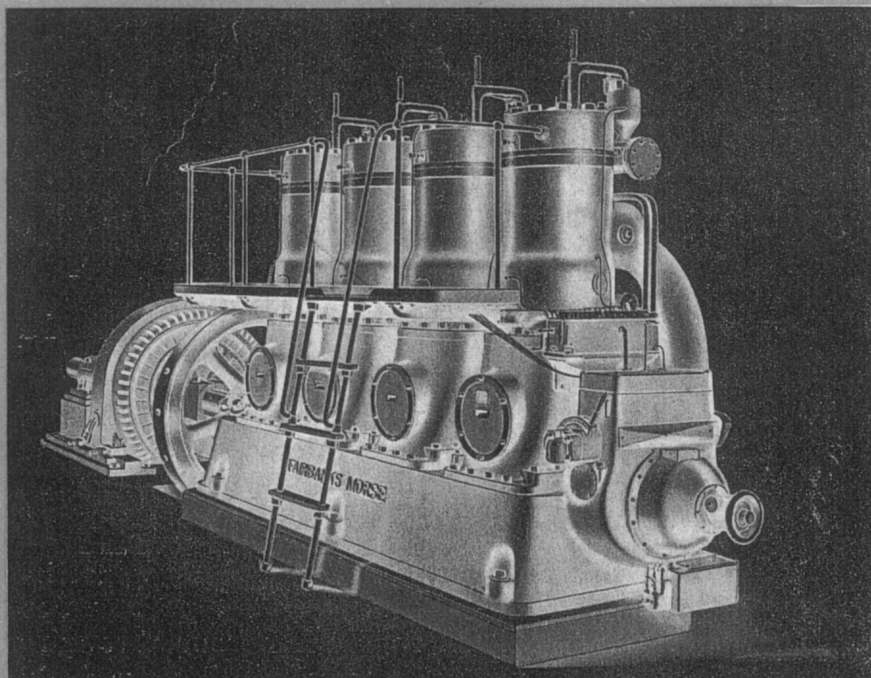
Bulletin 3200-E2



# Model 32-E DIESELS

for

Heavy Duty Stationary Service

## Fairbanks, Morse & Co.

# Lower Fuel Consumption *resulting from* Improved Scavenging

With this, the latest design of the Model 32 Automatic Scavenging Diesel engine, Fairbanks, Morse & Co. offers to industry a new conception of efficiency of operation and of simplicity in the design and construction of Diesel engines.

Back in 1912 this company developed the original heavy oil engine which was the fore-runner of the present design. From that original design the engine has gone through successive detailed improvements, among which were included the water jacketed combustion chamber, the two-stage combustion principle, open head combustion and finally the present development of the back flow principle of scavenging. During these years the guaranteed fuel consumption has been successively reduced from 0.60 lb. per brake hp.-hr. in 1912-13 to the present figure below 0.40 lb. per hp.-hr.

These improvements have been effected without any changes in fundamental design but with steady and consistent detailed improvement of injection, combustion and scavenging carried on through two decades in a consistent pursuit of the company's foremost policy: Improvement of performance with simplification of design.

The present result of this 24-year history of successive detailed improvements has been the creation of the modern Model 32-E, which by record is the most popular, dependable and efficient Diesel engine, with a record of 1,000,000 installed horsepower behind it.

# Salient Features

Full Diesel, two-cycle, direct airless - injection of fuel.

Open-head combustion, differential injection valve.

Back-flow scavenging resulting in lower fuel consumption.

Completely automatic lubricating system.

Accurate governor control of speed at all loads.

Simple and convenient starting controls.

Needle or quill roller type piston pin bearings.

Large main bearings resulting in low bearing pressure.

Complete combustion and freedom from carbon formation.

Cylinder head simplified by the elimination of air inlet and exhaust valves and their operating mechanism.

Extreme simplicity of design and construction simplifies operation and attendance.

All working parts enclosed—yet readily accessible.

Small number of moving parts, eliminates many adjustments and insures low maintenance.

Cylinder and head completely water jacketed and designed with large passages to allow free circulation.

Power impulse on each downward stroke.

Uniform delivery of power to the driven machinery without need for flywheel of abnormal size.

Rated on conservative basis, yet without excessive weight per horsepower.

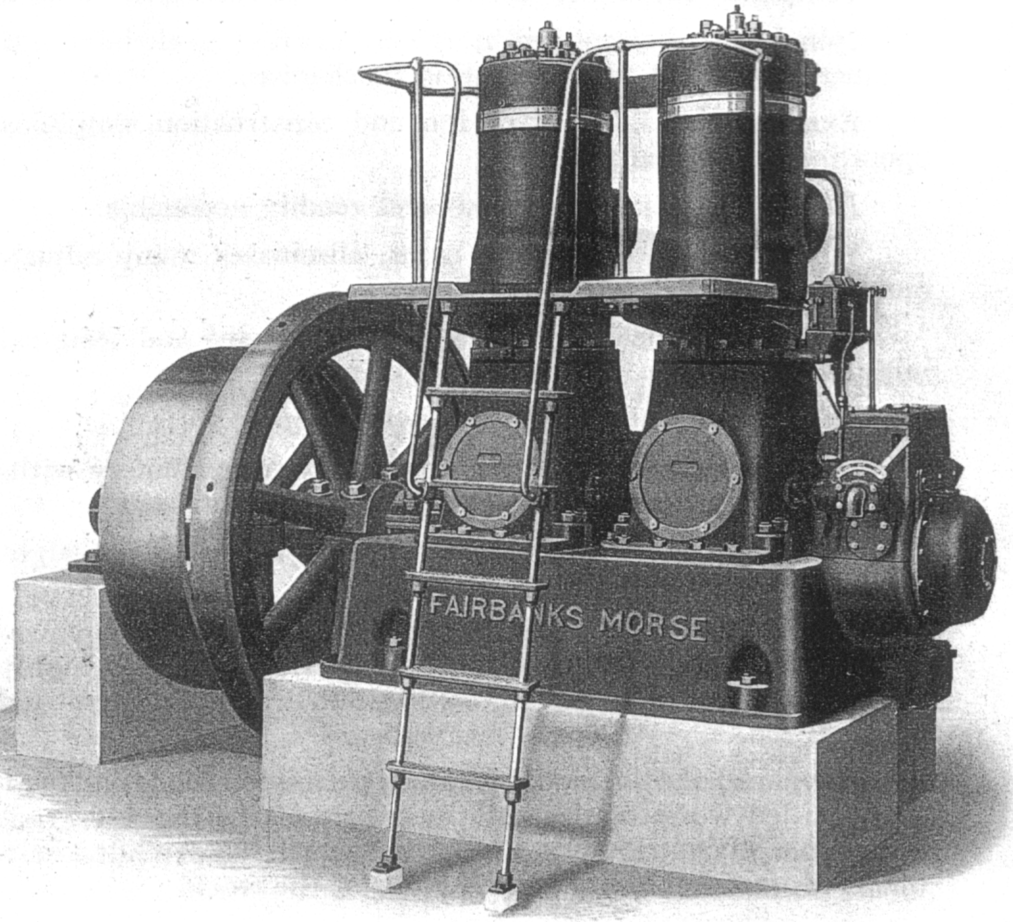
Fairbanks-Morse Diesel Engines are built by an organization having over forty-two years' experience in the highly specialized field of internal combustion engine design and construction.

Advanced design, modern manufacturing methods and facilities, skilled workmanship and materials of the highest grade obtainable all contribute to the success which has attended Fairbanks-Morse installations in all parts of the world.

# Model 32-E
## Stationary Diesels

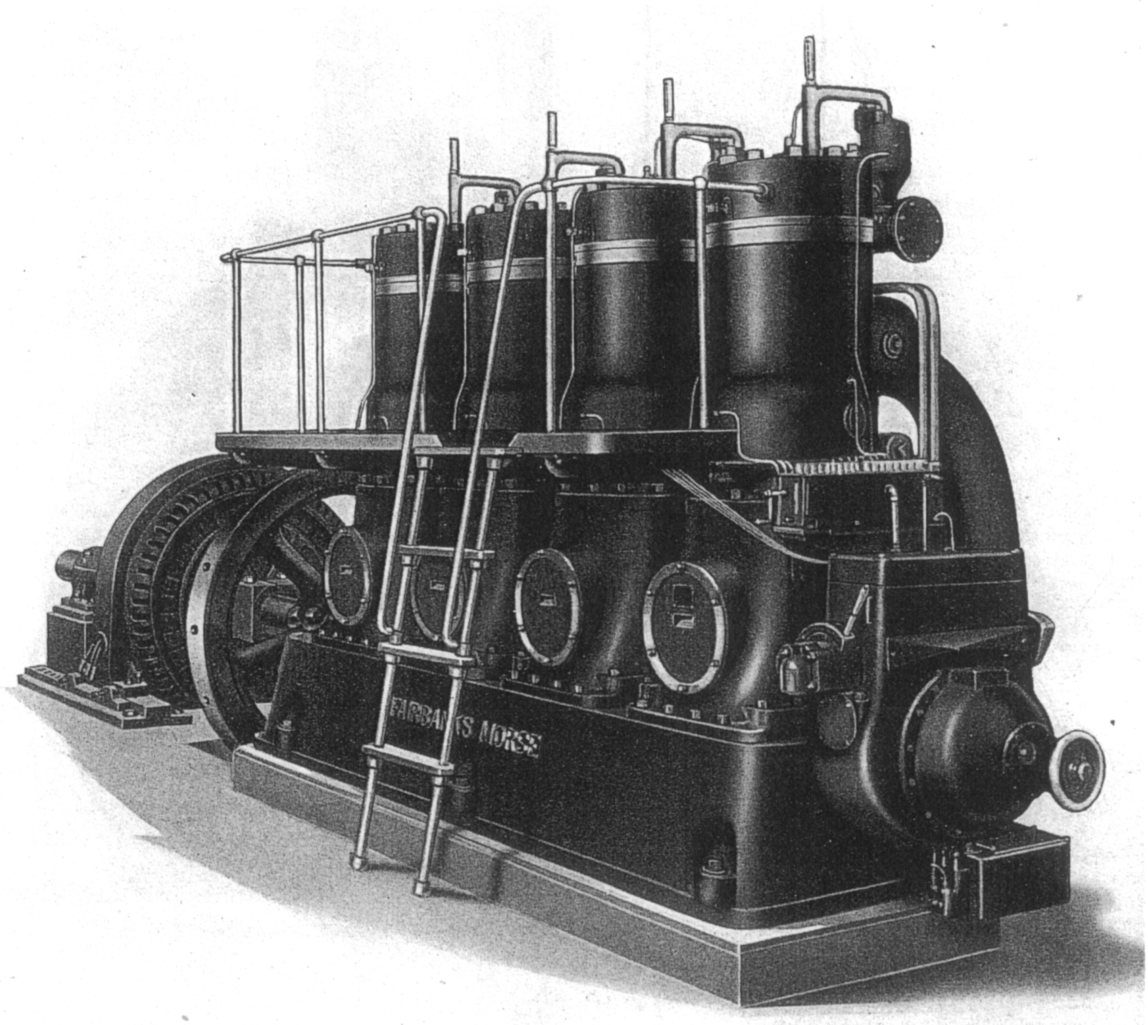
Fairbanks-Morse Model 32-E Diesel Engines enjoy an unsurpassed record for over-all economy of operation and dependability in the stationary power plant field. Several hundred thousand horsepower of these engines are to be found in daily operation in central station power and light plants, manufacturing plants, ice plants, flour mills, rock crushing plants, cotton gins, cotton seed oil mills, textile mills, irrigation and drainage pumping stations, and a host of similar installations including practically every requirement for primary power.

