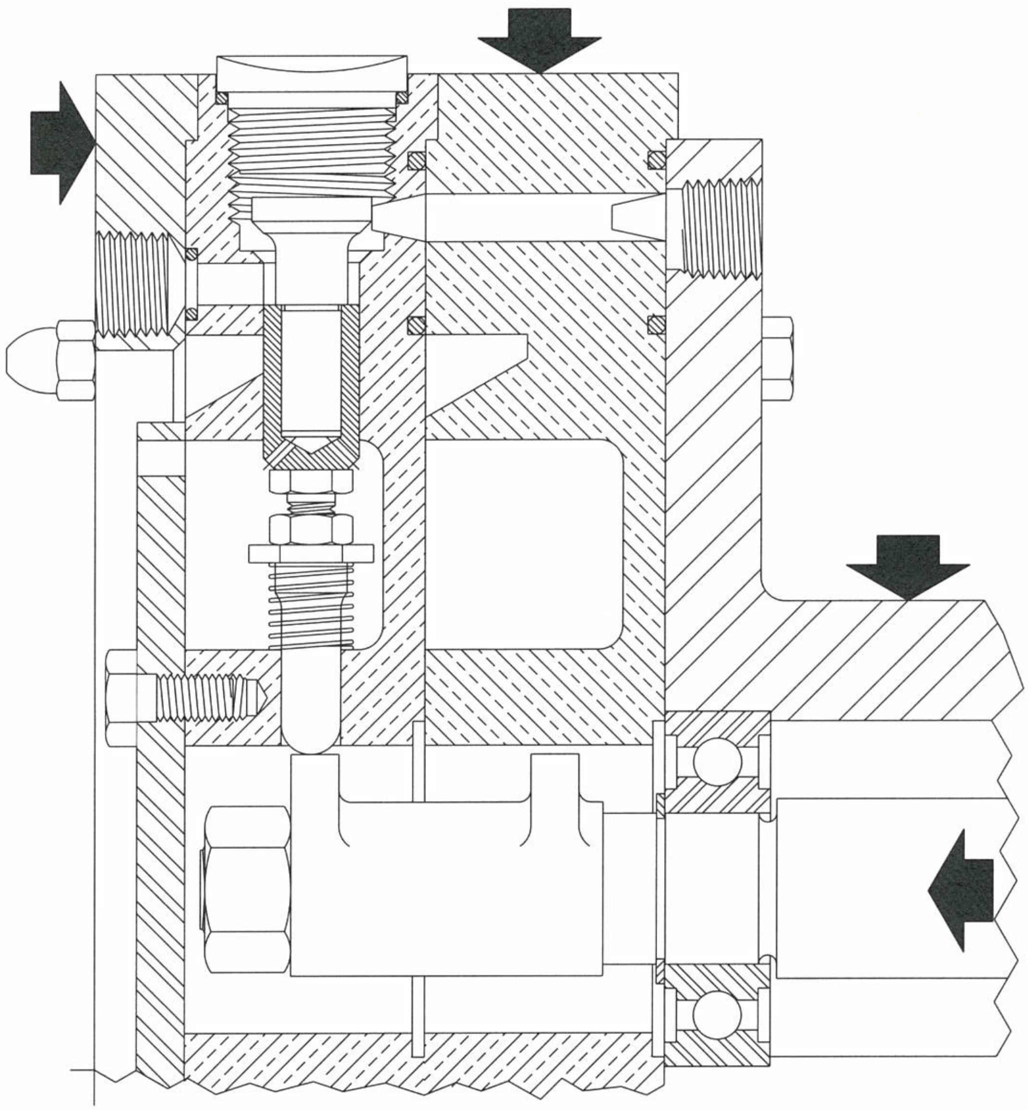


FIG. 9

VALVE AND SHAFT HOUSING CUTAWAY

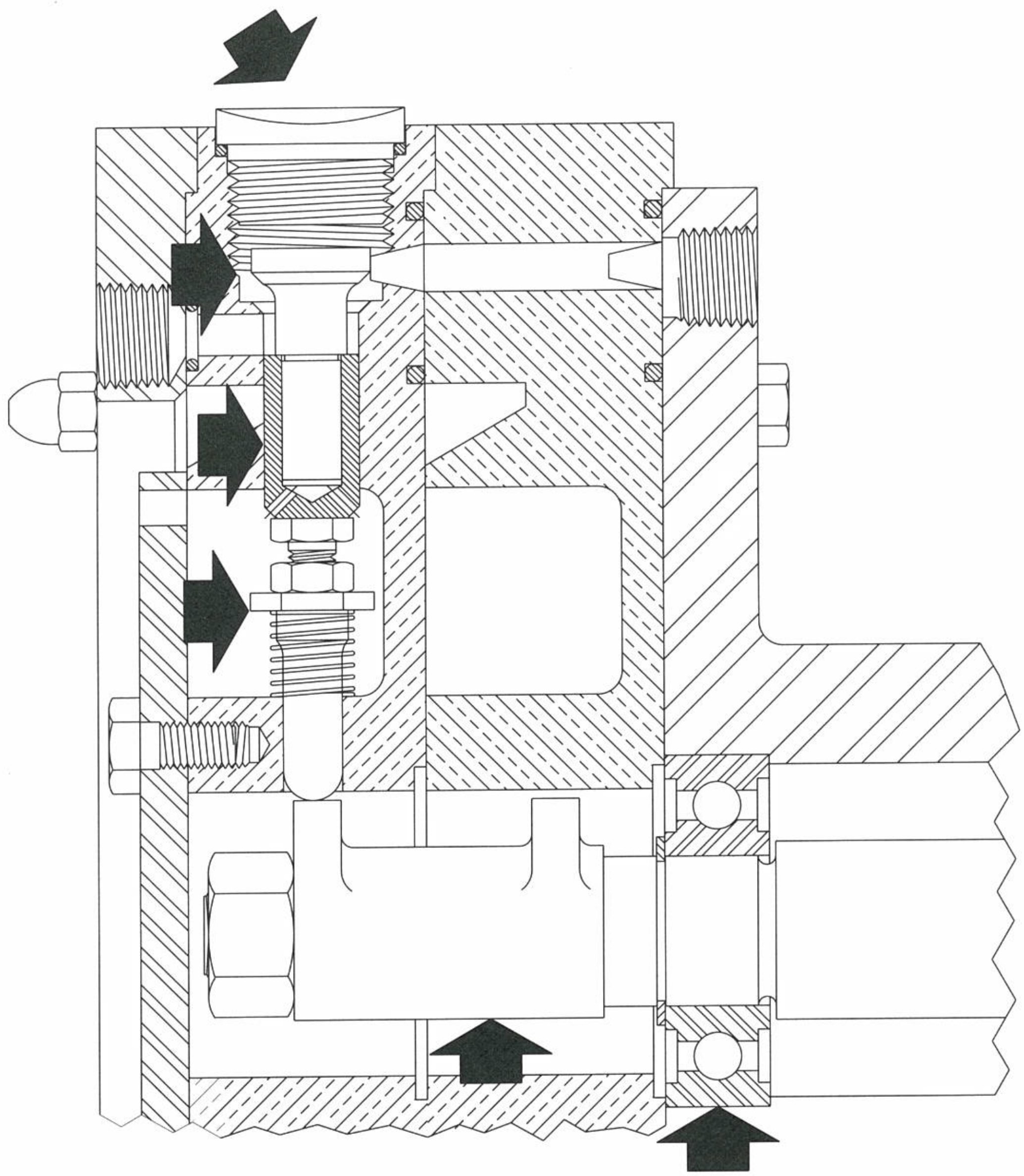


FIG. 10

VALVE AND SHAFT HOUSING CUTAWAY

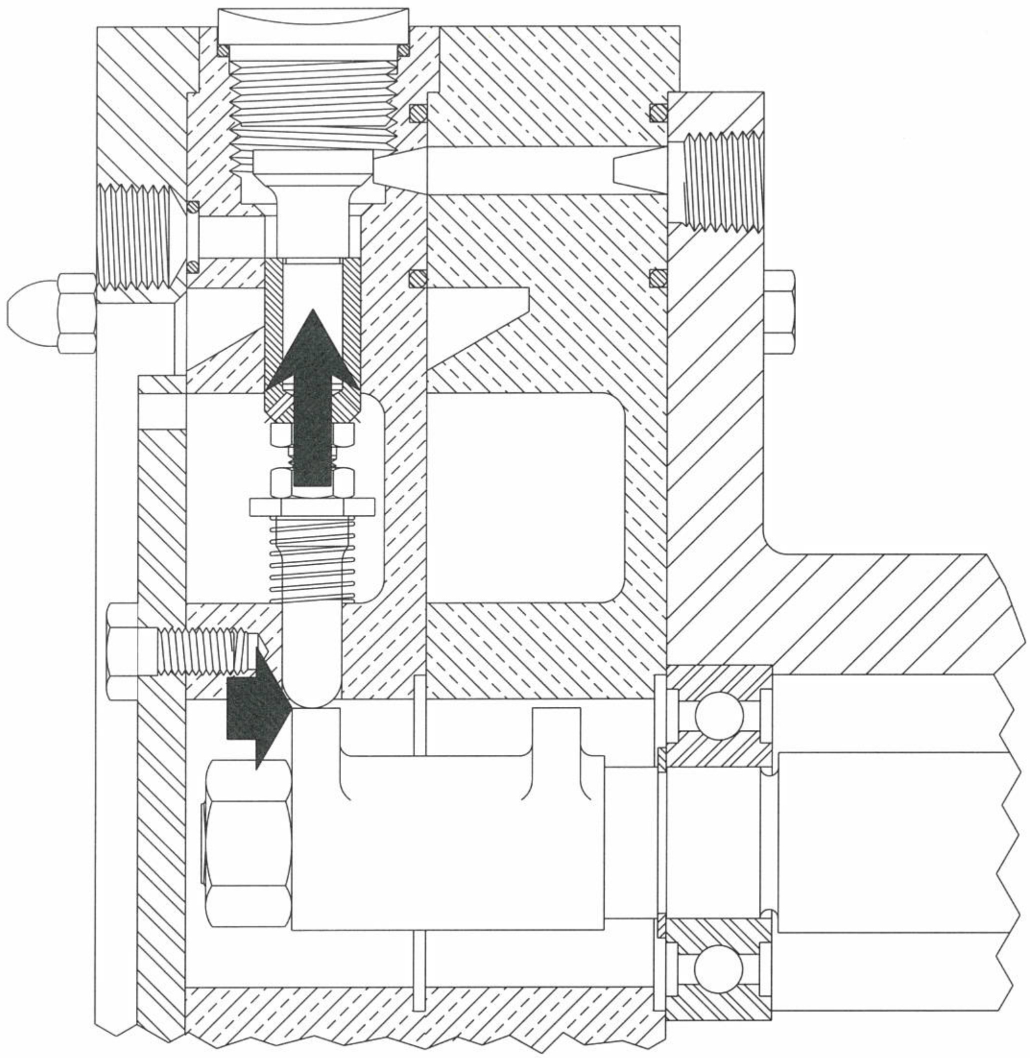


FIG. 11

VALVE AND SHAFT HOUSING CUTAWAY

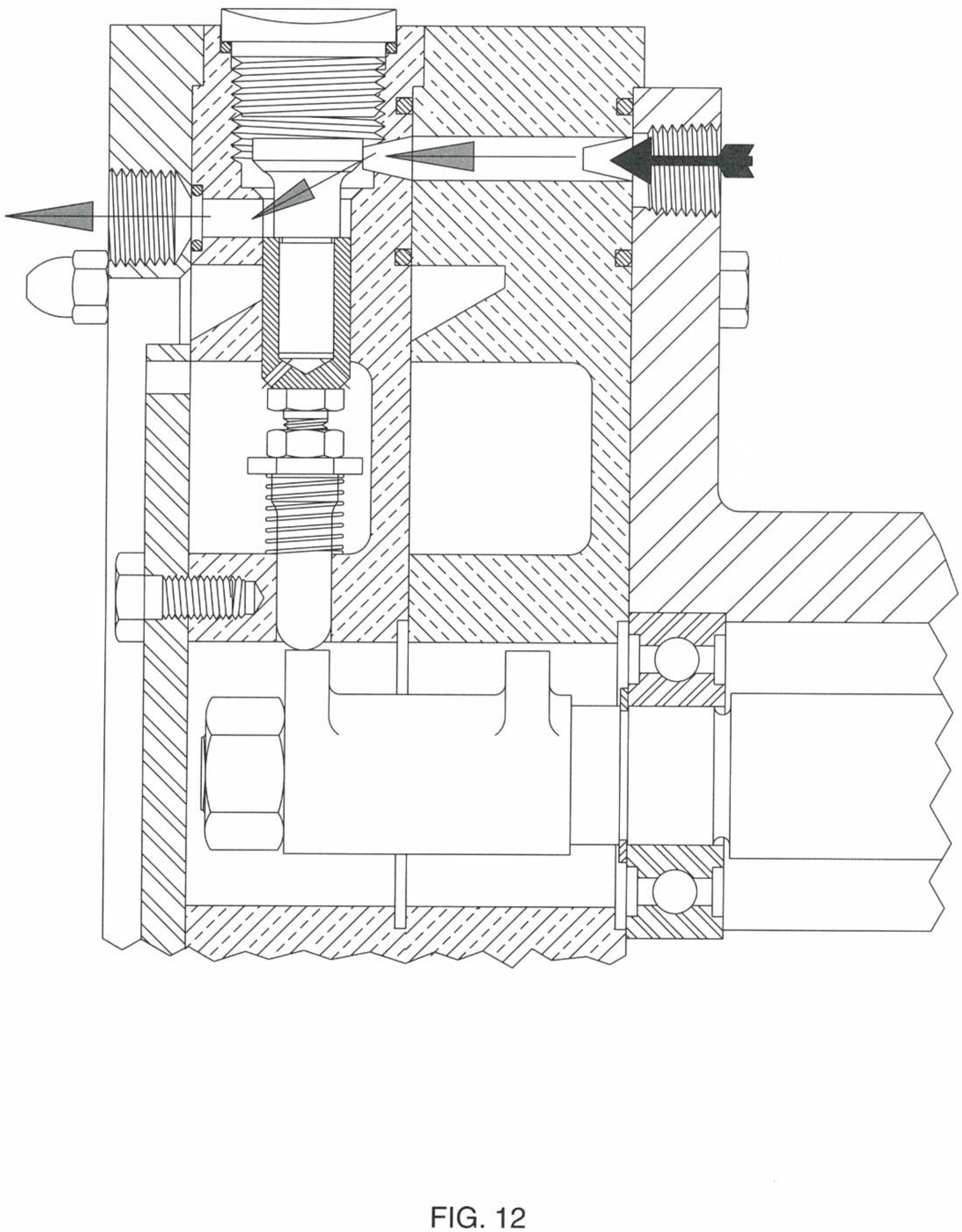


FIG. 12

POPPET VALVE CLOSED
VENT VALVE OPEN

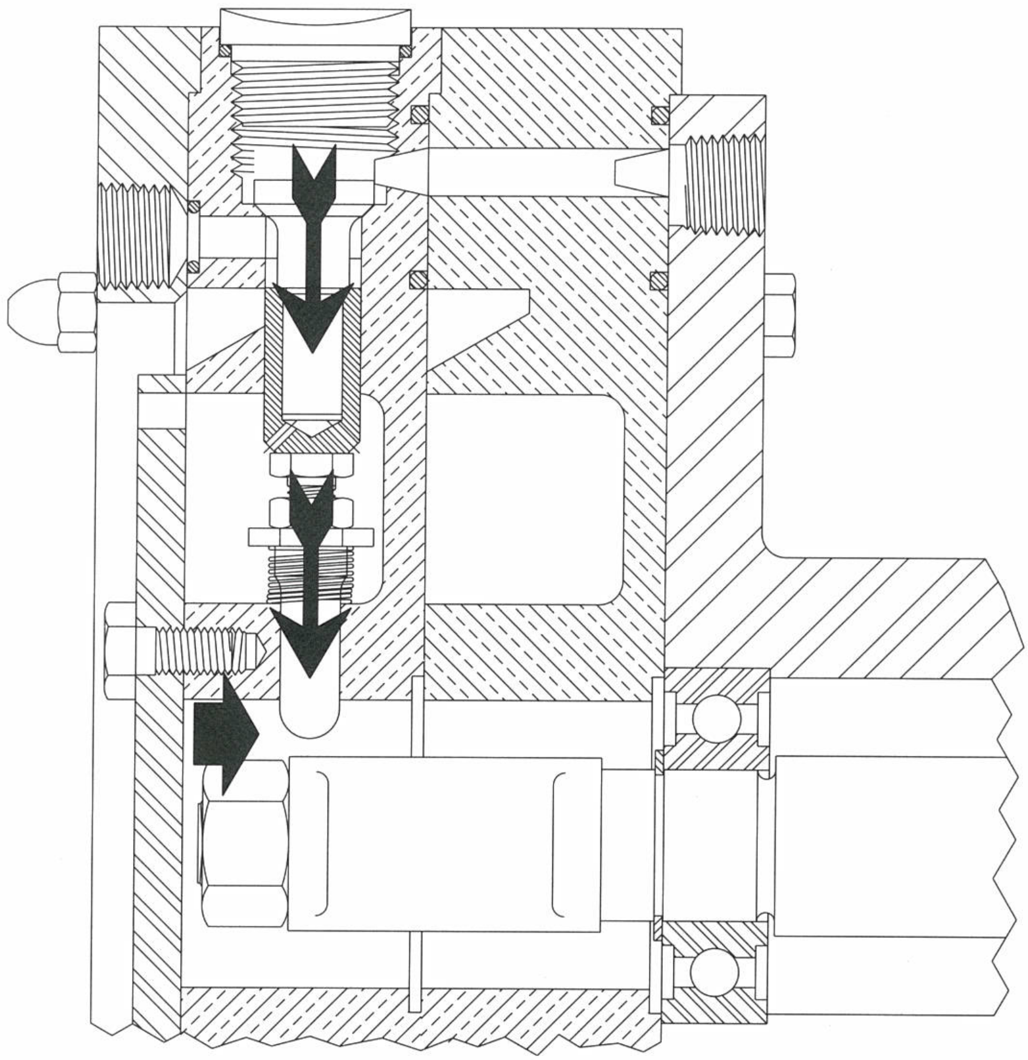


FIG. 13

POPPET VALVE CLOSED
VENT VALVE OPEN

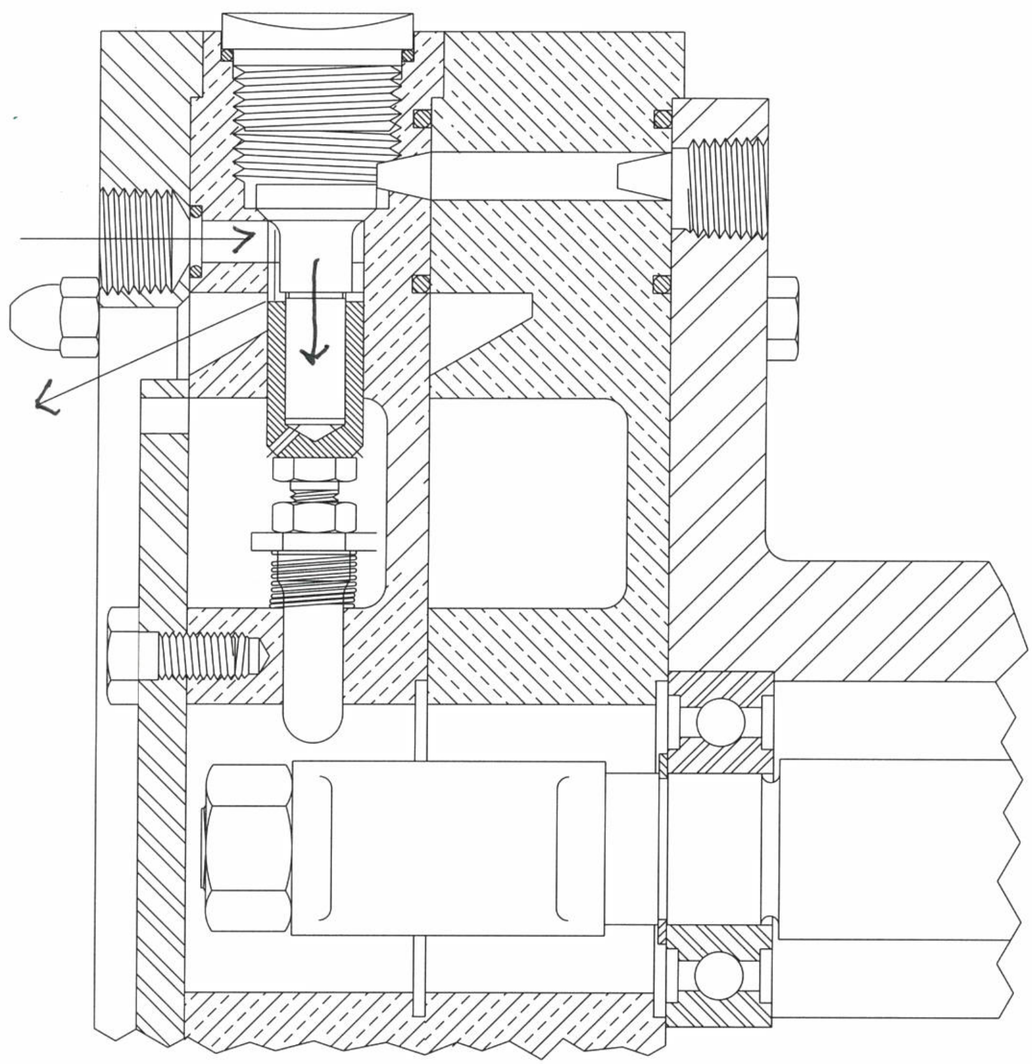


FIG. 14

The arrow on the right side of the valve and push rod points out the venting passage from the rear valve housing, when the second housing is used.

Some additional design features that are unique to the Exline air start distributor will be covered as we continue.

Fig. 15-A is a view of the valve housing assembly with the front cover removed. It shows the push rod assemblies in the "engine start sequence" when the air start signal is applied. All push rods have been forced inward by the starting air pressure on the poppet valves. The small push rod springs are shown compressed by this inward pressure.

