STEAM ATOMIZATION IN SERVICE

BY

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Introduction

In May 1974, H.M.S. *Diomede* completed a six-month refit during which Alteration and Addition 633—Steam Atomization Combustion System—was incorporated. The introduction into service of this system was described in some detail by Lieutenant-Commander J. A. Bolger and Mr. D. F. Kilborn in Volume 21, No. 2, the December 1973 issue of the *Journal of Naval Engineering*. This article gives an account of the experience of ship's staff in operating this combustion system over the past two years.

Boiler Operation

The installation on the starboard boiler is shown in FIGS. 1 and 2.

In addition to the advantages listed in the previous article, the flexibility of control of this combustion system has offered the following:

(*a*) A reduction of 30 to 45 minutes in the time to raise steam.

(*b*) A more rapid, smooth, and consistent response to telegraph orders.

(*c*) During periods of reduced notice for sea, it has been found easier to keep both boilers flashed using the centre and bottom burners on each boiler rather than banking one boiler. The system retains sufficient flexibility to carry the auxiliary load without undue adjustment by the boiler-room watchkeepers.

During periods of manoeuvring, there is a tendency to make white smoke. When main engines are at 'Stop', white smoke occurs at blower speeds over 1400 rev/min, whilst pulsation occurs if the blower speed falls below 1000 rev/min. Taking blower 'lag' into consideration, the range of blower speed to maintain a clear funnel under these conditions is small.

The tendency to make white smoke is also due in part to the difficulty of lining up the pointers of the 'in-line' gauges for fuel, atomizing steam, and RDL at low firing rates. This has been overcome to a certain extent by running the blowers at 1000 rev/min rather than depending on the 'in-line' reading of RDL.

Because of defects on the ship's auxiliary boiler, it became necessary to keep steam raised continuously for the last eight weeks of the ship's deployment and it became evident that external examinations on both boilers would be well overdue on hours steamed on arrival back in the U.K. The annual full-power trial was also due towards the end of this period.

A limited examination of the starboard boiler during a period under auxiliary conditions showed that deposits on tube roots and economizers were minimal and permission was obtained from CINCFLEET to carry out the annual full-power trial notwithstanding the limitations imposed by *BR 3000*, Article 1253. This trial was successfully completed with the port boiler hours at over 1900 and the starboard boiler hours at just under 1700.

Boiler Instrumentation

At powers other than as already described, good combustion conditions are achieved using the 'in-line' relationship. It is therefore essential that the associated instrumentation is accurate, particularly when exercising control from the MCR. For example, if the RDL gauge at the MCR control position

