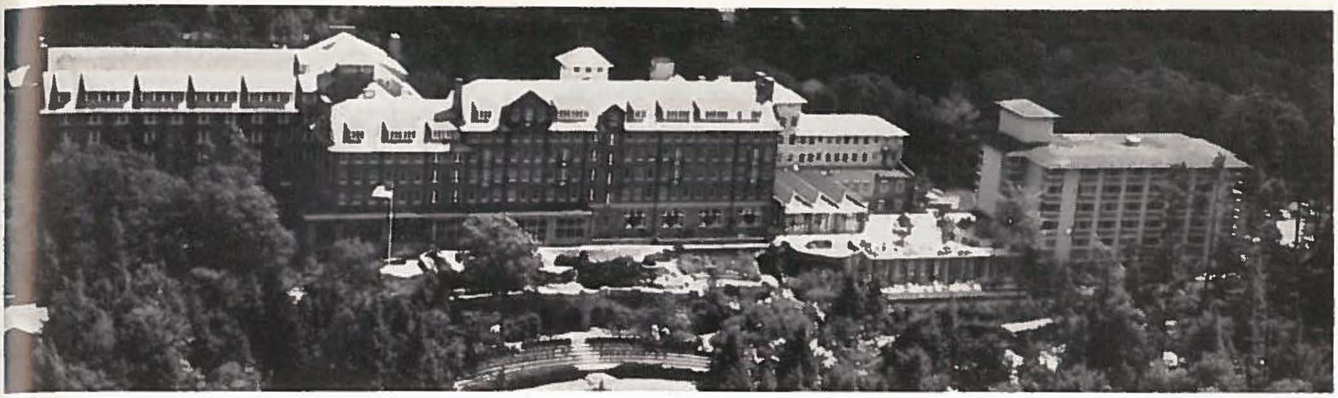

BUCK HILL INN AND GOLF CLUB—Site of the IDHA 62nd Annual Meeting . . . . . . Page 5

INTERNATIONAL DISTRICT HEATING ASSOCIATION IDHA

DISTRICT HEATING

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NEW TRENDS IN HEATING

A. Ernest Haseler, C Eng, FIEE, FIHVE

Mr. Haseler is a senior engineer in the Department of the Environment, Whitehall, England. He is Chairman of the British Standards Institution Committees on Thermally Insulated Underground Mains; founder and first Chairman of the District Heating Association (U.K.); and is considered one of the greatest authorities on district heating in the United Kingdom. He was awarded the Institution of Heating and Ventilating Engineers Medal in 1970 for his paper "District Heating in Denmark." One of his other recent papers is "New Heat Mains Techniques for Telethermics."

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The feasibility of district heating in the UK no longer has to be postulated by pioneer enthusiasts. It is now demonstrated in many excellent schemes all over the country—including those in Westminster and Sheffield—that have been operating successfully for up to 20 years.

There are now over 200 schemes in operation or under construction, and new schemes are being introduced at a steadily increasing rate. Most of them are local authority projects, but private enterprise developers and speculative builders, large and small, are now adding to the total.

District heating reduces building costs and provides more usable space to offer prospective customers. It enables faster building progress, because it is much simpler when all the combustion processes are banished to their proper place—the independent boilerhouse. Winter building is faster and safer when heating from the mains can be on at an early stage of construction in each building. This is done in countries with severe winters, such as Sweden, so that productivity is not reduced.

Density Unimportant

It is a common fallacy to assume that the feasibility of district heating is directly related to residential density. District heating overseas successfully serves individual houses at a density of four, six or eight dwellings per acre. The lower profit margin of district heating in very low density areas is helped by the higher residential density developments. The feasibility of district heating does not therefore depend on residential density but on the amount of heat sold through each meter of pipe each year.

The shorter the length of heat mains and the fewer the number of connections per consumer the better, and this is attainable by good planner-architect-engineer co-operation. The lower the cost-in-use of heat mains the lower the residential densities that can be served, and there is good news in this direction. The higher the heat load per acre the better, and now that we in this country have decided to live in properly warmed homes, this is very favourable.

We call all our centralised heat plant installations by the generic title district heating, but they are really group schemes serving buildings of one ownership, eg local authority or private housing. The same applies to large group schemes for commercial, industrial or Government buildings, as in Billingham new town, Teesside, Treforest, Aldershot, Whitehall, South Kensington, Chilwell, Harwell, Aldermaston and many more. District heating serves all types of buildings of different ownership in a town.