As long as the engine is being cranked or started, the valves, push rods, and springs remain in this configuration ... each one is raised and lowered by the rotating cam.

The air start signal is discontinued as soon as the engine starts and is running. As a result, the push rod springs force the push rods outward and no contact is made with the cam. This is illustrated in Fig.15-B.

This means there is no wear within the distributor valve housings while the engine is operating and the valves and push rods are off the cam when the engine is not running.

Another design feature of the Exline distributor is the adjustable pilot valve and vent valve timing arrangement as illustrated in Fig. 16. Adjustments with the adjustable push rods in the distributor valve housing are made to control the check valve opening and closing. This feature permits a positive and controlled overlap of valve dwell to ensure the opening of the next valve in the firing order before the preceding one closes.

The design of the Exline Air Start Distributor, with its valve adjusting features, eliminates any distributor "dead spots" which ensures the reliability required for automated site installations.

Earlier in this presentation we referred to the Exline distributor as having variable starting air injection control. As shown in Figs.17 and 19, this is accomplished by rotating the distributor with a lever attached to the shaft housing with an air cylinder attached to the lever.

The rotation control can be obtained pneumatically, from either of two systems, speed sensing (Fig. 17) or time delay (Fig. 19), depending on what is available from the control system installed on the engine.

The speed-sensing system consists of the following components:

1. Distributor control valve and filter
2. Amplifying relay
3. Adjustable precision relay
4. Distributor control cylinder
5. Pressure regulator for a constant air supply

