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THE ECONOMIC FEASIBILITY OF THE GENERATION OF
ELECTRICAL ENERGY BY THE UNIVERSITY OF ROCHESTER

by

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of the Requirements for the degree
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INTRODUCTION

The object of this project is to determine the economic possibility of the self-generation of electrical energy by the University of Rochester to supply the Mens' Campus, Medical School and the hospitals and auxiliary buildings. At present the University purchases this energy (on rate 9) from the Rochester Gas and Electric Corporation. The main three phase 60 cycle feed enters the steam generating plant on Elmwood Avenue. The energy enters at 4150 volts and is distributed to the various transformers at that voltage. The transformers reduce the potential to the standard 110-220 volts for use in the buildings. The University owns and maintains these transformers.

The University has an efficient steam generating plant which supplies these buildings with steam for heating, sterilizing and cooking. At present the steam is generated at 115 pounds gauge pressure and about 2 per cent moisture. Heating steam is used at reduced pressure very close to zero gauge pressure. It is proposed in this study that the University increase the boiler pressure to 200 pounds, add a turbine room, purchase and install turbo-generator sets, make the necessary piping changes and additions and generate electricity for its own consumption. The exhaust steam from the turbines would be used for heating purposes. This proposal was set forth by Mr. Gerald P. Troy as a student problem in 1933. Mr. Troy's findings showed a definite saving of \$4,450. per year

by generating from October 15th to June 15th and purchasing energy the remainder of the year. In the present study the addition of superheaters to the boilers, proposed by Mr. Troy, is not recommended. It is believed that the small saving, if any, does not warrant the initial expense and the additional maintenance.

A review of Mr. Troy's report and the changes recommended by the Rochester Gas and Electric Corporation show that the results obtained depend more on the investment, depreciation and interest charges than on steam cost chargeable to electrical generation. This is largely because the steam plant produces steam at a low cost and the per cent of that cost chargeable to generation is small in those months when the exhaust steam can be charged to heating.

PHYSICAL ASPECT

Although this problem is primarily a financial one, the physical aspect cannot be neglected. Of prime importance is the question of whether the existing piping is of sufficient size to carry the required quantity of steam at low pressure. Mr. Troy, using an empirical formula, found the pipe, which is of 10" nominal diameter, to be sufficiently large to carry exhaust steam. His computations also showed that the maximum back pressure required at the steam plant would be 17 pounds gauge to have a flow of 425 pounds of steam per minute and a pressure of 5 pounds gauge at the Physical Educa-

tion Building. This is the most remote point of distribution (sketch of piping, page 92 appendix). These findings were for steam which had 40 degrees superheat when entering the main.

For this study several tests were made by throttling the steam as it entered the River Campus main. Thus the steam leaving the plant was at low pressure. In the tests the pressure was reduced to 10 pounds gauge and held as closely as possible at that value. A record was kept of the quantity of steam flowing and the pressures, entering the main, at the end of the tunnel and at the Physical Education Building. The chief objection to this procedure was the short duration of the tests and the inaccuracy of meters at the low pressure. For this reason the data is not included here. The one conclusion that could be drawn was that it was possible to heat the River Campus buildings for periods of from one to two hours (the length of the tests) with low pressure steam. Further investigation of this question is necessary.

SELECTION OF GENERATORS

The next step is the selection of the turbo-generator sets. A broad study of the steam and electrical loads is best shown by a curve (page 94 appendix). It can be seen that the electric load is increasing more rapidly than the steam load. An independent study is now being made to find the reasons for this rapidly increasing

electrical load and to propose a remedy. It is only natural in an institution of this type, which is expanding, that the loadings should increase. For purposes of this project, with a thought for the distant future, it would be necessary that there be some parallel-
ing of the two loads. The curve (page 95 appendix) shows the ratio of pounds of steam consumed to kilowatt hours of electrical energy consumed. The curve would seem to indicate a trend toward a more constant ratio.

The results of a study of peak demands for successive years is illustrated by the curve (page 97 appendix). The peak demand is maximum power demand and is a very important factor in the determination of the generators to be selected. The trend of this demand seems to be a 24 kilowatt increase each year. Thus in 1937-1938 the peak should be about 700 kilowatts. In this report allowance will be made for a demand of 1000 kilowatts. This means that there will be an excess of 300 kilowatts and that no additional generators will be necessary to supply the demand for the next twelve years.

To select the generator units a study of the daily demand charts was made. The photograph (page 99 appendix) shows a portion of the chart from the Rochester Gas and Electric demand meter. This meter calculates the average kilowatt and kilovolt-amperes for each half hour and records that average on the chart at the end of that period. The meter factor is 600 and the chart readings are multi-

plied by that factor to read kilowatt and kilovolt-ampere.

The curve on page 100(appendix) shows the kilowatt readings as taken from the chart for November 5, 1936. The next curve (page 102 appendix) shows the results of plotting the similar curves of the following dates on one sheet.

October 21, 23, 26, 28, 30 1936

November 2, 11, 13 1936

December 7, 11, 17 1936

January 4, 22, 27 1937

All of the points when plotted lie within the shaded area. Using this curve as a basis the following generator units were selected.

2 - 400 kw. units

1 - 200 kw. unit

The horizontal lines illustrate how the units selected could supply the demand. The combination of all three units operating to give 1000 kilowatts is not shown.

SELECTION OF THE TURBINES

Turbines from the Terry Steam Turbine Company were selected to drive the generators. This manufacturer was chosen because of reliability and experience in small turbine building. The letter, steam rate curves and descriptive matter (pages 104-108 appendix) were received after a conference with a representative of that company.

The turbines are designed to operate at a throttle pressure of 185 pounds gauge and an exhaust pressure of 15 pounds gauge. The turbines will operate at back pressures ranging from 20 pounds to 5 pounds gauge. The total cost of the turbo-generator sets is \$33,520.

PRELIMINARY OF BALANCING LOADS

Since the heating load will be supplied wholly, or partially, by the turbine exhaust, it now becomes necessary to investigate the balance of the two loads. It will be possible in actual practice to operate the turbines at a fluctuating back pressure. When the heating steam demand becomes large it will be desirable to raise the back pressure to obtain the necessary flow. The turbines operating at a higher back pressure will require more steam for each unit of electrical energy. If the heating steam demand becomes low the back pressure may be lowered and the turbines will require less steam to supply the electric load. Inspection of the turbine steam rate curves verifies this. Thus by manipulating the back pressure it will be possible to make the steam demand of the turbines and the heating steam demand tend to approximate each other. It would be very difficult and impractical to make an exact analysis of the loads. For this reason the following analysis is made assuming a constant back pressure and a constant steam rate. A back pressure of 15 pounds gauge was selected. Inspection of the demand curve

(page 102 appendix) shows that the average kilowatt demand between 12:00 P.M. and 7:00 A.M. is about 175 kilowatts. At that load the 200 kilowatt machine requires 55 pounds per kilowatt hour. During the remainder of the day, 17 hours, it will be assumed that the 400 kilowatt machine operates at 400 kilowatts for the entire period and the 200 kilowatt machine operates at 150 kilowatts for 8 hours of the period. The steam rates are 41 pounds per kilowatt hour and 57 pounds per kilowatt hour respectively. The following computations gives the average steam rate.

Kilowatt hours

$$175 \times 7 = 1225$$

$$400 \times 17 = 6800$$

$$150 \times 8 = 1200$$

9225 kilowatt hours

Pounds of steam

$$1225 \times 55 = 67,500$$

$$6800 \times 41 = 278,000$$

$$1200 \times 57 = 68,500$$

414,000 pounds

$$\text{Average steam rate} = \frac{414,000}{9225} = 45 \text{ pounds per kilowatt hour}$$

It will also be assumed and later demonstrated that the University should generate during only a portion of the year and should purchase energy during the remainder. If operation is carried out in this manner it is necessary that the University purchase power for at least four months. The reason for this is to be found on page 113(appendix) in the Rate 3 Billing under Special Provisions. This states that operation with a reduced winter service is permissible for only eight months of any one year.

The heating load at the University occurs during the period from September to June. Thus generation must be within that period. In this project generation was considered to start when the heating load would use most of the turbine exhaust and to end when there would be an excessive waste of exhaust steam. This was found to occupy the period from September 15th to May 15th, or just eight months.