Extreme simplicity of design combined with modern manufacturing methods, skilled workmanship and the use of

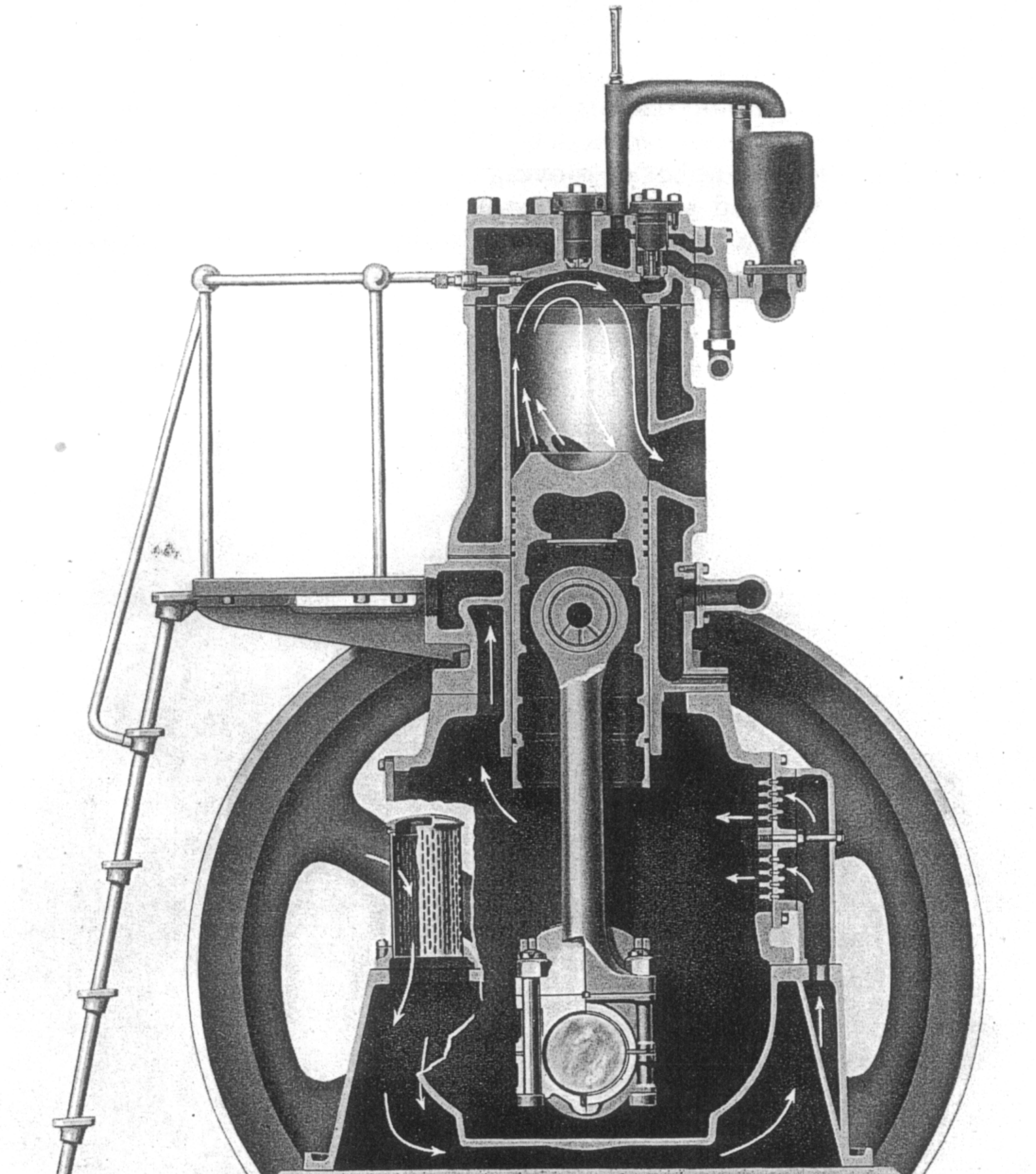



*The Only Moving Parts—Flywheel, Pistons, Rods, Crankshaft, Oil Pumps and Governor* materials of the highest grades contribute to the success which has attended installation of these engines in all parts of the world. The utmost simplicity of design embodied in the Model 32 engine results from the manner in which the two-cycle and airless-injection principles have been worked out. In these engines the number of moving parts has been reduced to an absolute minimum and all such parts are readily accessible for inspection and maintenance. The engines are most conservatively rated as to capacity, piston speed and bearing pressures and will consequently operate continuously at rated capacity without danger of strain or overheating.

In the design and manufacture of the Model 32 engine are embodied all of the requirements for low over-all operating costs, maximum dependability, long life, low maintenance expense and minimum operating attendance.




*Fairbanks-Morse Model 32-E Diesel with Direct-Connected Alternator*



*Simplicity of Design and Sturdiness of Construction are Features.*
*Backflow Scavenging Improves Combustion Efficiency.*

# Principle of Operation

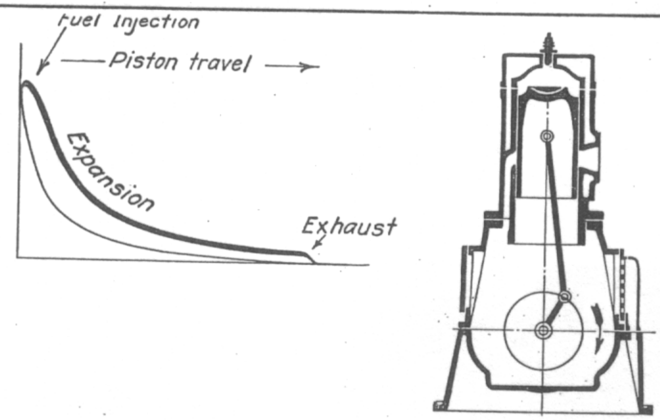
The cycle of events taking place in the two-cycle airless-injection crankcase scavenging Diesel is illustrated in the accompanying diagrams. It may be said to begin with the closing of the exhaust ports by the piston on the compression or upstroke, approximately 50 deg. past the bottom dead center, when the compression of the charge of fresh air begins.

Compression continues to within a few degrees of top dead center when injection occurs and spontaneous ignition takes place due to the rise in temperature of the compressed air. After a momentary pressure rise above the compression pressure, during which the piston passes its top dead center position, the piston continues its accelerated downward movement on the working stroke due to expansion of the gases.

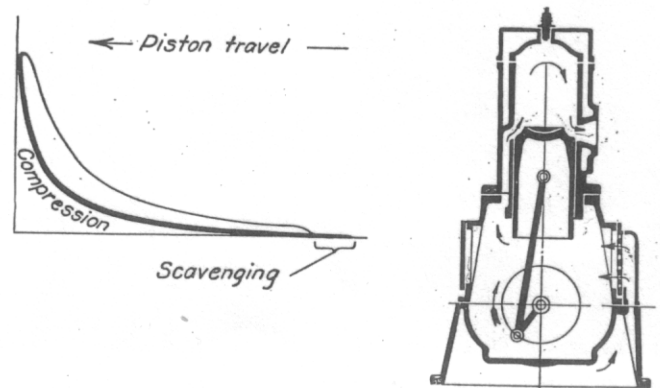
When the piston has reached a point about 50 deg. ahead of bottom center, the exhaust ports are uncovered and the burnt gases at a pressure slightly above atmospheric are released to the exhaust system.

As the piston moves farther down, the scavenging air ports are uncovered and air under slight pressure is admitted to the cylinder from the crankcase. On entering the cylinder this air is deflected upward by the contour of the piston head and thus drives the remaining burnt gases out the exhaust ports on the opposite side of the cylinder.

On the next upstroke, first the air ports and then the exhaust ports are covered and compression begins.




