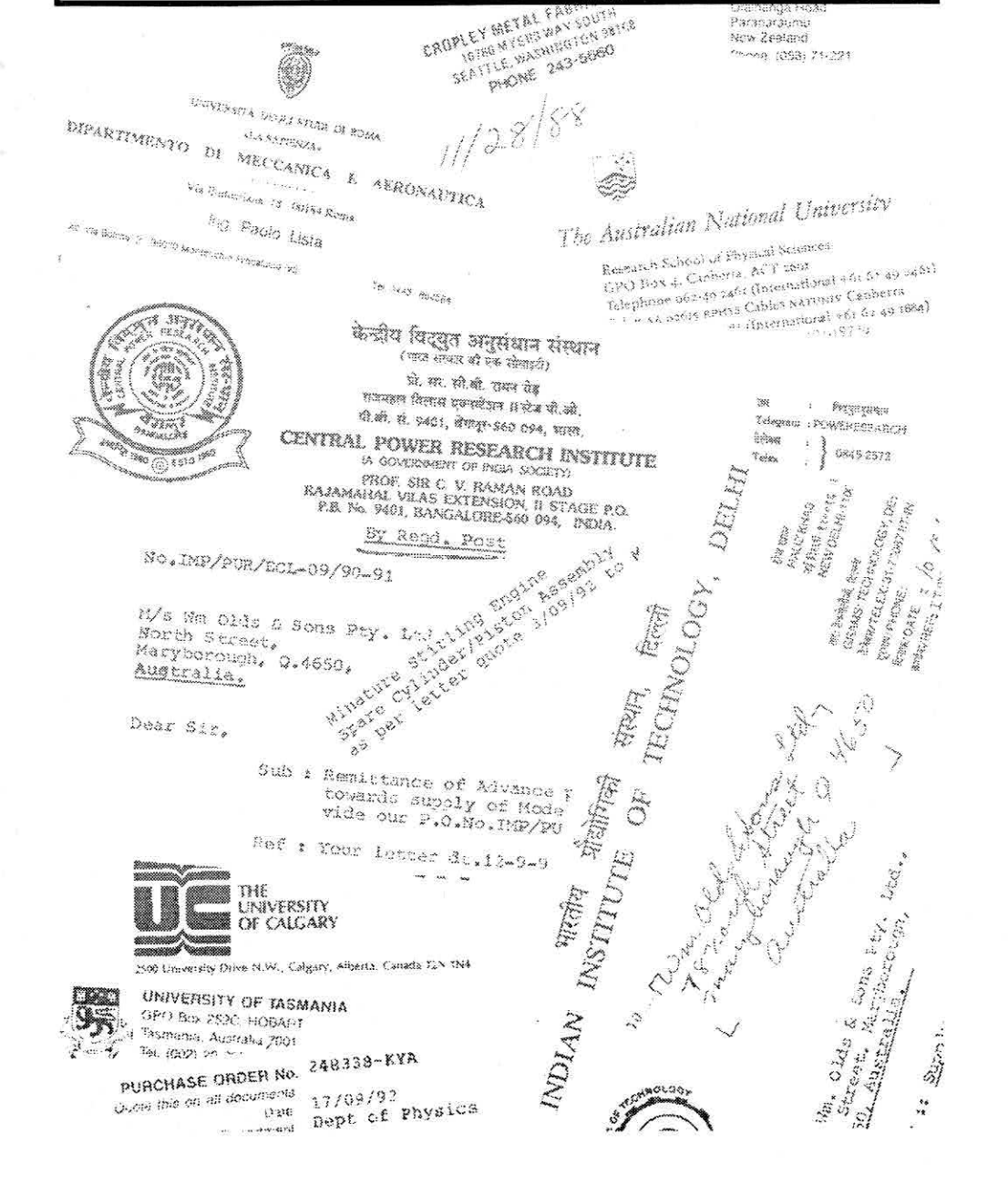
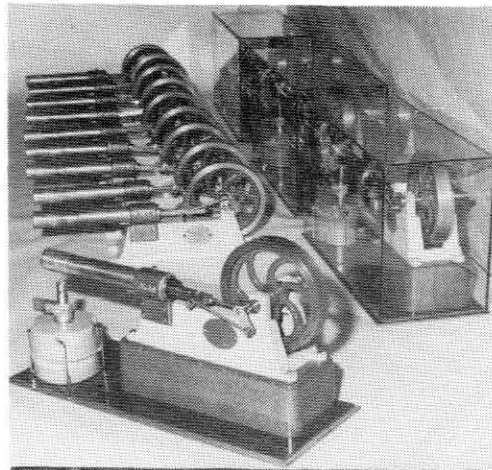
A BASIC HEAT ENGINE

BY ROBERT STIRLING - 1816



THE "HUXTABLE" HOT AIR ENGINE

A robust miniature "Stirling Engine" designed especially for educational purposes, but also makes a fine display piece and collector's item.