District heating installations for new or existing towns or large districts provide heat at about half the cost of group schemes because of the economies of scale (see graph on page 24). The capital cost per consumer is also considerably less. This is because district heating supplies many types of buildings, not just housing; and because the times of maximum heat demands in homes, offices, schools, public buildings, factories, shops etc are different, the boiler plant size has to be only 50 to 75 per cent of the theoretical maximum demand.

It is probably only 30 to 40 per cent of the aggregate capacity of all the thousands of individual installations otherwise required, because, according to a research survey, these are considerably oversized. Central plant obviates all the labour costs and problems in individual boiler plants and the chores, maintenance and heavy replacement costs every 7, 10 or 15 years with some domestic heaters.

Schemes in New Towns

District heating, using the international definition, has now come to Britain in a most impressive way. There are a number of new towns where, after thorough cost comparisons and sensitivity tests, eg on the effect of changed interest rates, district heating has been chosen. In some cases the first phases preceded these decisions, and individual methods were adopted; but no doubt in time this will be rectified. It is reasonable to predict that tenants with individual systems will want the modern, low-cost amenities the others enjoy.

District heating is also being installed in existing towns where whole districts are being rebuilt, and Nottingham has the credit of being the first to adopt this type of forward-looking total planning. Refuse will supply a third of the annual fuel requirements for district heating.

District heating is by no means the dearest heating method to install in a town; but since there is no heat supply authority equivalent to the other utilities, which use revenue to invest in capital expansion, any extra money required has to be borrowed. In some cases, including schemes of rehabilitated housing, the capital cost of district heating was less than individual methods as a result of thoroughly co-ordinated architect/engineer design.

It is a fact that a new town with district heating will cost a nation significantly less than would be the case if there were no rationalised approach to energy supply. The duplication or triplication of alternative space and hot-water heating facilities is the most expensive method of all; and since only one permutation can be used at a time it brings a poor return on investment for the utilities. In fact, it is known that many millions of paraffin heaters are now used instead of the purpose-built installations provided.

District heating has now become a feasible, economic proposition in Britain because of the backing and confidence from this growing industry, with designers and contractors rapidly gaining experience and knowledge of successful practice overseas. District heating plant and equipment are now available, eg boilers that are suitable for the conditions of cool return and high temperature flow water.

Variable-speed Pumps

There are variable-speed pumps to keep pressures in the pipe network automatically down to the minimum in the interests of economy. A pressure switch at the most distant point of the system sends a signal back over telephone wires to the pump motor controller. There are thermostatic and hydraulic controls to make sure that consumers obtain equality of supply conditions.

Satisfactory heat meters are now available for the larger service connections, eg for hotels, schools, commercial buildings, swimming-baths etc. Those authorities which still believe in metering are no doubt aware that simple and cheap hot water flow meters can now be obtained as well as evaporative 'meters' for fixing to each radiator and hot water supply, and that if desired an experienced firm has the organisation to do the meter reading and accounting.

District heating controls, such as return temperature limiters, have been a big asset because they ensure that all useful heat is extracted before water returns to the mains. This reduces mains sizes and the cost of pumping. Proper controls are modest in cost but could conceivably make all the difference between a scheme in a very low residential area being either of certain economical feasibility or a border-line case.

Like High-Voltage Cables

Good designers realize that district heating is merely a town's water system except that the water is hot instead of cold and it is continuously circulated. It is better, therefore, to have the smallest possible quantity of water in the closed circuit with the greatest feasible temperature difference between flow and return temperatures. (It is equivalent to the big saving in cost of electric cables by having high instead of low voltage). Expert advice is available from several firms on choice of heating controls.

District heating now has all the benefits of a greater amount of expert advice and experience from consultants, contractors and manufacturers, most of whom, together with some local authorities and officials from central and local government, are members of the District Heating Association.

These district heating members include highly qualified engineers, now in Britain, who have had many years direct experience of large, highly successful schemes in other countries. Our district heating installations can thus have all the advantages of the best techniques used in long established schemes overseas and avoid their early mistakes, which seem to have been very few.

Climatic Advantages in Britain

British district heating has an even more fundamental advantage over schemes abroad, in that our equable climate produces only a small difference temperatures in winter and in summer, whereas some Continental countries suffer from very cold winters and hot summers, Thus our boiler plants can be much smaller and cheaper and earn their keep almost all the year.