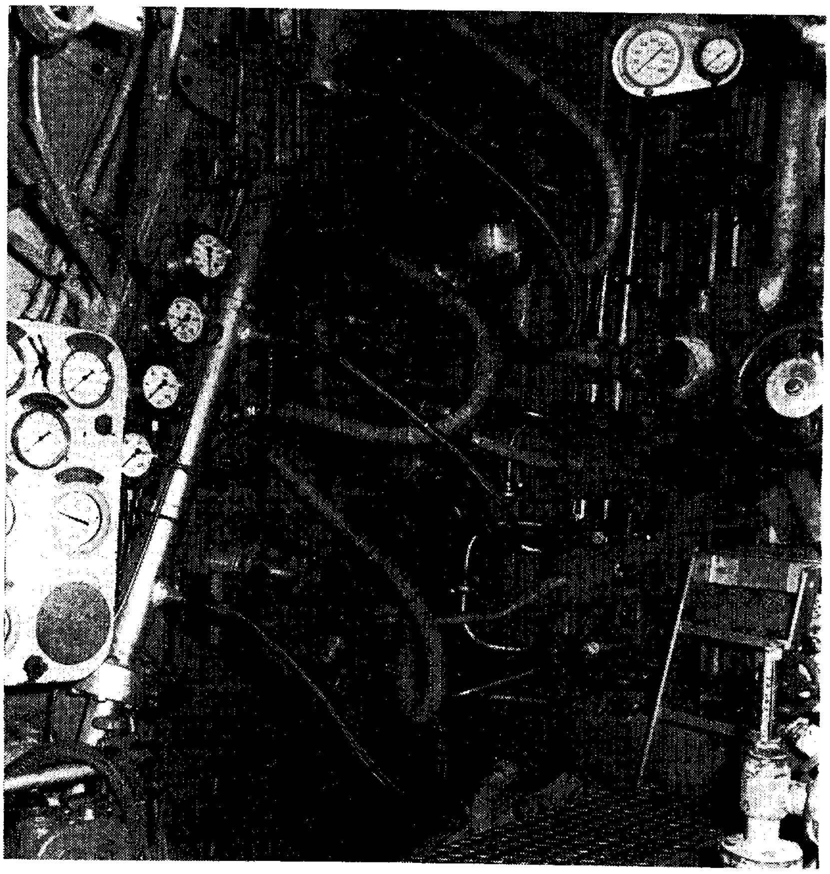

Fig. 1

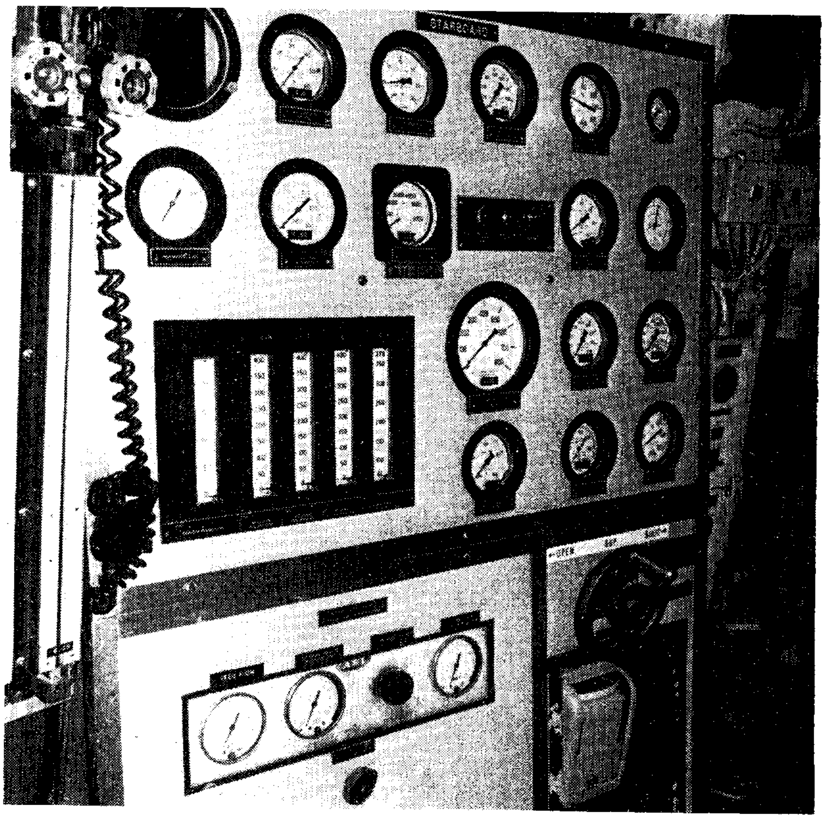

Fig. 2

has a gross error, pulsation at the boiler will occur without the MCR necessarily being aware of it. RDL manometers are provided at the boiler control position in addition to the RDL gauges.

Feed Water Consumption

No instrumentation is fitted to measure feed-water consumption or steam flow in the combustion system. Feed-water consumption before conversion was between 17 and 18 tons per day. Average feed-water consumption now is of the order of 22 tons per day which would infer that 4 to 5 tons per day is being used by steam atomization. This appears to bear out figures obtained during the shore trials conducted at the AMEE.

