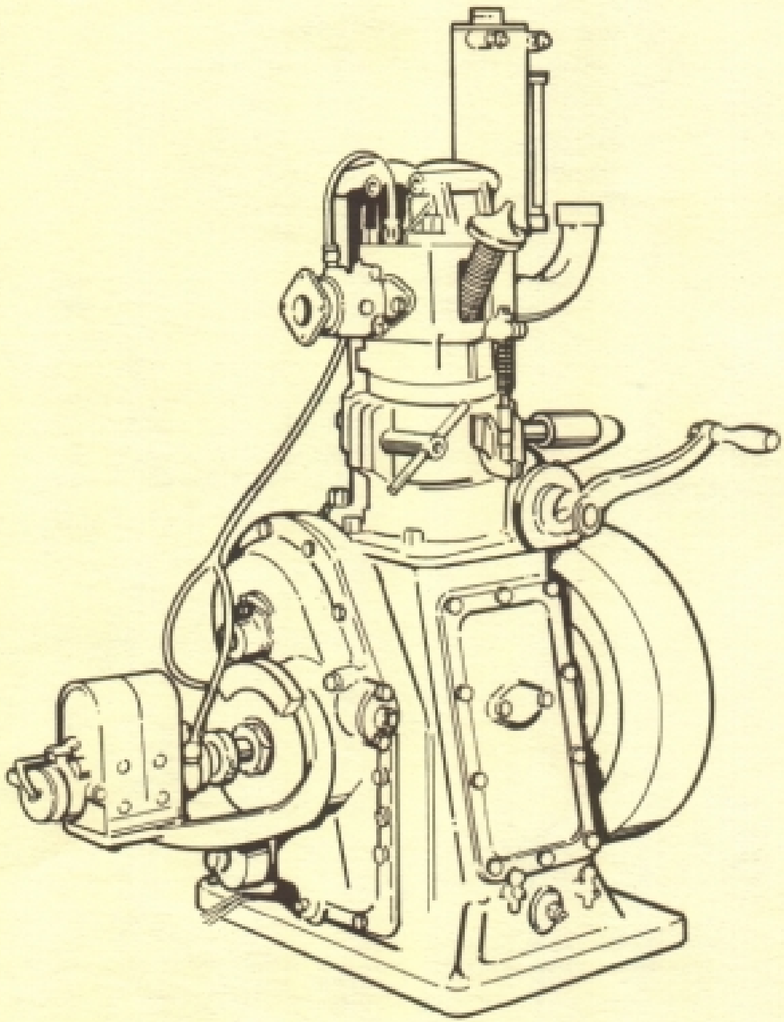
An International
Historic Mechanical
Engineering Landmark

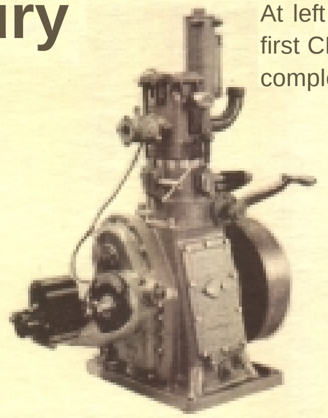
The Waukesha CFR Fuel Research Engine



Waukesha DRESSER

The CFR Engine:

A Standard of Excellence For Half a Century

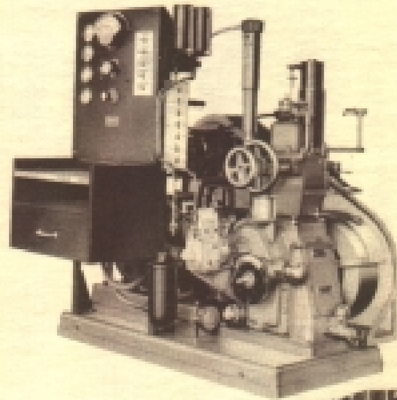


At left is the first CFR engine, completed in 1929.

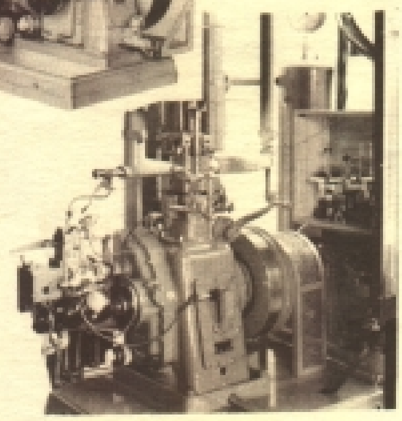
In the 1920's the Co-operative Fuel Research (CFR) Committee was formed to respond to the need for refiners and engine builders to develop a means of measuring and defining gasoline combustion characteristics. The Committee consisted of a far-sighted group of fuel producers and engine manufacturers. In 1928 the committee had reached the decision that a standardized single-cylinder test engine was needed as a first step in developing a gasoline knock-test method. In early December, 1928, the CFR Committee accepted the basic Waukesha Motor Company design, and detail drawings proceeded at once.

The first engine was designed, built, tested, and delivered to Detroit in under 45 days. It was put on display on January 14, 1929 at the Society of Automotive Engineer's Annual meeting.

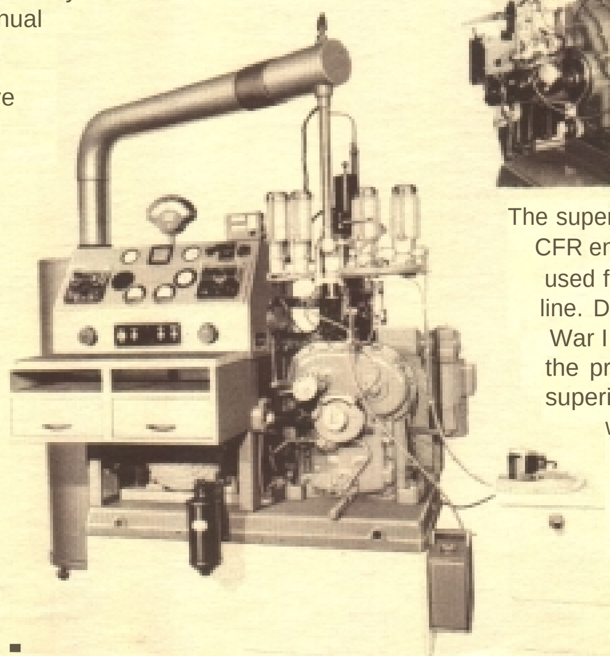
The engine improved the ability of the automotive and petroleum industries to tailor their products to perform better together, because it provided a recognized standard for defining fuel quality. It undoubtedly led to rapid evolution of both fuels and engines. These CFR engines are still sold today for basic research in such new areas as exhaust emissions and alternate fuels suitability.



This cetane rating unit at left is one of the first production diesel units. Circa 1936.



The supercharged version of the CFR engine shown above was used for rating aviation gasoline. Developed during World War II, this engine helped in the production of the Allies' superior aviation fuel, which was a decisive factor in winning the war.



This is one of the current CFR units, a motor model with water-cooled carburetor bowls.

