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'APPLIANCE NOISE'

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Pump Noise in Domestic Heating Systems.

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1. Early noise problems. (1) (2) The noise problem due to small water circulators arose when the **smallbore** central heating systems were introduced into this country. Such systems, utilizing small bore pipes ($\frac{1}{2}$" and $\frac{3}{4}$" i/d) and having high resistance to flow, had to have a small pump in the circuit to drive the water around the system. In the design of early pumps, the noise was not considered to be a principal design parameter, the major parameters being cost and simplicity of manufacture. With such pumps, the noise problem was soon felt by the occupants, especially in the evening or during the night. In fact, the pump noise was not high in terms of decibels, but usually the pump noise spectrum consisted of few discrete frequency peaks, which were usually generated by electrical sources (magnetic striction, rotor bar frequencies and intermodulation) and water sources. Water sources were mainly connected with blade passage frequencies or cavitation at higher temperatures. The choice of bearing material was also or prime importance, as the heights of the spectrum peaks were greatly influenced by the choice of material (Fig 1)

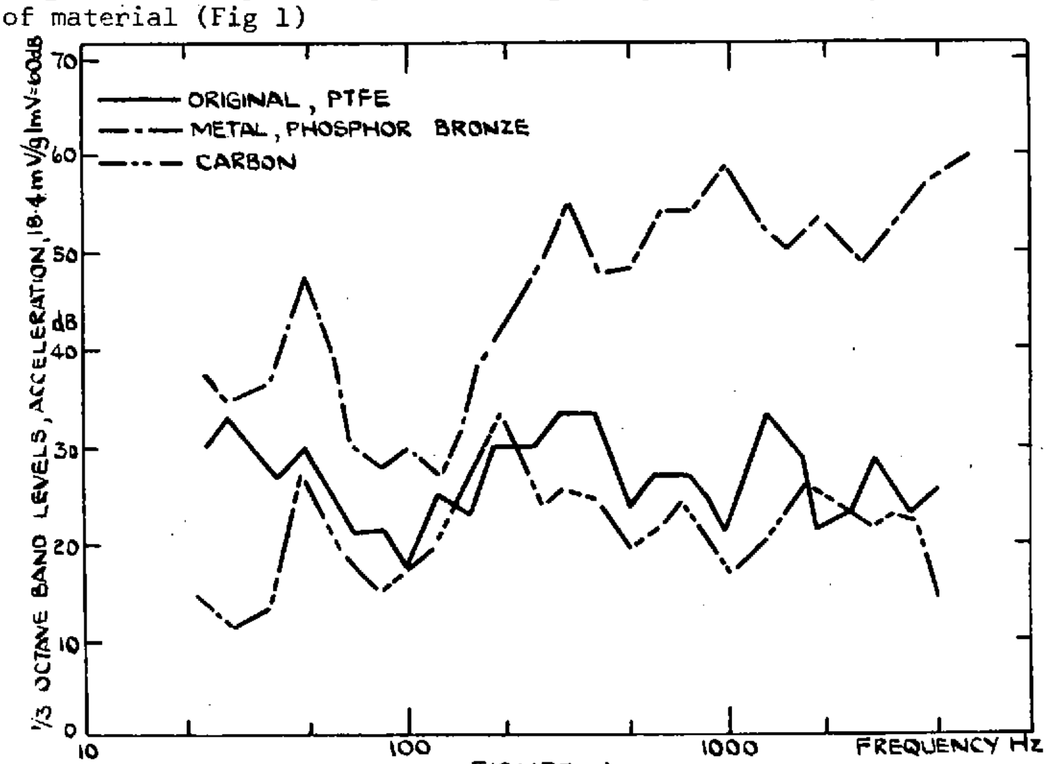

FIGURE 1.

With one exception all pumps used some sort of PTFE material, or carbon.

