Bright pictures of the prospects of superseding steam as a power medium have been visualised for many years, and while good progress has been made in competitive powers, the developments in steam generation have kept pace, and it would appear that progress in both steam generation and its principal competitor, the internal combustion unit, is limited by the materials available, and has reached a stage where the closest co-operation is required between the metallurgist and cost accountant and engineer.

As long ago as 1903 Serpollet, White and others in their steam cars were working at pressures and temperatures that have not yet been attained in stationary plants; a series of tests by Professor Benjamin on a White boiler covered a range of pressures between 480 and 725 lbs. per sq. in., with temperatures of 800 F. representing superheat up to 300 F. The boiler tested consisted of a 243 ft. length of \( \frac{3}{4} \) in. tubing with 45 sq. ft. heating surface, and this generated up to 488 lbs. of water per hour, or at the rate of over 10 lbs. of water per sq. ft. of heating surface inclusive of superheater.

At that period it was quite a common sight to see steam pipes red hot and cylinder heads a dull red glow, while the steam felt particularly lively and elastic notwithstanding its comparatively high density.

A large number of power stations have been equipped with boilers working at 350 to 400 lbs. per sq. in., while 550 to 600 lbs. is becoming common. The Boston Weymouth station has been in operation for approximately one year at 1200 lbs. per sq. in., and recent inspection of boilers and turbines show definite pitting and corrosion, in addition to a red dusty deposit, all indicating wastage.

The Benson Boiler at Rugby, England, has been experimented with at the critical pressure and temperature of 3200 lbs. and 700 F., and will afford excellent data when available.

A Swedish Revolving or Whirling Tube Boiler is also under test for working pressures of 1200 lbs. per sq. in.

These high pressures have not been accompanied by correspondingly high temperatures. Gennevilliers Station has successfully operated up to 900 and 914 F. for short periods, but the general limit appears to be 750 F., although the running of high pressure boilers at low output, such as occurs in
early morning loads, has resulted in excessive superheat for short periods.

The possibilities of increasing efficiency by using vapour having a higher range of temperature than water vapour has been appreciated for nearly a century. Sulphuric acid was used by Tremblay in 1850. Diphenal oxide has been suggested. Mercury vapour has been experimentally used.

It is now realised that boilers for higher pressures should be used for steam generation only, and should not be used for the concentration of impurities either inside or out, and a very wide field of water treatment, including distillation, has been exploited, and at the same time the growing use of washed coal has improved conditions in the furnace and flues.

Distilling plants or evaporators have been used for years in marine service, and although Parker’s proposals to use distilled water for the Boston Edison Station created quite a sensation in 1913, distillation has since been very largely adopted.

The primary reason for distillation is the elimination of corrosive or scale-forming constituents from the water before it reaches the steam generator, and this is effected by transferring the removal of these constituents to the body of the evaporator, where the control and removal are rendered simple and the risk of vital or material damage is considerably reduced.

On the furnace side developments are being effected along a number of competitive lines, involving the use of solid, liquid, pulverised and gaseous fuels, and this latter fuel, with by-products recovery, shows considerable promise for future development.

Recent developments in indirectly heated high pressure boilers indicate the future trend; evaporation produced by superheated steam, blown through water, with the hot gases in contact with superheater and economiser tubes only, has been successfully demonstrated by Dr. Loffler in Vienna.

The evaporator or steam generator is not in contact with the furnace or flue gases; steam travels in a closed cycle, being drawn from the evaporator and circulated by means of a pump through the superheater coils, which are directly in contact with furnace gases, thence through distributor pipe lying on the bottom of the evaporator or boiler drum.

An auxiliary low pressure boiler is used to generate a moderate pressure to start the system.

At a pressure of 1500 lbs. and temperature 825 F. it is necessary to pump $\frac{3}{4}$ times as much steam as is delivered for outside consumption.
The make-up feed water is forced by a motor-driven feed pump through an economiser into the steam-generating drum.

The system has been recommended as suitable for pressures exceeding 700 lbs. per sq. in.; below this pressure the power required for pumping the steam has been found excessive on account of the large volume handled.

A demonstration plant, having a capacity of 650 lbs. of steam per hour at 1500 lbs. per sq. in. and 900 degrees F., was put into commission two years ago, and others are said to be under construction.

An improvement on this system was recently patented. In this boiler the steam and water drum or generator is not in contact with the furnace product. Water is pumped from the bottom of the generator through a heater tube passing through the furnace, then returning to a distributor pipe in generator above the water level. An expansion valve is provided at the inlet to the generator maintaining a higher pressure in the heating coil, and as a result of the expansion and reduced pressure portion of the heated water is flashed into steam on entering the steam drum, and passes to steam main either through superheater or saturated as required.

