ENGINEERING

Steel and Fuel Saved for War

Recent Advances in Steam, Water and Wind Power Reduce the Fuel and Metal Needed for Industry

By DR. MORTON MOTT-SMITH

See Front Cover

A KILOWATT saved is a kilowatt earned—for it means that a brand-new kilowatt can be added to the vast amount of electrical power needed to carry on our war production.

One way to save kilowatts is to increase the efficiency of the engines that produce them, thus saving fuel and steel that can be used to produce more kilowatts or to produce more tanks and explosives.

Spectacular advances have been made in recent years in the efficiency of power generators. The most important of these have been described by Dr. Lionel S. Marks, emeritus professor of mechanical engineering at Harvard University, in lectures at several universities and colleges throughout the country. The lectures were given under the auspices of the Society of the Sigma Xi, national fraternity for the promotion of scientific research.

Thus Dr. Marks described a large steam-turbine plant that has attained a thermal efficiency of 33.5% from coal to electrical output, a record for this sort of engine. The engine uses steam at the almost unheard-of temperature of 1000 degrees Fahrenheit and at a pressure of 2300 pounds per square inch. This steam is nearly 300 degrees above the critical temperature, about 705 degrees, at which steam and water refuse to live together.

A few years ago, this development would not have been possible. The metals then available could not be used above 700° because they became too soft, too plastic. But new alloys have been developed that make large scale commercial operation at 1000° feasible. And this is the reason for the higher efficiencies, for the thermal efficiency attainable depends primarily on the top temperature that can be used in the engine.

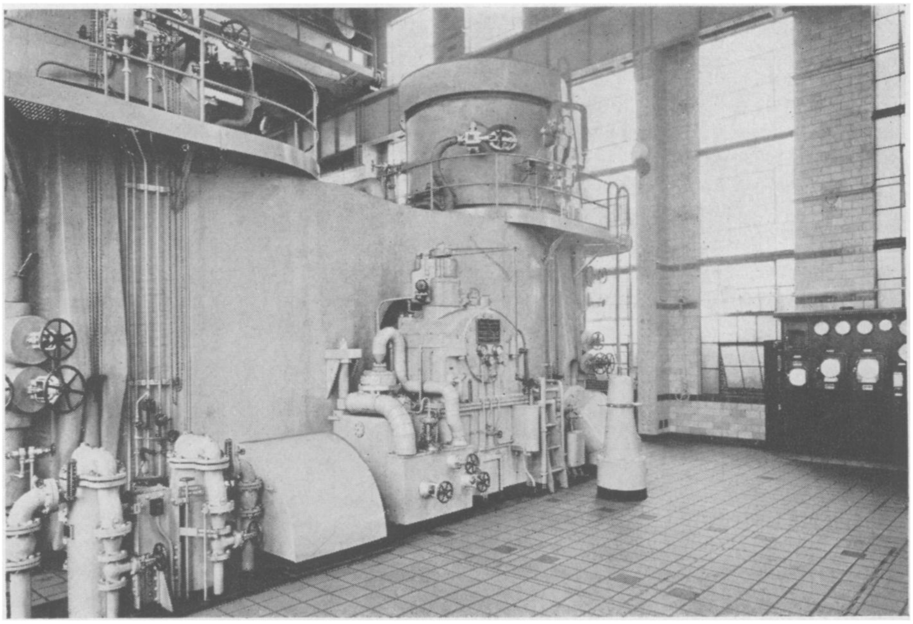
On the other hand, the development of these new alloys has been made possible largely through the extensive introduction of the electric furnace and the induction heater. The electrically heated metal is not tarnished in variable and uncertain ways by the products of fuel combustion blown through the melt. Much higher temperatures can be attained by the use of electrical methods and a far more accurate control of the heating is possible. This increased use of electricity in the metals industries accounts for a large part of the huge demand for the "juice" in the war industries.

But the highest record of efficiency of any plant for the conversion of heat into electrical energy, higher even than the famed Diesel engine, has been made by a mercury-steam turbine. A 20,000-kilowatt plant of this sort has developed a thermal efficiency of 37.5%. And this was not a sudden spurt or a test made under the most favorable conditions. It is based on tests made during 15 months of actual and almost continuous operation. This means that one kilowatt hour or 1-1/3 horsepower-hours of electrical energy were developed for every half pound of coal. Thus a handful of coal would run a 40 watt lamp continuously for a day and a night—24 hours. If you burned the coal in any other way, you could never get so large an amount of light from it.