The 'Stirling Hot Air Engine' was the brain-child of the Rev. Robert Stirling, who was an inventor of note as well as being a Minister of the Kirk. He was granted his first patent in 1816 at the age of twenty-six - the same year he was ordained to his first parish in the Church of Scotland.

The 'Huxtable' Engine has been devised as possibly the simplest form of 'Stirling' for the express purpose of revealing the basic functioning principle to anyone with even the slightest mechanical knowledge.

Quoting briefly from Stirling's own explanation, we find it difficult to outline the cycle more simply:-

> *"I employ the Expansion and Contraction (or either) of atmospheric air or any of the permanent gases by heat and cold to communicate motion to a piston or other similar contrivance. In order to produce this expansion and contraction I cause the air to pass from a cold to a hot part of the engine and the contrary alternately either in the same passage... or in different passages."*

He goes on to say:-

> *"The passages are of course Hot at the one extremity and Cold at the other, and in passing through them the air is alternately heated and cooled or expanded and contracted."*

By loosening the small knurled locking screw and removing the cylinder barrel from the 'Huxtable' engine, the vital parts are revealed. Rotation of the engine allows us to observe how the 'displacer' (or 'transfer piston') causes the air to pass from the hot to the cold parts and vice-versa, thus causing expansion and contraction of the same air within the completely closed cylinder. Naturally the expansion and contraction of the air causes increase and decrease in pressure, which is applied to the working piston.

The crank driving the displacer is 'timed' to cause the rise and fall in pressure to apply power in both directions to the main driving crank.

Many variations of the 'Stirling' Engine have been produced, some of which are quite complicated to say the least. The 'Huxtable' Engine has been designed as an introduction to the 'Stirling'; as it has been found that very few people indeed can grasp the principle, even after having a full explanation. It is designed to promote thought about heat engines, especially in the younger generations. It was never intended to be a very efficient 'Stirling' engine, rather one that is simple and pleasing to the eye of those who appreciate machinery. The unusual and unique feature of this particular little Stirling' engine is that by being able to easily remove the cylinder all of the working parts are exposed.

The 'heated end' of the cylinder which is grooved to give additional heating surface, is virtually isolated from the 'cool end' by the very thin 'neck' machined in it for this purpose . The process of cooling is by conduction to the cast aluminium base of the engine. This arrangement in the 'Huxtable' engine is for simplicity of operation. Water cooling as in the case of pumping engines and air cooling fins used in certain designs have been normal practice in the past.

As in the internal combustion engine, heat is converted to mechanical work by the expansion of air in the working cylinder. In the case of the former, high grade fuel is mixed with the air which is to be expanded. The resulting explosion is nothing more than the very rapid heating and expansion of the air-fuel charge. Like the steam Engine the Hot Air Engine is an 'external combustion' engine. The fuel is not in contact with the internal working parts as is the case of I.C. engines; therefore all types and forms of fuels may be used. The working piston, a vital component in any reciprocating engine, is working in the cool area of the cylinder and needs no special lubrication.

An additional fitting has been produced for the engine in the form of a parabolic reflector to enable the model to be run on solar heat. The 24" diameter 'dish' fits directly over the cylinder and the specially designed tripod and mounting bracket allows this to be focused accurately to the sun's rays.

When properly focused, a brilliant white 'light' will evenly surround the end of the cylinder. It is advisable to wear protective glasses to closely look at the 'heat spot' when focusing the reflector in bright sunshine. The aluminium reflector base also gives additional cooling to the cylinder, as waste heat is conducted through it to the much larger cooling area of the dish, which is in shade.

John Ericsson, born in Sweden in 1803, developed Robert Stirling's engine principle during that latter part of his life, which was spent in America. Indeed many thousands of engines bearing his name were built during the latter part of last century and also in the early part of this century. Few people would have realised that these engines, which were used for puming water, were of a design originally developed to operate on the heat of the sun. The famous engineer was credited with numerous inventions and developments, but few could have excited him more than when he reported his success in a letter in 1873.

He wrote to his good friend Harry De Lamater of the De Lamater Iron Works:

"New York,
October 22, 1873, 18 P.M.

DEAR HARRY, : The world moves - I have this day seen a machine actuated by solar heat applied directly to atmospheric air. In less than two minutes after turning the reflector toward the sun the engine was in operation, no adjustment whatever being called for. In five minutes maximum speed was attained, the number of turns being by far too great to admit of being counted.

Having found, by long experience, that small caloric engines cannot be made to work without fail, on account of the valves getting out of order, the above solar engine is operated without valves, and is therefore absolutely reliable.

As a working model, I claim that it has never been equalled; while on account of its operating by a direct application of the sun's rays it marks an era in the world's mechanical history. You shall see it in good time.