The internal combustion boiler has also received some consideration, and "Brunler" claims very high efficiencies for a generator of this type working at 170 lbs. pressure and 600 F., superheating being effected by further combustion in the steam main.

Returning to orthodox design, the boilers of the turbine steamship "King George V." call for comment. Working pressure 550 lbs. per sq. in., temperature 750 F., coal-fired Yarrow type boiler with integral superheaters and with air heaters located in smoke stack, drums forged from billets, metal to metal joints.

Generally the advantage of forced circulation in steam boilers is beginning to be appreciated, and the boiler of the future will be fitted with circulating pumps arranged to draw the water from the steam and water drum and force it at a rapid rate through the boiler tube or over the effective heating surface, with very apparent reduction in diameter of tubes and drums and increase in intensity of evaporation. Some difficulties will be experienced in maintaining a definite water level.

As a result of high pressures and temperatures a new type of metal fatigue has caused considerable misgiving. Caustic embrittlement has been the subject of considerable investigation in America; serious cracks and crystallised rivet heads have been found in high pressure boilers after upwards
of 10 years' service, generally along the outer row of rivets in double and treble riveted longitudinal joints, and while it has been suggested that metal has become brittle as a result of chemical absorption, I see only our old friend Fatigue as a result of constantly working a light plate operating about a rigid fulcrum. This feature will cause radical changes in future design.

There are still some differences in opinion as to the heat properties of water vapour at pressures in excess of 500 lbs. per sq. in., and a chart, said to be based on Stodola's figures, was recently shown by Sir James Kennal indicating a limiting heat content per lb. between 350 and 400 lbs. per sq. in., while other investigators show this maximum limit in excess of 1000 lbs. per sq. in. The differences appear to be due to difficulties experienced with the throttling calorimeter, but from my early experiments I would prefer to use the higher limits given until more authentic data be available.

The lecture was illustrated with a collection of slides showing diagrams of the boilers referred to in the text.

DISCUSSION

Mr. J. T. Noble Anderson moved a vote of thanks to Mr. Lewis for his lecturette. He would like to suggest that Mr. Lewis be asked to extend his paper, and repeat it in an extended form early next year. It was a most interesting subject, and the paper was as good as any they had had for some years. If Mr. Lewis would extend his paper it would be to the benefit of everyone, and would provoke a good discussion.

Mr. A. E. Hughes seconded the motion. Such a subject could be discussed with great interest and value to the members. Some 18 or 20 years ago there appeared to be a big future for the steam motor, and the White brothers, amongst others, devoted a large amount of study and research to put a highly efficient steam motor-car on the market. The illustration shown by Mr. Lewis was possibly not of the latest development of the White steam generator. The novelty of that boiler was the tubes with horizontal coils; and to overcome starvation the White brothers arranged the inlets of the coils so that the water leaving the first coil rose to the top of the generator, and then to the second, and so on. Marvellous efficiency was arrived at with those boilers. The trouble was to fit them for the man in the street. They were fitted with automatic control arrangements which were
extremely delicate, and though under normal circumstances the boilers did not scale up, they failed under excessive lubrication. He agreed with Mr. Anderson that they should persuade Mr. Lewis to elaborate the paper for the benefit of the members.

DISPLAY OF SLIDES ILLUSTRATING PROGRESS OF THE WORKS ON THE RIVER MURRAY.

By Thomas Hill (President).

Mr. Hill said the Hume Reservoir was designed to impound 1,000,000 acre feet of water; but it had since been decided to increase the capacity to 2,000,000 acre feet. Although the capacity was then doubled, owing to the increased area, being generally on slopes of 3 to 1, the actual increase in area was very small as compared with the increase in capacity, with the exception of that portion on the Mitta towards Tallangatta. The dam would be approximately a mile long, composed of earth with a rock-filled concrete core.

At Torrumbarry a structure was placed across a narrow neck of land caused by the bend in the river. Steel sheet piling was used, and there was no trouble experienced in the construction.

At Mildura the lock had been constructed with a slight extension of channel, but instead of blocking the whole river with a fixed construction, the movable steel trestles had been adopted over a portion of the structure.

The Wentworth site presented considerable difficulties. It was nearly a year's work to transport the materials to the site, but to have started the work without first having all the materials available would have entailed a serious financial loss because when once the work was commenced it must proceed without intermission, as there were only six or eight months in the year in which they could work.

The Hume Reservoir was the key to the whole work. It was a national asset, the value of which could hardly be estimated.

EXHIBITS AND DEMONSTRATIONS

THE DETECTOPHONE, by Mr. Wm. Chas. Rowe.

Mr. Rowe said the instrument was a device for detecting faults in moving machinery. It was really a microphone. It was particularly useful in tracing troubles in reciprocating pumps, whilst another most useful purpose for which it could
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The future of the steam boiler (Lecture & Discussion)

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