In the investigation of the balancing of the heating and generating loads, allowance must be made in the steam figures available for steam used at high pressure. The amount of steam used on the River Campus at high pressure is a negligible quantity, but the amounts used at the steam plant and the hospital should be accounted for. From data available at the steam plant it was found that the hospital uses about 96,000 pounds of steam in 24 hours at

high pressure. It will be assumed that this steam is used at an hourly rate of 4000 pounds. In all probability more of this steam is used during the working hours of the day than in the off hours because the kitchen and laundry, large users of high pressure steam, operate during these hours. This tends to show more steam for heating during the day and less during the other hours than is actually the case. This error is on the safe side because, as the figures show, there is usually an adequate amount of heating steam during the day.

High pressure steam is used at the plant itself to operate pumps, fan engines and other auxiliaries. This figure can best be expressed as a percentage of the total output. The following figures were compiled to find the average percentage.

Month	Ave. total output of steam per 24 hours	Ave. station steam per 24 hours	Station steam per cent of total
October	491,000	71,100	14.5
November	624,000	99,000	16.0
December	858,000	101,000	13.0
January	910,000	103,000	11.0
February	950,000	104,000	11.0
March	745,000	103,000	13.0
April	704,000	79,400	11.0
		Assumed average	12.0%

The steam and electrical data used in the following analysis were taken in 1935, that year being chosen because the data were complete and in a comprehensible graphic form. The individual days were selected because they seemed to be typical. That is, there was nothing extremely unusual about them. The procedure was to choose one day near the beginning of each month, one in the middle and one toward the end.

HEATING STEAM

The term Total Steam is the entire amount of steam generated by the boilers, thus including both high and low pressure consumption. Station Steam is the estimated amount of steam used in the plant and is 12 per cent of the total. Total High Pressure Steam is the Station Steam plus 4000 pounds which is the estimated consumption by the hospital. Heating Steam is the amount of steam which is used for heating and is the difference between total steam and total high pressure steam. It is the heating steam which is of importance in this problem because that load will be supplied by the turbine exhaust. These data are on the following pages.

TURBINE EXHAUST AND BALANCE

The heating load is now known and the figures on pages 38 to 63 are to prove that it can be met with exhaust steam from the turbines. The column "Kw." is the average kilowatt demand for the hour and is

September 19, 1935

Hour	Total Steam	Station Steam	Total High Pressure	Heating Steam
1:00 AM	3,000	3,600	4,360	0
2:00	12,000	1,440	5,440	6,560
3:00	7,000	840	4,840	2,160
4:00	7,000	840	4,840	2,160
5:00	6,000	720	4,720	1,280
6:00	7,000	840	4,840	2,160
7:00	8,000	960	4,960	3,040
8:00	8,000	960	4,960	3,040
9:00	9,000	1,080	5,080	3,920
10:00	8,000	960	4,960	3,040
11:00	11,000	1,320	5,320	5,680
12:00	15,000	1,800	5,800	9,200
1:00 PM	11,000	1,320	5,320	5,680
2:00	8,000	960	4,960	3,040
3:00	9,000	1,080	5,080	3,920
4:00	8,000	960	4,960	3,040
5:00	8,000	960	4,960	3,040
6:00	7,000	840	4,840	2,160
7:00	10,000	1,200	5,200	4,800
8:00	7,000	840	4,840	2,160
9:00	13,000	1,560	5,560	7,440
10:00	7,000	840	4,840	2,160
11:00	9,000	1,080	5,080	3,920
12:00	7,000	840	4,840	2,160

September 30, 1935

Hour	Total Steam	Station Steam	Total High Pressure	Heating Steam
1:00 AM	10,000	1,200	5,200	4,800
2:00	14,000	1,680	5,680	8,320
3:00	9,000	1,080	5,080	3,920
4:00	7,000	840	4,840	2,160
5:00	17,000	2,040	6,040	10,960
6:00	12,000	1,440	5,440	6,560
7:00	28,000	3,360	7,360	20,640
8:00	35,000	4,200	8,200	26,800
9:00	38,000	4,560	8,560	29,440
10:00	31,000	3,720	7,720	23,280
11:00	37,000	4,450	8,450	28,550
12:00	32,000	3,840	7,840	24,160
1:00 PM	32,000	3,840	7,840	24,160
2:00	32,000	3,840	7,840	24,160
3:00	35,000	4,200	8,200	24,800
4:00	28,000	3,360	7,360	20,640
5:00	28,000	3,360	7,360	20,640
6:00	24,000	2,880	6,880	17,120
7:00	20,000	2,400	6,400	13,600
8:00	17,000	2,040	6,040	10,960
9:00	18,000	2,160	6,160	11,840
10:00	9,000	1,080	5,080	3,920
11:00	10,000	1,200	5,200	4,800
12:00	9,000	1,080	5,080	3,920

October 5, 1935

Hour	Total Steam	Station Steam	Total High Pressure	Heating Steam
1:00 AM	12,000	1,400	5,400	6,600
2:00	14,000	1,680	5,680	8,320
3:00	6,000	720	4,720	1,280
4:00	10,000	1,200	5,200	4,800
5:00	24,000	2,800	6,800	17,200
6:00	29,000	3,500	7,500	21,500
7:00	27,000	3,240	7,240	19,760
8:00	36,000	4,320	8,320	27,680
9:00	38,000	4,560	8,560	29,440
10:00	37,000	4,440	8,440	28,540
11:00	37,000	4,440	8,440	28,540
12:00	32,000	3,840	7,840	24,160
1:00 PM	32,000	3,840	7,840	24,160
2:00	34,000	4,080	8,080	25,920
3:00	33,000	3,960	7,960	25,040
4:00	29,000	3,480	7,480	21,520
5:00	31,000	3,720	7,720	23,280
6:00	28,000	3,360	7,360	20,640
7:00	21,000	2,520	6,520	14,480
8:00	21,000	2,520	6,520	14,480
9:00	18,000	2,160	6,160	11,840
10:00	21,000	2,520	6,520	14,480
11:00	27,000	3,240	7,240	19,760
12:00	25,000	3,000	7,000	18,000

October 19, 1935

Hour	Total Steam	Station Steam	Total High Pressure	Heating Steam
1:00 AM	11,000	1,320	5,320	5,680
2:00	11,000	1,320	5,320	5,680
3:00	8,000	960	4,960	3,040
4:00	13,000	1,560	5,560	7,440
5:00	24,000	2,860	6,860	17,140
6:00	20,000	2,400	6,400	13,600
7:00	28,000	3,360	7,360	20,640
8:00	33,000	3,960	7,960	25,040
9:00	34,000	4,080	8,080	23,920
10:00	30,000	3,600	7,600	22,400
11:00	25,000	3,000	7,000	18,000
12:00	20,000	2,400	6,400	13,600
1:00 PM	13,000	1,560	5,560	7,440
2:00	13,000	1,560	5,560	7,440
3:00	11,000	1,320	5,320	5,680
4:00	11,000	1,320	5,320	5,680
5:00	12,000	1,440	5,440	6,560
6:00	13,000	1,560	5,560	7,440
7:00	13,000	1,560	5,560	7,440
8:00	13,000	1,560	5,560	7,440
9:00	11,000	1,320	5,320	5,680
10:00	8,000	960	4,960	3,040
11:00	12,000	1,440	5,440	6,560
12:00	8,000	960	4,960	3,040

October 31, 1935

Hour	Total Steam	Station Steam	Total High Pressure	Heating Steam
1:00 AM	8,000	960	4,960	3,040
2:00	11,000	1,300	5,300	5,700
3:00	13,000	1,550	5,550	7,450
4:00	10,000	1,200	5,200	4,800
5:00	23,000	2,760	6,760	16,240
6:00	17,000	2,040	6,040	10,960
7:00	27,000	3,240	7,240	19,760
8:00	32,000	3,840	7,840	24,160
9:00	32,000	3,840	7,840	24,160
10:00	30,000	3,600	7,600	22,400
11:00	34,000	4,080	8,080	23,920
12:00	27,000	3,240	7,240	19,760
1:00 PM	20,000	2,400	6,400	13,600
2:00	18,000	2,160	6,160	12,940
3:00	17,000	2,040	6,040	11,960
4:00	13,000	1,550	5,550	7,450
5:00	20,000	2,400	6,400	13,600
6:00	23,000	2,760	6,760	16,240
7:00	21,000	2,520	6,520	14,480
8:00	22,000	2,640	6,640	15,360
9:00	15,000	1,800	5,800	9,200
10:00	18,000	2,160	6,160	11,840
11:00	12,000	1,440	5,440	6,560
12:00	7,000	840	4,840	2,160