In Fig.2 a vibration spectrum for an early pump is shown for

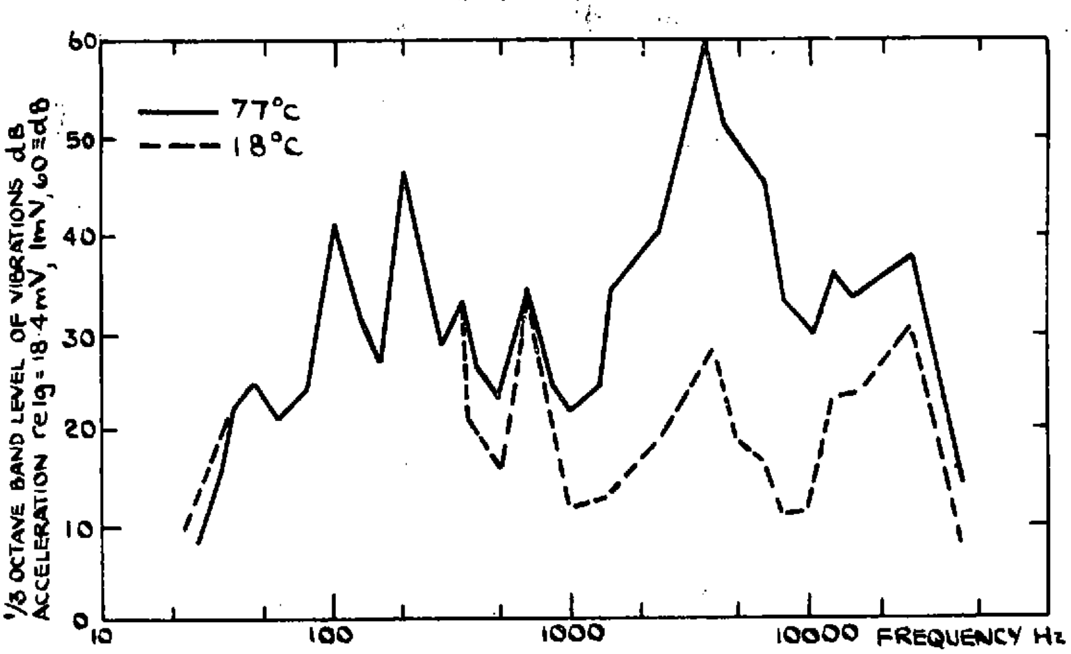

FIGURE 2

two temperatures. It can be seen that at the higher temperature there is an appreciable increase in vibration (and hence noise) at higher frequencies, but the peaks due to electrical and rotational sources were not altered. In this pump, with poorly designed impeller, boiling took place at the back of the blades due to high suction developing there.

It should be noted at this stage, that these circulators were of the canned rotor type, in which the rotor was rotating in the water, and the seal between the rotor and the stator was affected by a membrane or a metal can. Thus any eccentricity and vibrations of the rotor were directly transmitted to the water as noise, which manifested itself in the other parts of the system, usually radiators.

2. Intermediate Period. When the noise problem developed in the houses, complaints were common, and the manufacturers were forced to change the pumps which were still under the guarantee, free of charge. The manufacturers were slow in recognising the nature of the noise problem at this stage, and usually blamed the poor siting of the pump, badly designed systems or even indicated that some people were neurotic. Only when the volume of returned pumps increased, steps were taken to deal with the problem at its source. In this period, a number of pumps were re-designed, and indeed as a result of this, very few makes of pumps are available now, and the ones that remain, all are relatively quiet.

3. Adopted procedures for minimising the noise problem. In the interim period, when the problem was recognised and accepted, noise surveys were carried out in homes (about 400 surveys) and repeated in the laboratory. The noise tests carried out at Bath University were on all available models (1), including some special types. It was found that the actual noise surveys were very difficult to carry out in practice, due to the very low sound pressure levels obtained from the pumps.(Fig.3). Even in the laboratory, tests had to be carried out in the quiet periods only, and hence to speed-up the tests, a vibration pump test rig was designed, calibrated and used for assessing the noise potential of the pumps. With such a rig, isolated from the floor and system vibrations, it was sufficient to measure vibrations with an accelerometer using narrow band or 1/3 octave frequency analyser and then compare the resulting spectrum with the Pass Curve (Fig. 4) obtained previously during calibration. Time and time again it has been found that if the vibration spectrum obtained during test ever exceeded the Pass Curve, then such a pump would cause excessive noise in the heating system.

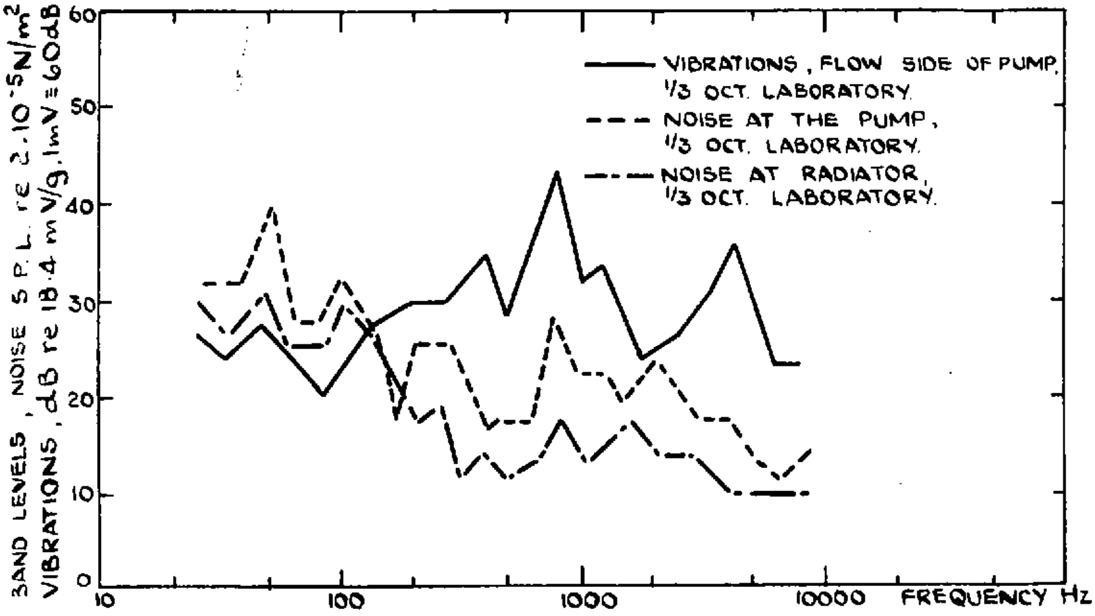

FIGURE 3.