A. In the position of the piston shown in the top diagram, fuel injection has taken place and combustion has begun. The piston then moves downward and first uncovers a portion of the exhaust port. Burned gases are exhausted to the atmosphere. When the piston has moved downward a slight distance farther the air inlet port is uncovered, and air from the crankcase under a slight pressure then flows through the cylinder, clearing out the remainder of the burned gases and filling the cylinder with fresh air.




B. As the piston moves upward on the compression stroke the air inlet and exhaust ports are covered and the entrapped air is compressed. Just before the piston reaches the top dead center, fuel oil is injected into the combustion chamber and ignition begins as the piston reaches the top of its stroke. The cycle has then been completed with the finish of the second stroke; hence the name two-stroke cycle or two-cycle.

*The Two-Cycle Engine Delivers One Power Impulse Every Revolution.*

# Details of Operation

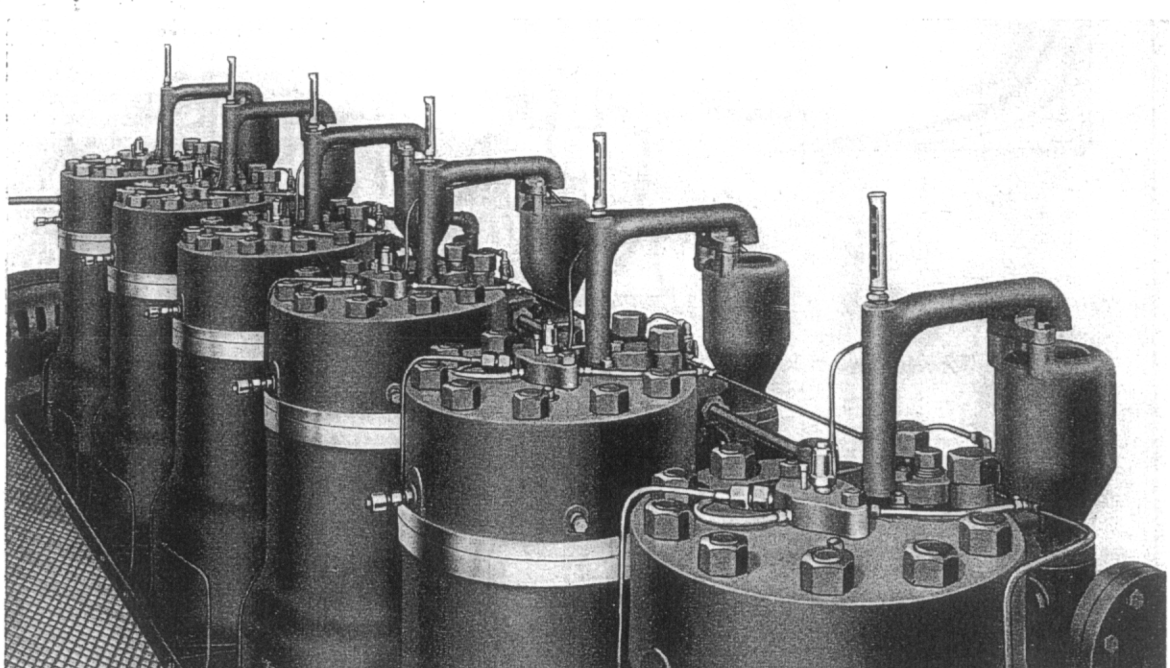
There are two fundamental principles responsible for the extreme simplicity of the Model 32-E Diesel, i.e., the two-cycle design and airless injection of fuel. These two factors combined with the crank-case scavenging principle result in an absolute minimum number of moving parts; hence maximum reliability in service and minimum maintenance expense.

The only moving parts in this engine are the pistons, rods, crank shaft, injection pumps, lubricating oil circulating pumps, fuel supply pumps, flywheel and the governor. The two-cycle principle eliminates both intake and exhaust valves and all attendant complicated operating mechanisms.

## Injection and Combustion

The fuel injection system utilizes an extremely simple spring loaded differential spray valve and the cam operated fuel pumps which inject a fine spray of fuel directly into the combustion space with just the correct combination of penetration and turbulance. No high pressure multi-stage air compressor system is required with its inter- and after-coolers.

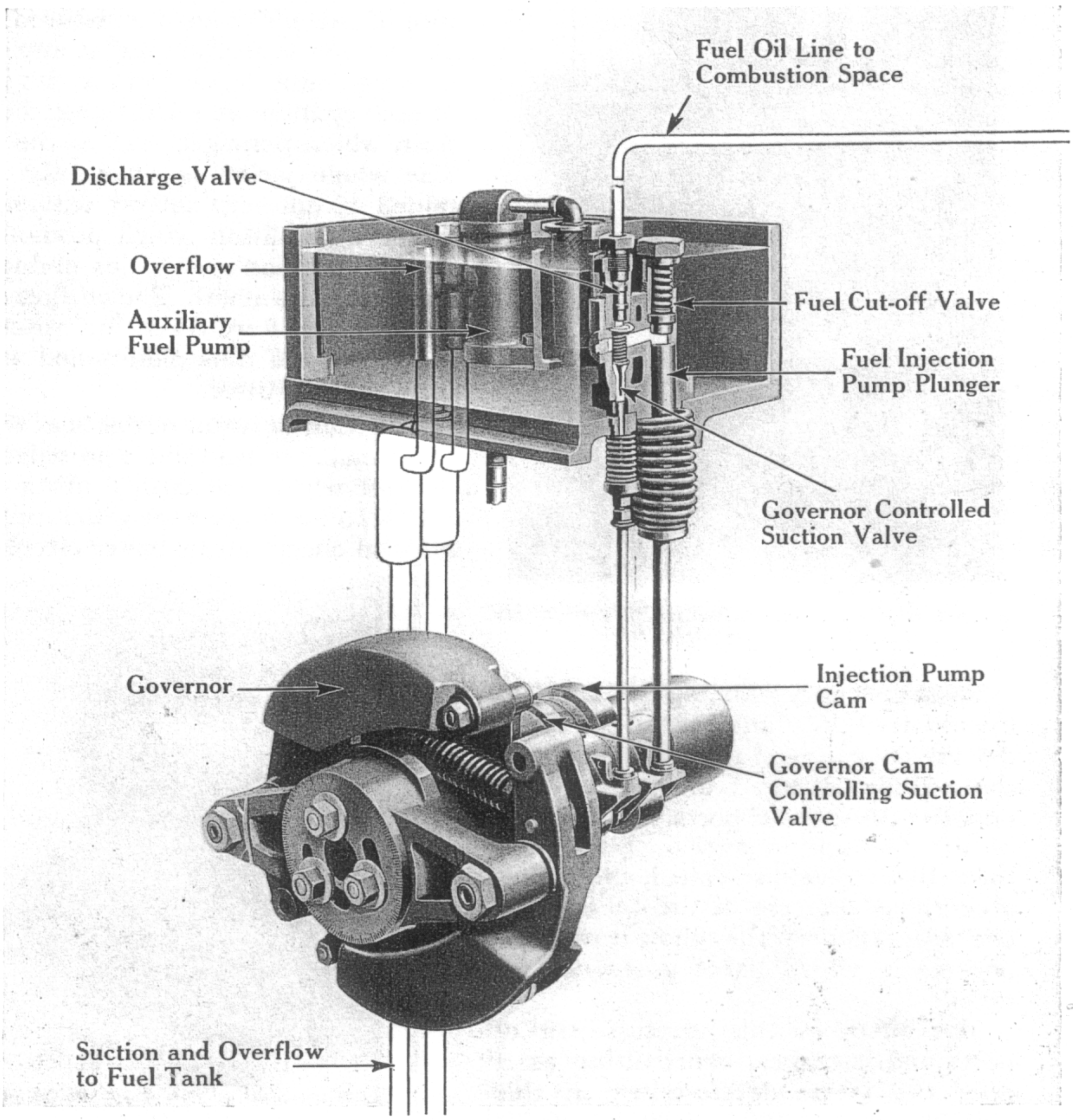
The fuel injection valve and nozzle is located in the center of the cylinder head and discharges directly into the cylinder. A few degrees before compression has been completed, near the top dead center of the piston travel, an accurately metered quantity of fuel is introduced into the cylinder through the multi-orifice nozzle. The charge is ignited by the heat of compression, and combustion takes place at a pressure of about 500 lb. per sq. in. This and the subsequent expansion of the products of combustion, forces the piston downward on its working stroke.



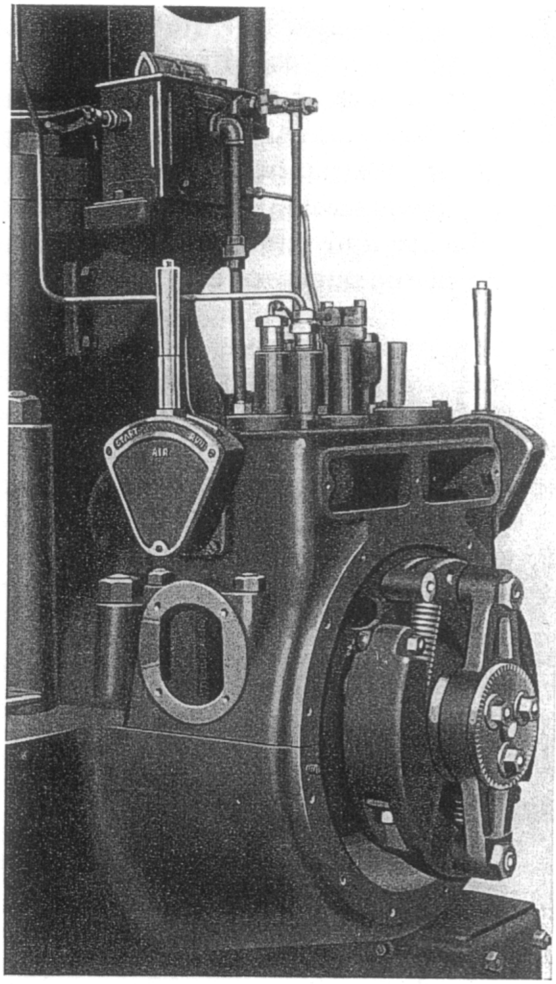
*Simplified Head Design Results in the Utmost Reliability.*

## Scavenging

In the Model 32-E engine employing crank-case scavenging, no separate scavenging air pump is required since the movement of the piston in the crank-case provides the necessary pumping action. On the upstroke of the piston, air is drawn through a screen and automatic air valve into the crank-case and is there compressed on the working or down stroke of the piston to a pressure of a few pounds. As soon as the piston has uncovered the air ports at the end of the down stroke, this air rushes into the cylinder and effects complete scavenging of the burnt gases.