In some parts of the UK heating is needed almost every day of the year. Indeed, office heating was turned on in mid-summer 1969 even in London, which is a comparatively warm place. This shows how misleading it can be to use 'degree days' only as a basis of comparison or for estimation of hours of heat usage annually. Heating required from May to October is not included in these calculations, nor is the heat required to counteract the dampness of our climate or the effect of our very windy, wet weather, which reduces the U values of brickwork.

The heat losses due to air change can be 150 per cent of those caused by the building. I have for some years proposed a new method using 'comfort days', instead of just degree days, to take account of all the factors that affect health and safeguard property.

Incidentally, the overdue improvement of insulation standards will cost rather less with district heating. The cheaper the heat and the milder the winters, the lower is the return on investment in insulation, so it is not economic to spend so much on capital cost as when individual heating methods are used.

The feasibility of economical district heating is critically dependent on heat mains. Now the position is extremely satisfactory. It seemed at one time that we had more problems with wet soils than other countries, but it is becoming evident that they are not so very different. Heat mains insulation in overseas schemes has also suffered from wettings in ducts, and when used in situ in the ground, except perhaps in areas with deeply drained porous soils. They are now using pressure-tight systems, a U.S. Development in parallel with one evolved from the British prototype pipe-in-pipe installations by the Ministry's Directorate of Engineering Services Development two decades ago.

First Installation

On my initiative the first installation of commercial productions systems in the UK was made at Aldershot eight years ago and was followed by others shortly afterwards. These are now the subject of a British Standards Institution code of practice, CP3009, and specification, BS4508.

The use of this code and specification is recommended. A ten-year guarantee is mandatory. The fully prefabricated

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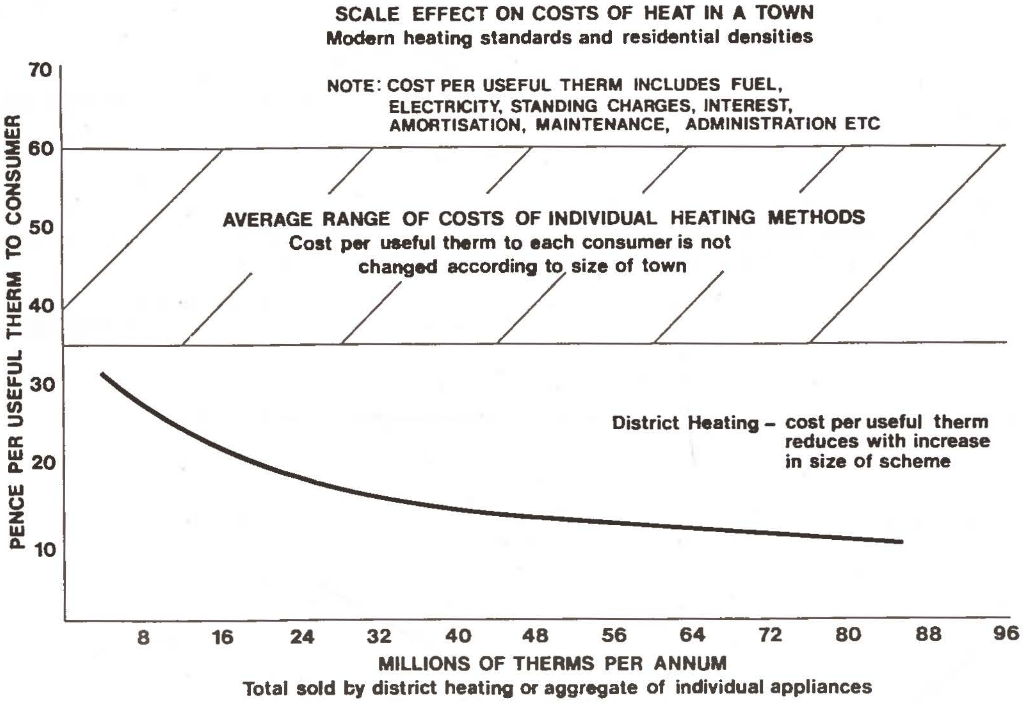

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systems have calcium silicate or foamed polyurethane insulation and steel, asbestos cement or plastics pressure-tight outer casings, fittings and manholes. Their cost as installed is normally less than pipes in ducts if lump sum alternative offers are obtained. The efficiency of insulation remains roughly constant throughout their long life, because there is warning in the event of accidental damage, so that it can be completely rectified quite quickly and cheaply.