Yours truly, J. Ericsson"

These words are taken from a volume , "The Life of John Ericsson", written by his secretary, William Church, in 1890. They could describe perfectly the result achieved when we apply the seemingly endless energy from the same old sun to the "Huxtable Engine" over 100 years later.

It is interesting to note that Ericsson, who came from a humble background, devoted a deal of his time to the study of the sun and other natural phenomena. Regarding solar engines he later wrote:

> "Those regions of the earth which suffer from an excess of solar heat will ultimately derive benefits resulting from an unlimited command of motive power, which will to a great extent compensate for disadvantages hitherto supposed not to be counterbalanced by any good.
>
> There is a rainless region extending from the northwest coast of Africa to Mongolia, nine thousand miles in length, and nearly one thousand miles wide. Besides the North African deserts, this region includes the southern coast of the Mediterranean east of the Gulf of Cabes, Upper Egypt, the eastern and part of the western coast of the Red Sea, part of Syria, the eastern part of the countries watered by the Euphrates and Tigris, Eastern Arabia, the greater part of Persia, the extreme western part of China, Tibet, and, lastly, Mongolia. In the western hemisphere, Lower California, the tableland of Mexico and Guatemala, and the west coast of South America, for a distance of more than two thousand miles, suffer from continuous intense radiant heat.
>
> We learn that 22,300,000 solar engines, each of 100 horsepower, could be kept in constant operation, nine hours a day, by utilising only that heat which is now wasted on the assumed small fraction of land extending along some of the waterfronts of the sunburnt regions of the earth. Due consideration cannot fail to convince us that the rapid exhaustion of the European coal fields will soon cause great changes with reference to international relations, in favour of those countries which are in possession of continuous sun-power. Upper Egypt, for instance, will, in the course of a few centuries, derive signal advantage and attain a high political position on account of her perpetual sunshine, and the consequent command of unlimited motive-power. The time will come when Europe must stop her mills for want of coal. Upper Egypt, then, with her never-ceasing sun-power, will invite the European manufacturer to remove his machinery and erect his mills on the firm ground along the sides of the alluvial plain of the Nile, where an amount of motive-power may be obtained many times more than that now employed by all the manufactories of Europe."

Talk everywhere of the so called "energy crisis" must surely make us think for a minute on these theories and our Creator's constant giver of life, the Sun. The fossil fuels as we know them, and which mankind seems hell-bent on consuming in a matter of a few generations, must certainly in turn owe their origin to that great bright ball in the heavens. We are told that the very oil and coal which is used in our engines or converted to electricity was formed from the early plant and animal life. Would it not then be true to say that we are burning

fossilised solar energy when we burn these fuels? Even wood, which has always been an important fuel throughout the history of mankind, and the various crops proposed for conversion to liquid fuels could not develop without sunlight.

For the care and long life of your "Huxtable" engine it should be lubricated with light mineral oil before being run. Keep it covered and free from dust when in storage and avoid overspeeding when in operation. We trust that it will cause you to reflect on the wonderful things which surround our lives and which, in many cases, we take for granted. Lastly, we hope that bright young minds might be stimulated in the endeavour to make the fullest possible use of this old World's resources. This Earth with her treasures is the only one we will ever have.

Wm Olds & Sons Pty. Ltd.
North St.,
Maryborough Qld. 4650.
Phone (071) 21-3649.

"Huxtable" the Name

The original 'Huxtable' miniature Stirling ("Hot Air") Engine was made as a special gift by Peter Olds for Mr. Robert Huxtable of Lansing, Michigan, USA. The pair had been corresponding for a number of years prior to their first meeting when Bob visited Australia in 1978. When presented with the unusual gift his immediate reaction was to enquire if a quantity could be made to supply fellow enthusiasts he knew. Production in limited numbers has continued since that time to fill orders both locally and over seas.

Throughout his long life Bob Huxtable maintained an intense interest in antique machines of all types. His enthusiasm for "Hot Air Engines" was such that he reproduced a 1906 Catalogue of "Rider and Ericsson Pumping Engines". Unfortunately the majority of these booklets were lost when the basement of his Lansing home was flooded during a very severe storm. For further explanation and understanding of these early machines a few pages of that Catalogue are again reproduced herewith from a surviving copy.

DOMESTIC WATER SUPPLY

THE IMPROVED

RIDER AND ERICSSON

HOT-AIR PUMPING

ENGINES

RIDER-ERICSSON ENGINE CO.