With the test rig developed, a programme of development was carried out on a number of pumps resulting in the present generation of "silent pumps".

4. <u>System Design</u>. For quiet running of the pump, a correct system is important, and a system which allows a suction to develop in any part with consequent introduction of air into the circuit, will cause the pump to run very roughly and will soon ruin the bearings. Furthermore, continual introduction of free oxygen into the system causes corrosion of the system equipment and also formation of black sludge (magnetite) which affects the pump bearings. Thus it is important to design a system in which the pressure is nowhere below the atmospheric, and that overflow and cold feed pipes are correctly placed. Thus with present-day pumps and correctly designed system, the noise problem need not exist, especially with new microbore systems using very small diameter pipes (6, 8 and 10 mm o/d) and distribution manifolds. In these cases, although more powerful pumps must be used, giving heads of 3 - 4 metres at the required flow rates, any noise generated by the pump is attenuated in the manifold and small bore pipes before it reaches the radiator.

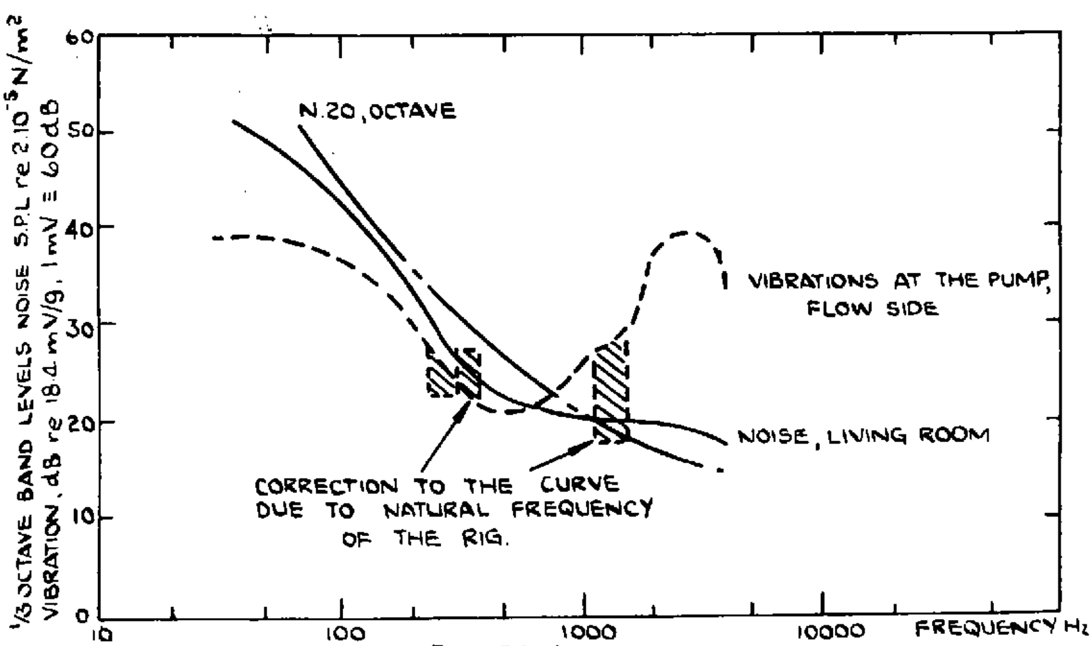

FIGURE 4

5. Location of the pump. This is very important in a system though this fact is rarely appreciated. The important factor is the location of the pump in relation to the expansion tank or pressure vessel connection, since the latter determines the pressure variation in the system. The problem of sub-atmospheric pressure occuring in heating systems is a function of the static head and pump head and can be explained thus:

The only pressure exerted at the neutral point of a closed system (the point at which the expansion tank or pressure vessel connects) is that arising from the static head of water. From the pump delivery to the neutral point of the system the pump exerts a positive pressure and from the neutral point to the pump suction the pump creates a negative pressure. With this simple explanation in mind, one can see that by changing the neutral point or changing the head or height of the vent or expansion tank it is possible to optimise as to the best position for the pump to work.

However, the effect of the closing of systems by thermostatic control or the arrangements for diverting the flow to allow the pump to become operational on the primary circuit of the cylinder demonstrates that care should be taken to ensure that, when any of these functions take place, there is sufficient head value to ensure that (a) pumping-over does not take place, and (b) air cannot be drawn into the system.

Pumping-over the vent, or drawing air down the vent pipe, will cause aeration of the system water. This will lead to rapid corrosion of the system parts. Pump bearing seizure could take place under these conditions due either to deposits or corrosive matter on the bearing or as a result of the pump running partially or wholly dry for considerable lengths of time. Blockage of waterways in the bearing by inhibitors coming out of solution due to excess air availability is also a possibility.

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(2) Clark, R.J. & Petrusewicz, S.A.
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