Heat Losses from Ducts

Heat losses from pipes in ducts have been measured in a number of installations and found to be high, in some cases extremely so. The theoretical figures of heat loss seem rarely, if ever, to be achieved in practice. Comparative heat loss and reliability tests under identical, operational conditions at a Ministry of Public Building and Works test station at Cardington, near Bedford, are being made on all commercially available heat mains systems, with the Heating and Ventilating Research Association acting as independent observers.

These lower-cost fully engineered pipe-in-pipe systems, with high efficiencies of about 95 per cent, contrast with the old technique, with efficiencies of 50 to 58 per cent, and have put the final stamp of assured feasibility on the prospects of our district heating.

It can now economically serve low residential densities—eg in new towns of eight properly heated dwellings per acre—especially if they are grouped together and the same techniques are used as in successful schemes operating in towns overseas with densities of four to six dwellings per acre. Low-density new-town housing in Denmark with district heating costing £35 to £45 a year for a 1,300/1,550 sq ft house. The annual cost for an individual system for such a 1,550 sq ft dwelling would be £90. Production of pipe-in-pipe systems is rapidly increasing, and prices are being reduced. *This new technique of heat mains is perhaps the most important contribution to the further progress of district heating in Britain and elsewhere.*

Although district heating is simple and taken for granted abroad, its feasibility depends on good design by experienced people, on value engineered installations and on efficient operation. The largest cost penalty unnecessarily incurred is that due to the failure of inter-disciplinary co-ordination at the initial skeleton plan stage.

Shorter routes for the mains as part of a co-ordinated site services layout, a greatly reduced number of expensive building entry points, service pathways provided within the buildings, the maximum use of above-ground heat mains, eg in garages or under walkways—all these can reduce the cost by £200 or more per dwelling, with an equivalent economy in annual charges. Another saving could be by obviating or reducing builders' on-cost, sometimes excessive, on district heating mains. There seems no reason why they should be treated differently from mains for other utilities.

Inherent Economic Advantage

There is an inherent economic advantage in the district heating concept owing to the economies of scale. Fuels are about a third the price of their retail equivalents, and the combustion efficiencies of district heating boilers are nearly double those of domestic boilers on annual average after allowing for utilisation factor.

This six-fold advantage is reduced by capital charges on heat mains (which are the dominant expense, of course) by the heat losses and operating costs. Close design co-operation between planners, architects and engineers and careful choice of the optimum heat mains insulation system will ensure that the economic viability is not unduly reduced.

A most important fact is that with district heating the fuel cost component is only about a third the total annual charges. This campares with 80 per cent for individual systems. As a result the extra capital costs (if any) of district heating, with its better standards, are insignificant, while the high running costs of individual methods make healthy standards of whole-house heating prohibitively expensive for most of the population.

It is therefore wise to make the most of the capital investment in district heating to provide modern heating standards all over the house, because the annual cost will still be lower than that for a sub-standard environment by other means.

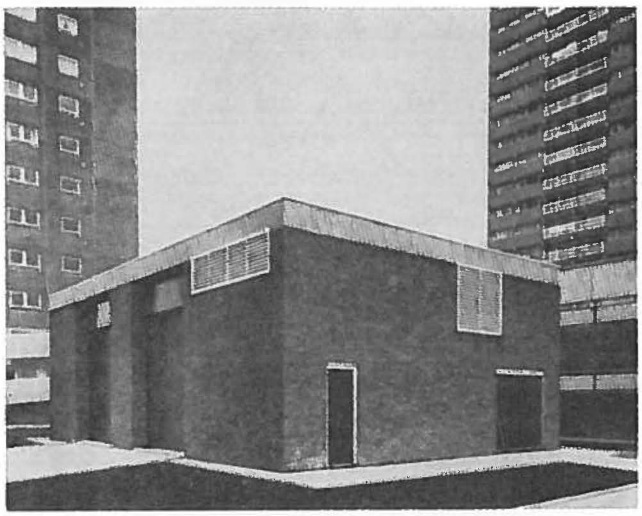
In an increasing number of cities overseas, eg Paris and Berne and many less well known towns, refuse incineration provides heat for the town's mains network, after first generating electricity. The valuable heat has to be thrown away unless there is district heating. To use it only for electricity is wasteful, because three-quarters of the heat is rejected into cooling towers and rivers. This calls for co-ordination between the disciplines concerned.

