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EXPANSION OF THE TOLEDO EDISON COMPANY STEAM-DISTRIBUTION SYSTEM

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(In this paper the author describes the original installation in 1930 and the extensions that have been made to the steam distribution system of The Toledo Edison Company to date, and also sets forth its present scope.)

In 1930 The Toledo Edison Company decided to develop a District Steam System in the downtown area of Toledo, Ohio, for a possible load of 500,000 lb per hr at 150 psi in an area of approximately 32 blocks.

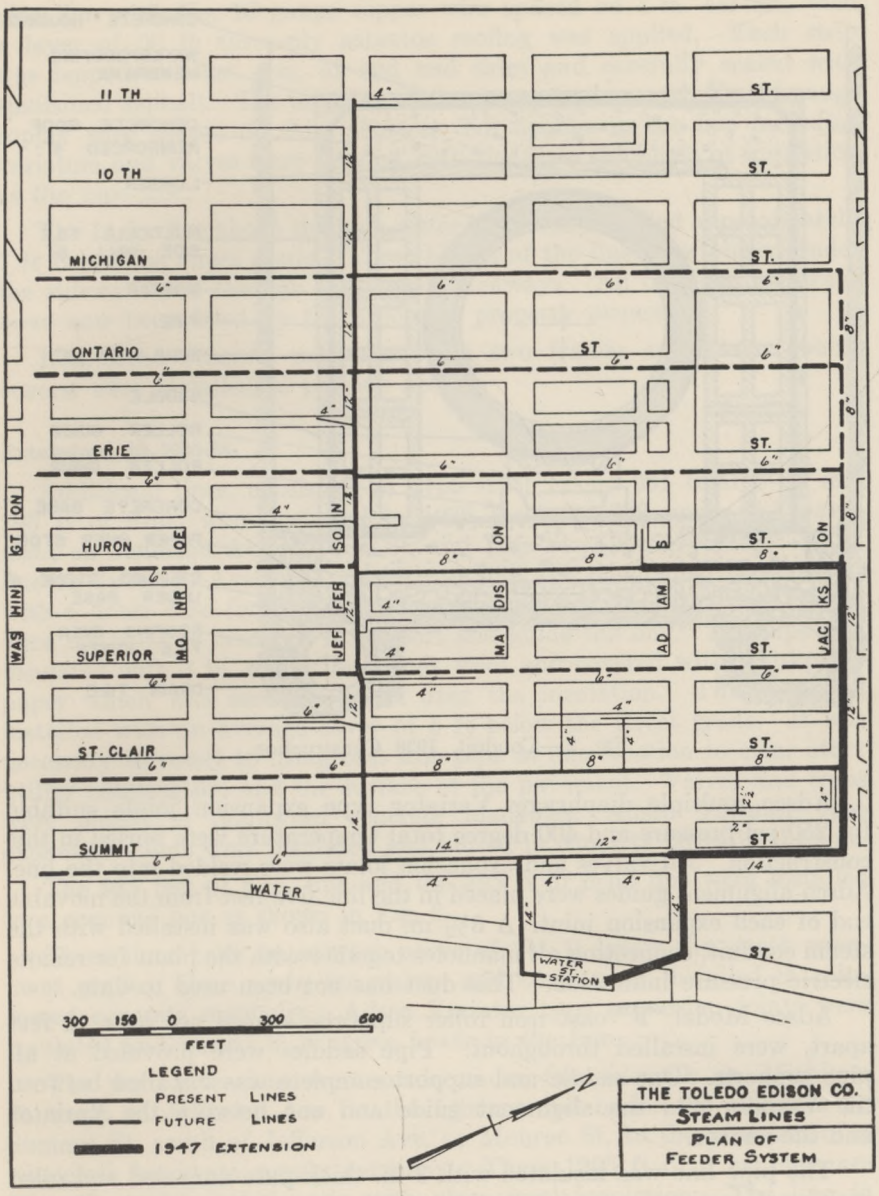
Fig. 1 shows the two 14-in. distribution feeders extending radially from the Water Street Station through the downtown area. The feeders are reduced to 12-in. in size approximately 1500 ft from the station. These two feeders, three blocks apart, are tied together at intersecting streets by one 12-in. and two 8-in. lines. The feeders and the tie lines form a steam heating network distribution grid. Condensate is not returned to the station.

