## DISTRICT HEATING

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## "The History of District Heating"\*

## JOHN F. COLLINS, JR.

For man to exist for long in the colder parts of the earth, he must have protection from the elements. Such defenses usually consist of heat, shelter and clothing. As man's protection has improved, he has been able to live in places where he formerly could not exist. Recent examples of improvement are man's abilities to remain in the antarctic and to pass under the polar ice cap.

How human beings first obtained fire is mere conjecture. There are several theories. One is that lightning from time to time hit trees, setting them on fire. Man, feeling the comfort of the heat, added logs to the fire. Another theory is that volcanoes provided the match to start fires. Some ancient tribes of savages started fires by briskly rubbing two sticks together, producing a spark from which a blaze was obtained. Some may approve the Indian legend that the hoofs of great buffalo, striking the flint-rock of the prairies, set the grass on fire. The classical explanation is that Prometheus carried a lighted torch down to earth from the sun.

In time, some one thought of building a shelter around the fire to keep out the howling wind. A hole was left in the roof to let out the smoke. The hole, as early as 300 B.C., had become a chimney, but these had not come into general use until 1100 A.D. Also, the chimney was moved from the center to the side of the house.

Other fuels than wood have been in use for a long time. Theophrastus, a Greek orator, in 300 B.C. described coal and Marco Polo, returning from his travels in China in 1275, told of its use in the Orient. Britons used coal before the Roman invasion. It was used to heat the Abbey of Peterborough in 852, and it was being shipped to London as early as 1240. In colonial days Joliet, Marquette and Father Hennepin all found coal on their travels. However, it was not until 1808 that Judge Jesse Fell demonstrated its use in a barroom in Wilkes-Barre at which time experiments were being carried on with grates.

In 1609 Helmont, a Dutch chemist, discovered natural gas, but at that time there was no apparent use for it.

A William Wardock in Cornwall piped artificial gas into his home for heating in 1798. A lecturer in London was laughed at for claiming coal gas was useful. The oil of Baku has been known for centuries and was mentioned in the Bible. Previous to 1856 an Ind<sup>i</sup>an squaw is known to have obtained oil from a stream by soaking it up in a blanket. It was not until 1859 that Colonel Drake of Titusville ob<sup>+</sup>ained oil by drilling a well. In 1861 Werner, a Russian, invented the first oil burner.

Progress on the design of heating systems was one of long duration. Sir Martin Trienwald in Sweden in 1716 installed a hot-water heating system in his greenhouse, using copper pipes for distribution and a wood fire for fuel.

In 1742 Sir Hugh Plat, English lawyer and amateur horticulturist, piped steam into a room to heat it. He simply let the steam escape into the room and everything was made too moist. He also ran a line from a covered cauldron into his greenhouse and piped steam inside.

At almost the same time as Plat, in 1745 Sir William Cook demonstrated the possibility of heating buildings with steam when he installed a system in his home in Manchester, England, using pipe coils. This could be said to be the first



Figure 1. Hugh Pat's Cauldron

attempt to warm a group of buildings from a single source of heat. Others will maintain that the heating of the Roman baths by passing hot fumes from fires through tile ducts might more



J. H. Walker—1921

O. W. Kastens-1924

Earle Shultz-1925



Figure 2. Birdsill Holly-Inventor of District Heating

properly be designated as the first. Incidentally, the Romans are said also to have heated water for their baths by passing it through fires in brass pipes.

A Christopher Sower of Germantown, Pa. in 1735 is credited with building the first stove intended to heat another room than the one in which it was located.

Benjamin Franklin's famous stove was invented by him in 1744. One purpose of the Franklin stove was to get heat on all sides. People had been toasted on one s'de, frozen on the other. Only four years later he heated a row of houses by means of an iron stove-furnace set in a chamber beneath 'he ground. The flue was an iron box-pipe ten inches across, laid beneath the floors. It was enclosed by brick walls and a tile top to prevent the floors from catching fire.

James Watt in 1874 invented a room heater. His workroom was 20 ft by 20 ft. To heat it, he installed a boiler of metal sheets in the basement. It is not known whether he employed pipe coils or an iron box as a radiator. He used valves to remove air.