ASME Recognition

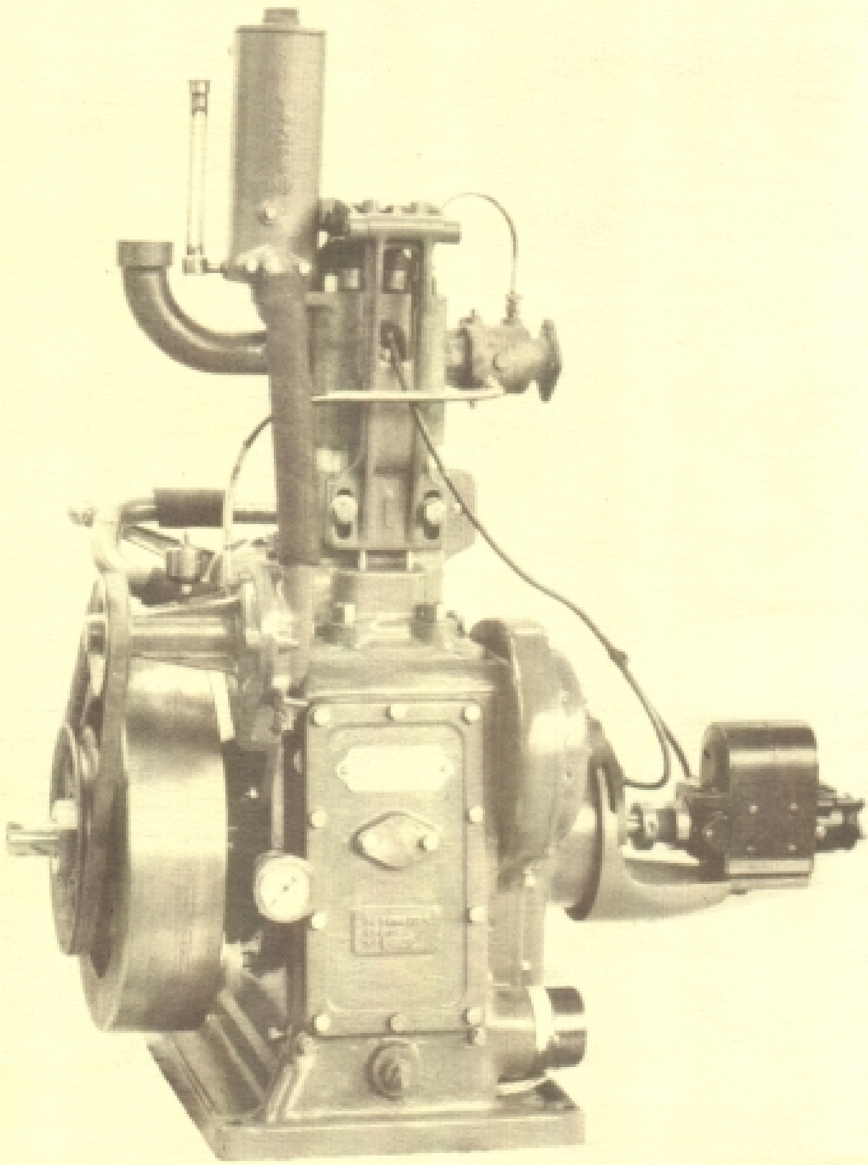
The Waukesha CFR (Cooperative Fuel Research) engine is recognized by the American Society of Mechanical Engineers as the forty-ninth in their series of historic mechanical engineering landmarks. Because of the international interest in the original CFR Committee which determined the need for this engine's development, and the engine's international usage since the very beginning, it is also the recipient of the *first* international landmark recognition by the ASME National History and Heritage Committee.

The CFR engine has been refined through the years since the first one was completed in 1929, but the basic design principles and combustion chamber characteristics remain today as they were in the beginning. Almost 5000 of these engines have been produced and sold world-wide since the first was made, with annual production around 85 engines per year. It is the longest continually produced model in the history of the company, and will undoubtedly remain in the line for years to come.

The Landmark Engine

The engine receiving this recognition is the very first prototype model which was built starting with the CFR Committee's approval of the design in early December, 1928. Detailed drawings were made, patterns and castings produced and machined and the engine completed in under 45 days to be shown at the January 14, 1929, annual meeting of the Society of Automotive Engineers in Detroit.

Howard M. Wiles, a former Waukesha research and development manager who was responsible for much of the machining and assembly of the first engine, obtained that engine after the refined design was in steady production. He preserved it at his home until the late 1960’s when he was about to retire. The engine then came back to the factory with the understanding that it would be restored and preserved for its historical value. The existence of this landmark engine today is due to the vision of Wiles in saving the engine in the early days before it was recognized what worldwide influence the CFR engine would have on the development of the petroleum refining and automotive industries.



Honor Points Up Waukesha's Tradition of Engineering Excellence

C. E. Lee, President
Waukesha Engine Division
Dresser Industries, Inc.

Waukesha Engine Division is proud of the American Society of Mechanical Engineers' designation of the CFR engine as the first international historic mechanical engineering landmark.

This honor points up our 75-year tradition of engineering innovation to meet the needs of the industries we serve.

Ever since the firm was founded in 1906 in a two story lannon stone garage on North Street in Waukesha, the company has strived to provide something better than what has gone before.

The first product was an Otto cycle internal combustion engine that was placed into marine service aboard a boat on a nearby lake.

Later, Waukesha introduced its internal combustion engines to the construction industry and the oil fields to replace steam power.

During World War I, Waukesha produced the first standard gasoline truck engines for military vehicles. In the 1920's it pioneered the L-head gasoline engine with the Ricardo type anti-knock combustion chamber, a technological development which revolutionized engine design and changed the whole trend of engine manufacturing in this country.

In the thirties, the company spearheaded wedge type non-sticking piston rings. During World War II, Waukesha did its part by meeting a variety of prime mover demands to defeat the enemy.

Its post-war diesel engines, with patented spherical combustion chambers, exclusive among American manufacturers, set a new standard for smoothness, power and efficiency.

And so the list goes on.

Today, the company is applying its reservoir of engineering expertise to the two-fold challenges of engine efficiency and emissions control.

At Waukesha, we never stop trying to convert problems of the times into opportunities to better serve our customers.

The Company and the CFR Engine

By Ivan Baxter
CFR Engine Program Manager
Waukesha Engine Division
Dresser Industries, Inc.

The Waukesha Motor Company (which later became the Waukesha Engine Division of Dresser Industries, Inc.) was formed in 1906 by Harry L. Horning, Fred Ahrens, and Allan Stebbins for the purpose of building a more reliable gasoline engine than was then available to local marine engine users. Their first engine cost $12,000 to produce and was sold for $500 to power a boat on nearby Pewaukee Lake. The reputation of this first model A engine spread and more orders came in. The four-cylinder model A was built for eight years, with improvements to enclose the gears and valve springs to make it a suitable tractor and truck engine.

By 1909, the factory was being enlarged, with further expansion in 1913. The company was powering many farm tractors, cars and trucks by the time World War I started. H.L. Horning was named chairman of the engine design committee for the Army's Class B military truck. The first of these engines was produced and shipped to President Wilson's attention in Washington in just eleven days after the specifications reached Waukesha.