Steam is supplied to this heating distribution grid by direct send-out from the station. The header pressure there is 175 psi and the delivered pressure to the grid feeders at present is 105 psi. The system demand is divided between two pressure reducing stations in the plant. Each reducing station has air pressure regulation, a steam flow meter and a desuperheater. The system is operated by controlled steam pressure compensated for steam flow.

The 1930 Installation

The first sections of this distribution system, consisting of 1125 ft of 14-in., 966 ft of 12-in. and 1578 ft of 8-in. line, were installed in 1930 on Madison Ave., Summit St., Jefferson Ave. and St. Clair St. This line was designed for 250 psi, 400 F use. A part was installed by the open trench method and the remainder by tunneling.

It was constructed as shown in Fig. 2, except that for the first 300 feet from the station and up Madison Avenue hill the conduit was made waterproof and the soft tile drains were omitted. The waterproof membrane was built up of two layers of roofing felt, thoroughly imbedded in three hot moppings of waterproof asphaltum pitch. In addition, the top and sides were surrounded by 4 in. of concrete over the waterproof membrane.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1947 EXTENSION
N
THE TOLEDO EDISON CO.
STEAM LINES
PLAN OF FEEDER SYSTEM

FIG. 1

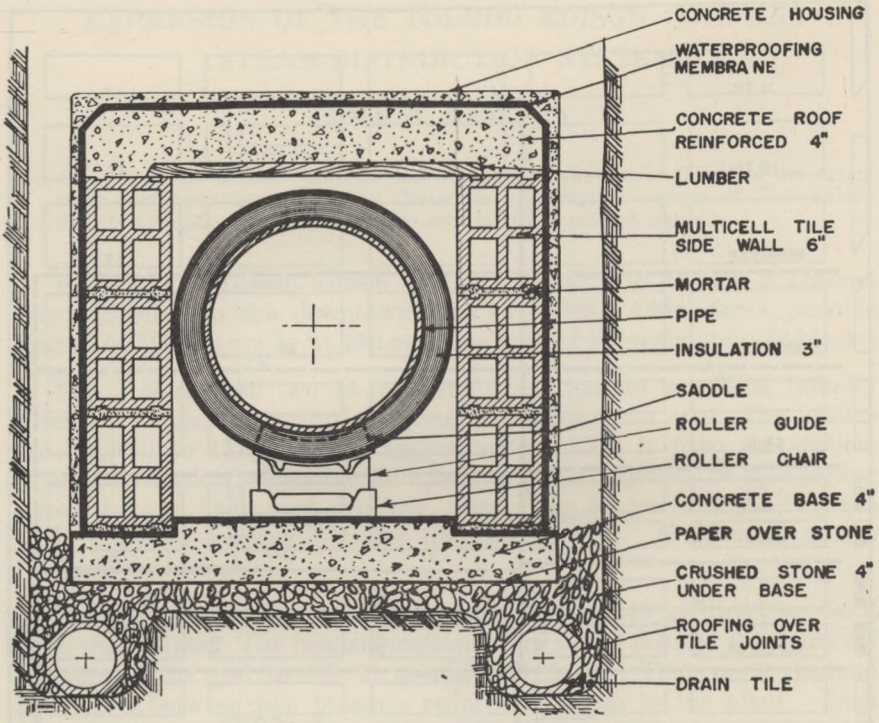

FIG. 2.—Conduit, 1930 Construction.

Adsco multiple diaphragm Variator type expansion joints suitable for 250 psi pressure and 400 degree total temperature were buried in this construction. All valves and expansion joints were welded into the line. Adsco alignment guides were placed in the line five feet from the movable end of each expansion joint. A 3½ in. duct also was installed with the steam conduit, connecting all manholes together with the plant for remote electric pressure indication. This duct has not been used to date.

Adsco Model "F" cast iron roller supports, spaced not over 12 feet apart, were installed throughout. Pipe saddles were provided at all pipe supports. One saddle and support complete was installed between the Variator and the alignment guide and one between the Variator and the anchor.