A Mr. Hoyle of Halifax in 1791 patented a system of heating, using pipes full of steam. He and his partner, Boulton, 16 years later installed a unique heating system in which the cast-iron columns supporting a building were also used as heating surface.

The kinetic use of steam had likewise been progressing at an increasing pace for centuries. Nero, in Alexandria as early as 120 B.C., invented the first known primitive steam turbine. However, it was not until 1698 that steam was used to raise water. This may have been the first industrial use.

In 1774 James Watt perfected a reciprocating engine. Fulton's ship, the Clermont, was built in 1807, and so quick was the progress that it was only 11 years later that the steamship, Savannah, was the first to cross the Atlantic Ocean under her own steam. In 1830 the Baltimore and Ohio Rail-



Figure 3. Holly's Home in Lockport

road was the first successfully to operate a steam locomotive, the De Witt Clinton.

In 1816 the Marquis de Chambonne and Jacob Perkins introduced a heating system to England, using hot water as the heating medium.

In 1793 a Mr. Green invented a heating system in which a three-in. steam line passed through the center of a nine-in. air duct. The duct ran around

J. E. Seiter—1926 J. C. Butler—1929 E. E. Dubry—1932









Figure 4. Holly's Boiler Plant

the edge of the floor somewhat like a baseboard heater. Hot air rose from openings.

The Eastern Hotel was built in Causeway Street in Boston, Mass. in 1844-45. This was something new for the United States, for although there were examples in France and England, we had up until that time had no large buildings heated with steam. Coils were run around the doors and windows and it is reported that occupants had to leave when steam was turned on.

The manufacture of heating equipment was on the upswing. In 1830 Nason and his brother-inlaw, J. J. Walworth, began installing hot-water heating systems in buildings in the United States and the manufacture of cast-iron fittings. This type system was more popular in Canada. Twenty five years later Crane began producing valves and fittings. A few years later, in 1865, J. P. Marsh started steam, vacuum and pressure gauge production.







R. L. Fitzgerald—1935

G. D. Winans-1939

L. S. Phillips-1941



Figure 7. First Excavation for Steam Mains

In 1859 Samuel F. Gold began manufacturing a radiator which it was said was a great improvement over pipe coils. Simultaneously, he patented a sectional cast-iron boiler. The following year cast-iron radiation came on the market.

As has been previously stated, there had been some crude attempts at heating small groups of buildings as early as 1798 and thereafter, but there was no success if for no other reason than that the needed equipment had not been invented, and no one did so until Birdsill Holly began his experiments in 1876-77. Mr. Holly deserves all credit as the first to put district heating on a successful commercial basis.

Mr. Holly was born in Auburn, N. Y. in 1820, later moving to Seneca. He was a noted hydraulic engineer and the inventor of over 150 items. Included with these is a rotary water pump and the Sybill steam fire engine, said to have been the best in its day.

Mr. Holly again moved, this time to Lockport to gain enlarged facilities for manufacturing. At the time, he was producing sewing machines, skeins, flat irons, boxes, sinks and cistern pumps.

However, he did not let his factory hold back his inventions. He perfected a system of pumping water through pipes under pressure. Skeptics of his success are said to have been knocked down when the water spurted forth.

Mr. Holly is said to have had three areas of interest in district heating. He had in mind, of course, to heat dwellings and buildings, but he also had in mind to furnish steam to fire engines to operate the pump. Each engine would have two hose connections—one for the water and one for the steam. Another thought which he is said to have had was to smother flames by filling a space with steam. The first purpose soon became the paramount one.

To carry out his experiments, Mr. Holly built a boiler in the cellar of his home at 31 Chestnut Street, Lockport. The grate was a sheet of steel with holes drilled in it. Pipe coils were used for radiation. He ran the steam line to a "distributor"

J. J. Schenk—1943 S. S. Sanford—1944 R. M. McQuitty—1945







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in the attic of his home, then down to coils in the various rooms and back to the basement. There, a loop served as a trap and condensate was returned to the boiler which operated at 10 psi pressure.