SUCCESSORS TO

DE LAMATER IRON WORKS
Established 1842

35 WARREN STREET
NEW YORK

40 N. SEVENTH STREET
PHILADELPHIA

RIDER ENGINE COMPANY
Established 1870

239-341 FRANKLIN STREET
BOSTON

40 DEARBORN STREET
CHICAGO

22 PITT STREET
SYDNEY, N.S.W., AUSTRALIA

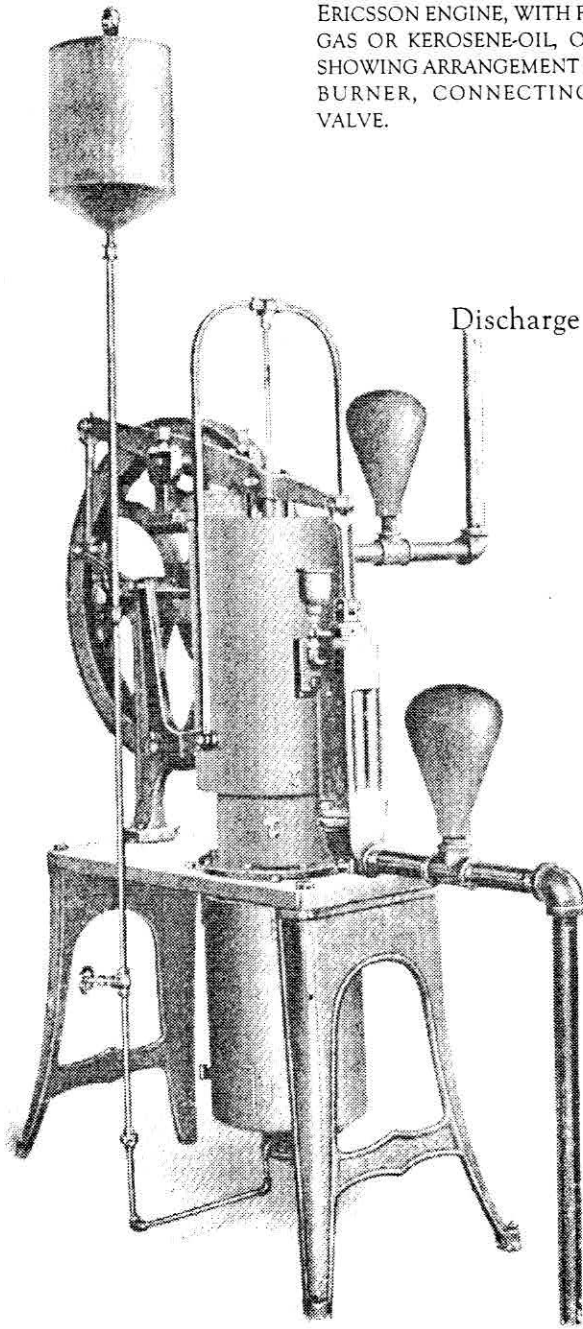
Additional copies are available from
The Robert B. Huxtable Co.
Box No. 1104, Lansing, Michigan 48904

December 1972
To Peter Oldo
from
"Bob" Huxtable

Catalogue
1906

Reprinted from Original Catalog with permission.
United States National Museum
Smithsonian Institution
Washington, D.C.

LITHOGRAPHED BY AL DYMOND COLOR SERVICE, CHARLOTTE, MICHIGAN



ERICSSON ENGINE, WITH FURNACE FOR GAS OR KEROSENE-OIL, OR GASOLINE, SHOWING ARRANGEMENT OF OIL-TANK, BURNER, CONNECTING-PIPE, AND VALVE.

The Rider Engine

THE OPERATION of the Rider Engine is briefly as follows: The compression-piston, C, first compresses the cold air in the lower part of the compression-cylinder, A, into about one-third its normal volume, when, by the advancing or upward motion of the power-piston, D, and the completion of the down stroke of the compression-piston, C, the air is transferred from the compression-cylinder, A through the regenerator, H, and into the heater, F, without appreciable change of volume. The result is a great increase of pressure, corresponding to the increase of temperature, and this impels the power-piston up to the end of its stroke. The pressure still remaining in the power-cylinder, and reacting on the compression-piston, C, forces the latter upward till it reaches nearly to the top of its stroke, when, by the cooling of the charge of air, the pressure falls to its minimum, the power-piston descends, and the compression again begins.

The Operation of the Rider Engine

In the meantime the heated air, in passing through the regenerator, has left the greater portion of its heat in the regenerator-plates, to be picked up and utilised on the return of the air toward the heater.

We have several styles of water-pumps for use in connection with these engines. Generally, however, the engine is placed near the source of water - supply, and is furnished with the Rider Rolling- valve Pump bolted to the cooler.

The Pump

The pump is made in two pieces. The upper or main part contains the delivery-valves, and also the barrel, which is a seamless drawn brass tube.

The lower chamber, to which the suction-pipe is attached, contains the suction-valves, and is bolted, as shown, to the main part.