The pipe line was insulated with 3-in. thick pure annealed and oiled rock wool sectional covering having metal wire mesh on the inside and waterproof Kraft paper on the outside. The covering was wired to the

pipe line with No. 13 gauge copper wire spaced on 4-in. centers, then a layer of 50 lb three-ply asbestos roofing was applied. Each strip was lapped at least 4-in. at end and sides and carefully sealed with emulsified asphalt. The asbestos roofing was wired on with No. 14 gauge copper wire spaced on 6-in. centers. All fittings in the line including variators and valves were covered with the same thickness of insulation as the pipe line.

The 14-in. line above the high water level was installed approximately 7 ft below the street grade. Three blocks of the line were placed under the sidewalk and through some open areaways. All of these areaways have now been filled by the adjoining property owners.

Reinforced concrete manholes, with two frames and 24-in. double covers, were installed to provide access.

Extensions in 1936-38

Additional lines, consisting of 1705 ft of 12-in., 981 ft of 8-in. and 395 ft of 6-in., were installed in 1936 through 1938 under the pavement on Jefferson Ave., Huron St. and Erie St. The 1705 ft of 12-in. line on Jefferson Ave. was placed in a split tile or channel tile conduit with a drain base for carrying off water and footing. Bars and rollers were installed at intervals to support and guide the line. The pipe was insulated with 3 in. of sectional rock wool and covered with waterproof paper which was securely wired over the insulation. This line was installed with an average cover of 5 ft below the street grade. It was necessary to resort to using cast iron pipe at one location to clear other utility construction and the surface of the pavement. Valves and traps were placed in reinforced concrete manholes. Adsco Variator type expansion joints were insulated and buried in concrete boxes in the line.

The 981 feet of 8-in. line and the 395 ft of 6-in. line were installed in a concrete box as shown in Fig. 3.

These lines have an average cover of 2½ ft below the street pavement grade. Here again the valves and traps were installed in reinforced concrete manholes. Adsco Variator type expansion joints were insulated and buried in concrete boxes in the line.

The next extensions were made under the sidewalk on Michigan St. north of Jefferson Ave. to the Library and under the sidewalk on Summit St. south of Jefferson Ave. to Monroe St. to the premises of a wholesale hardware supply company. These 1295 ft of 6 in. lines are Ric-wiL prefabricated units with glass wool insulation. The line to the Library was installed with 4 ft of cover below the sidewalk grade.

It has Adsco Variator type expansion joints insulated with glass wool. They are buried in concrete boxes. The line to the wholesale hardware

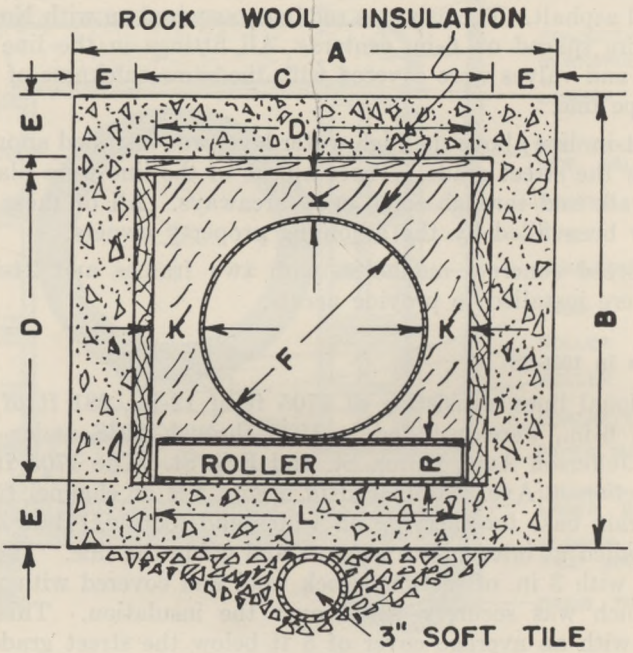

TABLE OF DIMENSIONS									
PIPE SIZE	A	B	C	D	E	F	K	L	R
6"	$22\frac{5}{8}$"	$21\frac{5}{8}$"	$14\frac{5}{8}$"	$12\frac{5}{8}$"	4"	$6\frac{5}{8}$"	3"	$12\frac{1}{2}$"	$2\frac{7}{8}$"
8"	$24\frac{5}{8}$"	$23\frac{5}{8}$"	$16\frac{5}{8}$"	$14\frac{5}{8}$"	4"	$8\frac{5}{8}$"	3"	$14\frac{1}{2}$"	$2\frac{7}{8}$"

FIG. 3.—Conduit, 1936-'38 Construction.

supply building was installed with 2 ft of cover below the sidewalk grade. Foster Wheeler type "S" expansion joints, insulated with glass wool, were buried in concrete boxes in the line.