Mr. Harry L. Horning was President of Waukesha Motor Company from shortly after its formation in 1906 until his death in 1936 and was an engineer of vast ability and inspiration. He hired Arthur W. Pope, Jr., as Chief Research Engineer in 1924. These two men were instrumental members of the Cooperative Fuel Research (CFR) Committee which was formed to respond to the need of refiners and engine builders to develop a means of measuring and defining gasoline combustion characteristics. In 1928 the committee had reached the decision that a standardized single cylinder test engine was needed as a first step in developing a gasoline knock-test method. In early December, 1928, the decision was made to proceed with a design, and the Fuel Research Engine was designed and built in 45 days to be ready for the January, 1929 SAE meeting! It is this engine which we have preserved at Waukesha today.

The people deeply involved at the beginning of the project were Arthur W. Pope, Chief Research Engineer, James B. Fisher, Chief Engineer, and Howard M. Wiles in the

This group photo, circa 1931, shows various cooperative fuel research committee members with the early CFR. First row from left are: A. W. Pope, Jr., J. B. Fisher, and J. E. Delong, all of Waukesha Motor Co.; K. T. Winslow, affiliation unknown; J. R. Sabina, Atlantic Refining Co.; C. B. Veal, secretary. CFR Steering Committee; N. R. White, affiliation unknown; L. A. Hunt, Ethyl Gasoline Co.; G. A. Hope, Socony Vacuum Co.; and A. C. Rodgers, National Bureau of Standards. Top row from left are: J. M. Campbell, General Motors Corp.; S. P. Marley, U. of Pittsburgh; W. G. Ainsly, Sinclair Refining Co.; W. M. Holaday, Standard Oil of Indiana; H. W. Best, Yale U.; K. L. Hollister, The Texas Co.; H. K. Cummins, National Bureau of Standards; T. C. Schulze and E. R. Rutenber, both of Waukesha Motor Co.

Experimental Laboratory. Wiles made many of the parts for the engine on a little old bench lathe in the experimental lab, including the crankshaft. This was made in five pieces (front end, rear end, two crank cheeks, and crankpin) from bar stock because there was no time to get forging dies made on such short schedule. The production run of engines had a forged nitralloy shaft after this initial engine was approved for production.

Wiles had participated in an undergraduate thesis project at Iowa State University involving the design and construction of a variable compression single cylinder engine, and he came to Waukesha after graduation with this experience and his thesis in hand and was hired in 1928. The basic design therefore probably represents an amalgamation of the ideas of Horning, Pope, and Wiles, with actual construction of numerous parts in very long days and nights by Pope and Wiles and assembly by them in the laboratory.

This engine gave the engine and fuel industries the first universally accepted standard test engine which could be produced in sufficient quantity to meet industry needs. There were other knock test engines in the running, but each of these had drawbacks which prevented universal acceptance, so that by the early 1930's most of these had gone out of use in favor of the new Waukesha CFR engine. The initial plan was that Waukesha would build 75 of these engines to satisfy the entire needs of the industry. This was changed before production began, and we have been building them ever since, and expect to produce the 5000th engine within the next two years. The engine is used world-wide and a fairly close metric copy has been produced in Russia since their trade was cut off after the lend-lease days of World War II when they obtained a number of our engines as allies.

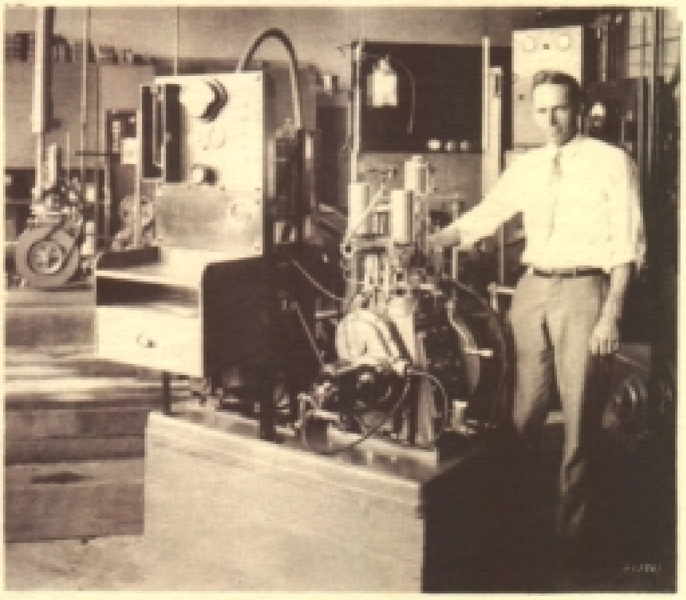
This design has survived and flourished through two upgradings of the crankcase to the present time without any change in combustion chamber shape, valve gear arrangement, or variable compression arrangement, so that a rating made on the earliest engine will still match the octane rating made on today's engine fifty years later. A number of the very first one hundred engines are still in use and well-maintained.

The means for quickly and accurately varying the compression ratio without affecting valve clearances or basic combustion chamber configuration was probably what caused this design to prevail over all other rivals. Moving the entire cylinder up and down with respect to the piston was far better than changing shims, moving a plug in the combustion chamber, or running with fixed compression as was done with some of the aforementioned other engines.

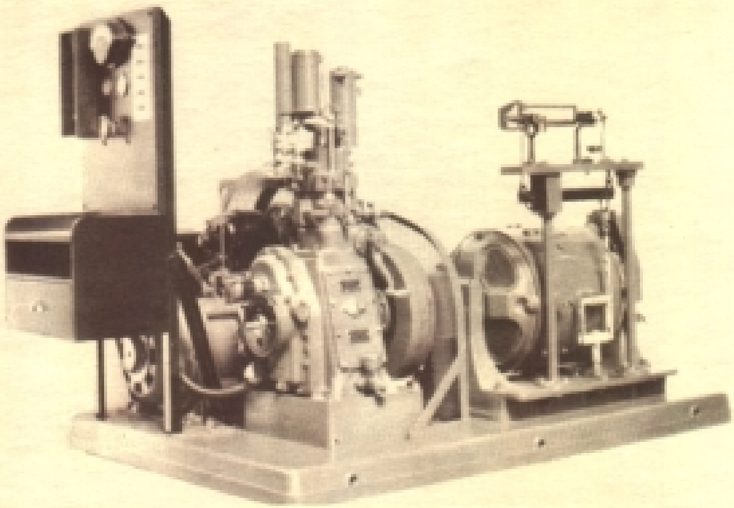
The improved ability of the automotive and petroleum refining industries to tailor their products to perform better together because of a recognized standard for defining fuel quality undoubtedly led to rapid evolution of both fuels and engines. This would have been more difficult without the octane scale and the better understanding of fuel/engine relationships which use of this engine in both industries promoted. The engines are still sold today for basic research in such new areas as exhaust emissions and alternate fuels suitability, contributing to tomorrow's problem solutions. These engines were produced on a three-shifts-per-day basis during World War II, making principally the supercharged aviation gasoline test unit which helped in the development of 100 octane and eventually 115/145 grade fuel which gave the allied air forces an edge over the axis nations which did not have such fuel at the time, thus contributing to the fall of the totalitarian powers.

Waukesha manufactured the original design from 1930 to 1948 as the low-speed crankcase design. The high-speed crankcase was made from 1936 to 1953, and the 1948 crankcase design from 1952 to the present time.

The company has developed many accessories and modifications for this engine to apply it to special uses other than knock testing and it appears to have a solid future ahead as long as piston engines are still in use.