November 7, 1935

Hour	Total Steam	Station Steam	Total High Pressure	Heating Steam
1:00 AM	10,000	1,200	5,200	4,800
2:00	10,000	1,200	5,200	4,800
3:00	8,000	960	4,960	3,040
4:00	12,000	1,440	5,440	6,560
5:00	22,000	3,000	7,000	28,000
6:00	25,000	2,640	6,640	15,360
7:00	35,000	4,200	8,200	26,800
8:00	38,000	4,560	8,560	29,440
9:00	40,000	4,800	8,800	31,200
10:00	38,000	4,560	8,560	29,440
11:00	39,000	4,690	8,690	30,310
12:00	37,000	4,450	8,450	28,550
1:00 PM	33,000	3,960	7,960	25,040
2:00	35,000	4,200	8,200	26,800
3:00	28,000	3,360	7,360	20,640
4:00	30,000	3,600	7,600	22,400
5:00	28,000	3,360	7,360	20,640
6:00	27,000	3,240	7,240	19,760
7:00	26,000	3,120	7,120	18,880
8:00	24,000	2,880	6,880	17,120
9:00	23,000	2,760	6,760	16,240
10:00	18,000	2,160	6,160	11,840
11:00	8,000	960	4,960	3,040
12:00	8,000	960	4,960	3,040

November 19, 1935

Hour	Total Steam	Station Steam	Total High Pressure	Heating Steam
1:00 AM	17,000	2,040	6,040	10,960
2:00	17,000	2,040	6,040	10,960
3:00	18,000	2,160	6,160	11,840
4:00	17,000	2,040	6,040	10,960
5:00	27,000	3,240	7,240	19,760
6:00	32,000	3,840	7,840	24,160
7:00	52,000	6,250	10,250	41,750
8:00	42,000	5,040	9,040	32,960
9:00	48,000	5,760	9,760	38,240
10:00	41,000	4,920	8,920	32,080
11:00	49,000	5,890	9,890	39,110
12:00	38,000	4,560	8,560	29,440
1:00 PM	40,000	4,800	8,800	31,200
2:00	43,000	5,160	9,160	33,840
3:00	37,000	4,440	8,440	28,560
4:00	39,000	4,690	8,690	30,310
5:00	40,000	4,800	8,800	31,200
6:00	32,000	3,840	7,840	24,160
7:00	29,000	3,480	7,480	21,520
8:00	27,000	3,240	7,240	19,760
9:00	28,000	3,360	7,360	20,640
10:00	22,000	2,640	6,640	15,360
11:00	9,000	1,080	5,080	3,920
12:00	11,000	1,320	5,320	5,680

November 30, 1935

Hour	Total Steam	Station Steam	Total High Pressure	Heating Steam
1:00 AM	17,000	2,040	6,040	10,960
2:00	18,000	2,160	6,160	11,840
3:00	20,000	2,400	6,400	13,600
4:00	13,000	1,560	5,560	7,440
5:00	20,000	2,400	6,400	13,600
6:00	30,000	3,600	7,600	22,400
7:00	41,000	4,920	8,920	32,080
8:00	45,000	5,400	9,400	35,600
9:00	48,000	5,750	9,750	38,250
10:00	47,000	5,650	9,650	37,350
11:00	45,000	5,400	9,400	35,600
12:00	42,000	5,050	9,050	32,950
1:00 PM	40,000	4,800	8,800	31,200
2:00	42,000	5,050	9,050	32,950
3:00	47,000	5,650	9,650	37,350
4:00	37,000	4,450	8,450	28,550
5:00	38,000	4,560	8,560	29,440
6:00	33,000	3,960	7,960	25,040
7:00	26,000	3,120	7,120	18,880
8:00	28,000	3,360	7,360	20,640
9:00	32,000	3,840	7,840	24,160
10:00	28,000	3,360	7,360	20,640
11:00	23,000	2,760	6,760	16,240
12:00	23,000	2,760	6,760	16,240

December 2, 1935

Hour	Total Steam	Station Steam	Total High Pressure	Heating Steam
1:00 AM	15,000	1,800	5,800	9,200
2:00	23,000	2,760	6,760	16,240
3:00	21,000	2,520	6,520	14,480
4:00	24,000	2,880	6,880	17,120
5:00	36,000	4,320	8,320	27,680
6:00	42,000	5,040	9,040	32,960
7:00	53,000	6,350	10,350	42,650
8:00	51,000	6,120	10,120	50,880
9:00	50,000	6,000	10,000	40,000
10:00	49,000	5,890	9,890	39,110
11:00	48,000	5,760	9,760	38,240
12:00	49,000	5,880	9,880	39,120
1:00 PM	47,000	5,640	9,640	36,360
2:00	50,000	6,000	10,000	40,000
3:00	52,000	6,240	10,240	41,760
4:00	49,000	5,890	9,890	39,110
5:00	48,000	5,760	9,760	38,240
6:00	38,000	4,560	8,560	29,440
7:00	37,000	4,440	8,440	28,560
8:00	32,000	3,840	7,840	24,160
9:00	36,000	4,320	8,320	27,680
10:00	27,000	3,240	7,240	19,760
11:00	20,000	2,400	6,400	13,600
12:00	23,000	2,760	6,760	16,240

December 14, 1934

Hour	Total Steam	Station Steam	Total High Pressure	Heating Steam
1:00 AM	29,000	3,480	7,480	21,520
2:00	36,000	4,310	8,310	27,690
3:00	27,000	3,240	7,240	19,760
4:00	40,000	4,800	8,800	31,200
5:00	44,000	5,280	9,280	34,720
6:00	45,000	5,400	9,400	35,600
7:00	41,000	4,920	8,920	32,080
8:00	45,000	5,400	9,400	35,600
9:00	48,000	5,760	9,760	38,230
10:00	49,000	5,880	9,880	39,120
11:00	45,000	5,400	9,400	35,600
12:00	47,000	5,640	9,640	37,360
1:00 PM	45,000	5,400	9,400	35,600
2:00	46,000	5,520	9,520	36,480
3:00	48,000	5,760	9,700	37,240
4:00	46,000	5,520	9,520	36,480
5:00	47,000	5,640	9,640	37,460
6:00	30,000	3,600	7,600	22,400
7:00	33,000	3,960	7,960	25,040
8:00	30,000	3,600	7,600	22,400
9:00	29,000	3,480	7,480	21,520
10:00	28,000	3,360	7,360	20,640
11:00	28,000	3,360	7,360	20,640
12:00	24,000	2,880	6,880	17,120

December 28, 1934

Hour	Total Steam	Station Steam	Total High Pressure	Heating Steam
1:00 AM	30,000	3,600	7,600	22,400
2:00	24,000	2,880	6,880	17,120
3:00	25,000	3,000	7,000	18,000
4:00	24,000	2,880	6,880	17,120
5:00	30,000	3,600	7,600	22,400
6:00	46,000	5,530	9,530	35,470
7:00	53,000	6,360	10,360	42,640
8:00	44,000	5,290	9,290	34,710
9:00	47,000	5,600	9,600	37,400
10:00	48,000	5,760	9,760	38,240
11:00	50,000	6,000	10,000	40,000
12:00	45,000	5,400	9,400	35,600
1:00 PM	43,000	5,160	9,160	33,840
2:00	46,000	5,510	9,510	36,490
3:00	45,000	5,400	9,400	35,600
4:00	40,000	4,800	8,800	31,200
5:00	37,000	4,400	8,400	28,600
6:00	26,000	3,120	7,120	18,880
7:00	28,000	3,360	7,360	20,640
8:00	24,000	2,880	6,880	17,120
9:00	25,000	3,000	7,000	18,000
10:00	24,000	2,880	6,880	17,120
11:00	25,000	3,000	7,000	18,000
12:00	22,000	2,640	6,640	15,360

January 3, 1935

Hour	Total Steam	Station Steam	Total High Pressure	Heating Steam
1:00 AM	20,000	2,400	6,400	13,600
2:00	20,000	2,400	6,400	13,600
3:00	20,000	2,400	6,400	13,600
4:00	21,000	2,500	6,500	14,500
5:00	25,000	3,000	7,000	18,000
6:00	38,000	4,600	8,600	29,400
7:00	50,000	6,000	10,000	40,000
8:00	47,000	5,600	9,600	37,400
9:00	47,000	5,600	9,600	37,400
10:00	47,000	5,600	9,600	37,400
11:00	47,000	5,600	9,600	37,400
12:00	44,000	5,400	9,400	34,600
1:00 PM	40,000	4,800	8,800	31,200
2:00	43,000	5,200	9,200	33,800
3:00	44,000	5,400	9,400	34,600
4:00	40,000	4,800	8,800	31,200
5:00	35,000	4,200	8,200	26,800
6:00	30,000	3,600	7,600	22,400
7:00	30,000	3,600	7,600	22,400
8:00	26,000	3,200	7,200	18,800
9:00	30,000	3,600	7,600	22,400
10:00	30,000	3,600	7,600	22,400
11:00	36,000	3,200	7,200	28,800
12:00	34,000	4,100	8,100	25,900