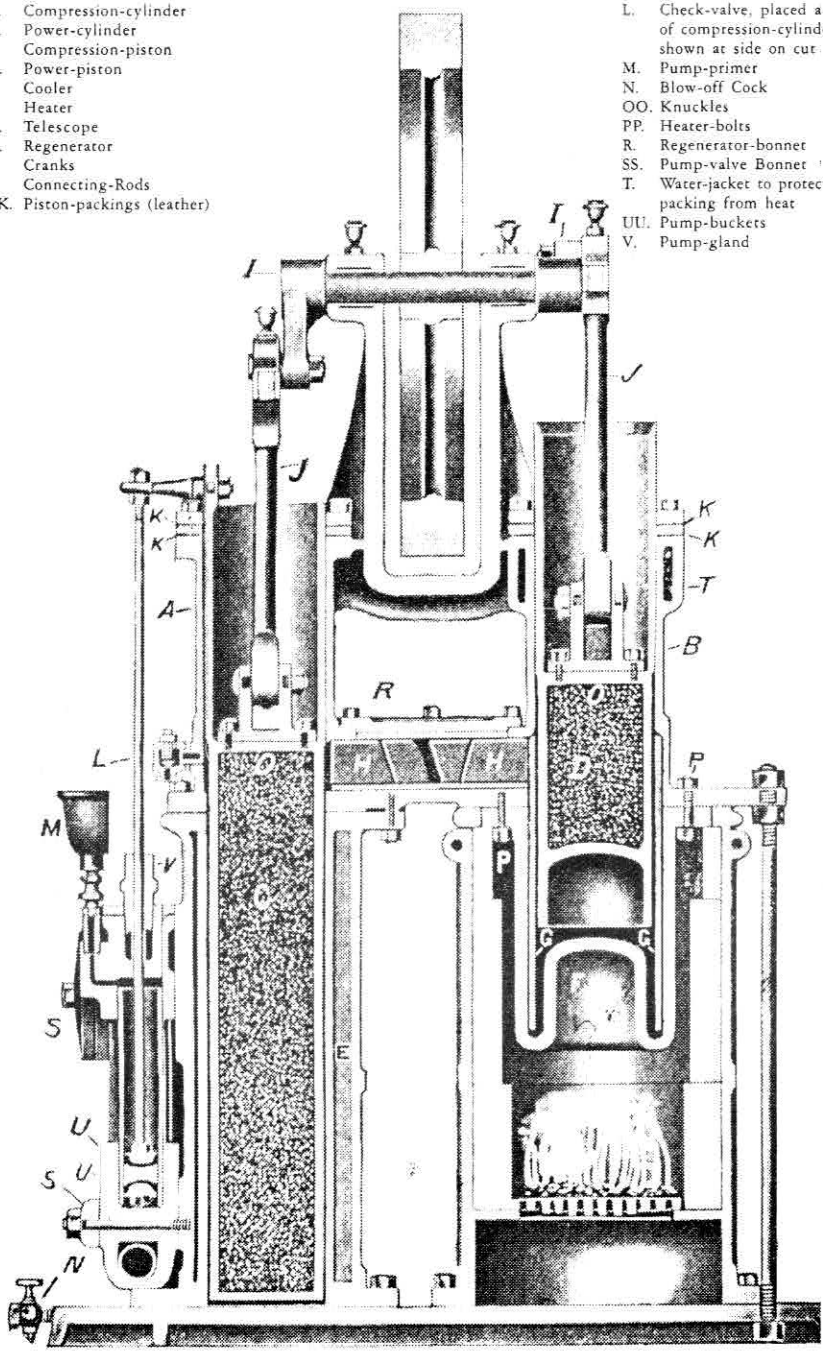
The bucket is provided with two reverse-cup leathers ; the rod passing upward through the stuffing-box is connected to an arm on the cold piston, as may be seen by referring to the cut of the engine. The pump is held to the cooler by two bolts, which are long enough to go through and secure the bonnets over the valves.

DESCRIPTION

A. Compression-cylinder
B. Power-cylinder
C. Compression-piston
D. Power-piston
E. Cooler
F. Heater
G. Telescope
H. Regenerator
II. Cranks
JJ. Connecting-Rods
KK. Piston-packings (leather)

DESCRIPTION

L. Check-valve, placed at back of compression-cylinder, but shown at side on cut
M. Pump-primer
N. Blow-off Cock
OO. Knuckles
PP. Heater-bolts
R. Regenerator-bonnet
SS. Pump-valve Bonnet
T. Water-jacket to protect packing from heat
UU. Pump-buckets
V. Pump-gland