*Fuel Injection and Governor Mechanism.*



*Complete Control of the Engine is Centered in this Compact and Accessible Unit.*

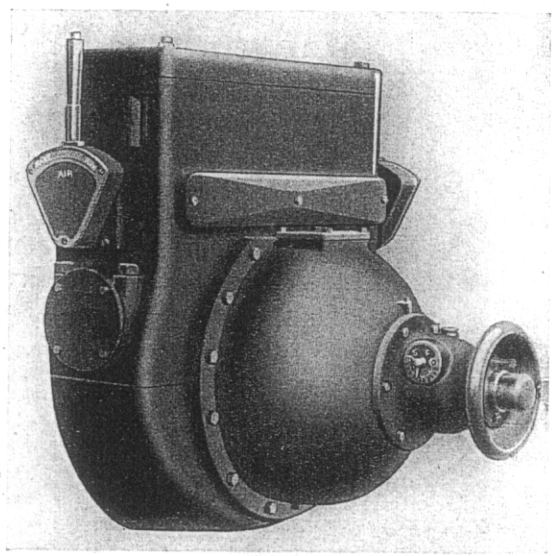
Passages for conducting the scavenging air from the crank case to the cylinder are so arranged that the air enters the cylinder directed toward the wall opposite the exhaust ports. As indicated on the diagram on page 6, this air follows the backwall, so-called, and makes a complete traverse of the cylinder up one side and down the other, leaving no pockets in which burnt gases can remain.

The effect of this arrangement of ports and passages, constituting as it does the latest development in this engine, has effected a reduction in fuel consumption to 0.38 lb. per hp. hr. on the 14″ by 17″ engine and to below 0.40 on the smaller 12″ by 15″ engine.

## Cooling Water System

The design of the cylinder head is such that complete water jacketing with large symmetrically arranged passages is accomplished and a uniform temperature of the entire head is assured without danger of overheating at any point. Cooling water is admitted to the jacket of each cylinder at a point near the base from which passages lead to the head. The whole jacket is constantly maintained within very narrow temperature limits, a condition which promotes efficient operation and avoids undue heat stresses in the metal. The bridges of the cylinder ports are cored for water passages and are thus maintained at uniform temperatures.

The cooling water outlet is at the top of the cylinder head and is provided with a spout which discharges into a water header, an arrangement which provides a visual check on the water circulation.



*Speed Regulation with Hand Wheel and Indicating Dial.*

Engines employing the closed system of cooling are not equipped with the open type visual spouts. Cooling water temperature is regulated by control valves at the inlet header and can be checked by means of thermometers located in the overflow elbows.

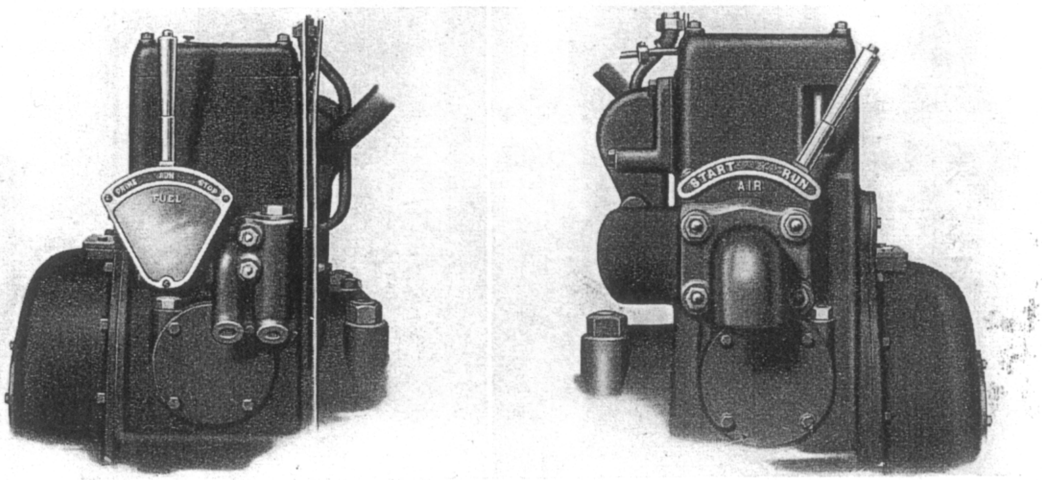
The Diesel engine, like every other form of internal combustion engine, must have cooling water which will not form scale or other deposits in the jacket, because the insulating effect of such deposits reduces the heat flow to the cooling water and causes overheating of the metal in the piston, cylinder and cylinder head. No detail of an installation is of more importance than a properly designed cooling system. Fairbanks-Morse engineers will co-operate in arranging the most suitable type.

## Centralized Control

In the design of control equipment the modern trend, as in the case of the engine itself, has been toward simplification, and in the Model 32 engine this very important detail has been highly perfected. The control of the entire engine is centered in a compact and easily accessible unit, located at one end of the engine, which houses the fuel injection pumps, the air starting mechanism and the governor. The standard controls consist of two levers; one for the starting air and one for priming or shutting off the fuel pumps. Where variable speed control over a wide range is required a counterspring device which works directly on the governor can be provided.

## Injection Pumps

Injection pumps, one for each cylinder, are located on a deck which forms the floor of an auxiliary fuel oil reservoir which is kept filled by an auxiliary fuel pump also located on this deck. All pumps are thus submerged in the fuel oil, an arrangement which entirely eliminates all piping to the pumps, establishes a perfect air seal, and enables one fuel suction line and one return line to serve any number of cylinders. Since the fuel reaches the pumps under a slight but constant head, the injection pumps are not called upon for suction duty. The fuel injection system shown in one of the accompanying illustrations




*Control Levers are Conveniently Located at one End of the Engine.*

is for a single cylinder engine and shows the arrangement of the fuel injection and auxiliary pumps.

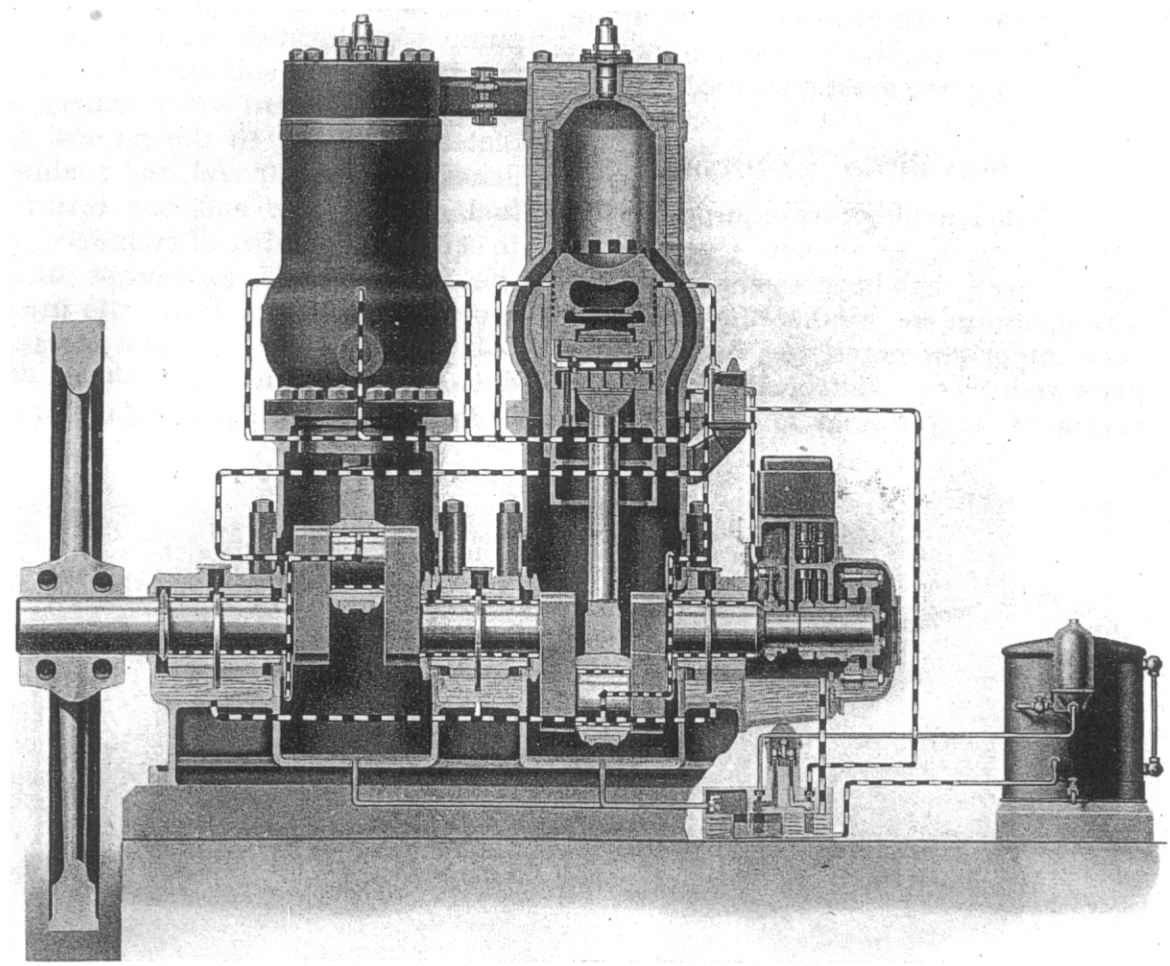
## Air Starting

Starting is accomplished by compressed air which is supplied by an auxiliary compressor and stored in steel tanks at a pressure of approximately 250 lbs. per sq. in. The pressure actually used for starting the engine cold is approximately 225 lbs. per sq. in.