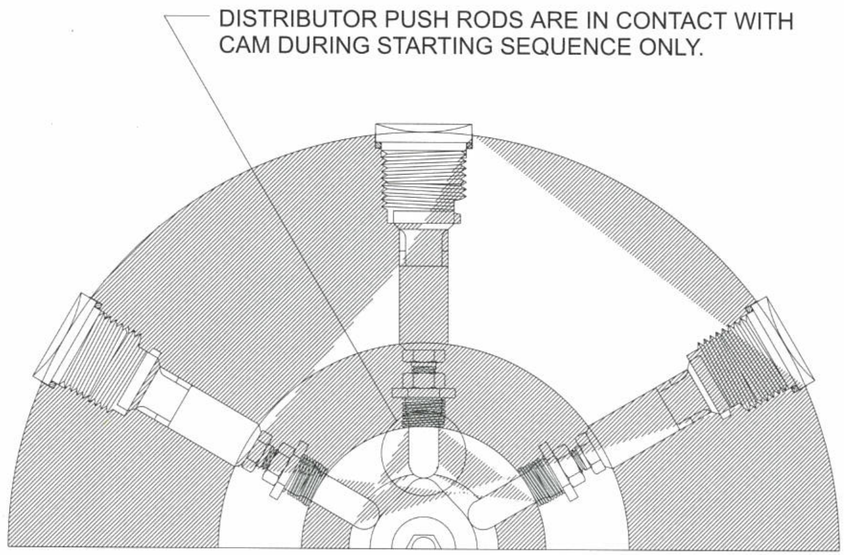


FIG.15A

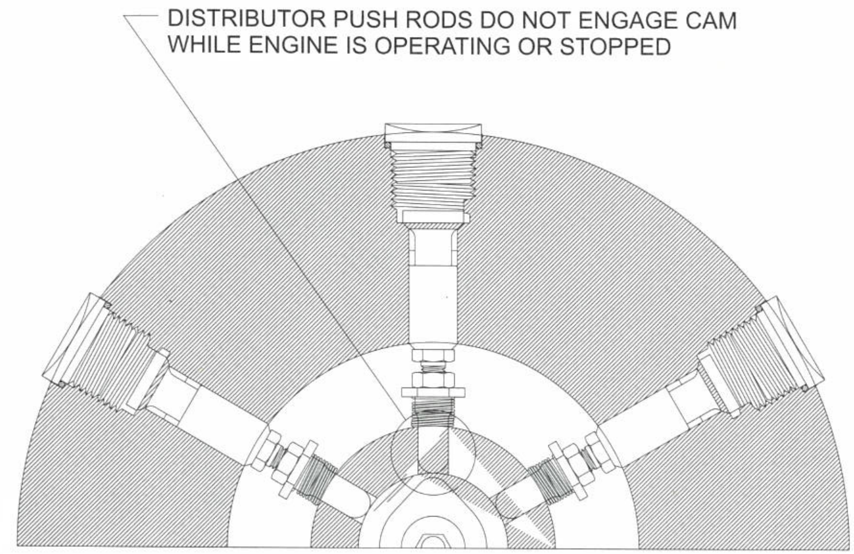


FIG.15B

PILOT VALVE
VENT VALVE TIMING ARRANGEMENT

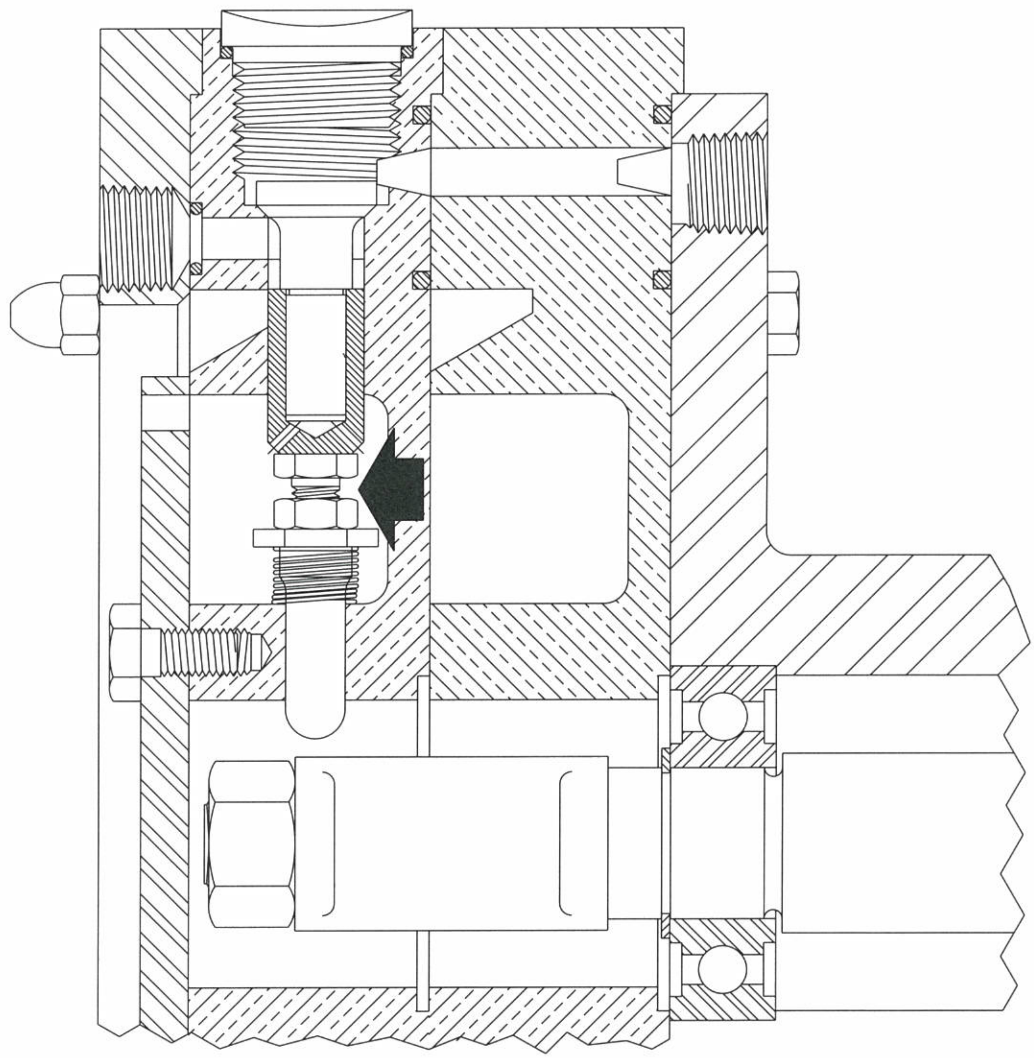


FIG. 16

AIR START DISTRIBUTOR SPEED SENSING SYSTEM

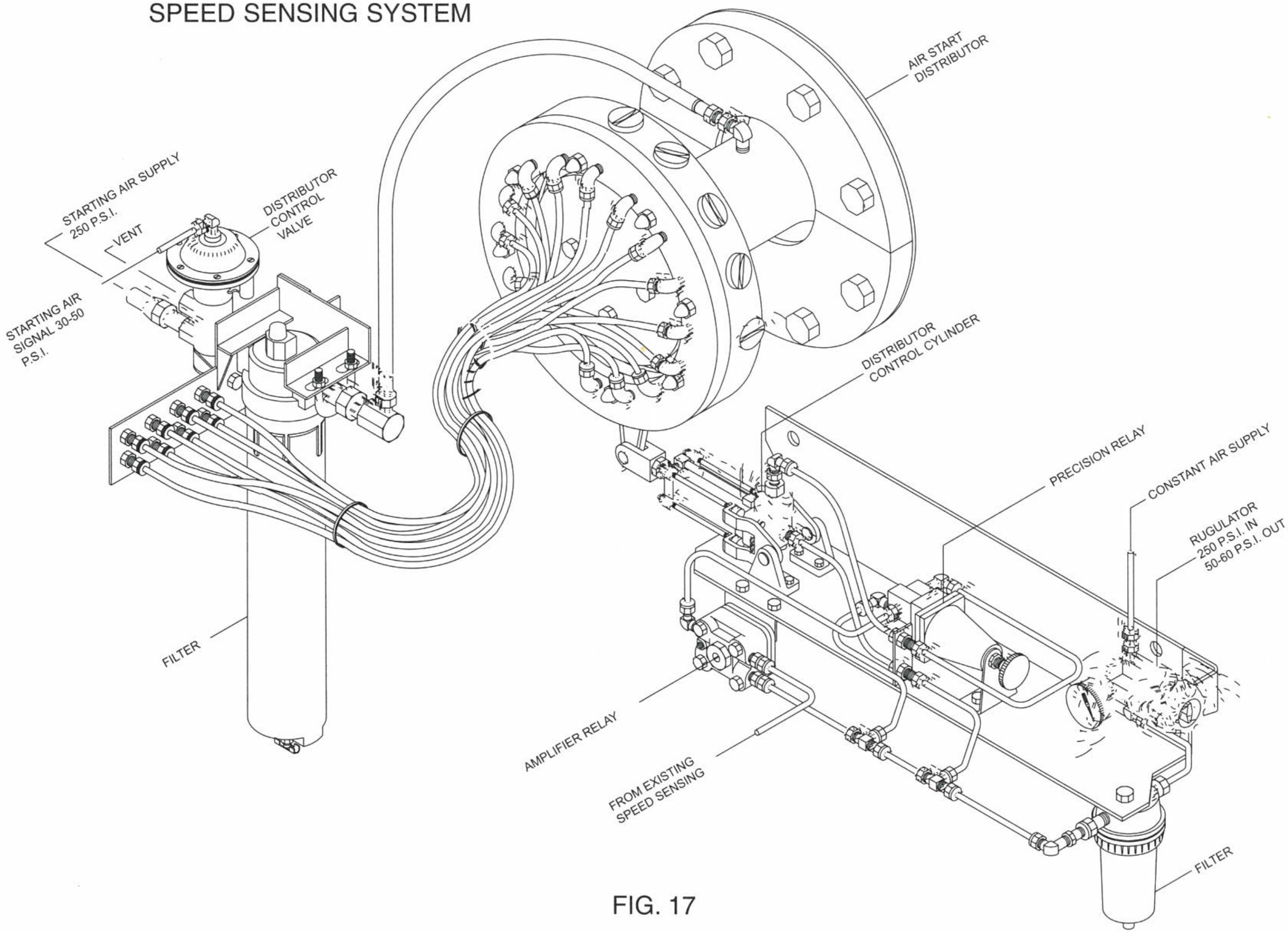


FIG. 17

Refer to the speed sensing schematic, Fig. 18. The sequence of events begins when starting air pressure is admitted into the distributor. The distributor is set in a retarded position. All air start distributor pilot valves are closed except the one held open by the distributor's camshaft. The valve held open by the distributor camshaft sends a signal to a starting air check valve on the cylinder, and the crankshaft begins its "breakaway" roll.

Existing pneumatic speed sensing equipment on the engine yields an output signal pressure of 3-psi at 0 rpm and 3.75-psi at 20 rpm. Distributor advancement occurs at 20 rpm. Because of the.75-psi pressure range and a constant psi at 0 rpm, a 3:1 ratio relay is used to provide a dependable control point. The working control pressure range is increased to 9-psi at 0 rpm (retarded) to 11.25 psi at 20 rpm (advanced). The adjustable precision relay opens at 11.25-psi and sends a pneumatic signal to the distributor control cylinder that rotates the distributor to the advanced position. This completes the starting sequence.

Upon completion of the starting sequence, loss of the start signal to the distributor control valve stops the flow of starting air to the distributor. All pilot valves close and no longer contact with the distributor cam. The distributor does not rotate back to the retarded position until the engine is shut down or the crankshaft rpm slows to less than 20 rpm, when loss of the speed-sensing signal to the control cylinder occurs.

The second control system is referred to as "time delay."