Sectional View of Rider Engine

The Ericsson Engine

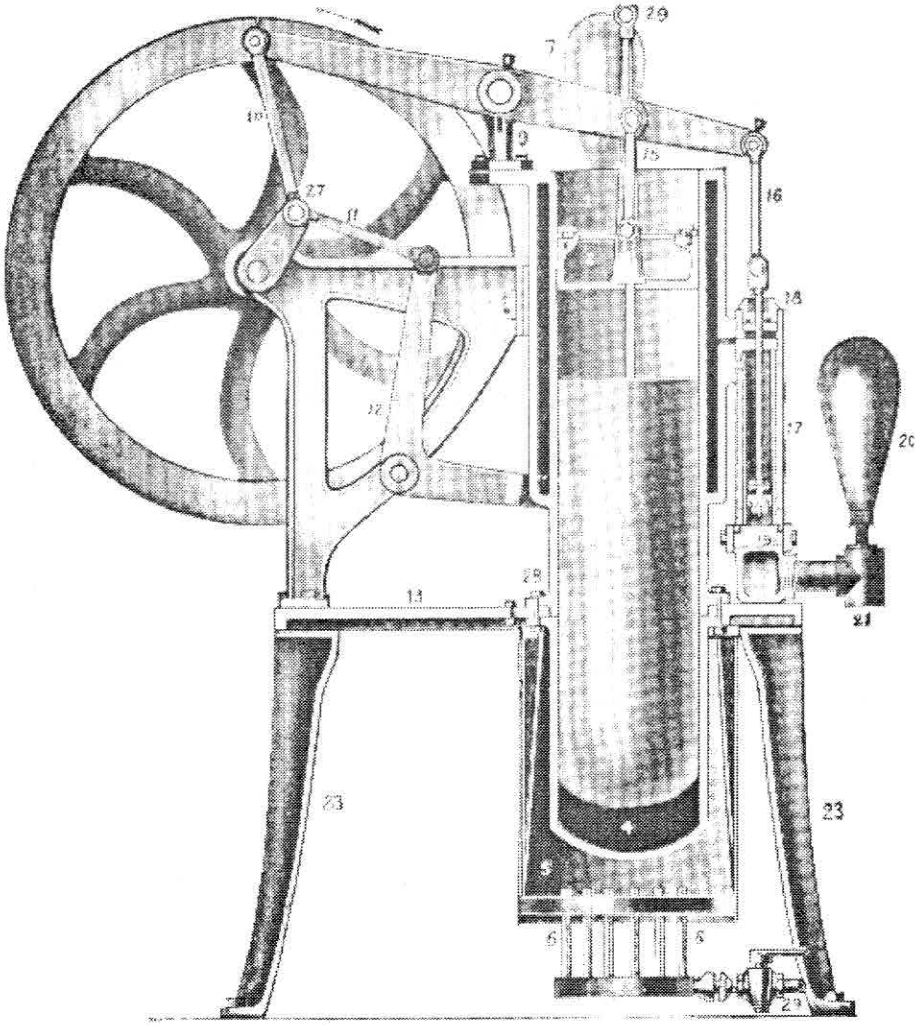
THE ERICSSON Hot-air Pumping-engine is a single-cylinder engine in which are two pistons, one called the main or air-piston, which receives and transmits the power, and the other called the transfer-piston, the office of which is to transfer the air contained in the machine alternately and at the proper time from one end of the cylinder to the other.

The cylinder is provided at its upper end with a water-jacket, through which all the water passes on its way from the well to the tank. This keeps the upper end of the cylinder cool, while the lower end is exposed to the fire and becomes as hot as it is practicable to make it. By the peculiar arrangement of connections between the air and transfer-pistons, the proper relative motions between these pistons are obtained.

The operation is as follows: After the lower end of the cylinder has been sufficiently heated, which takes only a very few minutes, the engine must be started by hand by giving it one or two revolutions. The air contained in the machine is first compressed in the cold part of the cylinder; it is then transferred to the lower end, where it is instantly heated and expanded, thus furnishing the power.
This engine, like all other hot-air engines, is only single-acting. The momentum of the fly-wheel continues the revolution until it receives an additional impulse by the repetition of the above mentioned conditions, which occur once in every revolution. The same air is used continuously, and is cooled, compressed, heated, and expanded in the regular order and without noise.

Furnace and Fuels

The furnaces of the Ericsson Engine are arranged for burning any kind of fuel. When gas or any liquid fuel is used the furnace shown on page 4 is used; but when coal and wood are used a very heavy cast-iron furnace, thoroughly lined with the best fire-brick and provided with a dumping-grate, is used, as shown on page 6. Either style of furnace may be substituted for the other without removing any other part of the machine.