Briefs for feasibility studies for new towns and building developments should put district heating as one of the essential requirements. This was the first recommendation of a world conference on the subject. Total environmental planning in a cool, damp, cloudy climate calls for the low-running-cost heat supply that district heating provides. The layout of the buildings and routes for services should be co-ordinated and optimised, perhaps by the use of a computer.

Co-ordinating Site Services

Site services also need co-ordinating on a master plan and perhaps placed in a common trench or in subways in town centres. Prefabricated tunnels complete with district-heating mains and other services are now available as an economical proposition. A very considerable economy results from architect/engineer discussion before building designs start, so that district heating and other utilities can be introduced at one point instead of involving very expensive multi-connections.

Prefabrication of domestic heating installations can reduce costs by 25 per cent, depending on the degree of repetition. The architect can help considerably in this way. The use of thermostatic radiator valves, single-entry radiators, pre-insulated soft-copper or steel pipe, manifold connectors etc. are some of the value engineering techniques in more common use overseas than here so far.



District heating without a single chimney: part of a gas-fired installation at Enfield (Photo by courtesy of the Eastern Gas Board)

The resultant economies can be obtained by thoughtful specifications that insist on these modern methods. Whole-house heating by radiators is now cheaper than warm-air methods, especially when fire and safety authorities insist on fully heated systems and two separate air circulation circuits.

Any fuel can be used for district heating, and unless there are any over-riding social or environmental reasons for doing otherwise, the choice should be that with the lowest cost in the particular locality. In areas near the natural gas grid this new fuel is giving the benefit of boiler plant on roof-tops or a small ancillary building for group schemes. Larger schemes are having large, attractive boiler houses. No chimney's, flue-cleaning plant or fuel storage is required.

Instead of a local authority or private builder providing and operating a boiler house and heat mains, a heat supply company or fuel authority can do this. Selection can be by competitive tenders from the six or seven heat contractors who can use coal, gas or oil, or dual fuels. The schemes can be wholly or partly financed by some of these firms, but the higher interest rate puts up the price per therm by a few pence, say from 1s to 1s 4d a useful therm on a new town scheme.

Alternative Financial Arrangement

An attractive alternative is to finance the central plant and mains and then get the heat-supply contractor to operate the scheme and sell heat to all consumers on a 20 to 30-year contract. If desired the heat supplier can employ a consultant and contractor instead to design and construct the whole installation.

The domestic installations can be an entirely separate arrangement, but obviously there must be thorough co-ordination of design dictated by the district heating requirements, especially regarding controls.

Unless the authority has experienced district heating engineers, it is essential that expert consultants or designer contractors who specialise in district heating should be employed. Published information shows that schemes have been done for £280 per dwelling and under £40 per annum whereas others cost at least double these sums. These figures may not be on a strictly like for like basis, but they show what co-ordinated design and value engineering can achieve.

The feasibility of district heating in new towns has greater scope than for small schemes because of the economies of scale. The cost of central plant is shared between many thousands of consumers, and its size benefits from the diversity factor as mentioned earlier. The smaller profit margins of low heat density areas is balanced by the considerable rewards elsewhere due to blocks of flats, offices, town centre and public buildings, industry, hospitals, university or school complex etc.

The town's amenities will benefit, eg heating of steep or elevated roads, shopping areas, food-production farms, sports facilities and air conditioning from central absorption plant using hot water. Swimming-pools can also have radiant heated terraces for all-the-year open-air use, as in towns overseas.

Unjustified Fears

These district heating schemes cause apprehension among the inexperienced, whose fears are naturally aroused by the sheer size. This attitude is quite without justification. A town, after all, comprises a number of small zonal developments which, if looked at separately, are essentially just the same sort of projects now being provided with group heating schemes.

Group schemes already serve mixed developments for residential, commercial, educational, religious and other purposes.The cost of the heat service can be included in the price of the land purchased by private owners. Each zone,

(Continued on next page)

(*Continued from page 25*)
whatever its main characteristic, should be considered for group heating and the costs compared with individual methods. If it is viable, then—when district heating develops later—by joining all the group schemes together into one or more large schemes, the profit margin will be about doubled.