L & K System Absorbed

In 1946 the L & K Company, a department store in the center of the business district, decided to discontinue supplying steam to 90 customers covering six blocks. They negotiated with The Toledo Edison Company to take over their steam customers and steam distribution system. The area added to the Company lines is shown in Fig. 4. The L & K lines consisted of parallel 15 psi and 75 psi lines in this area. Condensate was returned to their boilers.

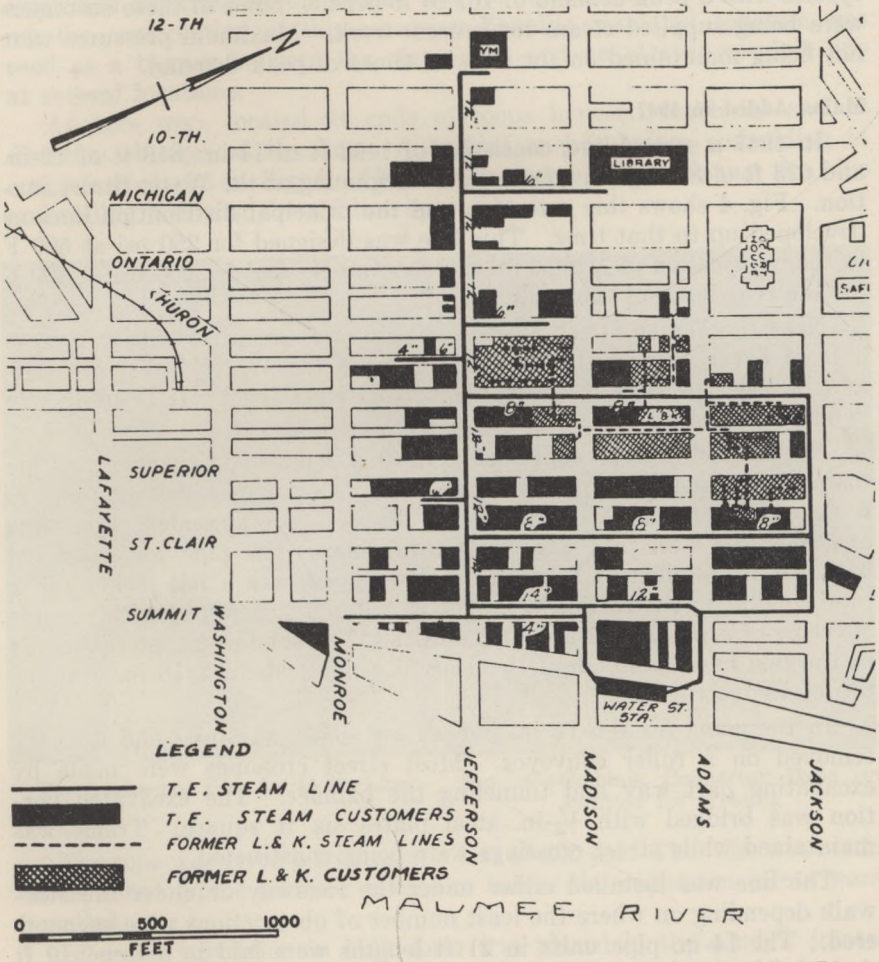

FIG. 4.—The Toledo Edison System after the 1947 Addition, Including the L & K Lines.

Three pressure reducing stations were installed in customers' buildings for interconnection of the former L & K lines and The Toledo Edison Company lines. A separate service was installed to the L & K building. The return lines were abandoned or connected through receivers to the sewers at the customers' premises. Present efforts are being directed to eliminate the low pressure 15 psi lines and to connect these customers through pressure reducing valves to the 75 psi lines.

During the 1946-1947 heating season there were 259 customers on the system with a peak demand of 167 M lb per hr. Some of these customers were being supplied steam for process work. Maximum pressures were not being maintained on the lines at times of peak demand.