January 22, 1935

Hour	Total Steam	Station Steam	Total High Pressure	Heating Steam
1:00 AM	20,000	2,400	6,400	13,600
2:00	20,000	2,400	6,400	13,600
3:00	20,000	2,400	6,400	13,600
4:00	20,000	2,400	6,400	13,600
5:00	35,000	4,200	8,200	26,800
6:00	50,000	6,000	10,000	40,000
7:00	47,000	5,600	9,600	37,400
8:00	48,000	5,800	9,800	38,200
9:00	50,000	6,000	10,000	40,000
10:00	48,000	5,800	9,800	38,200
11:00	50,000	6,000	10,000	40,000
12:00	47,000	5,600	9,600	37,400
1:00 PM	44,000	5,300	9,300	34,700
2:00	45,000	5,400	9,400	35,600
3:00	46,000	5,500	9,500	36,500
4:00	43,000	5,200	9,200	33,800
5:00	40,000	4,800	8,800	31,200
6:00	37,000	4,400	8,400	28,600
7:00	32,000	3,800	7,800	24,200
8:00	30,000	3,600	7,600	22,400
9:00	30,000	3,600	7,600	22,400
10:00	30,000	3,600	7,600	22,400
11:00	30,000	3,600	7,600	22,400
12:00	30,000	3,600	7,600	22,400

January 31, 1935

Hour	Total Steam	Station Steam	Total High Pressure	Heating Steam
1:00 AM	28,000	3,200	7,200	20,800
2:00	30,000	3,600	7,600	22,400
3:00	29,000	3,500	7,500	21,500
4:00	32,000	3,800	7,800	24,200
5:00	33,000	4,000	8,000	25,000
6:00	30,000	3,600	7,600	22,400
7:00	34,000	4,100	8,100	25,900
8:00	45,000	5,400	9,400	35,600
9:00	56,000	6,700	10,700	45,300
10:00	68,000	8,200	12,200	55,800
11:00	70,000	8,400	12,400	57,600
12:00	68,000	8,200	12,200	55,800
1:00 PM	58,000	7,000	11,000	47,000
2:00	63,000	7,600	11,600	51,400
3:00	64,000	7,700	11,700	52,300
4:00	44,000	5,300	9,300	34,700
5:00	60,000	7,200	11,200	48,800
6:00	60,000	7,200	11,200	48,800
7:00	49,000	5,900	9,900	39,100
8:00	52,000	6,200	10,200	41,800
9:00	51,000	6,100	10,100	40,900
10:00	45,000	5,400	9,400	35,600
11:00	48,000	5,600	9,600	38,400
12:00	32,000	3,800	7,800	24,200

February 2, 1935

Hour	Total Steam	Station Steam	Total High Pressure	Heating Steam
1:00 AM	15,000	1,800	5,800	9,200
2:00	17,000	2,000	6,000	11,000
3:00	20,000	2,400	6,000	12,000
4:00	25,000	3,000	7,000	18,000
5:00	30,000	3,600	7,600	22,400
6:00	46,000	5,500	9,500	36,500
7:00	40,000	4,800	8,800	31,200
8:00	46,000	5,500	9,500	36,500
9:00	46,000	5,500	9,500	36,500
10:00	47,000	5,600	9,600	37,400
11:00	47,000	5,600	9,600	37,400
12:00	43,000	5,400	9,200	33,800
1:00 PM	41,000	4,900	8,900	32,100
2:00	42,000	5,000	9,000	33,000
3:00	44,000	5,300	9,300	34,700
4:00	40,000	4,800	8,800	31,200
5:00	34,000	4,100	8,100	25,900
6:00	30,000	3,600	7,600	22,400
7:00	30,000	3,600	7,600	22,400
8:00	36,000	4,300	8,300	27,700
9:00	26,000	3,100	7,100	18,900
10:00	27,000	3,200	7,200	19,800
11:00	25,000	3,000	7,000	18,000
12:00	20,000	2,400	6,400	13,600

February 13, 1935

Hour	Total Steam	Station Steam	Total High Pressure	Heating Steam
1:00 AM	20,000	2,400	6,400	13,600
2:00	19,000	2,300	6,300	12,700
3:00	16,000	1,900	5,900	10,100
4:00	19,000	2,300	6,300	12,700
5:00	26,000	3,100	7,100	18,900
6:00	35,000	4,200	8,200	26,800
7:00	44,000	5,300	9,300	34,700
8:00	43,000	5,200	9,200	33,800
9:00	47,000	5,600	9,600	37,400
10:00	41,000	4,900	8,900	32,100
11:00	41,000	4,900	8,900	32,100
12:00	40,000	4,800	8,800	31,200
1:00 PM	38,000	4,600	8,600	29,400
2:00	42,000	5,000	9,000	33,000
3:00	43,000	5,200	9,200	33,200
4:00	41,000	4,900	8,900	32,100
5:00	35,000	4,200	8,200	26,800
6:00	34,000	4,100	8,100	25,900
7:00	30,000	3,600	7,600	22,400
8:00	35,000	4,200	8,200	26,800
9:00	37,000	4,400	8,400	28,600
10:00	34,000	4,100	8,100	25,900
11:00	27,000	3,200	7,200	19,800
12:00	27,000	3,200	7,200%	19,800

February 27, 1935

Hour	Total Steam	Station Steam	Total High Pressure	Heating Steam
1:00 AM	35,000	4,200	8,200	26,800
2:00	37,000	4,500	8,500	28,500
3:00	33,000	4,100	8,100	24,900
4:00	40,000	4,800	8,800	31,200
5:00	42,000	5,000	9,000	33,000
6:00	50,000	6,000	10,000	40,000
7:00	46,000	5,500	9,500	36,500
8:00	44,000	5,300	9,300	34,700
9:00	47,000	5,600	9,600	37,400
10:00	46,000	5,500	9,500	36,500
11:00	46,000	5,500	9,500	36,500
12:00	44,000	5,200	9,300	34,700
1:00 PM	43,000	5,200	9,200	33,800
2:00	44,000	5,300	9,300	34,700
3:00	43,000	5,200	9,200	33,800
4:00	42,000	5,000	9,000	33,000
5:00	42,000	5,000	9,000	33,000
6:00	40,000	4,800	8,800	31,200
7:00	40,000	4,000	8,000	21,200
8:00	37,000	4,500	8,500	38,500
9:00	37,000	4,500	8,500	38,500
10:00	35,000	4,200	8,200	36,800
11:00	36,000	4,300	8,300	37,700
12:00	32,000	3,800	7,800	34,200

March 2, 1935

Hour	Total Steam	Station Steam	Total High Pressure	Heating Steam
1:00 AM	15,000	1,800	5,800	9,200
2:00	16,000	1,900	5,900	10,100
3:00	20,000	2,400	6,400	13,600
4:00	18,000	2,200	6,200	11,800
5:00	23,000	2,800	6,800	16,200
6:00	40,000	4,800	8,800	31,200
7:00	44,000	5,300	9,300	34,700
8:00	39,000	4,700	8,700	30,300
9:00	40,000	4,800	8,800	31,200
10:00	37,000	4,500	8,500	28,500
11:00	40,000	4,800	8,800	31,200
12:00	36,000	4,300	8,300	27,700
1:00 PM	36,000	4,300	8,300	27,700
2:00	34,000	4,100	8,100	25,900
3:00	30,000	3,600	7,600	22,400
4:00	35,000	4,200	8,200	26,800
5:00	26,000	3,100	7,100	18,900
6:00	24,000	2,900	6,900	17,100
7:00	25,000	3,000	7,000	18,000
8:00	20,000	2,400	6,400	13,600
9:00	21,000	2,500	6,500	14,500
10:00	20,000	2,400	6,400	13,600
11:00	17,000	2,000	6,000	11,000
12:00	17,000	2,000	6,000	11,000