This dual system, now after 30 years of experimentation brought to perfection, uses mercury vapor in place of steam in the higher temperature range. At 1000°, the pressure of saturated mercury vapor is only 180 pounds per square inch. The vapor is expanded in a turbine down to one pound pressure, at which its temperature is 458°. The vapor is then used to raise steam to 460 pounds pressure and this steam drives another turbine.

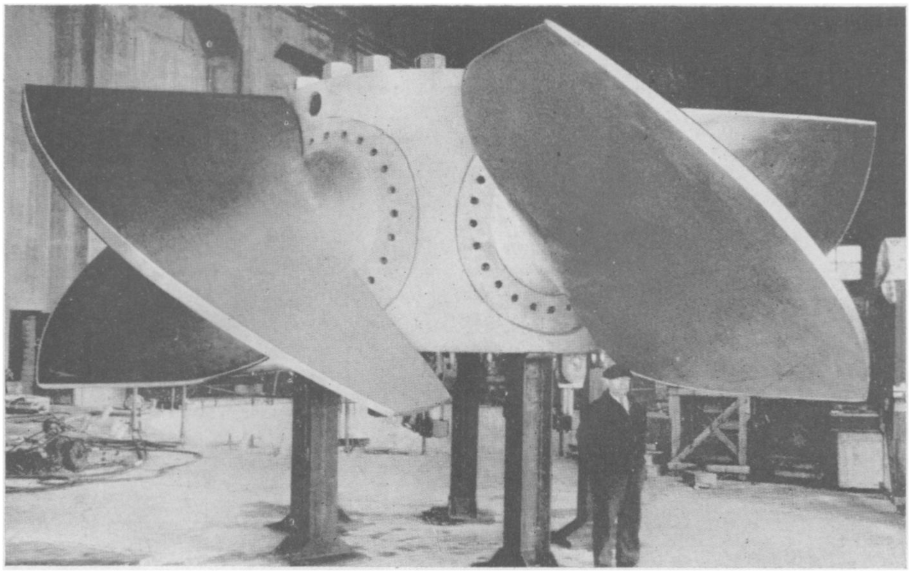
The great advantage of this dual system is that the pressures in the high temperature range are much lower than for steam. Hence they are easier to handle, and permit of lighter construction. This system saves steel as well as fuel.

Many steam plants throughout the country, using only moderate steam pressures, could have their capacity nearly doubled with only one-third more fuel consumption, by superposing on the plant a high pressure steam turbine taking steam at 1200 pounds pressure and 900° temperature, and on top of that a mercury turbine. This statement was made by A. R. Smith, managing engineer of General Electric's turbine division, in an address before the engineering societies of Schenectady. Where high



MOST EFFICIENT

The world's most efficient power plant uses mercury and steam in separate stages and develops 20,000 kilowatts. It gets a whole kilowatt from a handful of coal, ½ pound.



IMPROVED WATER WHEEL

It has blades the pitch of which can be varied, thus giving high efficiency at light loads as well as at full load.

pressure plants already exist, they could be topped simply with the mercury turbine. If both of these plans were applied throughout the country, Mr. Smith estimated, we would get 23½ million more kilowatts for our use.

But the war has stopped the extension of the mercury power plant to many important applications, H. N. Hackett, of General Electric's Construction Engineering Department, declares.

The production of power by the burning of coal under a boiler is a seemingly primitive method, since it was the first used by man with the exception of windmills and water-wheels, but it still provides more than half the power we use today. A good part of the rest is provided by the burning of other fuels, oil, natural gas, wood, etc., under boilers, so that the steam engine is still our mainstay.

Next in importance for large power production is falling water. Although this source supplies only about 4% of our total needs, and could not supply more than a fifth even if every available site were developed, it provides more than a third of our electrical power. This is understandable because water power sites are usually remote from industrial centers, and electrical energy is the one kind that can be transmitted considerable distances.

A notable improvement has recently been made in this field. While the best hydraulic plants have shown an efficiency of 90% in the conversion of water energy into electrical energy at full load, the efficiency is considerably less at reduced loads or lowered water level. A new type of turbine, the Kaplan wheel, maintains high efficiency over a wide range of conditions. This is accomplished by making the blades of the wheel, like those of an airplane propeller, of variable pitch so that the "bite" can be regulated according to load or water level.