Opportunities were taken during the ship's deployment to compare feed consumption employing only two burners per boiler. The saving in feed water has been estimated as approximately 0·7 tons per day at 16 knots. However, this saving in feed water does not compensate for the reduction in flexibility of the system when using two burners per boiler at normal powers and the practice is therefore to have all burners in use at all powers except as described already.

Sootblowing

The frequency of sootblowing was gradually extended from every other day during the first two months to every seventh day after twelve months following installation. External boiler examinations carried out during this period showed no appreciable build-up of deposits either on tube roots or on economizers.

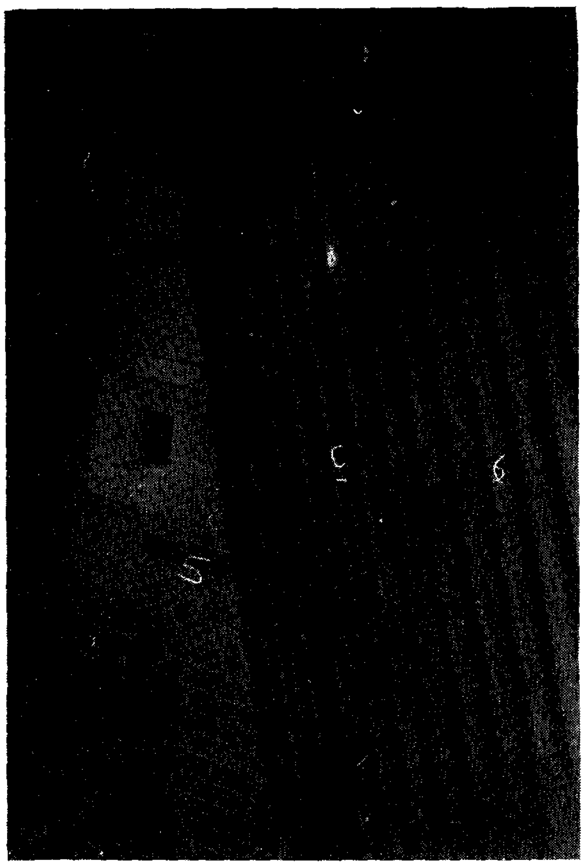

FIG. 3

A loosening of the deposits that are present in the uptakes still occurs after shut-down periods and the upper deck is subject to soot deposits on raising steam. Therefore, despite the increased interval of sootblowing that steam atomization allows, the existing practice of blowing soot as soon as possible after lighting up and before shutting down has been continued. At other items, the 965 aerial and Seacat deck and equipment have remained much cleaner.

The extension of the sootblowing interval is still under survey and further experience is required before making official these extended intervals for ships fitted with this combustion system.

U.S. Navy Distillate (F85)

During the latter part of November 1974, a total of 210 tons of U.S. Navy Distillate was embarked during Exercise MIDLINK. This fuel was burnt

FIG. 4

satisfactorily with no change in flame shape and no change in uptake temperatures.

Boiler Examinations

FIGS. 3 and 4 show the condition of the port boiler furnace fourteen months after installation and examinations carried out at intervals of four months have since confirmed the continued good condition of the boilers and their refractories.

This encouraging aspect of steam atomization indicates that an extension of the boiler-cleaning intervals laid down in *BR 3000,* Article 1253 would be acceptable with an obvious saving in the maintenance load on ships' staff. Subject to sufficient experience being gained, it would seem possible to extend the interval to eight months and therefore achieve the convenience of carrying out the examination in conjunction with the existing eight-monthly internal examinations.

Maintenance

The system has been remarkably free of trouble in operation and such defects as have arisen have generally been of a minor nature. The most common of these defects have been:

(*a*) Choking of the fuel filters in the burner bodies.

(*b*) Steam leakage at both ends of the steam hoses.

(*c*) Leakage of steam across the outer faces of the burner-body steam tube.