The experiment being a success, Mr. Holly decided to learn if steam could be transported for greater distances under ground. He buried 500 ft of one-in. line in his and adjacent lawns, successfully furnishing heat to his own and nearby lawns by this roundabout way. He followed this up with an extension of 490 ft of  $11/_2$  in. line to a neighbor's home. The iron pipe was wrapped with asbestos, felt and manila paper and tied with twine. It was buried from 3 ft to  $31/_2$  ft deep in a wooden box 10 in. x 12 in. filled with sawdust.

This experiment likewise being a success, Mr. Holly decided to start a heating utility in Lockport. He raised \$25,000 and organized the Holly Steam Combination Company.

A secondhand boiler from a closed factory in Buffalo was floated through the Erie Canal to Lockport. It was seven ft. in diameter and ten ft. high, having drop tubes. It was housed in a new boiler house with a 30 in. square stack 30 ft high.

After a franchise was secured, 2350 ft of 2 in. and 4 in. iron pipe was laid and enclosed in boredout wooden water line for insulation. It was found also that a wooden box filled with shavings was satisfactory insulation for the time.

Steam service began in October 1877, when 14 customers were connected to the boiler operated at 30 psi. To improve system performance, Mr. Holly made a number of important inventions including a steam trap, an expansion joint (the variator), a tin atmosphere radiator, an iron pipe atmospheric radiator, a pressure regulator and a condensate meter.

Substances getting into the system caused boiler trouble during the first winter, but after a screen was installed, this was overcome. A new water-tube boiler was also added. By 1879 there was in service 14,000 ft of line. Among Mr. Holly's unusual inventions was a steam stove, designed to enable school teachers in the local school to heat their food.

In 1880 an 80 psi, 8 in. line was extended to several factories. The exhaust steam from these supplied heat to several heating systems.

The need of equipment in the fast growing industry led to the formation of the American District Steam Company in 1881. Through the turns of fate, Mr. Holly, who had done so much for comfort, is said to have died a comparatively poor man.



Figure 8. Wallace C. Andrews

Information spread rapidly of the district heating developments in Lockport. Systems were put into operation within ten years in Pennsylvania in Bellefonte, Bloomburg, Clearfield, Harrisburg, Hazleton, Lock Haven, Phillipsburg, Reading, Wilkes-Barre and Williamsport and elsewhere in Auburn, N. Y.; Burlington, Iowa; Belleville, N. Y.; Dubuque, Iowa; Denver, Colo.; Garden City, Long Island; New Haven, Conn.; Springfield, Mass. and especially in New York City.

In 1879 Wallace C. Andrews, a leading financier, sent Dr. Charles Edward Emery, a noted engineer, to Lockport to investigate. His report and those of others were favorable. Mr. Andrews than organized the Steam Heating and Power Company of New York. Construction began at the same time that Thomas Edison was erecting electric lines in lower New York.

The following year, 1880, a rival company, The New York Steam Company, secured a franchise, but sold out when an explosion occurred. The new Company took its competitor's name.



J. F. Malone—1946 R. D. Martin—1947 H. L. Martin—1948



Figure 9. Dr. Charles Edward Emery

The new company built what would now seem like an unusual boiler plant. Forty-eight, 250 hp boilers were installed—16 on each of three floors. Three miles of mains were laid during the first year, using mineral wool as insulation.

The first customer was the United Bank Building at Broad and Wall Streets which peculiarily began taking steam on March 3, 1882 for power, pumping and elevator operation—not heating.

The great blizzard of 1888 settled any doubt that remained as to reliability of the service.

The steam system in Lockport and New York City were comparatively high pressure. However, there were at the time many small electric companies with plants located in business and industrial districts in which electric generators were driven by reciprocating engines and exhaust steam wasted to the atmosphere. Engineers saw a chance to utilize this waste steam at a profit. Service was provided in many cities and towns, especially along the Lakes. The number of steam companies rapidly increased. In time, however, three changes in the electric business affected and for a time almost knocked out the steam business.