Mains Added in 1947

In 1947 a second line, consisting of 1492 ft of 14-in., 816 ft of 12-in. and 628 ft of 8-in. pipe, was installed beginning at the Water Street Station. Fig. 4 shows this extension and the principal distribution lines as developed up to that time. This line was designed for 250 psi at 500 F to the intersection of Adams St. and Summit St. and for 250 psi at 400 F for the remainder of the route.

Near the Water Street Station, the line was installed with only 2 to 3 ft of cover, due to the limited space for the Water Street crossing, and in order to keep it above the normal river level. It is subject to flood water conditions.

No manholes were constructed in this section. Expansion of the main was taken care of by a loop, except for one expansion joint in a waterproof manhole in the plant. Ric-wiL prefabricated pipe units and seamless steel pipe were used throughout. The pipe was insulated with a 3 in. blanket of Fiberglas and wrapped with a felt jacket. The pipe conduit in the section below flood water was wrapped with a triple covering of asphalt-saturated asbestos felt. The conduit on the remainder of the line has the standard covering of asphalt about 3/16 in. over the top of the corrugations.

In tunneling for the 12 in. line an air spade was used and the clay removed on a roller conveyor. Most street crossings were made by excavating part way and tunneling the balance. The excavated portion was bridged with ½-in. steel plates six ft square. Traffic was maintained while street crossings were being constructed.

The line was installed either under the roadway or under the sidewalk depending on where the least number of obstructions were encountered. The 14-in. pipe units in 21 ft lengths were laid in a trench 9 ft deep under the pavement. All excavated material was trucked away.

Canvas slings were used for unloading and lowering the sections into the trench. Bell holes were made at conduit joints to facilitate welding. The pipe and conduit sections between manholes were welded after the pipe units were in the trench. The ends of the conduit have a waterproof preseal ring to keep the insulation dry until closure of the joint. These end seals remain permanently in place except that the vent plugs are removed before making the conduit joint. The trench was backfilled with screening. A front end loader was used for loading the excavated material on the trucks and for backfilling the trench. During the construction of this extension Zonolite insulated concrete was used as a barrier between the steam line and an electric conduit line at several locations.

Anchors were located at ends of loops between manholes and at direction changes of the line. A typical anchor before embedding in concrete is shown in Fig. 5. Chain falls were used for placing the pipe and rolling it during the welding operation.

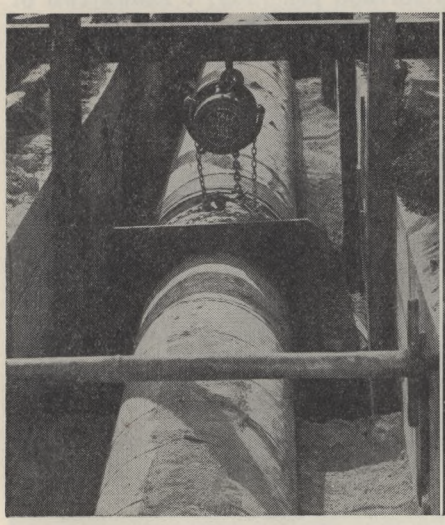

FIG. 5.—Anchor Unit for 14 In. Line

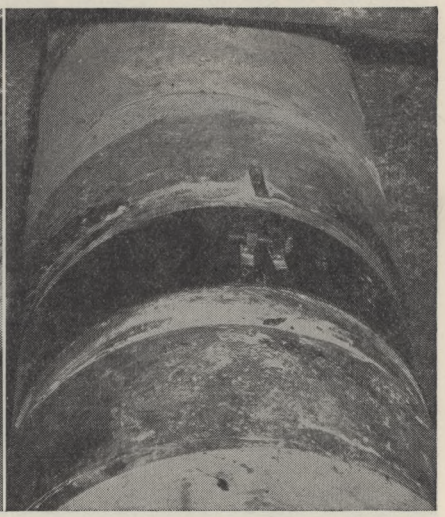

FIG. 6.—Conduit Connector Band in Position for Welding

The pipe was given a hydrostatic test of 400 psi. This test was made on sections of pipe between manholes before the expansion joints were installed.