The importance of a clean fuel system cannot be emphasized too strongly. The existing Autoklean strainer fitted in the system has a nominal cut-off of 0·008 inches and the clearance in the fuel-metering valves at minimum flow is less than 0·0005 inches. It can be seen that the fuel-metering valves act as very efficient filters when boilers are being steamed at low powers. Meticulous flushing of the system after installation and subsequently in wake of work on the fuel system is therefore essential. Even with all reasonable precautions taken, it is inevitable that fine particulate matter will find its way through the fuel system and the monthly routine of cleaning the fuel filters in the burner bodies must be faithfully carried out.

Steam leakage that occurred at both ends of the steam hoses was discovered to be due to the tapers on the burner bodies and coupling blocks being manufactured to an AP standard whereas the steam hoses were manufactured to a British standard. Corrective action has now been taken to overcome this anomaly.

The most persistent defect was the leakage of steam across the outer faces of the burner-body steam tube. Efficient separation of the steam and

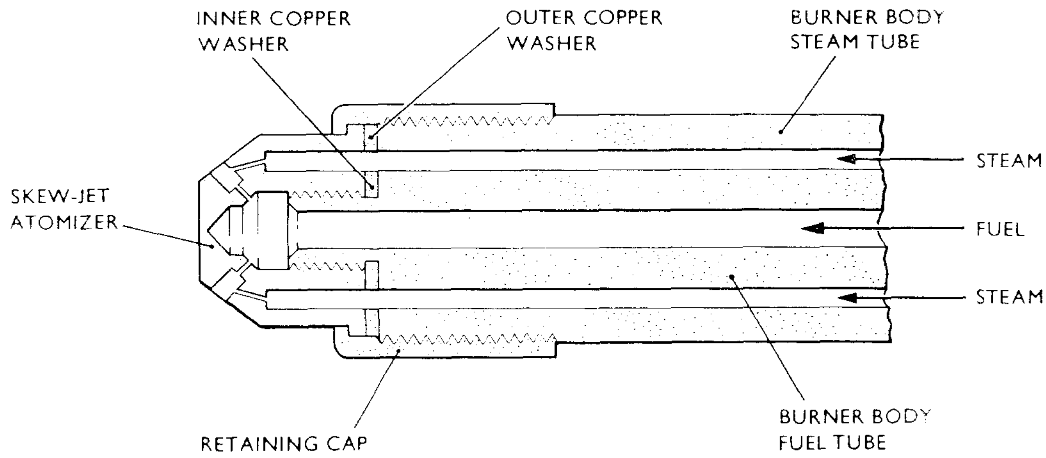

FIG. 5—ASSEMBLY OF ATOMIZER AND BURNER BODY

fuel passageways where the atomizer is connected to the burner body is a prerequisite for good combustion. Leakage can occur from the steam side to the fuel side and vice versa depending on the power developed, and this results in a ragged flame which generally impinges on the side and back walls of the furnace.

Despite the fitting of parallel and annealed copper washers, this steam leakage on occasion caused severe erosion and corrosion of the steam tube necessitating renewal of the burner body. Reports from other ships showed that this problem was not unique to H.M.S. *Diomede* and a number of minor trials were undertaken in the Fleet to find a solution. The problem appears to have been solved by replacing the existing outer copper washer with an ungraphited CAF joint $\frac{1}{32}$ inch thick using Hylomar SQ32 medium grease as a jointing compound.

Conclusion

From the foregoing, it can be seen that the Steam Atomization Combustion System requires a certain amount of care and attention to detail, particularly on matters of instrumentation and fuel system cleanliness, calling for a more stringent discipline than has hitherto been required in steam ships. Nonetheless, these higher standards are well within the capabilities of ships' staff, who, in H.M.S. *Diomede*, have been generally satisfied with the installation and operation. The concept of all burners on at all powers leaves the watch-keepers more able to attend to other routine boiler-room tasks despite a reduction of one MEM in the watch below.

Acknowledgements

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