The time delay system consists of the following components:

1. Distributor control valve and filter
2. Time-delay cylinder control
4. Distributor control cylinder
5. Pressure regulator for a constant air supply

Refer to the time delay schematic, Fig. 20. The sequence of events begins when starting air pressure is admitted into the distributor through the control valve and filter. The distributor is set in a retarded position. All air start distributor pilot valves are closed except the one held open by the distributor's camshaft. The valve held open by the distributor camshaft sends a signal to a starting air check valve on the cylinder, and the crankshaft begins its "breakaway" roll.

Starting air supply is reduced to 40 - 50 psi through another regulator and sent to an adjustable time-delay cylinder control valve. After a predetermined time lapse, a signal from the time-delay control valve activates the distributor control cylinder, which rotates the distributor from the retarded position to the advanced position. This completes the air start sequence.

Upon completion of the air start sequence, loss of the start signal to the distributor control valve stops the flow of starting air to the distributor and to the time-delay valve in the control system. All pilot valves open and no longer contact with the distributor cam. The distributor then rotates back to the retarded position for the next start sequence.

AIR START DISTRIBUTOR SPEED SENSING SCHEMATIC

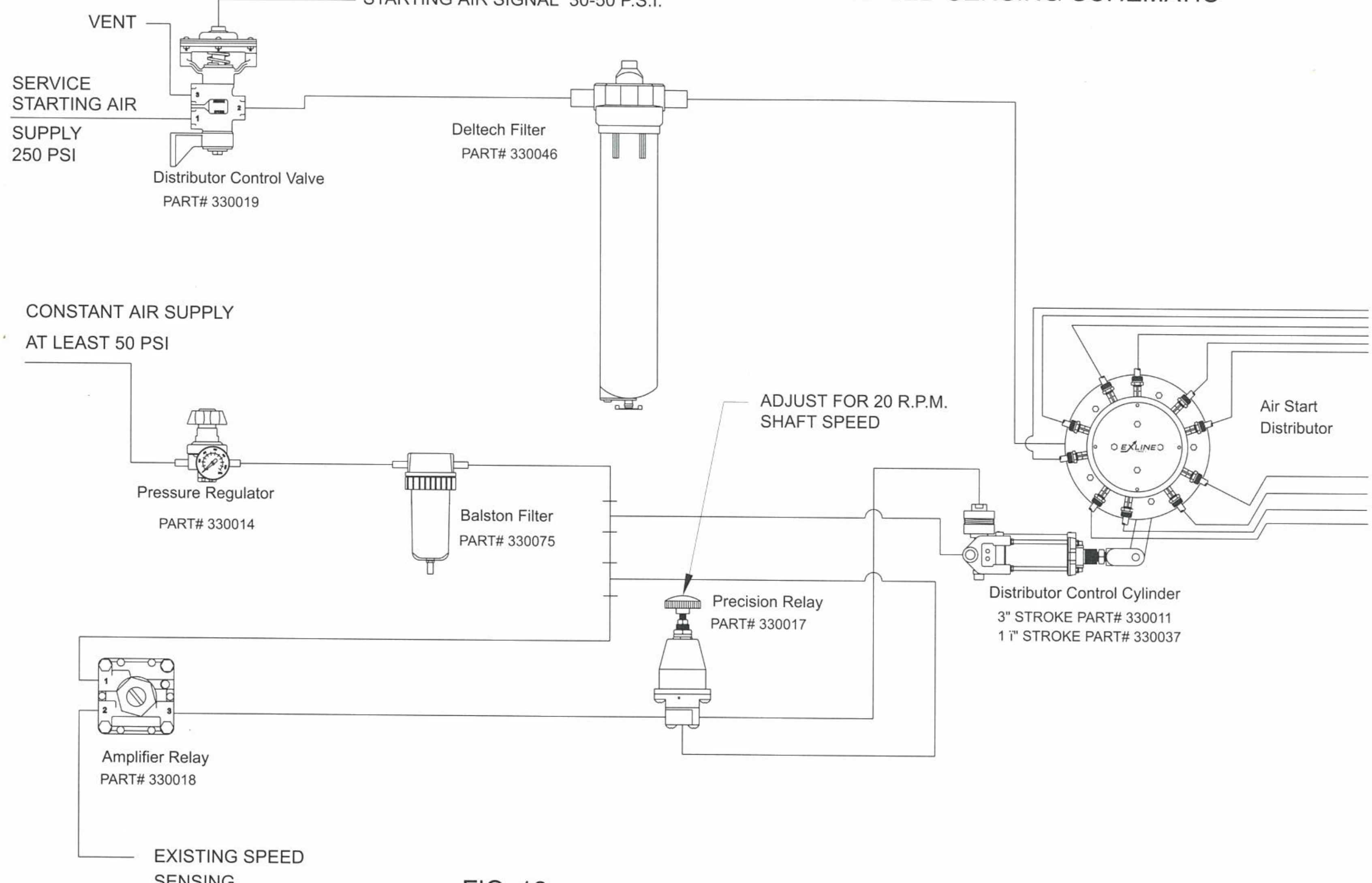


FIG. 18