The poppet valves which time the admission of the starting air are operated through rocker arms from a single lobe cam on the crank-shaft. From these timed valves the air flows to the cylinder through pipes and non-return valves on the cylinder heads.

For control of the starting air a single hand lever, marked for starting and running positions, is provided. When this lever is thrown to the starting position it opens a rotary-disc valve which admits air into a main starting-air chest. This action also allows the starting valve rollers to engage the cam and so lifts one of the poppet valves.

The starting air lever shaft is so interlocked that it is not possible to open the disc valve without the air starting



*Lubrication is Entirely Automatic. Oil is Continuously Filtered.*

roller engaging the cam nor is it possible to raise the roller off the cam without closing the disc valve. Because of this arrangement supercharging is impossible since the starting air is as closely timed as the fuel injection.

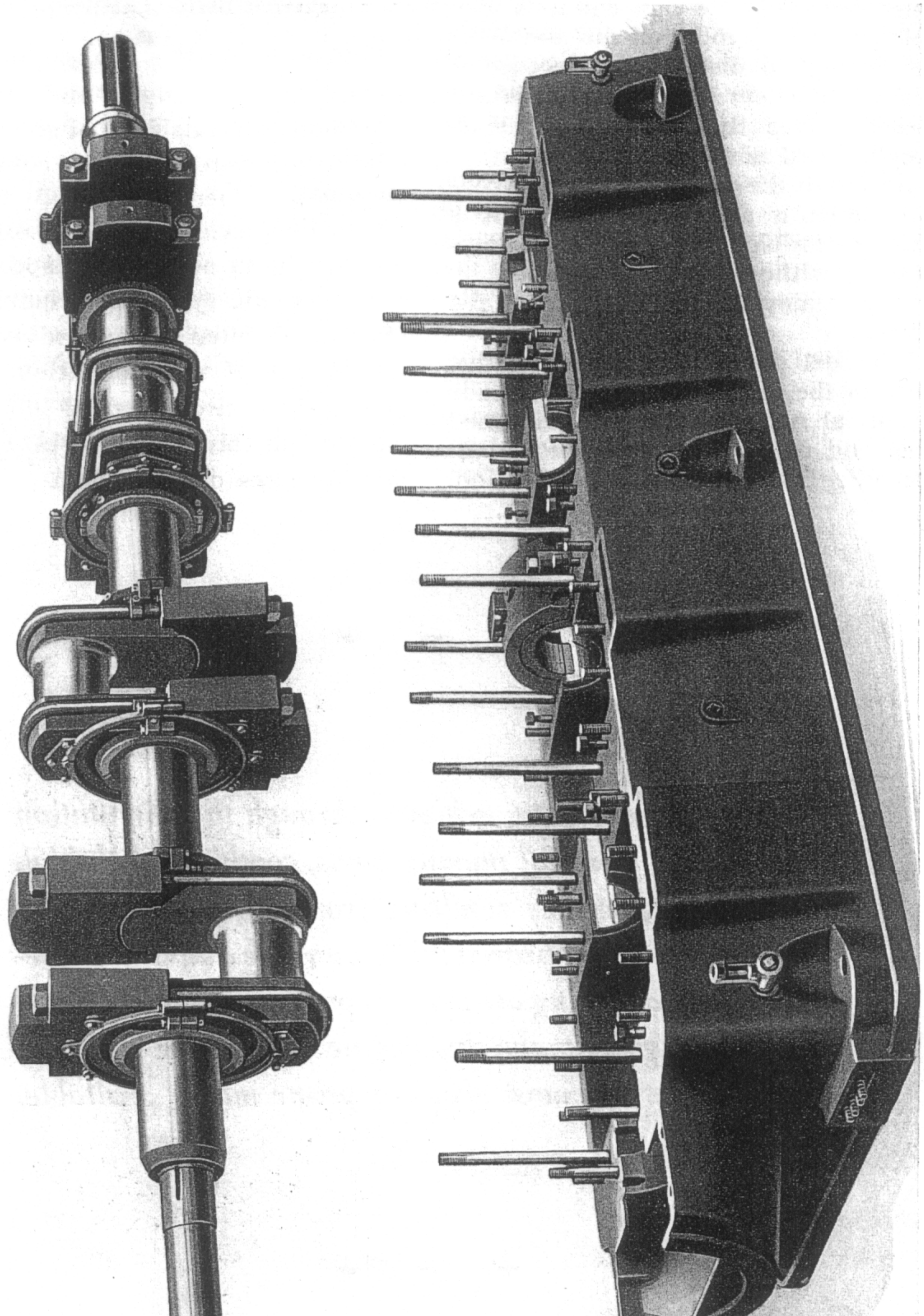
Although the fuel injection and control system is extremely compact it is easily accessible. All of the valve parts may be withdrawn for inspection by simply removing the caps over the valves.

The fuel pump plungers and valve parts of the injection system are made of special non-corrosive and hardened steel and require practically no attention other than an occasional inspection.

## Automatic Lubrication

In order further to simplify the operation of the engine and to assure maximum dependability of service, the lubricating system is made completely automatic. There are no oil holes or hand oiling devices to require attention; hence only an occasional inspection of the automatic system is required. An efficient oil filter is provided as an integral part of the lubricating system and positive circulation of lubricating oil through this filter assures clean oil and increases dependability.

*Extreme simplicity, achieved through the elimination of all but the essential moving parts, combined with high combustion efficiency resulting from advanced cylinder and head design, improved injection valve and the new design of the scavenging air ports to produce complete Back-Flow Scavenging, make this engine at once the simplest, most reliable and most efficient prime mover available.*



*Special Manufacturing Refinements Produce a Crank-shaft that will withstand Heavy Service.*
*Careful Machining of the Lower Base Assures Accurate Alignment of Bearings.*

# Construction Details

The design of this engine has been laid down with the primary purpose in view of securing the highest possible degree of reliability in operation and durability in service. Reliability is obtained by simplicity of parts, absence of delicate mechanisms and exceedingly simple adjustments where any are required. Durability is obtained by the ample proportions of parts in stress, by the use of highest grade materials, by employing especially large bearing surfaces to provide low bearing pressure, and by providing for ample and continuous lubrication of all moving parts.

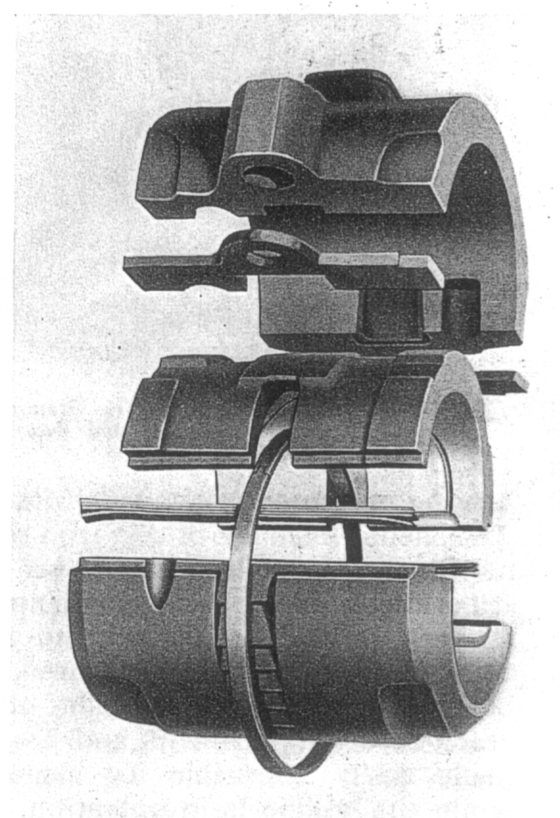
## Lower Base

The lower base is a single gray iron casting of sturdy construction with a wide supporting surface to rest on the foundation. This lower base forms the lower part of the crank-case.

Heavy bridges supporting the main bearings divide the base into separate crank-case compartments; one for each cylinder. An air passage beneath the crank-cases permits passage of air from the screen air inlet to the air inlet valves. The base is extended at the governor end to form a support for the fuel pumps and governor housing. Underneath each main bearing is an oil well and the base extension supporting the pump housing forms an oil reservoir which is connected to the several bearing wells by piping. The base is accurately machined to receive the crank shaft bearings and the upper surface is machined to receive the upper bases, main bearing caps and fuel pump housing. Each upper base is held in place by a number of studs.

## Crank Shaft

The crank shaft is made from a single billet of open hearth steel hydraulically forged and annealed and heat treated. The heat treating operations are conducted under exact observations allowed by recording pyrometers and the finished shaft is required to pass exacting physical tests for tensile strength, yield point, hardness, etc. The shaft is made of especially heavy design to provide a maximum factor of safety against any unusual stress and at the same time to insure cool running bearings with minimum wear. The crank shaft is machined all over and is carefully balanced

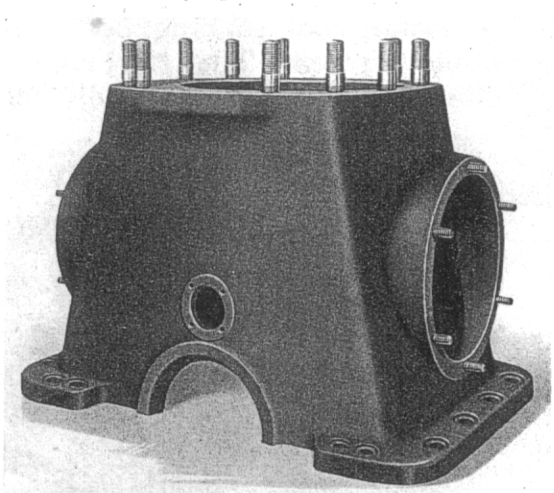


*Large Main Bearings with Nickel-Babbitt Linings Insure Low Bearing Pressure and Long Life.*

dynamically. All except 6 cylinder engines have counterweights attached by U-bolts directly to the crank cheeks. Perfect alignment of the journals and crank pins is obtained by the use of special crank pin lathes in which the shaft is held stationary and the tool revolved about the pin. No other method has been found by which equal accuracy of alignment can be secured.