March 16, 1935

Hour	Total Steam	Station Steam	Total High Pressure	Heating Steam
1:00 AM	15,000	1,800	5,800	9,200
2:00	17,000	2,000	6,000	11,000
3:00	17,000	2,000	6,000	11,000
4:00	20,000	2,400	6,400	13,600
5:00	16,000	1,900	5,900	10,100
6:00	27,000	3,200	7,200	19,800
7:00	40,000	4,800	8,800	31,200
8:00	38,000	4,600	8,600	29,400
9:00	35,000	4,200	8,200	26,800
10:00	35,000	4,200	8,200	26,800
11:00	33,000	4,000	8,000	25,000
12:00	25,000	3,000	7,000	18,000
1:00 PM	25,000	3,000	7,000	18,000
2:00	25,000	3,000	7,000	18,000
3:00	20,000	2,400	6,400	13,600
4:00	20,000	2,400	6,400	13,600
5:00	20,000	2,400	6,400	13,600
6:00	18,000	2,200	6,200	11,800
7:00	20,000	2,400	6,400	13,600
8:00	20,000	2,400	6,400	13,600
9:00	20,000	2,400	6,400	13,600
10:00	19,000	2,300	6,300	11,700
11:00	18,000	2,200	6,200	11,800
12:00	15,000	1,800	5,800	9,200

March 29, 1935

Hour	Total Steam	Station Steam	Total High Pressure	Heating Steam
1:00 AM	18,000	2,200	6,200	11,800
2:00	15,000	1,800	5,800	9,200
3:00	15,000	1,800	5,800	9,200
4:00	15,000	1,800	5,800	9,200
5:00	22,000	2,600	6,600	15,400
6:00	39,000	4,700	8,700	30,300
7:00	40,000	4,800	8,800	31,200
8:00	35,000	4,200	8,200	26,800
9:00	39,000	4,700	8,700	30,300
10:00	36,000	4,300	8,300	27,700
11:00	38,000	4,600	8,600	29,400
12:00	36,000	4,300	8,300	27,700
1:00 PM	36,000	4,300	8,300	27,700
2:00	35,000	4,200	8,200	26,800
3:00	35,000	4,200	8,200	26,800
4:00	29,000	3,500	7,500	21,500
5:00	34,000	4,100	8,100	25,900
6:00	29,000	3,500	7,500	21,500
7:00	27,000	3,200	7,200	19,800
8:00	22,000	2,600	6,600	15,400
9:00	20,000	2,400	6,400	13,600
10:00	20,000	2,400	6,400	13,600
11:00	21,000	2,500	6,500	14,500
12:00	15,000	1,800	5,800	9,200

April 3, 1935

Hour	Total Steam	Station Steam	Total High Pressure	Heating Steam
1:00 AM	20,000	2,400	6,400	13,600
2:00	19,000	2,300	6,300	12,700
3:00	15,000	1,800	5,800	9,200
4:00	17,000	2,000	6,000	11,000
5:00	27,000	3,200	7,200	19,800
6:00	40,000	4,800	8,800	31,200
7:00	40,000	4,800	8,800	31,000
8:00	40,000	4,800	8,800	31,000
9:00	40,000	4,800	8,800	31,000
10:00	40,000	4,800	8,800	31,000
11:00	35,000	4,200	8,200	26,800
12:00	35,000	4,200	8,200	26,800
1:00 PM	33,000	4,000	8,000	25,000
2:00	36,000	4,300	8,300	27,700
3:00	38,000	4,600	8,600	29,400
4:00	33,000	4,000	8,000	25,000
5:00	27,000	3,200	7,200	19,800
6:00	22,000	2,600	6,600	15,400
7:00	27,000	3,200	7,200	19,800
8:00	22,000	2,600	6,600	15,400
9:00	23,000	2,800	6,800	16,200
10:00	20,000	2,400	6,400	13,600
11:00	22,000	2,600	6,600	15,400
12:00	18,000	2,200	6,200	11,800

April 10, 1935

Hour	Total Steam	Station Steam	Total High Pressure	Heating Steam
1:00 AM	15,000	1,800	5,800	14,200
2:00	15,000	1,800	5,800	19,200
3:00	15,000	1,800	5,800	9,200
4:00	20,000	2,400	6,400	13,600
5:00	25,000	3,000	7,000	18,000
6:00	35,000	4,200	8,200	26,800
7:00	36,000	4,300	8,300	27,700
8:00	37,000	4,500	8,500	28,500
9:00	36,000	4,300	8,300	27,700
10:00	35,000	4,200	8,200	26,800
11:00	35,000	4,200	8,200	26,800
12:00	36,000	4,300	8,300	27,700
1:00 PM	32,000	3,800	7,800	24,200
2:00	34,000	4,100	8,100	23,900
3:00	34,000	4,100	8,100	23,900
4:00	30,000	3,600	7,600	22,400
5:00	28,000	3,400	7,400	20,600
6:00	27,000	3,200	7,200	19,800
7:00	26,000	3,100	7,100	18,900
8:00	20,000	2,400	6,400	13,600
9:00	19,000	2,300	6,300	12,700
10:00	19,000	2,300	6,300	12,700
11:00	18,000	2,200	6,200	11,800
12:00	15,000	1,800	5,800	9,200

April 30, 1935

Hour	Total Steam	Station Steam	Total High Pressure	Heating Steam
1:00 AM	18,000	2,200	6,200	11,800
2:00	20,000	2,400	6,400	13,600
3:00	17,000	2,000	6,000	11,000
4:00	20,000	2,400	6,400	13,600
5:00	20,000	2,400	6,400	13,600
6:00	25,000	3,000	7,000	18,000
7:00	40,000	4,800	8,800	31,200
8:00	35,000	4,200	8,200	26,800
9:00	37,000	4,500	8,500	31,500
10:00	40,000	4,800	8,800	31,200
11:00	38,000	4,600	8,600	29,400
12:00	40,000	4,800	8,800	31,200
1:00 PM	38,000	4,600	8,600	29,400
2:00	35,000	4,200	8,200	26,800
3:00	40,000	4,800	8,800	31,200
4:00	30,000	3,600	7,600	22,400
5:00	37,000	4,500	8,500	28,500
6:00	30,000	3,600	7,600	22,400
7:00	30,000	3,600	7,600	22,400
8:00	25,000	3,000	7,000	18,000
9:00	27,000	3,200	7,200	19,800
10:00	28,000	3,400	7,400	20,600
11:00	28,000	3,400	7,400	20,600
12:00	22,000	2,600	6,600	15,400

May 3, 1935

Hour	Total Steam	Station Steam	Total High Pressure	Heating Steam
1:00 AM	19,000	2,300	6,300	12,700
2:00	19,000	2,300	6,300	12,700
3:00	16,000	1,900	5,900	10,100
4:00	22,000	2,600	6,600	15,400
5:00	21,000	2,500	6,500	14,500
6:00	35,000	4,200	8,200	26,800
7:00	40,000	4,800	8,800	31,200
8:00	45,000	5,400	9,400	35,600
9:00	42,000	5,100	9,100	32,900
10:00	45,000	5,400	9,400	35,600
11:00	44,000	5,300	9,300	34,700
12:00	45,000	5,400	9,400	35,600
1:00 PM	42,000	5,100	9,100	32,900
2:00	45,000	5,400	9,400	35,600
3:00	40,000	4,800	8,800	31,200
4:00	42,000	5,100	9,100	32,900
5:00	40,000	4,800	8,800	31,200
6:00	33,000	4,000	8,000	25,000
7:00	33,000	4,000	8,000	25,000
8:00	30,000	3,600	7,600	22,400
9:00	25,000	3,000	7,000	18,000
10:00	26,000	3,100	7,100	18,900
11:00	25,000	3,000	7,000	18,000
12:00	20,000	2,400	6,400	13,600

May 16, 1935

Hour	Total Steam	Station Steam	Total High Pressure	Heating Steam
1:00 AM	10,000	1,200	5,200	4,800
2:00	10,000	1,200	5,200	4,800
3:00	11,000	1,300	5,300	5,700
4:00	11,000	1,300	5,300	5,700
5:00	12,000	1,400	5,400	6,600
6:00	18,000	2,200	6,200	11,800
7:00	25,000	3,000	7,000	18,000
8:00	25,000	3,000	7,000	18,000
9:00	27,000	3,200	7,200	19,800
10:00	25,000	3,000	7,000	18,000
11:00	23,000	2,800	6,800	16,200
12:00	25,000	3,000	7,000	18,000
1:00 PM	21,000	2,500	6,500	14,500
2:00	15,000	1,800	5,800	9,200
3:00	15,000	1,800	5,800	9,200
4:00	16,000	1,900	5,900	10,100
5:00	15,000	1,800	5,800	9,200
6:00	12,000	1,400	5,400	6,600
7:00	14,000	1,700	5,700	8,300
8:00	14,000	1,700	5,700	8,300
9:00	14,000	1,700	5,700	8,300
10:00	13,000	1,600	5,600	7,400
11:00	10,000	1,200	5,200	4,800
12:00	10,000	1,200	5,200	4,800