The internal combustion engine does not figure in large power production, however useful it may be for automobiles, tanks, airplanes and submarines. Its efficiency is high, far higher than that of the steam engine until the recent developments. But in a transport engine it is capacity, power in proportion to weight, rather than efficiency that counts most, and development has been mostly along this line. No great advances in efficiency have been made except perhaps in the case of the airplane engine, where the load of gasoline to be carried must be considered.

The internal combustion engine was, so to speak, naturally efficient from the beginning, because the fuel was burned inside the engine instead of outside under a boiler, and the top temperature was that of the fire instead of that of the fluid in the boiler. Also no heat went up the chimney. But boilers have lately been so improved that only 8% of the heat goes up the chimney, in place of more than half of it not so long ago.

The remarkable improvement in the steam engine is, in fact, well illustrated by the fact that, starting far behind the internal combustion engine when the latter was first introduced, it has now overtaken the most efficient of them all—the Diesel engine, which for many years was the world's most efficient engine, and still is for small plants.

There are many other possible sources of power, wind, tides, waves, internal heat of the earth, temperature difference between surface and deep-sea water, solar heat, and atomic energy. But all of these are in the experimental stage, at least as far as large scale commercial production is concerned. Only one of them shows promise—the wind.

A huge windmill has just been completed and put into operation on a mountain summit, 2000 feet above sea level, in Vermont. It generates 1000 kilowatts of electric power. This windmill, as shown by the illustration on the front cover of this week's SCIENCE NEWS LETTER, has but two blades like an airplane propeller. The blades are 16 feet in maximum width and 175 feet from tip to tip—the height of a 15-story building. These blades have been designed in accordance with the most modern aerodynamic theory. The pitch or slope to the wind can be varied according to the strength of the wind and is regulated by a governor that keeps the speed constant at 30 revolutions per minute in winds from 15 to 70 miles per hour.

These are some of the ways in which modern power engineers are saving fuel and steel for our war effort.

Science News Letter, May 9, 1942

SCIENCE CLUBS OF AMERICA

Sponsored by Science Service

NEWS OF CLUBS

JACKSON, Mich.—A Science Fair was held in the auditorium of the Jackson County Building, April 27-May 2. This Fair is sponsored by the Public Schools of the City and County of Jackson and the Local Recreation Council. The Fair Committee reports that the turn-out of exhibits and visitors was very gratifying. Merit awards contributed by wellknown Jackson business concerns, clubs and other associations, have helped to make this Fair an outstanding success.

SPRINGFIELD, Mass.—You have heard of an Aquacade and a Cavalcade, but did you ever hear of a "Technicade"? That is the name for their technical science show concocted by members of the Chemistry Club at the Technical High School. The recent "Technicade" included discussions and demonstrations of chemical warfare, incendiary bombs, explosives and projects showing the distillation of crude oil, chemistry of photography, spectroscopy and plastics. The club is sponsored by Alfred R. Lincoln, chemistry teacher.

CEDAR RAPIDS, Iowa—Instead of saying "here" when a member's name is called, each person announces his presence by quoting a short scientific fact. This method of answering the roll call is practised at the S.O.S. Club (Students of Science) at Woodrow Wilson High School. Members of the club prepare exhibits for an annual science club convention, work on laboratory projects, show motion pictures and hold an annual picnic every spring and an initiation supper in the fall. The club, sponsored by Thelma Morton, also is affiliated with the State Junior Academy of Science.

BELLEVUE, Ohio—Heads of local manufacturing concerns frequently lecture to members of the Bellevue High School Science Club. This club meets every other week. At times motion pictures are exhibited to members to illustrate industrial procsses and conservation programs; on other occasions laboratory and exhibit projects take up most of the meeting period. Members of the club also exhibit at the Bowling Green State Science Convention. This club is a member of the Junior Academy of Science of Ohio. Herbert E. Wolfe, chemistry and physics instructor, is the sponsor.

Clubs are invited to become affiliated with SCA for a nominal $2 for 20 members or less. You can become an associate of SCA for 25 cents. Address: Science Clubs of America, 1719 N St., N.W., Washington, D. C.

Science News Letter, May 9, 1942