AIR START DISTRIBUTOR TIME DELAY SYSTEM

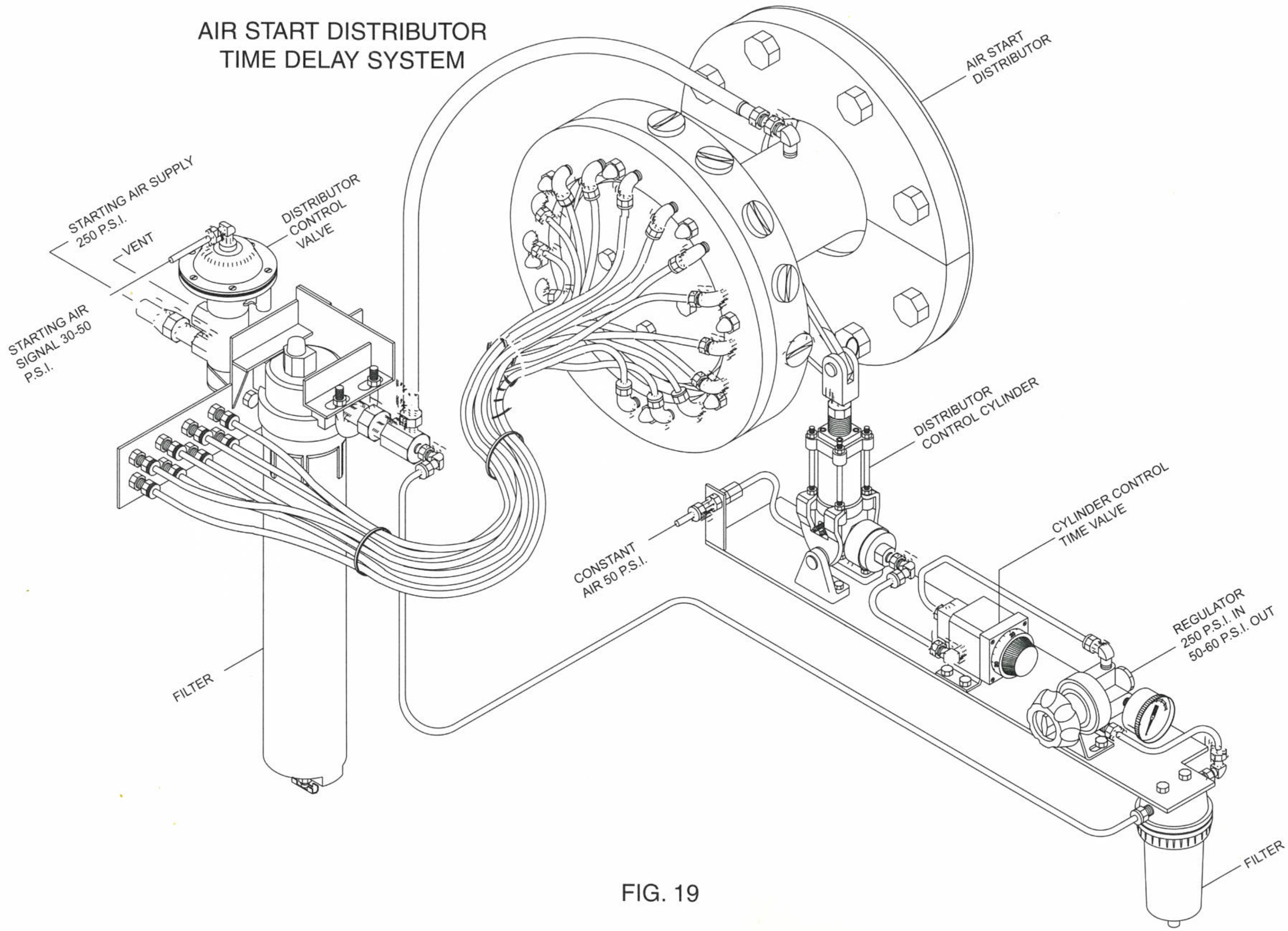


FIG. 19

AIR START DISTRIBUTOR TIME DELAY SCHEMATIC

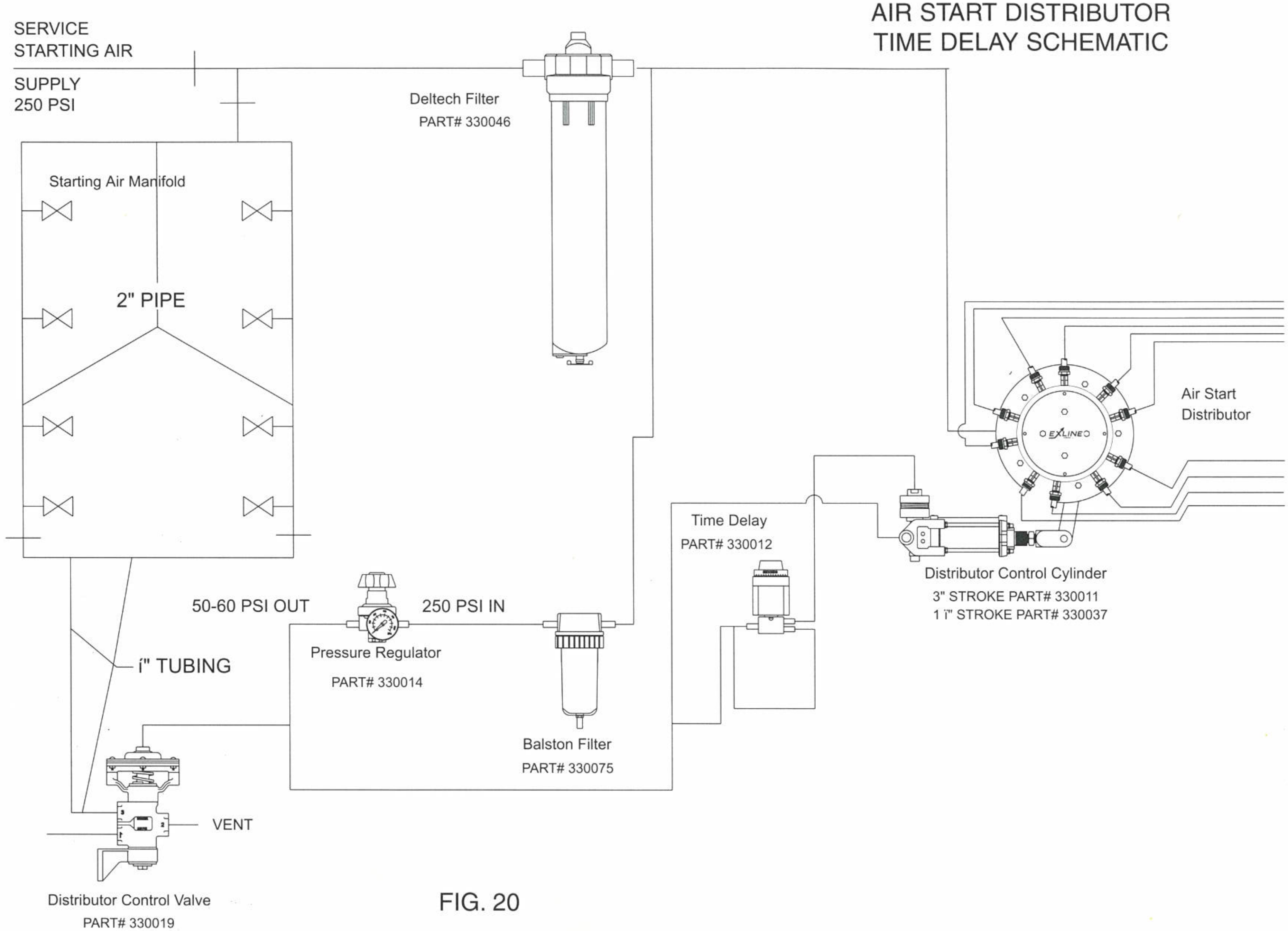


FIG. 20

AIR START DISTRIBUTOR TIME DELAY SCHEMATIC

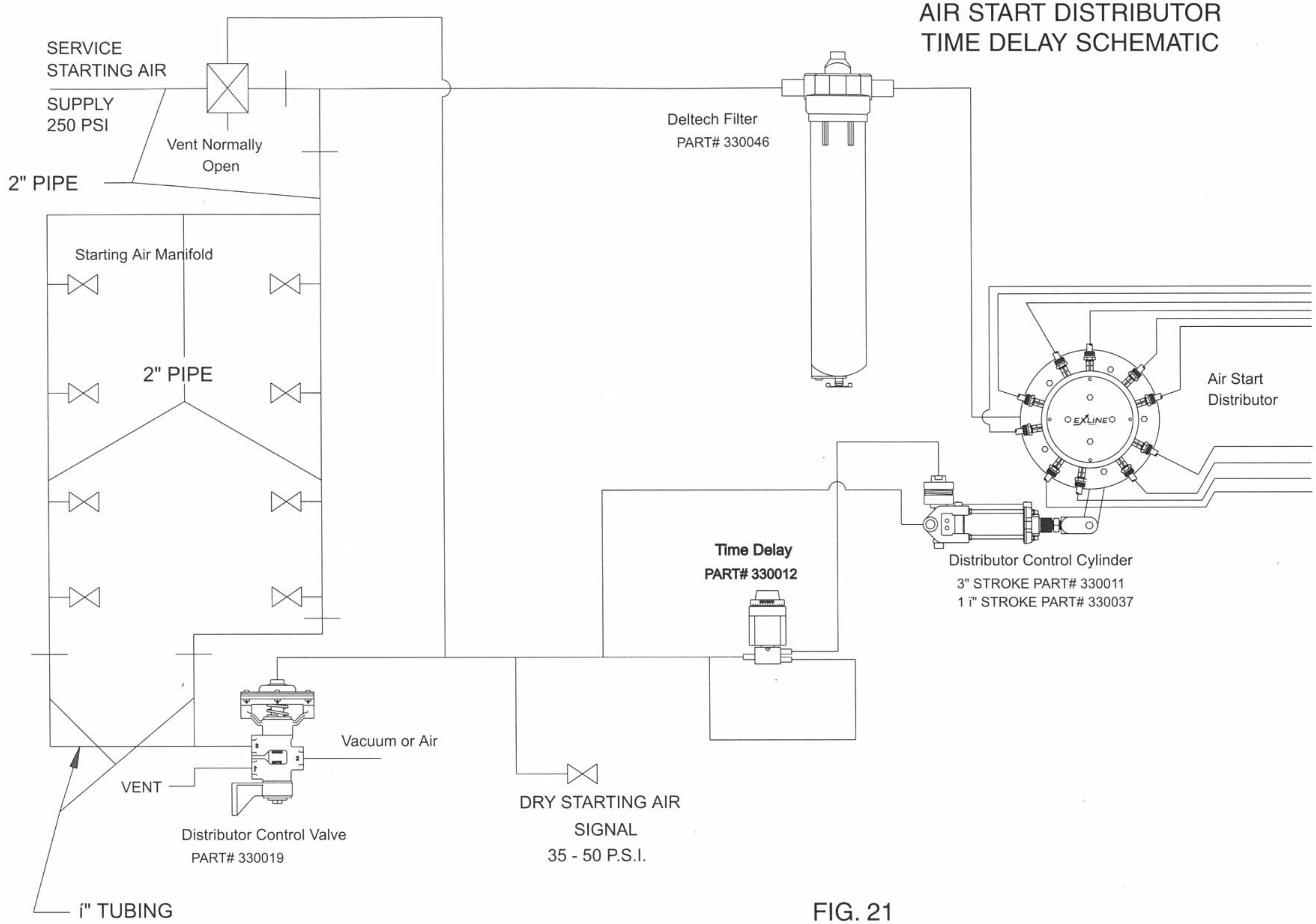


FIG. 21

DETAILS OF INSTALLATION

The Exline air start distributors are installed on engines equipped with pneumatically controlled air start check valves located on the power cylinder heads (on some engines not so equipped, pneumatic control valves are available).

The Exline air start distributor replaces the original equipment air start distributor that is driven by the end of the engine camshaft. As illustrated in the accompanying drawings, flexible tubing from the distributor is connected either to the *pneumatic terminal bracket, where used, or directly to the existing airlines. Universal brackets and tubing are supplied, but some field fabrication may be needed under certain circumstances.

Distributor variable injection may be controlled in one of two ways, by time delay or speed sensing. Time delay is used on engines without any speed sensing equipment and is the most commonly used system. Components required are shown on the enclosed drawing titled "Time Delay Schematic." Speed sensing delay uses a pneumatic signal generated by the present speed sensing equipment already installed on the engine. Components required are shown on the enclosed drawing titled "Speed Sensing Schematic."

*Pneumatic terminal bracket may not be applicable in some installations.