Arthur W. Pope, Jr., with one of the first CFR production engines. Circa 1930.



This is the first CFR dynomometer unit built for the U.S. Army. Circa 1931. This unit permitted testing of fuels at various horsepowers.

Currently, the Waukesha CFR engine is offered in five basic packages according to the method of testing involved. These include:

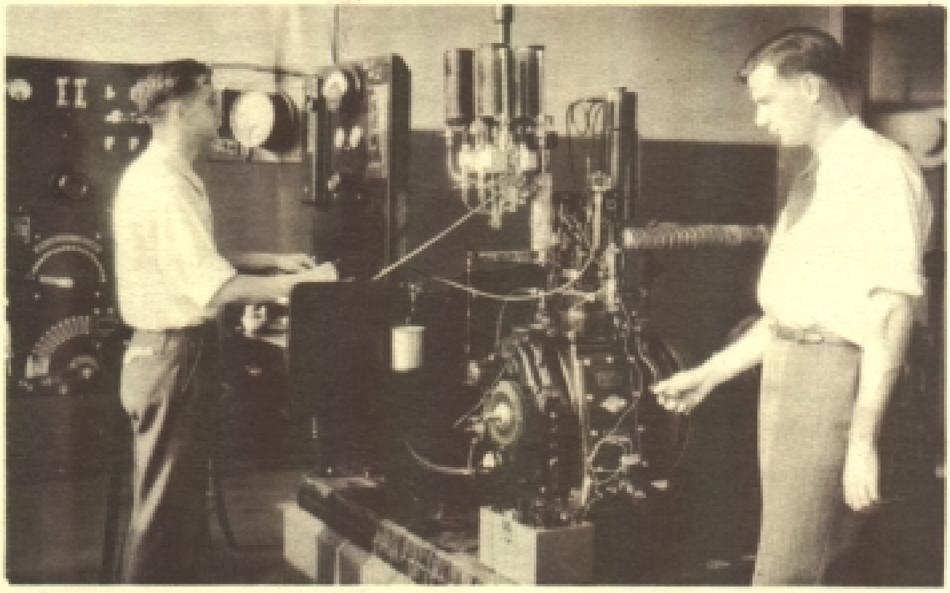
1. The motor method for rating fuels under severe engine conditions.

2. The research method for rating fuels under mild conditions.

3. The motor (LP) method, which has specification details similar to the motor unit with the addition of special equipment for rating liquified petroleum (LP) gases.

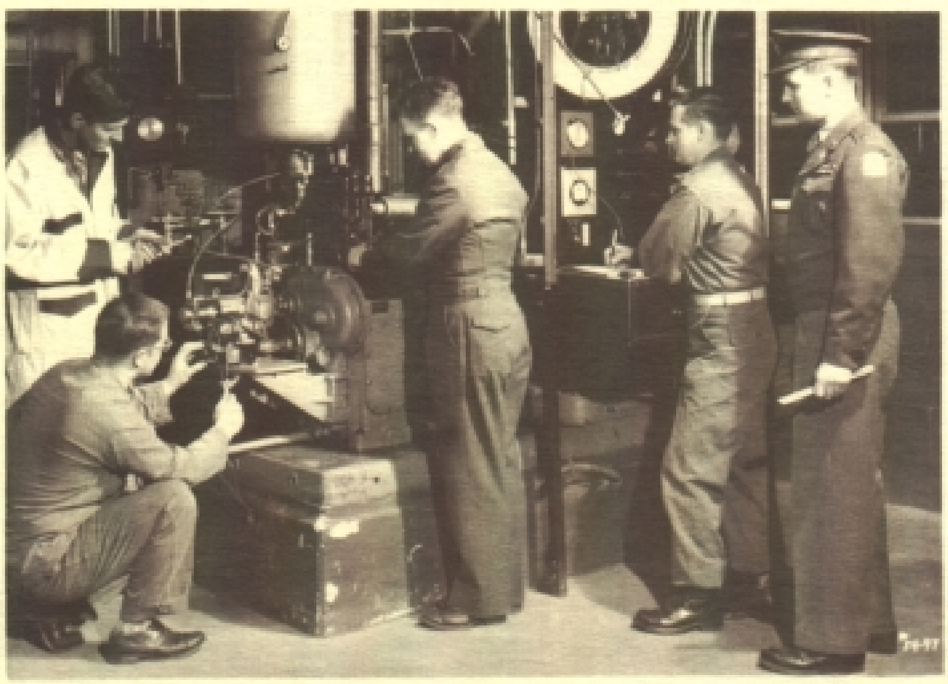
4. The diesel cetane method for indicating a diesel fuel's ignition delay (Long ignition delay, or low cetane number, generally causes engine roughness or tendency to irregular firing at light loads).

5. The supercharge method for rating aviation fuels under conditions simulating maximum power with a high fuel/air ratio.



Above, G. A. Hope, left, of Socony Vacuum Oil Co., and A. C. Rodgers, of the National Bureau of Standards, operate a CFR unit during the early 1930's in a CFR Committee evaluation program.

At right, this group is engaged in a cooperative test program at Waukesha in the early 1930's. They are validating a test procedure on the new CFR units.

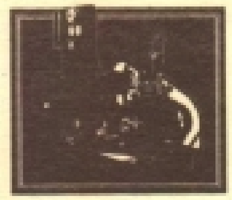


During the 1950's, the U.S. Army 983rd Quartermaster Reserve Petroleum Unit trained in the Waukesha engineering laboratory two nights per month on CFR engines. Carl Borgstrom, right, CFR assembly supervisor at Waukesha, was the lieutenant in charge.

The First Brochure

On these pages, the first brochure of the fuel research engine has been reproduced. Note that it was offered in both a variable-compression overhead valve version and a fixed-compression ratio side valve version in the beginning. The side valve version was discontinued many years ago as less usable for octane rating work.

"CFR"
FUEL TESTING ENGINE



SINGLE-CYLINDER
....LABORATORY ENGINES.
FOR FUEL KNOCK TESTING AND
OTHER LABORATORY PURPOSES
"CFR" [?]

WAUKESHA MOTOR COMPANY
WAUKESHA. . . . . WISCONSIN
Eastarn Sales Offices Eight W. 40th Street, New York City
ENGINE BULLETIN No. [850]

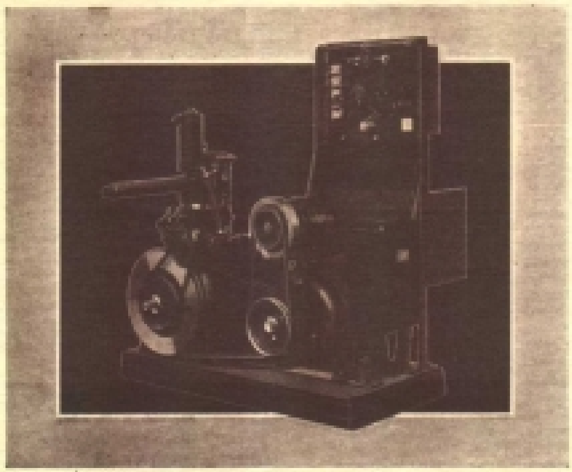


Figure 2—Rear view of complete testing Unit with Belt-Guard Removed to Show Water Pump, Induction Motor and Generator Drivers, Enclosed Magnetic Starting Switch, and flexible Exhaust Pipe with Variable Compression Integral Head Engine.