## Main Bearings

The main bearings are of the ring oiling type of unusually heavy construction with ample surfaces to provide



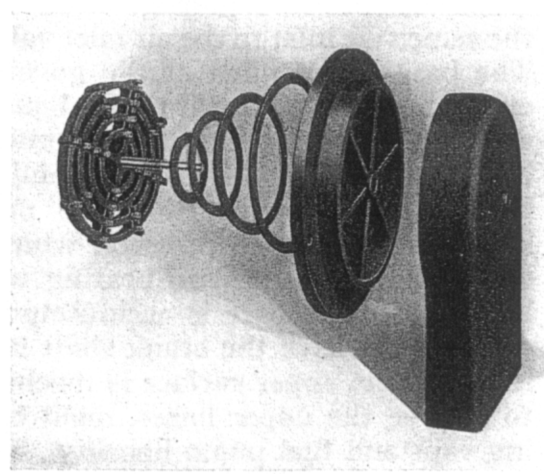
*Upper Base Has Openings to Permit Easy Access to Connecting-Rod Boxes.*

bearing pressures below usual practice. The shells which are of cast iron rest in machined receptacles in the lower base. All of these receptacles are machined in a single operation and accurate alignment is thus definitely assured. All bearings are located outside of the crank-case compartments and are thus made easily accessible for inspection while the engine is in operation. The assembly is so designed that the bearing caps and shells may be readily removed for repair or replacement without dismantling any of the major parts of the engine. The main bearing shell is parted so that each half may be rolled out and lifted clear. All bearing oil rings are made in two pieces with smooth dove tail joints and can be easily removed or replaced should circumstances require. Exceptionally high grade nickel babbitt is used for lining the shells.

This metal is hard and will withstand severe operating conditions. It is accurately cast and held in place with dovetail anchors. After being poured the bearings are bored and accurately scraped to a bearing seat. Shims are provided so that any wear may be easily taken up. Heavy studs are used to hold down the main cap and a large opening in the top of the cap permits the inspection of the bearing while the engine is in operation.

## Air Seal and Oil Rings

To prevent air and lubricating oil from being blown out through the main bearings under the pressure of the scavenging air in the crank-case a seal ring,



*Inlet Valves for Scavenging Air Are Arranged as a Removable Unit.*

split and bolted together, is placed on each side of each crank case compartment. These rings are surfaced to the crank-case web to make perfectly tight joints and are held there by means of springs which rest against the crank webs. These rings are driven by lugs that straddle the crank webs and are split so that they may be removed if necessary without dismantling the engine. On the fly wheel end of the main bearing an oil throw ring is fitted to the crank shaft at the outer end of the bearing shell to prevent loss of lubricating oil at that point. Oil is delivered from the force feed lubricator to the crank pins by oil collector rings which are bolted to the crank webs. Oil is fed to these rings and from that point is delivered to the crank pins through holes in the crank-shaft.

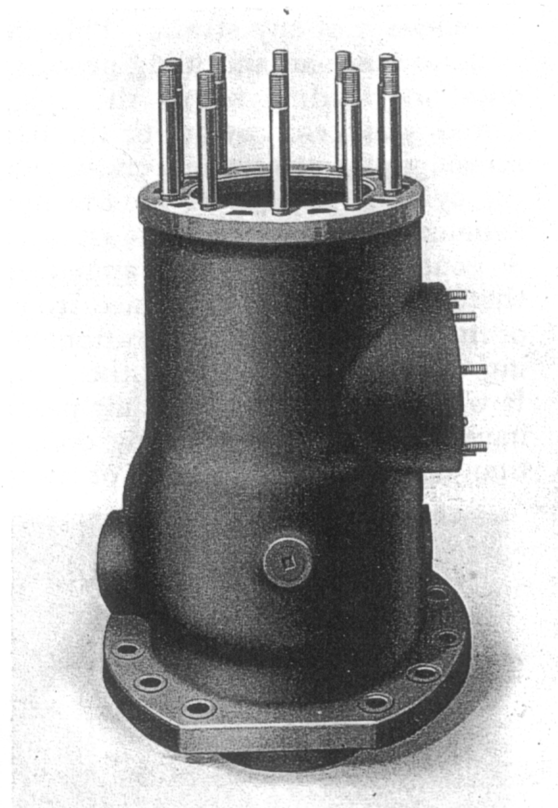
## Upper Base

Individual upper bases are provided for each cylinder so spaced on the lower base that the bearings are readily accessible from the outside for maintenance and inspection. The upper bases form the upper portion of the crankcases, making completely enclosed structures for each cylinder to serve as housings for the crank and reciprocating parts as well as pump chambers to provide scavenging air. Large openings are provided on each side of the bases to permit easy access to the connecting rods and bearing boxes. A hand hole plate covers one of these openings while in the opposite one is located the automatic scavenging air inlet valve assembly.

Also small hand holes are provided directly above the main bearing caps to provide a means for inspection and cleaning of the crank shaft oil passages through the crank pin.

## Air Valve

The scavenging air inlet valve and air transfer passage are assembled together and form a complete removable unit that is bolted over one of the openings on the side of each upper base. The

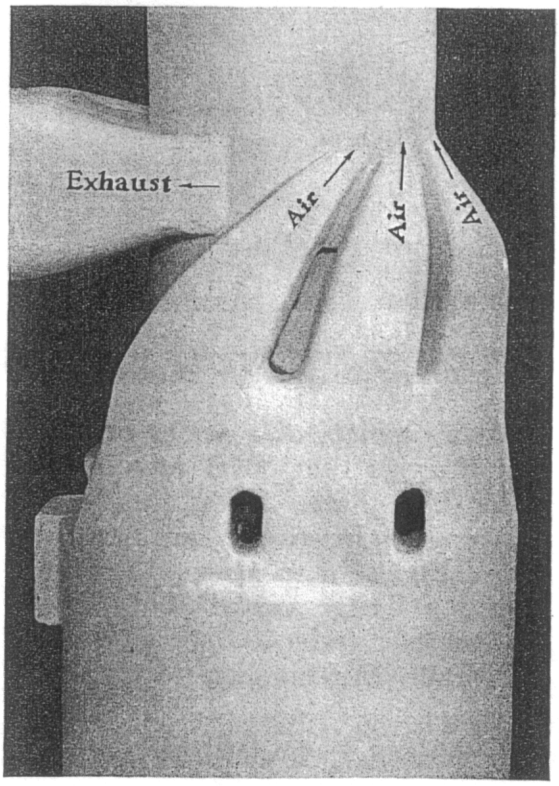


*Cylinders for Model 32-E Engine Are Accurately Cast, Using a Special Close-grain Iron.*

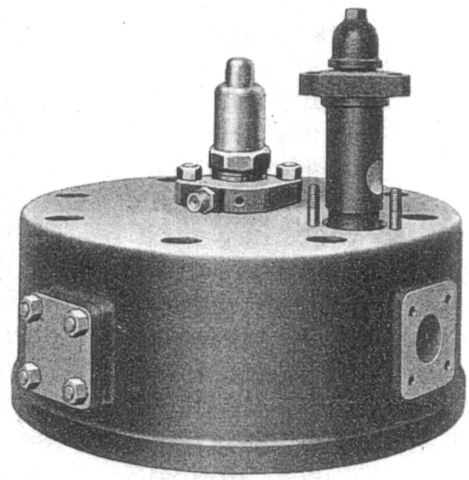
valve consists of a series of concentric steel rings that cover annular ports in the valve plate. These rings are loaded by very light springs and the lift is limited by the stop plate. The unit is a simple flutter valve which is entirely automatic, quiet in operation and offers a minimum resistance to air flow.

## Cylinder

A special grade of iron containing approximately 30 percent steel is used for the cylinder. This metal produces a hard close-grained uniform casting which possesses greatly increased wearing qualities as compared with the metals commonly used for this purpose. Before assembly each cylinder casting goes through a special curing process to relieve it of any strain. This curing is in no sense an annealing process and does not tend to soften the cylinder. Cored passages provide for the flow of scavenging air from the crank case to the cylinder as well as for the flow of exhaust gases to the exhaust system. A general idea of the arrangement of these passages may be gained from one of the accompanying illustrations showing the core used in casting the cylinder. It will be noted that these air passages have a gradually decreasing cross section which under the action of the pres-



*Cylinder Core Illustrating the Arrangement of Scavenging Air Passages to Secure Complete Scavenging.*


*Cylinder Head with Injection Nozzle in Place and Air Starting Valve Partially Removed.*

sure in the crank case gives the air a substantial velocity on entering the cylinder itself. Furthermore the direction of the passages is such as to direct the air back along one side of the cylinder. From this point the air proceeds up along one side of the cylinder across under the cylinder head down the opposite side of the cylinder and out the exhaust port, thus pushing all traces of burned gases ahead and filling the cylinder with a complete charge of fresh air. This arrangement of air passages is a recent development of the Fairbanks-Morse Organization which has resulted in a substantial decrease in specific fuel consumption.