INSTALLATION PROCEDURE

1. Rotate crankshaft to top dead center position for the Number 1 cylinder in the firing order.
2. Remove the existing air distributor.
3. Observe, and make a notation, of cam lobe location. Indicate with a punch mark on the end of the camshaft adaptor, both sides of the coupling, and the distributor camshaft. Place the Exline air start distributor in position, using the replacement coupling (supplied if required), and note the position of the cam.
4. With the mounting ring provided, attach the air start distributor to the engine with existing or replacement cap screws.
5. Install the *pneumatic terminal bracket with the control valve and filter attached.
6. Connect the existing airlines from the air start check valves to the backside of the *terminal bracket and identify each line by its cylinder number and location.
7. Install the distributor control cylinder and anchor bracket.
8. Loosen the clamp bolts on the lever arm assembly.
9. Attach a service airline to an air supply port downstream from the starting air valve. For testing and timing, disconnect the flexible hose from the air distributor filter and adapt this hose to any tool air hose with 90-psi working pressure.
10. Extend and retract the air cylinder shaft. Attach the distributor control arm to the cylinder shaft with the air start distributor in the full advanced position.
11. Locate the airline fitting that supplies an air signal to the Number 1 cylinder check valve in the firing order on the front cover of the distributor.
12. Turn on the service air line. Rotate the distributor housing to allow a small flow of air through the Number 1 fitting. (THE DISTRIBUTOR HOUSING ROTATION MUST BE TOWARD THE NOSE OF THE DISTRIBUTOR CAM. THIS ROTATION IS THE OPPOSITE DIRECTION OF THE CAMSHAFT ROTATION.)
13. With the distributor in the FULL ADVANCED POSITION, tighten the lever arm clamp bolts.
14. Turn off service air supply and remove the hose. Install the starting air supply line from the distributor control valve to the air supply port.
15. A. IF USING A TIME-DELAY SYSTEM, adjust the time-delay valve for approximately 2 seconds. Connect the time-delay per the piping schematic. When constant air is connected and pressured up, the distributor will rotate to the retarded position.

B. IF THE SPEED SENSING SYSTEM IS INSTALLED, mount the speed signal amplifier and the precision relay in a suitable location, preferably in the control panel. Install the tubing according to the piping schematic. Adjust the relay to pass the pneumatic signal to the distributor control air cylinder at approximately 20-rpm crankshaft speed. Note: The distributor will remain in the advanced position until the crankshaft slows to less than approximately 20 rpm.

16. Install flexible 3/8" tubing from the air distributor to the *pneumatic terminal bracket. Starting with the Number 1 fitting on the front cover, proceed around the distributor in the same direction as the rotation of the camshaft. Follow the firing order sequence when connecting the tubing to the terminal bracket.

17. IMPORTANT: Check for any crimped, cracked, or broken places in the existing tubing. Also, correct any malfunction that may exist in the starting air check valves.
18. The Exline air start distributor is now ready for operation.

*Pneumatic terminal bracket may not be applicable in some installations.

DISASSEMBLY FOR SERVICE AND REPAIR

The following procedure should be used to remove the distributor from the engine for service, repair and adjustment, and re-installation.

IMPORTANT NOTE: An Exline dwell plate assembly is required for re-installation after disassembly.

1. Set the Number 1, in firing order, power piston to its top dead center.
2. Detach and identify all airlines from the distributor. Remove the clevis pin from the air cylinder control arm.
3. While holding the distributor in place, remove the mounting-ring bolts. Observe and make notation of the cam lobe position. Indicate this position with a punch mark on the end of the camshaft adaptor, both sides of the coupling and on the distributor camshaft.
4. Using the lower portion of the control arm, clamp securely in a bench vise (distributor shaft parallel to vise jaws). DO NOT loosen the control arm to distributor bolts.
5. After scribing a reference mark on the front cover and valve housing, remove the nuts located around the front cover from the bolts holding the front cover and the valve housing(s) in place.
6. Remove the front cover. (CAUTION: "O" rings are free to fall from valve housing.) Remove "O" rings from the air passages and from around the 1/4" retaining bolts.
7. Remove the valve housing(s), using caution in handling. The machined surfaces could be easily scratched or nicked, especially on rough bench tops. If the distributor has dual valve housings, remove the second housing (be sure to retain "O" rings).
8. Remove the 1/4" bolts from the shaft housing. Remove the shaft housing thrust washers.
9. Remove the cam-retaining nut from the camshaft. Remove the cam from the shaft and remove key from the keyway if necessary.
10. Remove the snap ring. If a press is available, remove the camshaft from the bearings. Remove the front and rear bearings from the shaft housing. If a press is not available, use a hammer and brass drift.
11. Remove the pilot valve cover caps from the valve housing.
12. Remove the pilot valves and sliding vent valves.
13. Loosen the lock nuts, and remove the tappet adjusting screws from the push rods. Remove the push rods and springs from the valve housing(s).
14. Remove the two (2) large-diameter "O" rings from the backside of the valve housing.
15. Using a good grade-cleaning agent, wash and clean all the distributor parts, and let air dry. (DO NOT wash ball bearings in cleaning solution.)
16. Blow out the valve and shaft housings with air. Using a soft, lint-free cloth, wipe and polish all stainless-steel valves and push rods. Inspect valve housing(s), valves, push rods, and valve guides before re-assembly.
17. Insert the push rods through the springs and into the push rod guides in the valve housing. Screw the tappet adjusting crews with lock nuts into the push rods.
18. Install the sliding vent valves and pilot valves into the valve guides of the valve housing.

NOTE: In the two preceding steps of the assembly, be certain all the push rods, vent valves, and pilot valves work freely in their guides. They are spring-loaded and should readily move to the open position when inward finger pressure is released.

19. Install the pilot valve caps with "O" rings attached.
20. Install the air distributor camshaft with ball bearings in the shaft housing and replace the snap ring.
21. With the key in place, install the cam on the camshaft.
22. Reinstall the two large "O" rings on the backside of the valve housing(s). Use a suitable cam lubricant on the cam lobe. Install the valve housing over the cam, and seat firmly against the shaft housing. Insert the 1/4" bolts from the back through the shaft housing into the valve housing.
23. Install the "O" rings around the 1/4" bolts, inserting them back into the valve housing counterbore. Install the "O" rings into the counterbore of each passage.
24. Install the dwell adjusting plate over the 1/4" bolts, and secure in place with 1/4" nuts. Tighten the pointer against the cam. The position of the pointer is not important. Turn all air cocks to the "off" position.
25. Attach service air to the inlet port of the shaft housing. With the air turned on, all valves will compress the push rod springs and be forced down on their valve seats, except the one held open by the cam lobe.
26. Determine the valve that is held open and open the air cock on the test ring. Air will be allowed to pass through.
27. Using a socket wrench on the pointer nut, rotate the cam slowly CW until air does not flow through the air cock. At this point, while holding the cam securely, refer to the 360-degree dwell adjusting plate and pointer. Take and record the reading. Rotate the cam CCW. Air will begin to flow through the air cock again. Continue cam rotation slowly until the airflow stops again. Again refer to the dwell plate and pointer. Record this reading. The difference in these readings is the dwell setting. Dwell adjustments are made with the tappet screw and lock nuts. Adjusting the adjusting screw outward (lengthen) increases the dwell reading. Adjusting the adjusting screw inward (shorten) decreases the dwell reading. Refer to the following example.
IMPORTANT: A minimum of 4∞ overlap between valves is required to eliminate distributor 'dead spots'.