FUEL RESEARCH ENGINE

A Universal Yardstick The joint committee of the American Petroleum Institute and Society of Automotive Engineers, in studying the question of universal fuel tests, found that a standard engine for measuring fuel operating characteristics, and built to certain uniform specifications was a basic need. The fuel research engine, herein described, is the result of the joint efforts of these two engineering societies, and follows the recommendations of their Sub-Committee on Detonation. It is built to accommodate two cylinder assemblies; one for fixed compression, and one for variable compression, both interchangeable on the same crankcase.

Fixed Compression Engine The fixed compression combination (figure 3) is a simple single cylinder all head engine with three standard heads for compression ratios of 5:1, 6:1, and 7:1. For fuel refiners, this is the simplest design for the routine tests required for production control. In this form, it is also an ideal type for any laboratory study of combustion chamber shapes, as the experimentor needs only to cast a new head of whatever design is required—a relatively inexpensive procedure.

Variable Compression Engine For testing with variable compression ratios, changing cylinder assemblies converts the engine to an overhead valve type (figure 4). A hand crank which engages through a worm and screw, raises or lowers the cylinder, and a micrometer insures precise settings for any compression ration between 3:1 and 30:1. In making compression ratio changes, a compensating mechanism permits the raisking or lowering of the cylinder with respect to the piston without changing any of the valve adjustments, and a linkage between the cylinder and the spark advance lever automatically gives the correct spark position for all compression ratios. Thus, the engine need not be stopped while making compression changes. A gas-tight flexible exhaust connection accommodates itself to various cylinder positions. Two types of cylinders are available for the variable compression engines; one type is made with an integral cylinder head, the other with separately cast head. Either construction is optional with the purchaser. The variable compression cylinder with integral head is piloted by guides at each end which prevent cylinder rocking during adjustment of the compression ratio. Four springs, equally spaced around the outside of the cylinder, climinate all vertical back lash.

Long Life The engine is built with great sturdiness to insure long life and to withstand the strain of continuous detonation tests. The crankcase is of cast iron with front and rear walls one inch thick. The counter-balanced crankshaft is carried in large closely-spaced, sleeve-type bearings of double the normal dimensions for an engine of this size. Full pressure lubrication reaches the main bearings, the crankpin, piston pin, the camshaft, the timing gears and by spray, the piston and cylinder. the cast-iron piston is equipped with five rings, and is unusually long, and of heavy section. With such a long

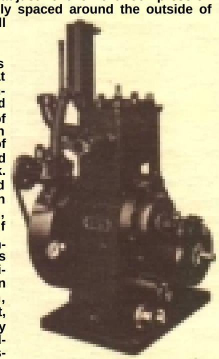
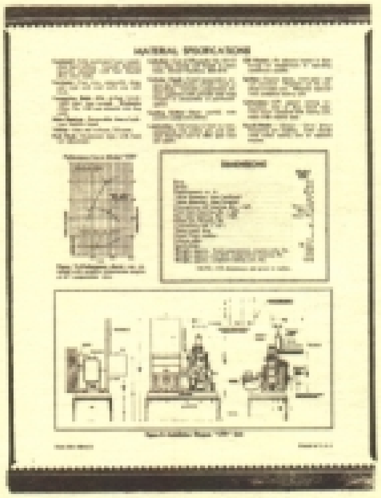


Figure 3—Fixed Compression Engine showing Battery Ignition System, Steam Cooling Condenser, and Water Pump.



piston skirt, and the long connecting rod, wear is reduced to a minimum.

Steam Cooled The engine is equipped with a steam cooling system and a built-in condenser which maintains a uniform water jacket temperature of about 208° F. A. belt driven water pump insure positive circulation. To vary the temperature, solutions of alcohol may be used for cooler-runing, while higher temperatures can be secured by using ethylene-glycol solutions.

Other Engine Features A neon tube spark position indicator, standard battery, interrupter and coil for ignition, a combination oil filler,. sight-gauge, and drain, a three-beat electric element to bring the crankcase oil up to working temperature quickly, cylinder indicator openings, a crankshaft extension for indicator drive mechanisms and a set of spare parts and wrenches are the standard accessories with which each engine is equipped. A carburetor and magneto ignition are available at extra cost.

CFR Carburetor A carburetor has been developed by the Committee, with the U. S. Bureau of Standards cooperating, which meets the special requirements of fuel testing. It is of the air-bled fuel jet type with a fixed fuel jet, and adjustable air bleed. A very small fuel jet is required, and experience has shown that adjusting the air bleed instead of the fuel jet for various mixture ratios is a more dependable and accurate method where such small fuel jets are used. It can be had with either two or four float bowls connected by quick acting valves for rapid shifting from one fuel sample to another.

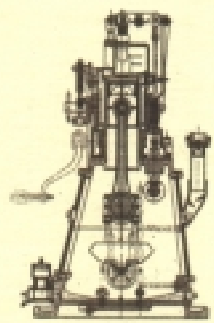


Figure 5 — End Section of Variable Compression Engine

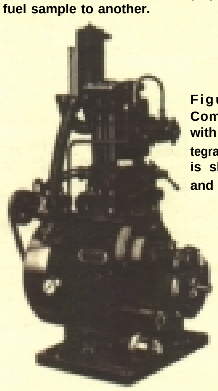


Figure 4—Variable Compression Engine with Separate Head. Integral Head construction is shown in Figures 1 and 2.

Performance Characteristics The engine stroke is 3¼ × 4½, and its performance under fuel testing conditions is shown in the curve (figure 7). The most convenient speed for fuel testing is 600 rpm, although the engine will operate satisfactorily at high speeds. To secure normal power at higher speeds, a special camshaft and a light weight piston are needed, and can be supplied.

A Complete Testing Unit A complete fuel testing unit embodying the recommendations of the Cooperative Fuel Research Committee is shown on the cover (figure 1). Mounted on a substantial cast-iron base is a fully equipped variable compression engine, complete with carburetor, magneto and all other accessories. It is belted to a special induction motor which has the constant speed characteristic of a synchronous motor, and which is mounted on a sliding base for belt adjustment. Above this is mounted a small belt driven direct current generator which serves the bouncing pin and the ignition circuits when a breaker and coil is used instead of a magneto. On the same base a frame to which is bolted an "Ebonite" panel which carries the switches, meters and gas evolution burette and engine oil pressure gauge, Below this control panel and mounted on the same angle irons is a desk with a drawer, shelf and back board. The standard equipment of this unit also includes the V-belt drives, pulleys, main line enclosed starting switch, and a grilled belt guard mounted on a substantial, well braced frame.

Knock Meter To save time in making fuel tests, an electric knock-meter is a available, which is shown in figure 1 at the top of the unit control panel. This is special equipment, and an extra charge is made for it. Bouncing pin reading can be indicated either on the standard gas evolution burette or on the knock-meter as desired. The knock-meter is especially advantageous where speed of testing is important.

Fuel Testing Technique A pamphlet is now in preparation giving the recommended practice for conducting anti-knock fuel tests as at present devised for securing the greatest possible uniformity of results. A mimeographed copy of the Committee's advice in this matter is available pending the completion of the printed pamphiet.