Sectional View of the Ericsson Engine

1. Cylinder
2. Air-piston
3. Transfer-piston
4. Heater
5. Furnace
6. Gas-burners
7. Air-chamber
8. Main-beam
9. Beam-center Bearing
10. Connecting-rod
11. Bell-crank Link
12. Bell-crank
13. Bed-plate
14. Fly-wheel
15. Air-piston Link
16. Pump-link
17. Pump-chamber
18. Pump-gland
19. Suction-valve
20. Vaccum-chamber
21. Suction-pipe
22. Pump-bottom
23. Legs
24. Gas-cock (not furnished by us)
25. Crank-shaft Bracket
26. Crank
27. Crank-pin
28. Heater-bolts
29. Transfer Piston-rod Cross-heads

RIDER AND ERICSSON ENGINES

pump water into elevated tanks, from which it flows by gravity to any part of the premises. These engines are perfectly safe and can be run without previous experience by any person who can build a little fire, and they will work for ten hours with no more fuel than would be necessary to START up steam in a boiler.

Having no valves, steam, exhaust or noise, they can be used where no other device would be tolerated.

A small Rider or Ericsson engine will pump as much water as a windmill of the proportions shown in this illustration, and pump it WHEN it is NEEDED, independent of wind or weather.

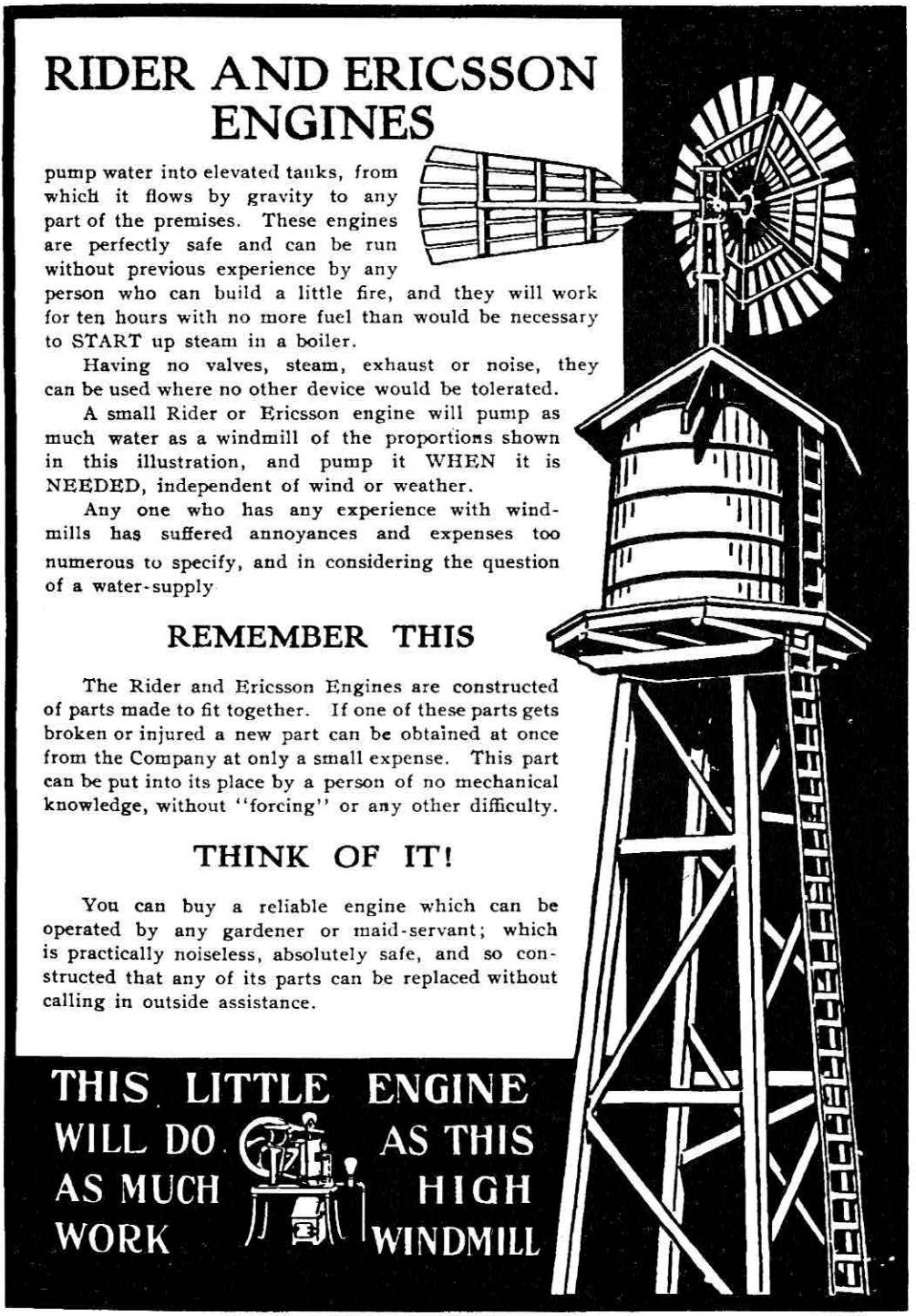
Any one who has any experience with windmills has suffered annoyances and expenses too numerous to specify, and in considering the question of a water-supply

REMEMBER THIS

The Rider and Ericsson Engines are constructed of parts made to fit together. If one of these parts gets broken or injured a new part can be obtained at once from the Company at only a small expense. This part can be put into its place by a person of no mechanical knowledge, without "forcing" or any other difficulty.