May 27, 1935

Hour	Total Steam	Station Steam	Total High Pressure	Heating Steam
1:00 AM	4,000	500	4,500	- 500
2:00	4,000	500	4,500	- 500
3:00	4,000	500	4,500	- 500
4:00	6,000	700	4,700	1,300
5:00	13,000	1,600	5,600	7,400
6:00	10,000	1,200	5,200	4,800
7:00	15,000	1,800	5,800	9,200
8:00	12,000	1,400	5,400	6,600
9:00	17,000	2,000	6,000	11,000
10:00	16,000	1,900	5,900	10,100
11:00	14,000	1,700	5,700	8,300
12:00	10,000	1,200	5,200	4,800
1:00 PM	9,000	1,100	5,100	3,900
2:00	8,000	1,000	5,000	3,000
3:00	8,000	1,000	5,000	3,000
4:00	9,000	1,100	5,100	3,900
5:00	7,000	800	4,800	2,200
6:00	8,000	1,000	5,000	3,000
7:00	5,000	600	4,600	400
8:00	5,000	600	4,600	400
9:00	7,000	800	4,800	2,200
10:00	6,000	700	4,700	1,300
11:00	8,000	1,000	5,000	3,000
12:00	6,000	800	4,800	1,200

therefore equal to kilowatt hours. Kilowatt hours times the assumed steam rate (45 pounds per kilowatt hour) gives the required pounds of steam necessary to supply the electrical load and is thus the pounds of exhaust steam. If that amount of steam is less than the heating steam, the remainder of the heating steam must come direct from the boiler.

No record is made in the data of the amount of steam which must come direct from the boiler because, as will be proved later, this has no effect on the cost of generation. The column "Heating Steam (exhaust)" is the amount of turbine exhaust steam which can be used for heating. If the total exhaust steam is greater than the heat load demand the excess must be thrown away. A record is made of this steam in the column "Atmosphere (exhaust)".

In this analysis no allowance has been made for the difference in heat content (enthalpy) of the present and proposed steam. The present steam at 115 pounds gauge and 2 per cent moisture has a heat content of 1176 B.T.U. per pound. The proposed steam at 200 pounds gauge and 2 per cent moisture would contain 1182 B.T.U. per pound. If the steam rate is taken as 45 pounds per kilowatt hour the following gives the heat content of the exhaust steam from the turbines.

$$\frac{3413}{45} = 76 \text{ B.T.U.}$$

$$1187 - 76 = 1106 \text{ B.T.U. per pound}$$

This means that a given heating load will call for more exhaust

September 19, 1935

Hour	Kw.	Kw. x 45	Heating (exhaust)	Atmosphere (exhaust)
1:00 AM	108	4,860	0	4,860
2:00	102	4,600	4,600	0
3:00	132	5,940	2,160	3,780
4:00	132	5,940	2,160	3,780
5:00	126	5,670	1,280	4,390
6:00	132	5,940	2,160	3,780
7:00	108	4,860	3,040	1,820
8:00	186	8,380	3,040	5,340
9:00	288	12,950	3,920	9,030
10:00	330	14,850	3,040	11,810
11:00	336	15,100	5,680	9,420
12:00	336	15,100	9,200	5,900
1:00 PM	282	12,700	5,680	7,020
2:00	306	13,800	3,040	10,760
3:00	306	13,800	3,920	9,880
4:00	318	14,300	3,040	10,260
5:00	270	12,100	3,040	9,060
6:00	204	9,200	2,160	7,040
7:00	234	10,530	4,800	5,730
8:00	240	10,800	2,160	8,640
9:00	222	9,800	7,440	2,360
10:00	210	9,460	2,160	7,300
11:00	180	8,100	3,920	4,180
12:00	120	5,400	2,160	1,840
			83,800	147,980

September 30, 1935

Hour	Kw.	Kw. x 45	Heating (exhaust)	Atmosphere (exhaust)
1:00 AM	96	4,320	4,320	0
2:00	96	4,320	4,320	0
3:00	126	5,680	3,920	1,760
4:00	126	5,680	2,160	3,520
5:00	120	5,400	5,400	0
6:00	132	5,950	5,950	0
7:00	144	6,490	6,490	0
8:00	218	9,800	9,800	0
9:00	288	13,000	13,000	0
10:00	360	16,200	16,200	0
11:00	384	17,300	17,300	0
12:00	372	16,700	16,700	0
1:00 PM	318	14,300	14,300	0
2:00	384	17,300	17,300	0
3:00	402	18,100	18,300	0
4:00	342	15,400	15,400	0
5:00	284	17,300	17,300	0
6:00	258	11,600	11,600	0
7:00	294	13,200	13,200	0
8:00	288	13,000	10,960	2,040
9:00	306	13,800	11,840	1,960
10:00	252	11,300	3,920	7,380
11:00	210	9,450	4,800	5,650
12:00	168	7,560	3,920	3,640
			248,400	25,950

October 5, 1935

Hour	Kw.	Kw. x 45	Heating (exhaust)	Atmosphere (exhaust)
1:00 AM	120	5,400	5,400	0
2:00	144	6,480	6,480	0
3:00	150	6,750	1,280	5,470
4:00	150	6,750	4,800	1,950
5:00	150	6,750	4,800	0
6:00	144	6,480	6,480	0
7:00	138	6,210	6,210	0
8:00	234	10,500	10,500	0
9:00	288	13,000	13,000	0
10:00	360	16,200	16,200	0
11:00	378	17,000	17,000	0
12:00	366	16,500	16,500	0 0
1:00 PM	300	13,500	13,500	0
2:00	330	14,800	14,800	0
3:00	264	11,400	11,400	0
4:00	234	10,500	10,500	0
5:00	228	10,300	10,300	0
6:00	240	10,800	10,800	0
7:00	264	11,900	11,900	0
8:00	264	11,900	11,900	0
9:00	234	10,500	10,500	0
10:00	198	8,900	8,900	0
11:00	162	7,300	7,300	0
12:00	150	6,750	6,750	0
			<hr/>	<hr/>
			239,150	7,420

October 19, 1935

Hour	Kw.	Kw. x 45	Heating (exhaust)	Atmosphere (exhaust)
1:00 AM	138	6,210	5,680	530
2:00	168	7,550	5,680	1,870
3:00	156	7,020	3,040	3,980
4:00	150	6,750	6,750	0
5:00	156	7,020	7,020	0
6:00	132	5,950	5,950	0
7:00	156	7,030	7,030	0
8:00	216	9,730	9,730	0
9:00	288	13,000	13,000	0
10:00	348	15,700	15,700	0
11:00	372	16,700	16,700	0
12:00	360	16,200	13,600	2,600
1:00 PM	288	11,700	7,440	4,260
2:00	306	13,800	7,440	6,360
3:00	270	12,100	5,680	6,420
4:00	204	9,180	5,680	3,500
5:00	204	9,180	6,560	2,620
6:00	270	12,100	7,440	4,660
7:00	288	13,000	7,440	5,560
8:00	288	13,000	7,440	5,560
9:00	256	11,500	5,680	5,820
10:00	216	9,730	3,040	6,690
11:00	210	9,450	6,560	2,890
12:00	186	8,360	3,040	5,320
			183,320	68,640

October 31, 1935

Hour	Kw.	Kw. x 45	Heating (exhaust)	Atmosphere (exhaust)
1:00 AM	132	5,940	3,040	2,900
2:00	156	7,030	5,700	1,330
3:00	144	6,480	6,480	0
4:00	150	6,750	4,800	1,950
5:00	150	6,750	6,750	0
6:00	132	5,940	5,940	0
7:00	168	7,550	7,550	0
8:00	252	10,300	10,300	0
9:00	362	16,300	16,300	0
10:00	431	19,400	19,400	0
11:00	444	19,950	19,950	0
12:00	420	18,900	18,900	0
1:00 PM	336	15,100	13,600	2,500
2:00	384	17,300	12,940	3,360
3:00	366	16,450	11,960	4,490
4:00	336	15,100	7,450	7,650
5:00	360	16,200	13,600	2,600
6:00	402	18,100	16,240	1,860
7:00	342	15,400	14,480	920
8:00	348	15,700	15,360	340
9:00	348	15,700	9,200	6,500
10:00	294	13,200	11,840	1,360
11:00	252	11,300	6,560	4,740
12:00	192	8,640	2,160	6,480
			260,500	48,980