Your Problem If you have some special laboratory requirements, we will be glad to make recommendations, and co-operate in any practicable manner to help you to solve them.

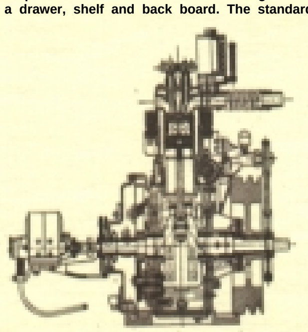


Figure 6 — Side Section of Variable Compression Engine

The First Purchasers

It was first thought that 75 CFR engines would probably satisfy the needs of all the interested laboratories. However, orders poured in after the first engine was exhibited and demonstrated, and by November 1931, the first hundred engines had already been produced.

Many familiar names appear in the list of the first 100 purchasers while others have disappeared in mergers and some are unknown today. Many of the 13 engines built for Waukesha stock were later sold to oil companies, while some were kept for laboratory and development test work.

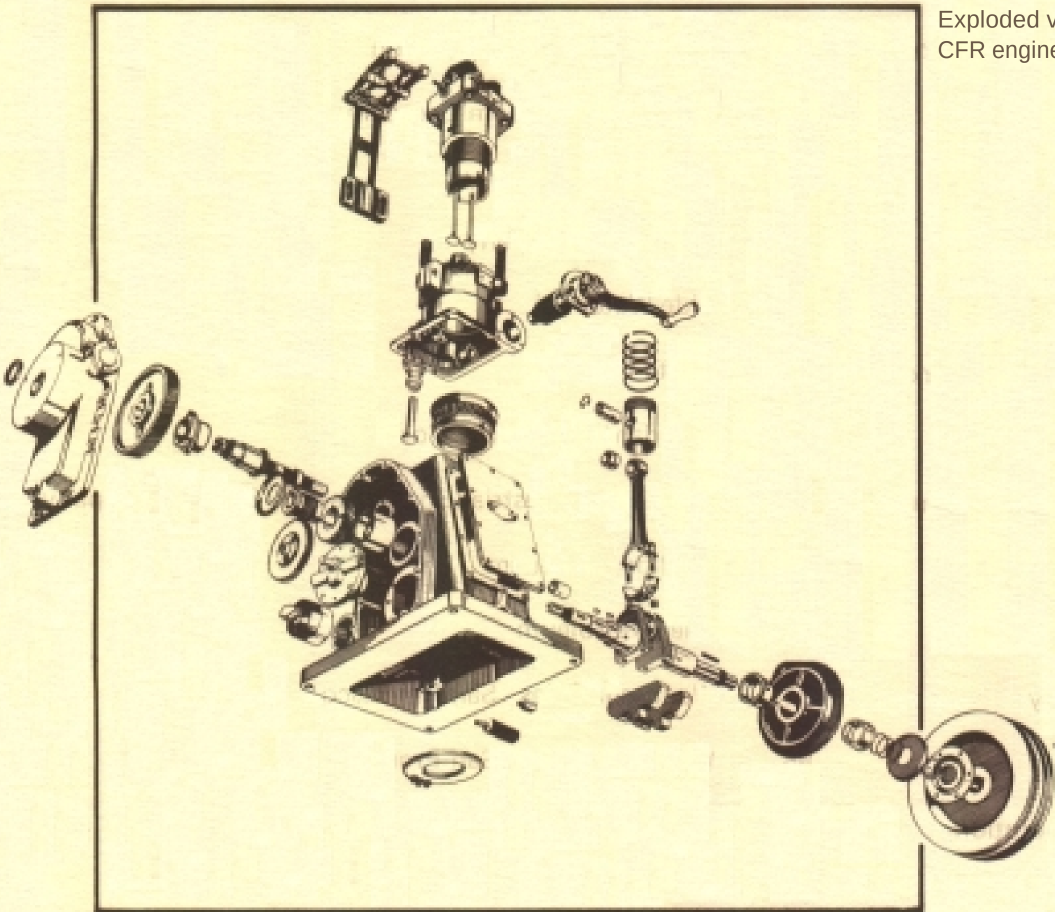
Amazingly, there are some of the engines in this first hundred which are still in regular usage today.

THE FIRST 100 CFR ENGINES AND THEIR PURCHASERS,
FROM JANUARY 7, 1929 FOR S/N 1 TO NOVEMBER 17, 1931 FOR S/N 100

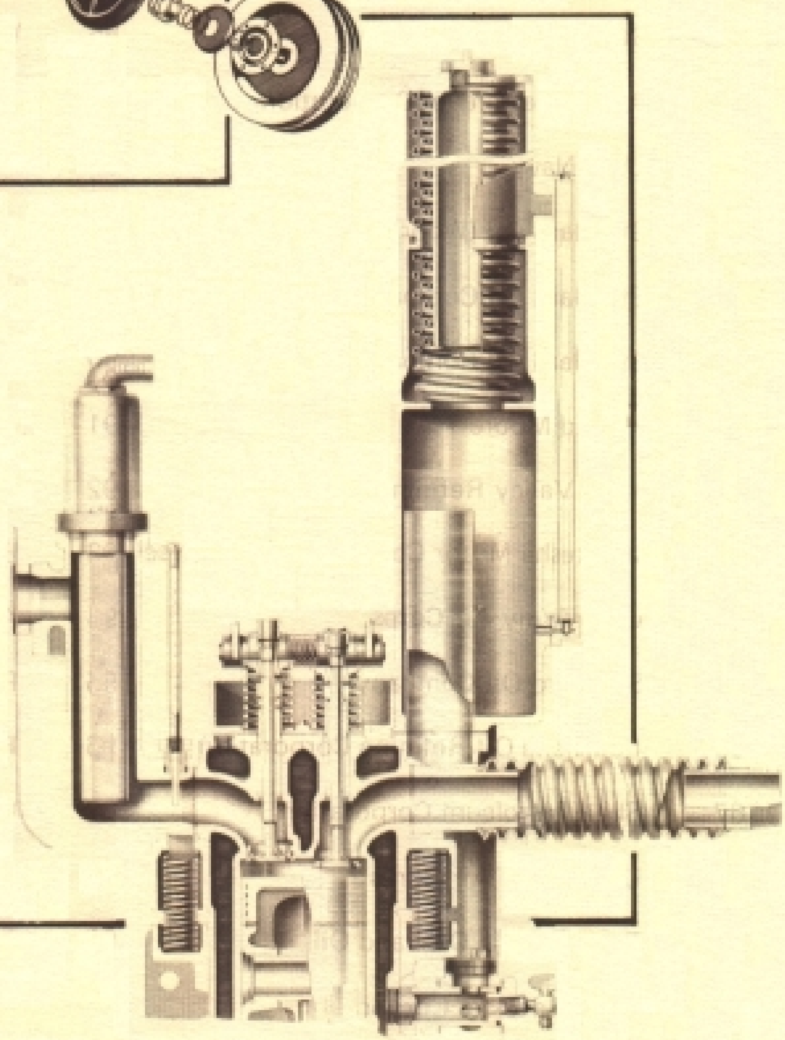
NUMBER	DESCRIPTION		
1	Waukesha Motor Company	21	Motor Fuel Products Company
2	Waukesha Motor Company	22	Gulf Refining Company
3	The Texas Company	23	Massachusetts Institute of Technology
4	The Texas Company	24	Fiat
5	Standard Oil Company	25	The Atlantic Refining Company
6	Standard Oil Company	26	Standard Oil Company
7	Bureau of Standards	27	Society of Automotive Engineers
8	Ethyl Gasoline Corporation	28	The Texas Company
9	General Motors Corporation	29	Waukesha Motor Stock
10	The Atlantic Refining Company	30	Houston Oil Company of Texas
11	Phillips Petroleum Company	31	Atlantic Refining Company
12	The Texas Company	32	Atlantic Refining Company
13	Marland Refining Company	33	Vacuum Oil Company
14	Waukesha Motor Company Stock	34	The Texas Company
15	Waukesha Motor Company Stock	35	Polytechnic Institute of Brooklyn
16	Vacuum Oil Company	36	Waukesha Motor Company Show
17	Petroleum Conversion Corporation	37	Crown Central Petroleum Corporation
18	University of Wisconsin	38	General Electric Company
19	Anglo American Oil Company Limited	39	Standard Oil Company of New Jersey
20	Shell Petroleum Corporation	40	Vacuum Oil Company (Paris)