Fiberglas insulation in bulk form was placed in the conduit joints. It is held in place by a felt jacket. Glasfab, a membrane fabric, was

wrapped around the covering and a waterproof material spread on to ¼ in. thickness. The conduit was joined by a connector band as shown in Fig. 6. This band was drawn together by two angle irons welded to the ends of the band. It then was electric welded at the circumferential and longitudinal seams. The conduit joints were tested with air at 15 psi. A soap solution was applied on the connector bands during the pressure test. An asphalt blanket was wrapped around the connector band, then heated and fused to the asphalt coating on the conduit ends. An additional asphalt blanket wrapping was put on in the section subject to high water.

The manholes are of reinforced concrete. Each manhole has two 30-in. openings with Adsco double covers. The manholes were equipped with cast iron P-traps and drains to the sewers. Reinforcing steel was omitted and recesses were inserted in the manhole walls for future service connections.

The expansion joints are Yarway gun-pakt sleeve type, single end, welded, with anchor bases, designed for 300 psi. Fig. 7 shows two of these expansion joints installed in a manhole. The anchor bases are bolted to the structural steel channel. All structural steel in the man-

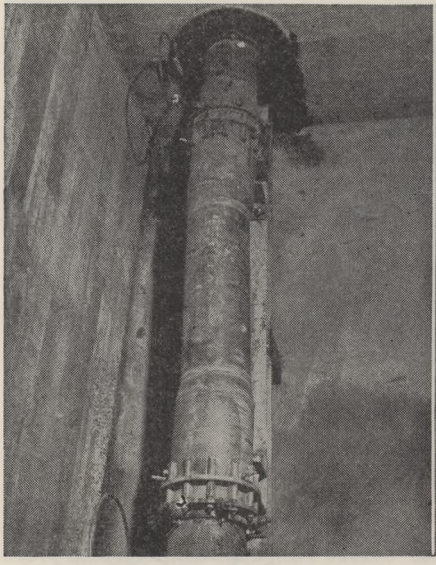

FIG. 7.—Expansion Joints in Manhole with Anchor Bases Bolted to Structural Steel Channel

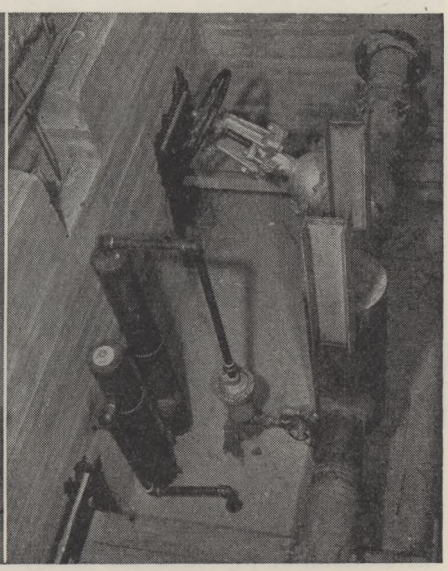

FIG. 8.—Steam Manhole Showing Combination Vertical Distributor Pipe and Drip Pocket (right) and Flash Tanks (left).

hole was thoroughly cleaned and given a coat of rust-inhibiting paint, followed by a coat of red lead and oil paint, then a final coat of asphalt base paint. An extra heavy mastic was applied on the wall where steel plates were secured to the manhole walls.

Number 4/0 bare stranded copper wire was connected to the conduit, to the pipe and to the steel anchor base in each manhole, for bonding, to shunt stray electric currents around the expansion joints. The steam line pipe was bonded to a neutral bus in the plant.

The vertical piece of pipe in Fig. 8 between the two H-beams is the distributor pipe. The two H-beams were anchored in the roof of the manhole. The distributor pipe is used in a manhole where there is a difference in elevation between the lines. The distributor pipe is usually 4 to 6 in. larger in diameter than the largest connected line. It also serves as a drip pocket for trap installations.

The two vertical tanks on the left wall of the manhole in Fig. 8 are flash tanks for the trap discharge. These flash tanks are partially full of condensate. The outlet from the flash tanks is connected to the sewer.

The valves on the 14-in. and 12-in. lines are flanged, since welded ends in these sizes could not be obtained at that time. Crane triplex bolt studs, Cranite and Anchorite gaskets were used with the flanged valves.