November 7, 1935

Hour	Kw.	Kw. x 45	Heating (exhaust)	Atmosphere (exhaust)
1:00 AM	144	6,480	4,800	1,680
2:00	150	6,740	4,800	1,940
3:00	144	6,480	3,040	3,440
4:00	150	6,740	6,560	180
5:00	150	6,440	6,440	0
6:00	198	8,910	8,910	0
7:00	168	7,550	7,550	0
8:00	240	10,800	10,800	0
9:00	312	14,000	14,000	0
10:00	390	17,500	17,500	0
11:00	396	17,800	17,800	0
12:00	378	17,000	17,000	0
1:00 PM	324	14,600	14,600	0
2:00	366	16,500	16,500	0
3:00	354	15,900	15,900	0
4:00	378	17,000	17,000	0
5:00	426	19,200	19,200	0
6:00	462	20,800	19,760	540
7:00	348	15,700	15,700	0
8:00	336	15,100	15,100	0
9:00	318	14,300	14,300	0
10:00	252	11,300	11,300	0
11:00	204	9,180	3,040	6,140
12:00	168	7,550	3,040	4,510
			295,590	18,430

November 19, 1955

Hour	Kw.	Kw. x 45	Heating (exhaust)	Atmosphere (exhaust)
1:00 AM	144	6,490	6,490	0
2:00	132	5,950	5,950	0
3:00	156	7,020	7,020	0
4:00	144	6,490	6,490	0
5:00	156	7,020	7,020	0
6:00	156	7,020	7,020	0
7:00	156	7,020	7,020	0
8:00	240	10,800	10,800	0
9:00	324	14,600	14,600	0
10:00	384	17,300	17,300	0
11:00	396	17,800	17,800	0
12:00	384	17,300	17,300	0
1:00 PM	324	14,600	14,600	0
2:00	402	18,100	18,100	0
3:00	408	18,300	18,300	0
4:00	396	17,800	17,800	0
5:00	486	21,900	21,900	0
6:00	396	17,800	17,800	0
7:00	360	16,200	16,200	0
8:00	372	16,800	16,800	0
9:00	360	16,200	16,200	0
10:00	282	12,700	12,700	0
11:00	198	8,900	3,920	4,980
12:00	168	7,560	5,680	1,880
			294,810	6,860

November 30, 1935

Hour	Kw.	Kw. x 45	Heating (exhaust)	Atmosphere (exhaust)
1:00 AM	156	7,020	7,020	0
2:00	138	6,200	6,200	0
3:00	156	7,020	7,020	0
4:00	150	6,750	6,750	0
5:00	156	7,020	7,020	0
6:00	150	6,750	6,750	0
7:00	168	7,550	7,550	0
8:00	252	11,300	11,300	0
9:00	312	14,000	14,000	0
10:00	360	16,200	16,200	0
11:00	372	16,700	16,700	0
12:00	342	15,400	15,400	0
1:00 PM	306	13,700	13,700	0
2:00	366	16,500	16,500	0
3:00	342	15,400	15,400	0
4:00	330	14,800	14,800	0
5:00	324	14,500	14,500	0
6:00	258	11,600	11,600	0
7:00	264	11,900	11,900	0
8:00	258	11,600	11,600	0
9:00	234	11,500	11,500	0
10:00	222	10,000	10,000	0
11:00	174	7,830	7,830	0
12:00	156	7,020	7,020	0
			268,260	0

December 2, 1935

Hour	Kw.	Kw. x 45	Heating (exhaust)	Atmosphere (exhaust)
1:00 AM	126	5,760	5,760	0
2:00	126	5,760	5,760	0
3:00	144	6,480	6,480	0
4:00	138	6,200	6,200	0
5:00	174	7,830	7,830	0
6:00	132	5,940	5,940	0
7:00	168	7,560	7,560	0
8:00	270	12,100	12,100	0
9:00	384	17,300	17,300	0
10:00	456	20,500	20,500	0
11:00	456	20,500	20,500	0
12:00	420	18,900	18,900	0
1:00 PM	372	16,700	16,700	0
2:00	438	19,700	19,700	0
3:00	456	20,500	20,500	0
4:00	480	21,600	21,600	0
5:00	522	23,500	23,500	0
6:00	432	19,500	19,500	0
7:00	342	15,400	15,400	0
8:00	366	16,400	16,400	0
9:00	342	15,400	15,400	0
10:00	270	12,100	12,100	0
11:00	216	9,710	9,710	0
12:00	180	8,100	8,100	0
			333,440	0

December 14, 1934

Hour	Kw.	Kw. x 45	Heating (exhaust)	Atmosphere (exhaust)
1:00 AM	150	6,750	6,750	0
2:00	168	7,550	7,550	0
3:00	132	5,940	5,940	0
4:00	156	7,020	7,020	0
5:00	168	7,550	7,550	0
6:00	162	7,290	7,290	0
7:00	162	7,290	7,290	0
8:00	210	9,440	9,440	0
9:00	282	12,700	12,700	0
10:00	414	18,600	18,600	0
11:00	432	19,400	19,400	0
12:00	444	19,900	19,900	0
1:00 PM	390	17,500	17,500	0
2:00	432	19,400	19,400	0
3:00	438	19,700	19,700	0
4:00	438	19,700	19,700	0
5:00	504	22,600	22,600	0
6:00	444	20,000	20,000	0
7:00	264	11,900	11,900	0
8:00	300	13,500	13,500	0
9:00	288	13,000	13,000	0
10:00	240	10,800	10,800	0
11:00	204	9,180	9,180	0
12:00	162	7,300	7,300	0
			314,010	0

December 28, 1934

Hour	Kw.	Kw. x 45	Heating (exhaust)	Atmosphere (exhaust)
1:00 AM	132	5,940	5,940	0
2:00	108	4,860	4,860	0
3:00	138	6,200	6,200	0
4:00	126	5,680	5,680	0
5:00	150	6,750	6,750	0
6:00	156	7,020	7,020	0
7:00	168	7,550	7,550	0
8:00	240	10,800	10,800	0
9:00	318	14,300	14,300	0
10:00	372	16,700	16,700	0
11:00	396	17,800	17,800	0
12:00	384	17,300	17,300	0
1:00 PM	360	16,200	16,200	0
2:00	402	18,100	18,100	0
3:00	450	20,200	20,200	0
4:00	468	21,000	21,000	0
5:00	438	19,700	19,700	0
6:00	264	11,900	11,900	0
7:00	234	10,500	10,500	0
8:00	270	12,100	12,100	0
9:00	234	10,500	10,500	0
10:00	204	9,190	9,190	0
11:00	180	8,100	8,100	0
12:00	138	6,200	6,200	0
			<hr/>	<hr/>
			284,590	0

January 3, 1935

Hour	Kw.	Kw. x 45	Heating (exhaust)	Atmosphere (exhaust)
1:00 AM	108	4,860	4,860	0
2:00	132	5,940	5,940	0
3:00	126	5,670	5,670	0
4:00	120	5,400	5,400	0
5:00	150	6,750	6,750	0
6:00	156	7,030	7,030	0
7:00	162	7,300	7,300	0
8:00	240	10,800	10,800	0
9:00	288	13,000	13,000	0
10:00	360	16,200	16,200	0
11:00	372	16,700	16,700	0
12:00	384	17,300	17,300	0
1:00 PM	324	14,600	14,600	0
2:00	360	16,200	16,200	0
3:00	450	20,200	20,200	0
4:00	468	21,000	21,000	0
5:00	408	18,400	18,400	0
6:00	228	10,300	10,300	0
7:00	204	9,200	9,200	0
8:00	228	10,300	10,300	0
9:00	228	10,300	10,300	0
10:00	216	9,700	9,700	0
11:00	192	8,650	8,650	0
12:00	138	6,200	6,200	0
			272,270	0

January 22, 1935

Hour	Kw.	Kw. x 45	Heating (exhaust)	Atmosphere (exhaust)
1:00 AM	144	6,490	6,490	0
2:00	138	6,200	6,200	0
3:00	132	5,950	5,950	0
4:00	162	7,300	7,300	0
5:00	192	8,650	8,650	0
6:00	168	7,550	7,550	0
7:00	180	8,100	8,100	0
8:00	270	12,100	12,100	0
9:00	336	15,100	15,100	0
10:00	420	18,900	18,900	0
11:00	444	20,000	20,000	0
12:00	438	19,700	19,700	0
1:00 PM	396	17,800	17,800	0
2:00	414	18,600	18,600	0
3:00	408	18,400	18,400	0
4:00	348	15,700	15,700	0
5:00	372	16,700	16,700	0
6:00	348	15,700	15,700	0
7:00	264	11,900	11,900	0
8:00	294	13,200	13,200	0
9:00	288	13,000	13,000	0
10:00	246	11,000	11,000	0
11:00	228	10,200	10,200	0
12:00	180	8,100	8,100	0
			<hr/>	<hr/>
			306,340	0