41 Crown Central Petroleum Corporation
42 Crown Central Petroleum Corporation
43 Standard Oil Company of New York
44 The College of the City of New York
45 Waukesha Motor Show
46 Not Identified
47 The Atlantic Refining Company
48 Associated Oil Company
49 The College of the City of New York
50 Waukesha Motor Company
51 Chalmette Petroleum Corporation
52 Vacuum Oil (Cairo)
53 Yale University
54 Tide Water Oil Company
55 State University of Iowa
56 Asiatic Petroleum Corporation
57 U. S. Navy
58 Standard Oil (Wood River)
59 Standard Oil Company
60 Standard Oil Company
61 Harold Moore
62 Penn Valley Refining Company
63 Waukesha Motor Company - First Diesel
64 U. S. Army Air Corps
65 Standard Oil Company
66 Louisiana Oil Refining Corporation
67 Shell Petroleum Corporation
68 U. S. Army Air Corps
69 Texas Pacific Coal and Oil
70 Gray Processes Corporation
71 Shell Eastern Petroleum Products
72 Cities Service Refining
73 Ethyl Gasoline Corporation
74 Ethyl Gasoline Corporation
75 Magnolia Petroleum Company
76 Union Oil Company
77 Derby Oil Company
78 Tide Water Oil
79 White Eagle Oil
80 Standard Oil of New York
81 Waukesha Industrial Engine Sales & Service Company
82 Phillips Petroleum
83 Shell Petroleum
84 Waukesha Sales - San Francisco
85 Waukesha Sales - San Francisco
86 Kellogg Company
87 Independent Oil and Gas
88 Independent Oil and Gas
89 Kanotex Refining
90 Lion Oil
91 Waukesha Motor - CPI Show
92 Waggoner Refining
93 El Dorado Refining Company
94 Atlantic Refining
95 Pan American Petroleum (Lago Oil & Transport Company)
96 French Government Technical Department
97 Garber Refining Inc.
98 Phillips Petroleum
99 Ethyl Gasoline Còrporation
100 Continental Oil Company