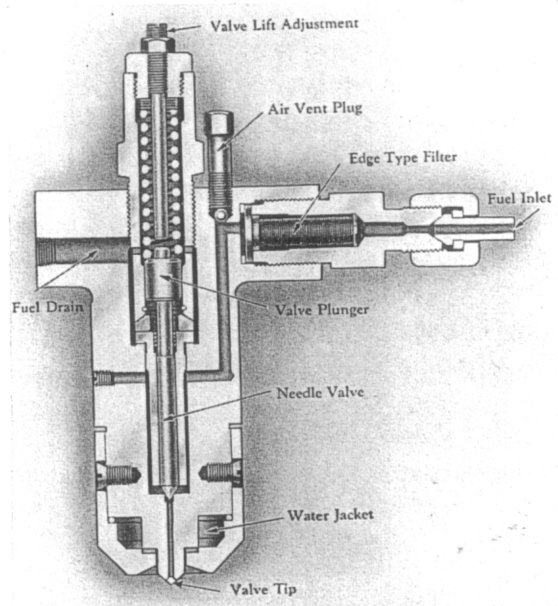
## Cylinder Head Assembly

Because of the absence of valves and valve ports the cylinder head is extremely simple in design and it has, therefore, been possible so to proportion the walls and so place the metal that expansion and contraction cause no unusual internal stresses. The differential fuel injection nozzle is located in a simple circular opening in the center of the head. Cored passages are provided for starting air and for compression release. The starting air valve is assembled in a removable cage in the cylinder head. It opens only under pressure from the starting air system and remains closed during normal operation. The compression relief valves are opened individually to aid in barring over the engine when necessary. The cylinder head is completely water jacketed with all water passages of generous proportions to assure free and unrestricted circulation.

Solid copper gaskets located in the counter-bore between the cylinder and cylinder head prevent leakage from within the combustion space. Individual molded gaskets at the water passages effectively prevent water leakage at these points. This construction is particularly advantageous in that it positively prevents leakage of water into the combustion space and at the same time gives immediate external evidence of the leakage of cylinder pressure or of circulating water. The fuel injection nozzle is mounted centrally in each cylinder head and is operated automatically by the fuel pressure.

## Injection Valve

The injection valve, as shown in the accompanying illustration, contains a spring-loaded needle valve which is a lapped fit in a bushing or guide which is in turn fitted into the main valve body. Through drilled passages in the body and passages formed by external fluting on the bushing the fuel reaches the valve tip, the passage through which is closed by the needle valve. When the pressure at this point reaches a predetermined value the needle is lifted off its seat against spring tension and fuel is forced through the passage in the tip and into the cylinder through multiple orifices. As soon as the needle valve opens the fluid pressure immediately drops and the needle valve reseats itself, thus cutting off the flow of fuel to the cylinder.

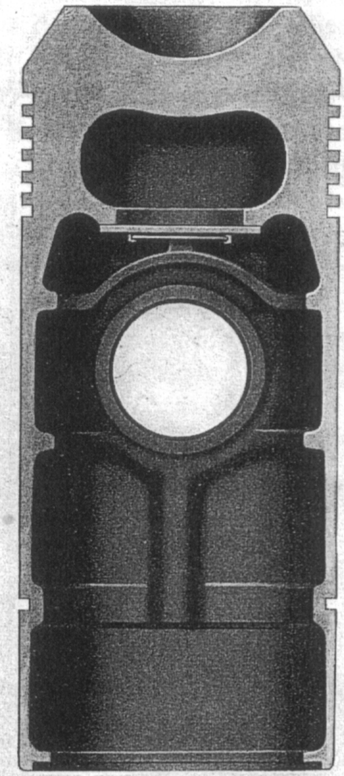


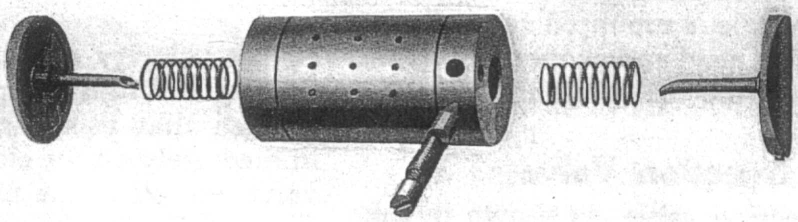

*Differential Injection Valve Provides Correct Combination of Penetration and Turbulence with No Dribbling.*

The velocity and inertia of the fuel flowing through the passage in the tip is such that this passage clears itself immediately on the closing of the needle valve and all of the fuel is injected into the cylinder in the form of a fine mist or spray and no after dribbling occurs. The multiple orifices of the tip are so drilled and are of such size as to contain the most advantageous combination of turbulence and penetration to effect complete combustion.

## Piston and Piston Pin

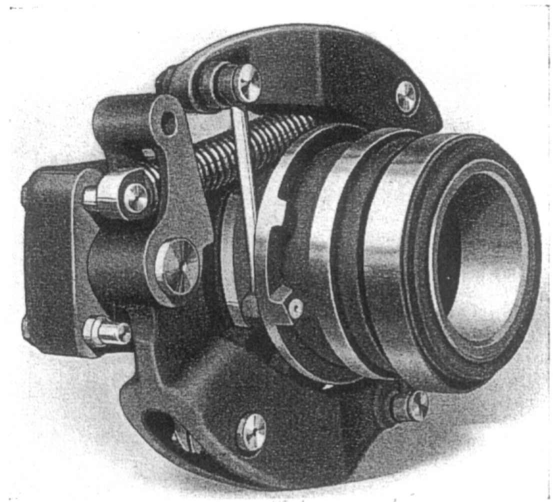
The piston is of the open or trunk type made of close grain cast iron accurately machined to size. The length





*Long Trunk Pistons Minimize Wall Pressure. Special Wiping Arrangement Lubricates Pins.*

is made great in proportion to the diameter to provide for low bearing pressures on the cylinder wall. Each piston is fitted with six cast iron rings closely spaced and designed to exert only a low wall pressure and to form a gas tight joint without excessive wear. A number of circular ribs on the inside of the barrel of the piston also an oil regulating ring on the lower part of skirt prevent distortion and a suitable flange above the piston pin hub deflects oil from the under side of the crown. The piston pin is of high grade steel, case-hardened and accurately ground. It is a floating fit in the piston and is held at one end only by a tapered dowel. The bearing surface is lubricated by wipers centered and guided in the pin and shaped so as to conform with the bore of the cylinder. These wipers are held against the cylinder wall by spring pressure and serve to wipe off sufficient oil from the cylinder wall to properly lubricate the pin. An oil feed through the cylinder wall from a mechanical lubricator is directly in line with each wiper so that the pin is assured of ample lubrication.



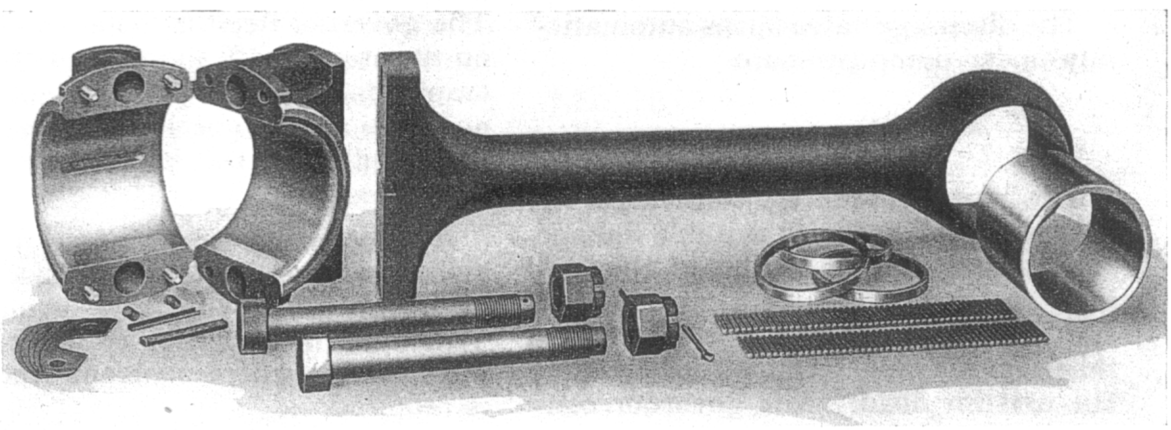
*Governor and Cams Are Arranged As A Compact Removable Unit.*