THINK OF IT!

You can buy a reliable engine which can be operated by any gardener or maid-servant; which is practically noiseless, absolutely safe, and so constructed that any of its parts can be replaced without calling in outside assistance.



THIS LITTLE ENGINE WILL DO AS MUCH WORK AS THIS HIGH WINDMILL

OLDSMOBILE 75th ANNIVERSARY PARADE
LANSING, MICHIGAN

AUGUST 19, 1972

Interesting Association

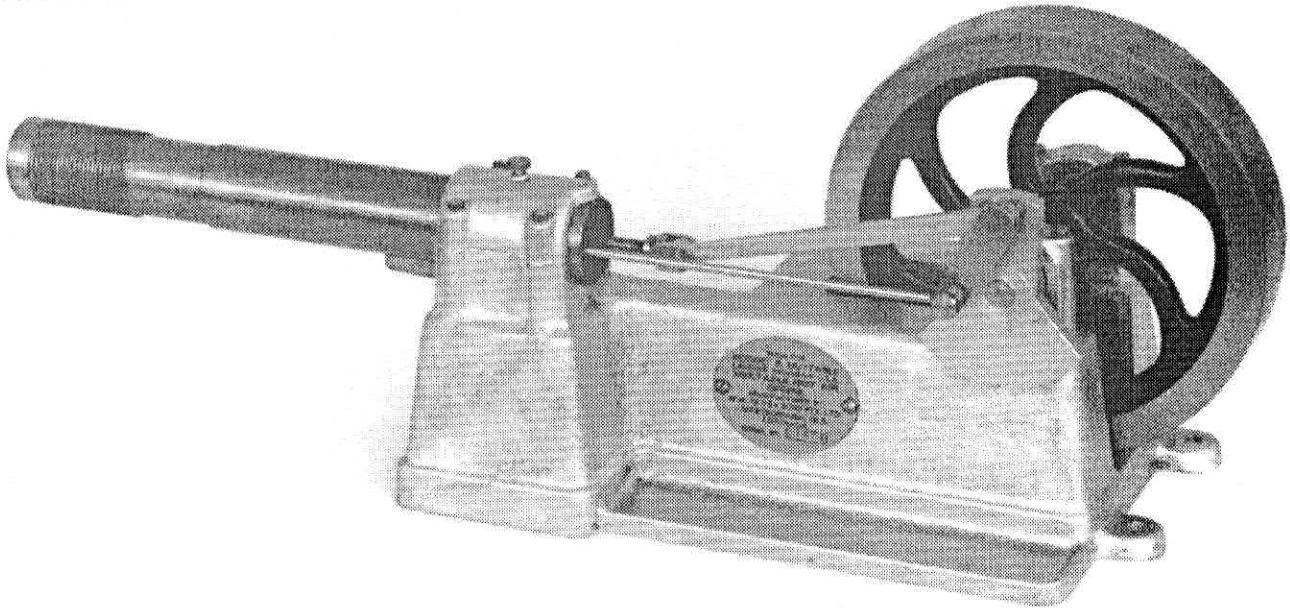
Bob Huxtable was born in Lansing, Michigan in 1897. He was interested in machinery of all kinds but his first love was for antique automobiles especially Oldsmobiles. In the above picture he is shown leading the Oldsmobile 75th Anniversary Parade in Lansing in 1972 in his 1901 "Curved Dash Olds". With Serial No 20 it was the oldest car in the procession.

His association with Wm. Olds & Sons began after he acquired a single cylinder OHV marine engine built by the Australian Company. He contacted the firm with a request to produce replica brass carburettors for early Oldsmobiles similar to those in the above photograph. Many were in various stages of restoration in USA and other countries and in most cases the carburettors were missing. The Maryborough firm continued to make and export the carburettors for many years, even after the passing of Robert Huxtable in 1991 aged 94.

The Huxtable Miniature Stirling Engine

1" (25.4 mm) bore & stroke - Weight 2.7 Kg.

Featuring - Removable brass cylinder
Ball bearing mounted crankshaft
5½ " (140mm) diameter cast iron flywheel
Cast aluminium base



Manufactured by:- **Wm. Olds & Sons Pty. Ltd.**
78-80 North Street,
Maryborough, Qld. 4650
Australia.
P. O. Box 30, Pallas St. Maryborough Qld. 4650
Phone: (071) 21 3649 Fax: (071) 233 590

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