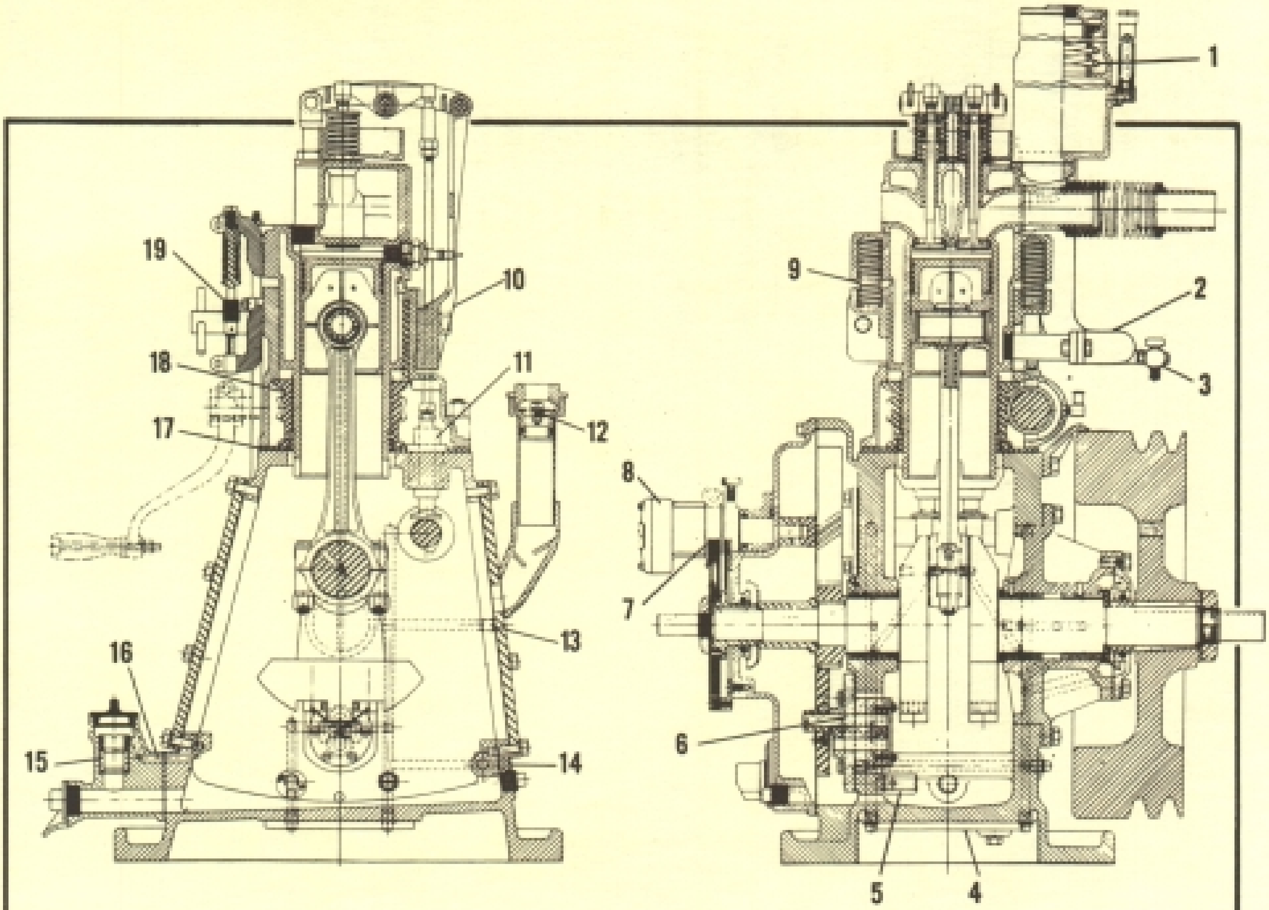
Some Drawings of Interest

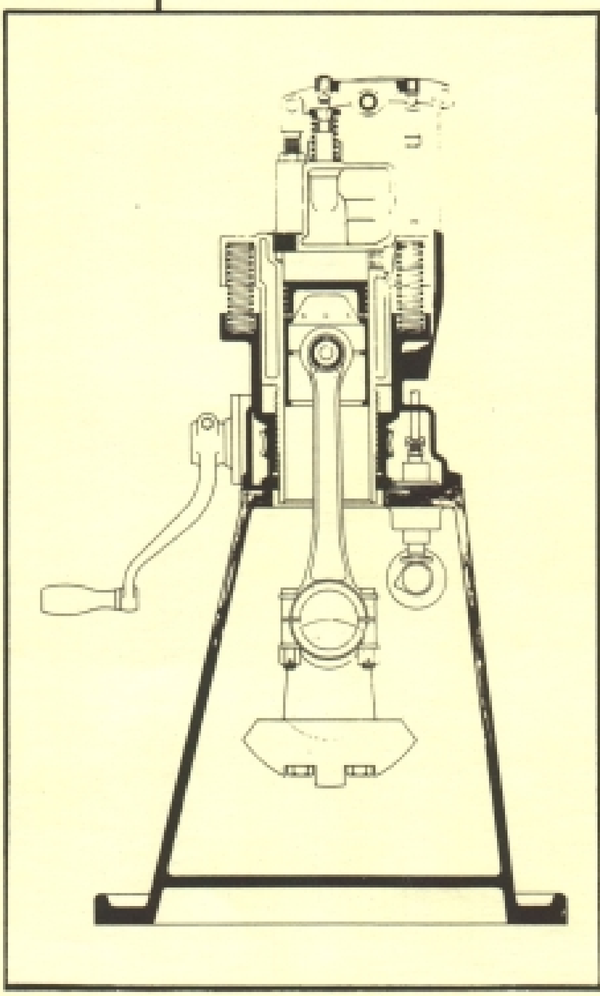


Exploded view of an early model CFR engine.



This cross section of the combustion chamber area of a motor method CFR engine shows a segment of the engine which has remained unchanged since development of the first model.





The diagrams on this page are early cross-sectional views of the CFR engine. The numbers in the drawings above refer to the following: 1) Condenser cooling coils; 2) water return from condenser to cylinder; 3) cooling water drain; 4) electrical oil heater; 5) oil pressure control valve; 6) oil pump; 7) spark timing indicator ring; 8) ignition timing unit; 9) springs to compensate for cylinder weight; 10) flexible valve gear support casting; 11) valve tappet and tappet guide; 12) crankcase breather check valve; 13) oil passage to main bearings; 14) oil pressure gauge connection; 15) crankcase oil level sight glass; 16) oil filler vent passage; 17) cylinder guide plate; 18) cylinder elevating worm gear; 19) cylinder height micrometer.

The National Historic Mechanical Engineering Landmark Program

The American Society of Mechanical Engineers re-activated its history and heritage program in September 1971 with the formation of the National History and Heritage Committee. The committee's overall objective is to promote a general awareness of our technological heritage among both engineers and the general public.

One of the committee's responsibilities is to gather data on all works and artifacts with a mechanical engineering connection that are historically significant to the profession. It's an ambitious goal, and one achieved largely through the volunteer efforts of the section and division history and heritage committees and interested ASME members.

Two major programs are carried out by the sections, under the direction of the national committee. One is a listing of industrial operations and related mechanical engineering artifacts in local historic engineering records, and the other is the national historic mechanical engineering landmark program. The former is a record of detailed studies of sites in each local area, while the latter is a demarcation of local sites which are of national significance – people or events which have contributed to the general development of civilization.

ASME also cooperates with the Smithsonian Institutution in a joint project to contribute historic material to the National Museum of History and Technology in Washington, D.C. The Smithsonian's permanent exhibition of mechanical engineering memorabilia is directed by a curator, who also serves as an ex-officio member of ASME's national history and heritage committee.

Other Historic Landmarks

Waukesha CFR Engine is the first international and 49th historic landmark to be designated since the program began in 1973. The others are:

Ferries and Cliff House Cable Railway Power House, San Francisco, Calif.

Leavitt Pumping Engine, Chestnut Hill Pumping Station, Brookline, Mass.

A.B. Wood Low-Head High-Volume Screw Pump, New Orleans, La.

Portsmouth-Kittery Naval Shipbuilding Activity, Portsmouth, N.H.

102-Inch Boyden Hydraulic Turbines, Cohoes, N.Y.

5000 KW Vertical Curtis Stream Turbine-Generator, Schenectady, N.Y.

Saugus Iron Works, Saugus, Mass.

Pioneer Oil Refinery, Newhall, Calif.

Chesapeake & Delaware Canal, Scoop Wheel and Engines, Chesapeake City, Md.

U.S.S. Texas, Reciprocating Steam Engines, Houston, Texas

Childs-Irving Hydro Plant, Irving, Ariz.

Hanford B-Nuclear Reactor, Hanford, Wash.

First Air Conditioning, Magma Copper Mine, Superior, Ariz.

Manitou and Pikes Peak Cog Railway, Colorado Springs, Colo.

Edgar Steam-Electric Station, Weymouth, Mass.

Mt. Washington Cog Railway, Mt. Washington, N.H.

Folsom Power House No. 1, Folsom, Calif.

Crawler Transporters of Launch Complex 39, J.F.K. Space Center, Fla.

Fairmont Water Works, Philadelphia, Pa.

U.S.S. Olympia Vertical Reciprocating Steam Engines, Philadelphia, Pa.

5-Ton "Pit-Cast" Jib Crane, Birmingham, Ala.

State Line Generating Unit No. 1, Hammond, Ind.

Pratt Institute Power Generating Plant, Brooklyn, N.Y.

Manongahela Incline, Pittsburgh, Pa.

Duquesne Incline, Pittsburgh, Pa.

Great Falls Raceway and Power System, Paterson, N.J.

Vulcan Street Power Plant, Appleton, Wis.

Wilkinson Mill Pawtucket, R.I.

New York City Subway System, New York, N.Y.

Baltimore & Ohio Railroad, Baltimore, Md.

Ringwood Manor Iron Complex, Ringwood, N.J.

Joshua Hendy Iron Works, Sunnyvale, Calif.

Hacienda La Esperanza Sugar Mill Steam Engine, Manati, Puerto Rico

RL-10 Liquid-Hydrogen Rocket Engine, West Palm Beach, Fla.

A.O. Smith Automated Chassis Frame Factory, Milwaukee, Wis.

Reaction-Type Hydraulic Turbine, Morris Canal, Stewartsville, N.J.

Experimental Breeder Reactor (EBR-1), Idaho Falls, Idaho

Drake Oil Well, Titusville, Pa.

Springfield Armory, Springfield, Mass.

East Wells (Oneida St.) Power Plant, Milwaukee, Wis.

Watkins Woolen Mill, Wawson, Missouri

First All Welded Steam Drum, Chattanooga, Tennessee

Georgetown Steam Plant, Seattle, Washington

Equitable Building Heat Pump System, Portland, Oregon

Shipping Port Atomic Power Station, Pittsburgh, Pennsylvania

Jumbo Nine Engine-Driven Dynamo, Greenfield Village, Dearborn, Michigan

Triple Expansion Engine-Driven Dynamo, Greenfield Village, Dearborn, Michigan

Port Washington Power Plant, Port Washington, Wisconsin

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