1. Electric turbines replaced reciprocating engines in the generating of electricity. There was no longer any exhaust steam available for heating, and condensing water did not have a high enough temperature for heating.

2. Larger electric plants became the rule, replacing groups of smaller ones and these plants were moved away from congested areas as electric transmission became possible over greater distances.

3. As generation of electricity became less expensive in larger plants, the smaller ones in town from which steam was obtained became obsolescent.

Steam, which had been regarded as an inexpensive by-product and sold by the electric companies at a very low price, had to bring a return or at least balance expenses. Some ultilities quit. Others were able to raise their rates.

The district heating industry had been in need of a means of exchanging information pertaining to the management and operation of district heating systems almost from the beginning. The customary method of exchange of information was for equipment salesman to pass along knowledge which they picked up on their travels. They did a good job, but there was no means of making a permanent record and no definite plan for increasing the fund of knowledge.

The old Ohio Electric Light Association held a meeting in the popular old Boody House (with a fireplace in each of its 133 rooms) in July 1909. During this meeting David L. Gaskill of Greenville, Ohio OELA Secretary, was asked by W. A. Wools of Columbus if a group interested in district heating could hold a meeting during the afternoon (July 9), when the auditorium would not be in use. All facilities were readily offered.

The record shows that at least the following were on hand:

A. N. Cope, Springfield, Ohio
Edward F. Gwynne, Delaware, Ohio
Colonel D. J. Hard, Cleveland Power & Light Company
Grant Miller, Toledo, Ohio

A. C. Rogers, Toledo, Ohio

W. A. Wolls, Columbus Railway Power & Light Company

At the meeting a decision was reached and the groundwork laid to hold a convention at the Southern Hotel in Columbus the following October.

Mr. Rogers was elected President; Mr. Cope,

D. W. Loucks—1949 G. H. Tuttle—1950 A. T. Veness—1951











Figure 10. First New York Steam Plant

Vice-President; Mr. Wolls, Secretary-Treasurer; and Messrs. Gwynne, Wolls, Cope and Hard, the Executive Committee.

Mr. Wolls invited Mr. Gaskill to attend the Columbus meeting, and he was elected NDHA Secretary-Treasurer. The record indicates there were about thirty in attendance. Their names can be ascertained by a search of the First Annual Proceedings.

Mr. Gaskill is said to have paid personally for the first 87-page Proceedings which cost \$132, about three per cent of present ones. His first year's salary was \$300.

One of the first things attempted by Secretary Gaskill was to learn how many heating utilities actually were in existence. He found about 150, whereas it had been thought there were 300 to 400. Since there are about 250 at present, it can be seen there has been no loss in numbers and no loss in properties. It was said that practically all were "in the red."

Year after year the Association continued to expand its activities and broaden its investigations. Mr. Gaskill, originally elected for a one-year term, served 25; and when he resigned in 1934, was elected an Honorary Member of the Association. Miss Melissa C. Stocker, Secretary to Mr. Gaskill, served efficiently as Acting-Secretary for two years after he resigned.

At that time, Landis Shaw Smith of Rochester was editor of the magazine which had been published quarterly since 1909. He greatly improved its appearance by making the covers attractive.

Space will not permit discussion of the many changes that have taken place over the years. About all that can be done is to bring to your attention a few things that have taken place from time to time.

In 1884 Marsh produced the first automatic air valve; and six years later William Penn Powers, a temperature control.

Wallace C. Andrews of New York in 1891 was granted a patent for pumping powdered coal in water, something which has only recently been done successfully.

As early as 1894 the heating of railroad cars was accomplished by the Edison Light and Fuel Company in Grand Rapids.

Mr. Holly died in 1894 and Mr. Robert Hall began his long career with the American District Steam Company. Warren Webster opened his factory the following year, his first big contract calling for replacing the stoves in the Palmer House in Chicago with radiation.

Nineteen twelve was a year of near disaster for NDHA. One day of the annual meeting was spent on a boat in the St. Clair River near Detroit. It is said the session was not too successful because the scenery was too interesting. The session ended abruptly when two nearby boats collided, one sinking and several persons being drowned.