## Connecting Rod

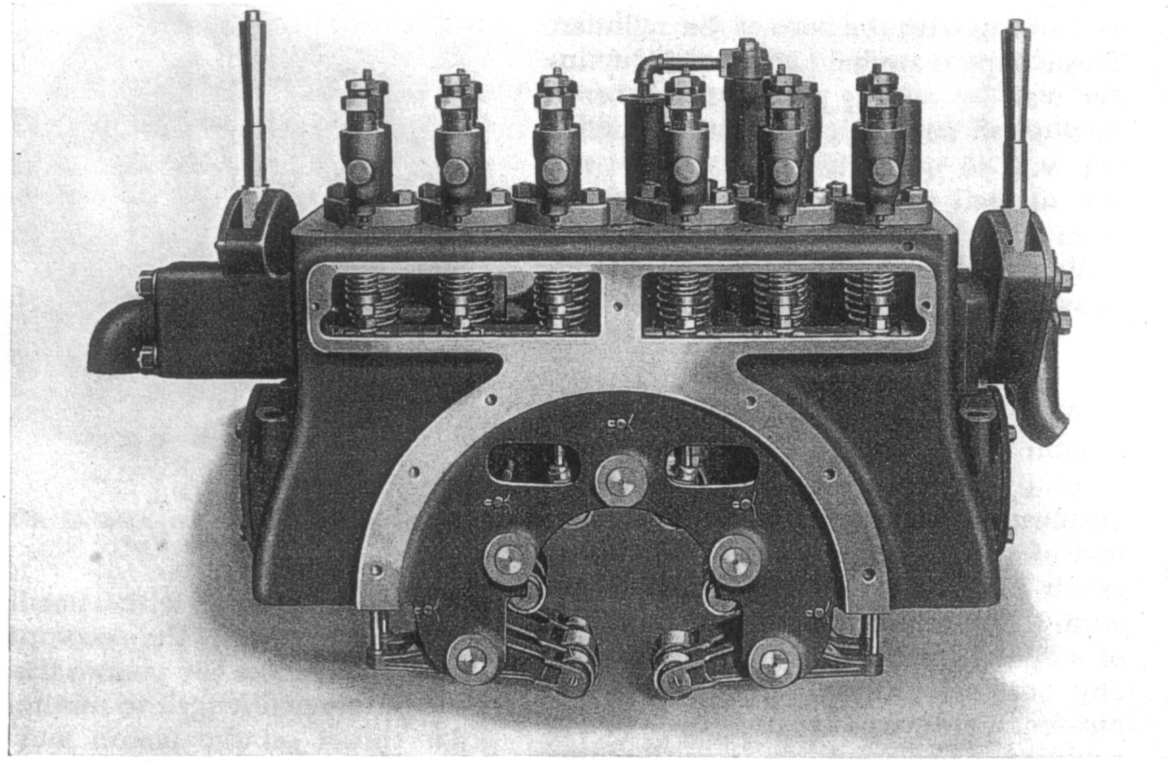
The connecting rod is die-forged from a solid billet of open hearth steel and carefully machined to gauges to assure absolute interchangeability. The "tee" end of the rod engages a babbitt-lined crank pin bearing of conventional design. The crank pin bearing bolts are of stay-bolt metal heat-treated to resist any possible fatigue. Special positive nut-locking devices are provided. Oil is supplied to the crank pin from the force feed lubricator by means of a centrifugal oil ring and through a drilled passage in the crank shaft to the bearing. The lower half of the crank pin box is provided with an oil reservoir and wick to lubricate the crank pin bearing when the engine is first started, pending the establishment of the usual supply of oil from the lubricator. The piston pin end of the rod is provided with a needle type bearing as shown in the accompanying illustration. Like the piston, the rod is made of unusual length to minimize angular thrust on the piston and hence high cylinder wall pressures.

## Fuel Injection Pump

A separate fuel injection pump is employed for each cylinder. The pump barrel and plunger are made of relatively great length to minimize the wear on these parts as well as to eliminate the necessity for stuffing boxes and glands.



*Piston Pin Needle Bearings Minimize Wear. Crank-pin Box is Permanently Aligned with Rod.*



*Pump Case Assembly for Six-Cylinder Engine Showing Compact and Accessible Arrangement.*

The plunger is of stainless steel, hardened, ground and lapped to a perfect fit in the pump barrel. Each pump is fitted with a spring-loaded inlet and discharge valve, made of non-corrosive steel. The inlet valve is under the control of the governor.

The discharge valve opens automatically under pump pressure.

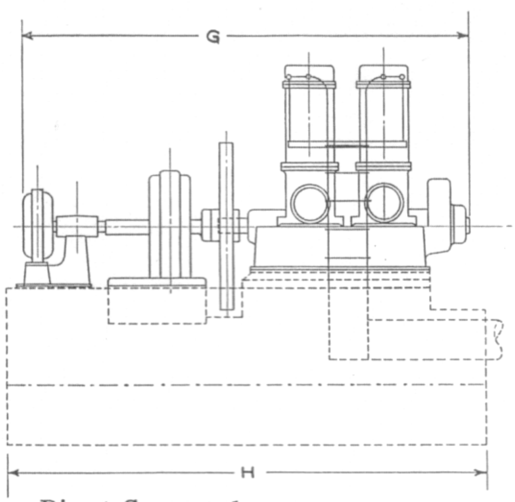
## Governor

The governor is of the centrifugal fly ball type provided with suitable linkage for transmitting its action to the fuel injection pumps in such a manner that the injected fuel is just sufficient to maintain the predetermined speed under the existing load. The governor controls the time of closing of the injection pump suction valve with relation to the injection pump plunger. The stroke of the injection pump plunger is constant and the amount of fuel delivered to the injection valve is controlled by the time of closing of the fuel pump suction valve. The governor itself is mounted directly on the crank shaft and is thus driven at crank shaft speed. The governor mechanism as a whole performs a very light duty and is, therefore, subject to very little wear.

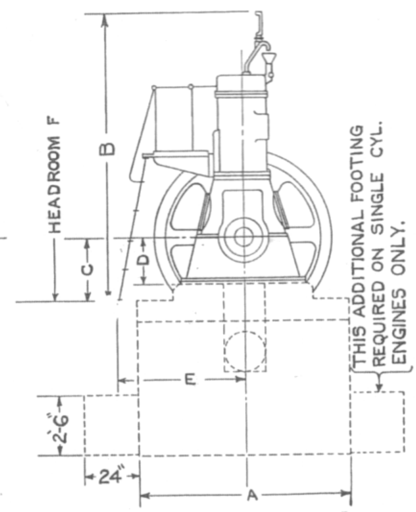
A Woodward isochronous governor (with zero speed droop at all loads) can be furnished as optional equipment. This type of governor is desirable in installations where constant frequency is required.

# Specifications and Overall Dimensions

Model 32-E engines are furnished for three standard types of drive. For commercial drive, a narrow faced fly-wheel is used. For belted electric service, the engine is equipped with a wide crown-faced flywheel for carrying the driving belt. For direct connected electric service, a special fly-wheel suitable for parallel operation of alternating current generators is used.



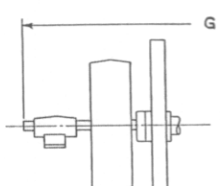

Direct Connected
Electric Drive




## Model 32-E-12

| No. Cylinders | | 1 | 2 | 3 |
|---|---|---|---|---|
| Dimension — | A | 8′ 0″ | 8′ 0″ | 8′ 0″ |
| | B | 9′ 0″ | 9′ 0″ | 9′ 0″ |
| | C | 22″ | 22″ | 22″ |
| | D | 18″ | 18″ | 18″ |
| | †E | ⊕ | 4′ 6¾″ | 4′ 6¾″ |
| | *F | 11′ 8″ | 11′ 8″ | 11′ 8″ |
| Direct Conn. Elec. Drive | G | 13′ 9″ | 16′ 2″ | 18′ 11¾″ |
| | H | 14′ 9″ | 17′ 2″ | 19′ 10″ |
| Belt Drive | G | 10′ 1¼″ | 12′ 11¼″ | 15′ 9¼″ |
| | H | 10′ 10″ | 13′ 6″ | 16′ 4″ |
| Friction Clutch Pulley Drive | G | 12′ 2¼″ | 15′ 1¼″ | 18′ 1¼″ |
| | H | 12′ 11″ | 15′ 8″ | 18′ 8″ |

Dimensions shown are for preliminary work only; for installations obtain certified plans from the Manufacturing Division. Engineering facilities are available for preliminary work where desired.

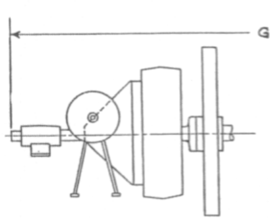



Belt Drive

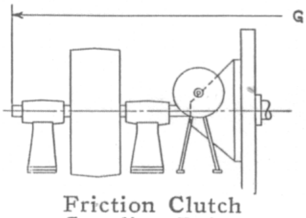
## Model 32-E-14

| No. Cylinders | | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| Dimension — | A | 8′ 0″ | 8′ 0″ | 8′ 0″ | 8′ 0″ | 8′ 0″ | 8′ 0″ |
| | B | 10′ 0″ | 10′ 0″ | 10′ 0″ | 10′ 0″ | 10′ 0″ | 10′ 0″ |
| | C | 2′ 3″ | 2′ 3″ | 2′ 3″ | 2′ 3″ | 2′ 3″ | 2′ 3″ |
| | D | 20″ | 20″ | 20″ | 20″ | 20″ | 20″ |
| | †E | ⊕ | 4′ 10½″ | 4′ 10½″ | 4′ 10½″ | 4′ 10½″ | 4′ 10½″ |
| | *F | 13′ 2″ | 13′ 2″ | 13′ 2″ | 13′ 2″ | 13′ 2″ | 13′ 2″ |
| Direct Conn. Elec. Drive | G | 13′ 10¾″ | 17′ 2¾″ | 20′ 5″ | 22′ 11″ | 25′ 10″ | 29 ″2″ |
| | H | 14′ 10″ | 18′ 1″ | 21′ 4″ | 23′ 10″ | 26′ 9″ | 30′ 1″ |
| Belt Drive | G | 10′ 9″ | 14′ 1″ | 17′ 4″ | 23′ 11¾″ | 28′ 1″ | 30′ 11¾″ |
| | H | 11′ 3″ | 14′ 7″ | 17′ 10″ | 24′ 10″ | 28′ 11″ | 31′ 10″ |
| Friction Clutch Pulley Drive | G | 13′ 1″ | 16′ 5″ | 19′ 2″ | .......... | .......... | .......... |
| | H | 13′ 7″ | 16′ 11″ | 19′ 8″ | .......... | .......... | .......... |
| Friction Clutch Coupling Drive | G | .......... | .......... | .......... | 24′ 2½″ | 28′ 6⅞″ | 31′ 3⅞″ |
| | H | .......... | .......... | .......... | 25′ 6″ | 29′ 10″ | 32′ 7″ |

†Low Mounting.
*Dimension F does not allow for hoist or crane
⊕Stairs and Hand rail not furnished on single cylinder engines.




Friction Clutch
Pulley Drive




Friction Clutch
Coupling Drive

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*Manufacturers*

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