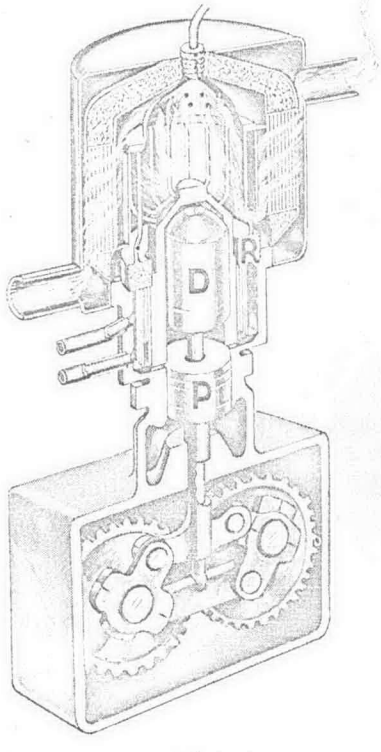
Regenerative Thermal Machines

by THEODOR FINKELSTEIN

Invented almost 150 years ago as the Stirling engine, regenerative thermal machines promise efficient power generation and performance of other useful functions for today's technology.



A modern 40-horsepower version of the Stirling engine. Like the original, shown on the next page,, this engine has a displacer (D), a regenerator (R), and a piston (P). In the laboratory, this modern engine was reported to have an over-all efficiency of 39 per cent.

REGENERATIVE UTILIZATION OF thermal energy is a scientific principle currently under intensive study for applications as diverse as outboard motors and infrared cell coolers, air conditioners and irrigation pumps. Thermal machines based on this principle are extremely versatile. They can convert heat energy to mechanical power or can elevate heat energy to a higher temperature level by a basic process which is much more efficient than that used in conventional devices.

Modern machines are usually quite different from their original prototypes; not only are they more efficient, but almost invariably they have had so much technical development that they no longer resemble the earliest design. With regenerative thermal machines, this is not the case. The original of these machines, built more than 100 years ago, was in many respects superior to later designs and has not been equalled until recently.

In 1816, Robert Stirling, a young Scottish minister who had just been assigned to his first parish, invented the engine shown on page 4. The caloric theory was then still current, but the design was so much ahead of scientific knowledge at the time that about thirty years passed before a theory was developed which could explain how the engine worked. Even today some engines under development still use a nearly identical design, like the very recent example shown on this page, where the only important difference between the prototype and the modern version is merely an improved link mechanism.

Stirling's patent became void due to a technicality, and although similar machines came into use later, no record of the invention was found until recently. When Stirling patented his invention, it was necessary not only to "seal" an invention but also to "enroll" it by copying the specifications onto parchment and stitching this skin to the end of the preceding patent, making one long continuous roll. Stirling's invention is not included in the rolls stored at the Patent Office in London, and the only official record of his invention was the title entered in the ancient "Docquet Book of the Great Seal" for patents granted up to 1852. No mention was made of Stirling's invention in the literature during the next hundred years, though at one time these so-called "caloric engines" were quite common, and 50 U.S. daily papers were printed on presses powered by them. All these later engines had inferior designs and more than 100 years passed before Stirling's specifications turned up again.

The principle of regenerative thermal machines applies to many different designs, and the configuration illustrated is only one example of many possible prac-