The pipe, expansion joints and valves in the manholes were insulated with three in. of Fiberglas sectional pipe covering. This was bound with Signode straps on six in. centers. Glasfab, a membrane fabric, was wrapped around the covering and a waterproof material spread over the fabric to a ¼ in. thickness.

This new line went into service on November 30, 1947. One hundred sixty-eight working days were required to install it.

Extent of System in 1950

At the present time in the system there are 26,444 ft of various sizes of pipe, from 4-in. to 14-in.; there are 296 condensate and 23 shunt meters and there are 23 sleeve type and 118 Variator or diaphragm expansion joints. The sleeve type joints are lubricated every thirty days in the winter and every sixty days in the summer. Packing is only added to these sleeve joints when necessary.

A uniform pressure can be maintained on this network steam distribution grid with the two outlets from the Water Street Station. Sections of the grid can be isolated for maintenance and for making service connections. The grid has been installed to provide for future expansion.

Expansion of The Toledo Edison Company heating system is further shown in Table I. An index of the steam sold is shown graphically in Fig. 9.

TABLE I

	Steam—M Lb						Meters		
	Sendout	Sold	Ratio Sold to Send-out	Max. Hourly	Cents Per M Lb Sold	Customers Served	Condensate	Flow	Feet of Steam Mains
1930	....	17779	....	..	....	16	..	..	1963
1931	....	41032	....	..	72.00	18	..	..	6020
1932	....	49873	....	..	68.50	23	..	..	6020
1933	....	37829	....	..	71.60	26	..	..	6020
1934	....	46297	....	..	74.00	31	..	..	6092
1935	....	104173	....	..	68.00	50	..	..	7780
1936	....	181841	....	..	68.00	68	..	..	8155
1937	....	193693	....	..	68.50	71	..	..	8916
1938	....	183728	....	..	70.00	87	..	..	9200
1939	....	166846	....	82	74.00	93	125	3	9200
1940	218371	194693	89.23	88	72.00	102	127	11	9850
1941	209682	186167	88.79	94	73.40	120	146	12	10510
1942	283234	257875	91.05	100	70.70	122	139	13	10510
1943	322660	296609	91.93	116	70.70	127	142	14	10510
1944	314112	287359	91.48	120	76.47	136	145	14	10510
1945	338162	309570	91.54	135	75.28	156	164	18	10510
1946	367713	328079	89.22	167	81.09	259	291	16	23406
1947	511953	451197	88.13	180	95.61	259	280	19	26342
1948	492186	441103	89.62	200	116.00	264	290	19	26342
1949	467641	417913	89.34	200	105.10	276	296	23	26444

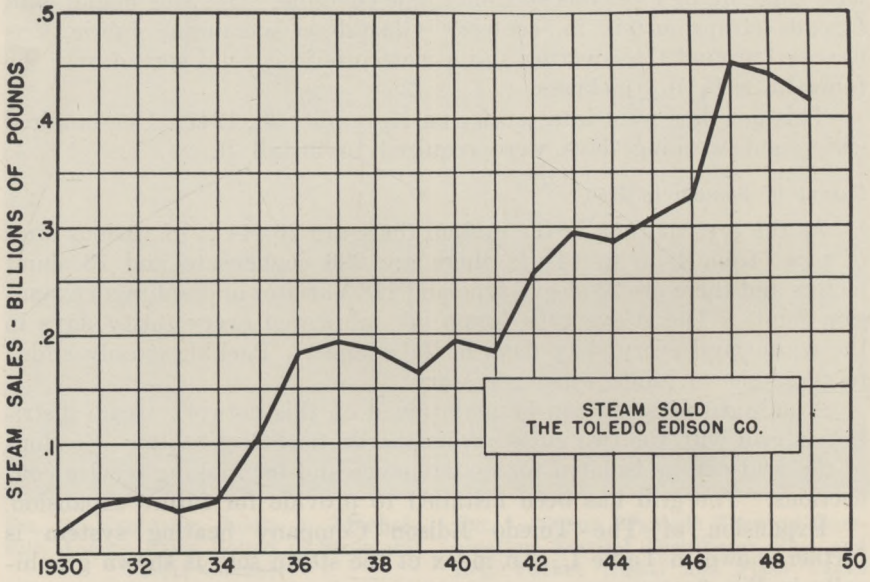

FIG. 9