EXAMPLE

4∞ Overlap

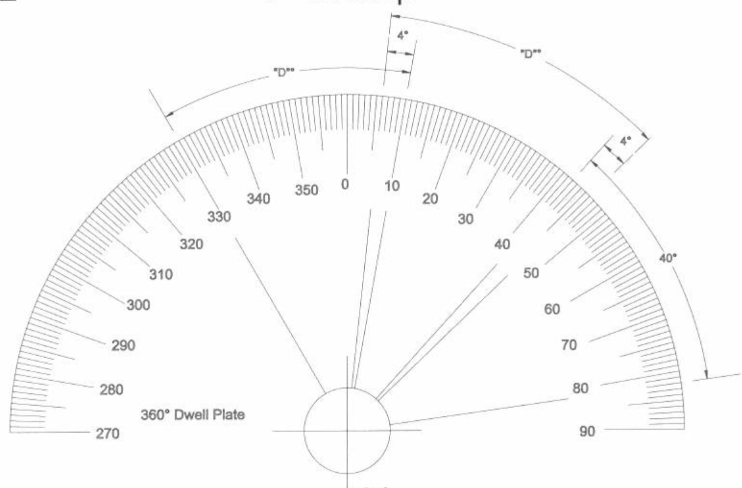


FIG. 22

28. Use this procedure to adjust the dwell on all valves in the valve housing. Dwell specification covering this distributor and engine installation is found with the specification sheet sent with the air start distributor.
29. If this distributor uses two valve housings, upon completion of the first valve housing dwell adjustment, remove the front test cover. Remove the 1/4" bolts and replace with longer 1/4" bolts. Use caution with the "O" rings when inserting bolts through the housing(s). Install large "O" rings on the backside of the second or front valve housing. Install the valve housing over the cam and in place against the back valve housing. Install "O" rings around the 1/4" bolts, inserting them into the counterbore. Install "O" rings in each air passage counterbore provided. Install the test cover and secure in place with 1/4" nuts. Repeat the procedure explained in steps 27 through 29.(When using two valve housings, overlap between valves may not exist. The overlap is introduced between the two valve housings.)
30. When the dwell adjustment is completed, open all air cocks. Rotate the cam with a socket wrench and check for air as the cam passes each air cock. The purpose of this check is to be sure that the preceding valve does not close until the next valve in the same housing opens. This is the 4∞-dwell "overlap" referred to earlier.
31. After all dwell checks and adjustments are completed, remove the service airline, dwell adjusting plate, and pointer. Install the front cover, referring to the reference marks made earlier during disassembly (see step 5). Tighten all 1/4" nuts on the front cover.
32. Install thrust washers on the shaft housing.
33. The unit is now ready for re-installation on the engine. Proceed as follows:
A. Place the Exline distributor with coupling in place.
Note the Cam lobe position. It MUST be the same as when removed (step 3).
B. Install the mounting ring and tighten the bolts. The distributor housing should rotate freely by hand.
C. Install the clevis pin, attaching the air cylinder to the distributor control arm. If the control arm bolts were not loosened during servicing, it is not necessary to re-time the distributor to the engine.
D. Install the distributor air supply to the supply port at the back of the valve housing(s).
E. Reinstall the 3/8" flexible tubing from the distributor to the *pneumatic terminal fittings, following the same sequence when they were removed (see step 2).
34. The Exline Starting Air Distributor is now ready for air start service.

Problems with the Exline Air Start Distributor control system develop when starting air is extremely moist. To eliminate this problem air timers and regulators are mounted in a control panel that use regulated dry air. Do this by following these instructions and refer to the schematic in Fig. 21.

1. Separate the distributor control valve #330019 from the filter and modify the bracket to hold the filter.
2. Run 1/2" pipe or tubing from the starting air manifold, downstream from the engine starting air valve, to the air distributor filter.
3. Mount the air timer in the control panel and connect according to the schematic.
4. To keep the engine starting air manifold dry, mount the control valve #330019 near the end of the starting air manifold and connect 3/8" tubing from the ends of the engine starting air manifold to the #3 port in the valve. The #1 port of the valve is vented. The #2 port is connected to the air intake side of the engine or turbocharger inlet. This allows air to flow through the starting air manifold when the engine is running.

When signal air is not available, use the schematics in Fig. 20 or Fig. 22 and the instructions given below.

1. Remove the distributor control valve #330019 and modify the filter bracket to support the filter.
2. Connect the supply airline* to the starting airline downstream from the starting air valve. Connect as shown in Fig. 22.
3. At locations where air leaks are a problem, connect the distributor control cylinder according to the schematic in Fig. 20.
4. If the starting air valve is not equipped with a bleed-off port (vent), valve #330019 may be used for this purpose. Connect port #3 of valve #330019 to the extreme far end of the engine starting air manifold with 3/8" tubing. Ports #1 &#2 of valve #330019 are vented. Connect the signal airport to the outlet side of regulator #330014.

* The source of supply air should be obtained from the engine starting air piping downstream from the engine starting air valve. For testing and timing, disconnect the flexible hose from the air distributor filter and adapt this hose to any air tool hose with about 90 psi working pressure.

AIR START DISTRIBUTOR TIME DELAY SCHEMATIC

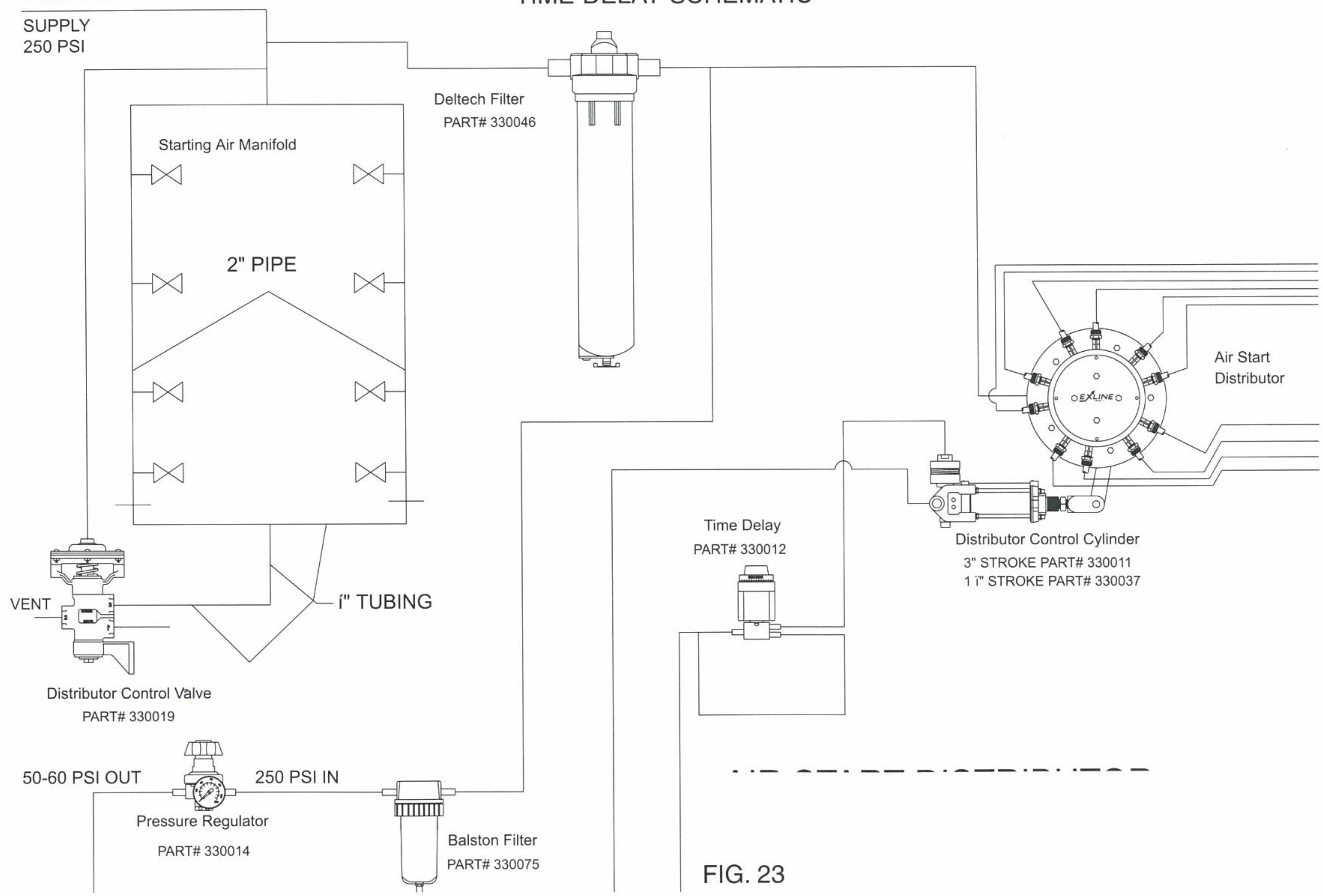


FIG. 23

SYSTEM CONTROL COMPONENTS LIST

NOTE: All of the following components are used in both speed sensing and time-delay systems, except #330034 or #330012. These parts are used in time-delay systems only.

Exline Part #	Description	Vendor Part #
NONE	Balston support core	SS100-12
330011	Bellows-Valvair 3" stroke air motor, pivot mount, pilot operated.*	B-80125023
330012	Kuhnke (formerly Agastat) time valve	PT31B
330014	Schrader Bellows regulator w/gauge	3560-2200
330019	Bellows-Valvair control valve single diaphragm	
330034	Pneucon time valve	CTV911
330037	Bellows-Valvair 1-1/2" stroke air motor, pivot mount, pilot operated.*	B-80125023
	*NOTE: both air motors carry the same vendor number. Identification is by length of stroke.	
330041	Bellows-Valvair pilot valve (single acting)	B414-2001
330046	Deltech filter w/flow gauge	814
330075	Balston filter housing	A912A-BX
330076	Balston filter kit consists of:	
	Demister Assembly	91450
	Balston filter element	BX100-12
	"O" ring set	22091

SPECIAL COMPONENTS USED WITH SPEED SENSING SYSTEMS ONLY

(Eliminate time valve #330034 or #330012 from the above list and add the components listed here.)

330017	Moore relay	Mod. 67-25
330018	Robert Shaw ratio relay	CR100-A3

OPTIONAL SPECIAL PNEUMATIC CHECK VALVE REPLACEMENT
FOR O.E.M. MECHANICAL CHECK VALVES. (If applicable)

330047	Bellows-Valvair hi-speed inline poppet type, 2-way, normally closed, remote operated valve	
	Port sizes-1 1/4" NPTF Exh. All other ports 1"NPTF	N324-71-091
Available Optional Port Sizes	1 1/2" NPTF Exh. All other ports 1 1/4" NPTF	N324-81-091
	1 1/2" NPTF Exh. All other ports 1 1/2" NPTF	N324-01-091