F. A. Hyde—1952 C. W. Deeg—1953 L. F. Collins—1954 Soon after the meeting, Secretary Gaskill sent the Proceedings manuscript to Dayton for printing. The bindery burned down and the manuscript was destroyed. Fortunately, Secretary Gaskill had another copy, but the Association had no money to pay for printing. The book was printed when friends provided the needed \$450. The only annual Proceedings which did not go into print was that of 1918 when the program was abandoned due to World War I.

In 1914 the group had to abandon their annual meeting facilities when the rooms were wanted for the Memorial Day auto races.

The next year a very interesting trip was held when the American District Steam Company had the members as their guests for an entire day on a trip from Rochester to Lockport, N. Y. to see the city and the original district heating plant. The group then inspected the ADSCO plant in North Tonawanda and saw Niagara Falls. The wonderful day ended with a banquet at the Clifton Hotel in Canada.

The 1919 meeting was a unique one, being a joint gathering with ASHAE, as then named.

In 1921 the first of the three editions of the Handbook was produced. It was loose leaf and soon outgrew its intended purpose. Only three years later it was necessary to put out the second edition. A great amount of work was done on this volume by J. H. Walker. In addition, C. H. B. Hotchkiss worked on it and H. R. Wetherell of Peoria, a past president, was for a time employed as technical secretary.

In 1925 Secretary Gaskill reported that the late Czar Nicholas had been a member of the Association under an assumed name.

For a time in the thirties the manufacturers maintained an organization of their own with a separate constitution. C. Gottwald, then president of the Ric-wiL Company, was one of those responsible for the progress that was made. Other activities that were carried on included a two-week long sales conference in April 1926, and long consideration of the benefits of the production of a house organ.

When William H. Sanford was named Secretary-Treasurer of NDHA in April 1934, the headquarters was moved to the Engineers Club of Philadelphia where it remained until September 15, 1939. Mr. Sanford was in ill health and resigned at that time.

John F. Collins, Jr. was appointed Secretary-Treasurer. The office was moved to the Grant Building in Pittsburgh, and in a few months to 827 N. Euclid Ave., its present location.

A number of changes have been made in the publications in recent years. The margins of the Proceedings were made narrower than formerly. This has resulted in their being more type per page and 15 to 20 per cent less pages per volume. Beginning with the July 1953 issue the name of the magazine was changed from "The Bulletin" to "District Heating," and the size of the pages was increased to that of other heating magazines. This saves cost to advertisers in the production of cuts.

After five years of work by over 50 members and the editorial board, consisting of J. Earl Seiter, Ernest E. Dubry, Henry L. Martin, Robert D. Martin, Sterling S. Sanford, George H. Tuttle and Secretary Collins, the Third Edition of The District Heating Handbook was completed in June 1951.

Some have expressed the thought that district heating has passed its zenith. Quite the contrary is true. While there are not many new steam utilities being organized in the United States and Canada, there has been no appreciable loss. Meanwhile, the annual statistics of NDHA show that there is a steady gain in sales and investment. The supplying of steam for air conditioning and industrial uses, as well as for off-peak purposes, should improve the load factors of the suppliers, something that has been sought. Another activity which may prove valuable in expansion is the turning over of obsolescent electric plants for the production of steam when conditions warrant. Elsewhere, the generation of steam at higher pressures to supply both electricity and steam itself should decrease investment for generation.

District heating by hot water has not been looked on with great favor, but the use of hightemperature hot water should increase in the right atmosphere.

With the looked-for increase in college enrollments in the next few years, there should be much more campus heating from central plants.

Finally, in Europe there should be a great increase in district heating.

The industry has a bright future.

\* The author wishes to express his appreciation for the material and pictures which came from many sources including: 1. "District Heating" by Bushnell and Orr.

- 2. The "Adsco Advocate," published by ADSCO in 1920.
- 3. A statement by Miss Melissa C. Stocker on the formation of NDHA.

V. J. Suche—1955 W. A. Gillespie—1956

J. C. Haroldson-1957