The capital cost can be kept below that of individual methods in the earlier development stages by *not* putting in central plant or the primary mains but using instead local, temporary boiler plants that are complete and transportable. The short connecting pipe between the boiler plant and the buildings can be taken up and used again. This is the normal method overseas and with large projects here, eg the Whitehall heating scheme.

This technique reduces the building time and the number of activities in the initial construction programme, so that the first phases of a new town are more quickly and cheaply completed. This fact is worthy of closer study by planners.

In time these group schemes can be merged into larger schemes, and the temporary boilers, on loan from a fuel supplier or contractor, will be moved to other new areas. Heat transformer stations may take their place, as in large schemes it usually pays to have high-temperature primary mains in order to keep their size to a minimum. The heat transformers reduce the temperature to a low level for domestic use and by a new technique also provided instantaneous hot water.

These transformers are remarkably compact and make it unnecessary to have hot water storage.

The evolutionary process will continue, step by step, as soon as each economic point is reached for district heating in place of several group schemes.

This same process will happen in existing towns too. Indeed it is already starting to take place as a natural logical development. One plant will serve several adjacent schemes, each of which at present has its own boilers. This will reduce costs. When future schemes are added, the existing boiler plant, perhaps supplemented, will provide the heat.

New towns and several existing ones already have powers to sell heat. Local authorities are having their powers increased to include district heating whenever the opportunity arises. If no public roads have to be broken open or the routes of existing utilities disturbed, normally no new legislation is necessary in new towns.

New-town Potential

Our new towns have great potential for the provision of first-class, economical district heating schemes. They need a total plan to allocate spaces under pavements and in the superstructures for primary mains in the long term. The central plant(s) may be thermal or thermal electric, perhaps total energy gas turbines, plus boilers burning refuse fed by underground vacuum pipe; or the heat may come from a distant power station now that cross-country pipelines are economically feasible. It seems inevitable that all the public utilities will ultimately be working together in some of the larger schemes, so they should be invited to comment on long-term planning.

District heating in Britain is now a possibility for new towns and old, for villages and estates. We must not be held back by the prejudices that arise from lack of sufficient experience and knowledge and the failure to keep up with new concepts and new technologies.

We must see how simply and successfully district heating has been accomplished abroad. Hot water from the mains will become as normal as cold water is now—and don't forget that the cold water was strongly opposed at one time. This time let us be on the side of progress and improve the nations health and prosperity by providing the means for everyone to live in a warm, clean, dry and safe environment. □

NECROLOGY

G. DANA KENYON, Vice-President and Manager of Concord Steam Corporation, Concord, New Hampshire on March 7, 1971. Mr. Kenyon became associated with the Corporation when it was founded in 1938; and Concord Steam, and Mr. Kenyon as their representative, have been Association members since 1939.

ROBERT E. BOHONAN, District Manager of Steam Sales at Consolidated Edison Company of New York on February 17, 1971.

FRANCIS A. LIEDEL, Engineer, The Toledo Edison Company, Toledo, Ohio in February 1971. Mr. Liedel was his Company's official representative in IDHA.

JULIUS J. SCHENK, past president of the Association (1943-44), on February 27, 1971. Mr. Schenk was Superintendent of Steam Distribution at Rochester Gas and Electric Corp., Rochester, N.Y. when he retired in 1964.

NEW ENGLAND SECTION OF IDHA

The New England Section held a dinner meeting on March 3. Following the dinner and business meeting, Mr. Stephen Banyacski, Vice-President of Product Engineering for Spence Engineering Company, Walden, N.Y., spoke about: pressure-reducing valve design; selection and installation of noise-reducing stations; steps being taken by reducing and control valve manufacturers to minimize noise generated in valves; the possibility of reducing regenerated valve noise; and recommendations regarding use of noise specifications.

The Section hopes to inaugurate a new feature soon for its members—the circulation of a newsletter containing technical information and items of personal interest.

Five-Year Index of Publications

The Association has had a limited number of Five-Year Index Booklets reprinted from the 1970 Proceedings. These will be distributed complimentary to members, upon request, for as long as the supply lasts. If you would like to have one of these ready-reference booklets which index the contents of the Proceedings and District Heating Magazines from 1965-1969, please address your request to the IDHA Headquarters.