January 31, 1935

Hour	Kw.	Kw. x 45	Heating (exhaust)	Atmosphere (exhaust)
1:00 AM	228	10,300	10,300	0
2:00	252	11,400	11,400	0
3:00	222	10,000	10,000	0
4:00	222	10,000	10,000	0
5:00	270	12,100	12,100	0
6:00	300	13,500	13,500	0
7:00	300	13,500	13,500	0
8:00	318	14,300	14,300	0
9:00	324	14,600	14,600	0
10:00	282	12,700	12,700	0
11:00	312	14,100	14,100	0
12:00	288	13,000	13,000	0
1:00 PM	270	12,200	12,200	0
2:00	270	12,200	12,200	0
3:00	270	12,200	12,200	0
4:00	270	12,200	12,200	0
5:00	270	12,200	12,200	0
6:00	240	10,800	10,800	0
7:00	270	12,200	12,200	0
8:00	240	10,800	10,800	0
9:00	240	10,800	10,800	0
10:00	210	9,500	9,500	0
11:00	222	10,000	10,000	0
12:00	228	10,300	10,300	0
			284,900	0

February 2, 1935

Hour	Kw.	Kw. x 45	Heating (exhaust)	Atmosphere (exhaust)
1:00 AM	150	6,750	6,750	0
2:00	156	7,030	7,030	0
3:00	144	6,490	6,490	0
4:00	150	6,750	6,750	0
5:00	192	8,650	8,650	0
6:00	174	7,830	7,830	0
7:00	192	8,650	8,650	0
8:00	258	11,600	11,600	0
9:00	378	17,000	17,000	0
10:00	480	21,600	21,600	0
11:00	540	24,300	24,300	0
12:00	498	22,400	22,400	0
1:00 PM	372	16,700	16,700	0
2:00	402	18,100	18,100	00
3:00	438	19,700	19,700	0
4:00	396	17,800	17,800	0
5:00	324	14,600	14,600	0
6:00	252	11,300	11,300	0
7:00	240	10,800	10,800	00
8:00	282	12,700	12,700	0
9:00	270	12,200	12,200	0
10:00	264	11,900	11,900	0
11:00	210	9,450	9,450	0
12:00	180	8,100	8,100	0
			312,400	0

February 13, 1935

Hour	Kw.	Kw. x 45	Heating (exhaust)	Atmosphere (exhaust)
1:00 AM	150	6,800	6,800	0
2:00	156	7,000	7,000	0
3:00	144	6,500	6,500	0
4:00	150	6,800	6,800	0
5:00	192	8,600	8,600	0
6:00	168	7,600	7,600	0
7:00	186	8,400	8,400	0
8:00	282	12,700	12,700	0
9:00	372	16,700	16,700	0
10:00	414	18,600	18,600	0
11:00	432	19,500	19,500	0
12:00	426	19,200	19,200	0
1:00 PM	390	17,600	17,600	0
2:00	420	18,900	18,900	0
3:00	426	19,200	19,200	0
4:00	402	18,100	18,100	0
5:00	426	19,200	19,200	0
6:00	366	16,500	16,500	0
7:00	306	13,800	13,800	0
8:00	402	18,100	18,100	0
9:00	390	17,500	17,500	0
10:00	318	14,300	14,300	0
11:00	228	10,300	10,300	0
12:00	180	8,100	8,100	0
			330,000	0

February 27, 1935

Hour	Kw.	Kw. x 45	Heating (exhaust)	Atmosphere (exhaust)
1:00 AM	180	8,100	8,100	0
2:00	120	5,400	5,400	0
3:00	168	7,600	7,600	0
4:00	174	7,800	7,800	0
5:00	192	8,600	8,600	0
6:00	168	7,600	7,600	0
7:00	180	8,100	8,100	0
8:00	252	11,300	11,300	0
9:00	336	15,100	15,100	0
10:00	396	17,800	17,800	0
11:00	414	18,600	18,600	0
12:00	408	18,400	18,400	0
1:00 PM	366	16,500	16,500	00
2:00	402	18,100	18,100	0
3:00	421	18,900	18,900	0
4:00	354	15,900	15,900	0
5:00	330	14,900	14,900	0
6:00	324	14,600	14,600	0
7:00	348	15,600	15,600	0
8:00	438	19,700	19,700	0
9:00	426	19,200	19,200	0
10:00	360	16,200	16,200	0
11:00	252	11,300	11,300	0
12:00	216	9,700	9,700	0
			<hr/>	<hr/>
			325,000	0

March 2, 1935

Hour	Kw.	Kw. x 45	Heating (exhaust)	Atmosphere (exhaust)
1:00 AM	162	7,300	7,300	0
2:00	168	7,600	7,600	0
3:00	144	6,500	6,500	0
4:00	144	6,500	6,500	0
5:00	198	8,900	8,900	0
6:00	156	7,000	7,000	0
7:00	156	7,000	7,000	0
8:00	252	11,400	11,400	0
9:00	360	16,200	16,200	0
10:00	450	20,200	20,200	0
11:00	438	19,700	19,700	0
12:00	408	18,400	18,400	0
1:00 PM	378	17,000	17,000	0
2:00	390	17,500	17,500	0
3:00	366	16,500	16,500	0
4:00	288	13,000	13,000	0
5:00	252	11,400	11,400	0
6:00	240	10,800	10,800	0
7:00	288	13,000	13,000	0
8:00	330	14,900	13,600	1,300
9:00	312	14,000	14,000	0
10:00	276	12,400	12,400	0
11:00	210	9,500	9,500	0
12:00	186	8,400	8,400	0
			293,800	1,300

March 16, 1935

Hour	Kw.	Kw. x 45	Heating (exhaust)	Atmosphere (exhaust)
1:00 AM	132	5,900	5,900	0
2:00	162	7,300	7,300 ^{1/2}	0
3:00	138	6,200	6,200	0
4:00	150	6,800	6,800	0
5:00	180	8,100	8,100	0
6:00	156	7,000	7,000	0
7:00	180	8,100	8,100	0
8:00	252	11,300	11,300	0
9:00	344	15,500	15,500	0
10:00	419	18,800	18,800	0
11:00	420	18,900	18,900	0
12:00	408	18,400	18,000	400
1:00 PM	342	15,400	15,400	0
2:00	420	18,900	18,000	900
3:00	432	19,500	13,600	5,900
4:00	342	15,400	13,600	1,800
5:00	294	13,200	13,200	0
6:00	216	9,700	9,700	0
7:00	366	16,500	13,600	2,900
8:00	366	16,500	13,600	2,900
9:00	348	15,600	13,600	2,000
10:00	318	14,300	11,700	2,600
11:00	294	13,200	11,800	1,400
12:00	174	7,800	7,800	0
			287,500	20,800

March 29, 1935

Hour	Kw.	Kw. x 45	Heating (exhaust)	Atmosphere (exhaust)
1:00 AM	138	6,200	6,200	0
2:00	150	6,800	6,800	0
3:00	150	6,800	6,800	0
4:00	150	6,800	6,800	0
5:00	192	8,700	8,700	0
6:00	156	7,000	7,000	0
7:00	156	7,000	7,000	0
8:00	222	10,000	10,000	0
9:00	300	13,500	13,500	0
10:00	402	18,100	18,100	0
11:00	402	18,100	18,100	0
12:00	426	19,200	19,200	0
1:00 PM	408	18,400	18,400	0
2:00	468	21,000	21,000	0
3:00	498	22,400	22,400	0
4:00	564	25,400	21,500	3,900
5:00	540	24,300	24,300	0
6:00	438	19,700	19,700	0
7:00	318	14,300	14,300	0
8:00	336	15,100	15,100	0
9:00	336	15,100	13,600	1,500
10:00	276	12,400	12,400	0
11:00	228	10,300	10,300	0
12:00	192	8,700	8,700	0
			329,900	5,400

April 3, 1935

Hour	Kw.	Kw. x 45	Heating (exhaust)	Atmosphere (exhaust)
1:00 AM	144	6,500	6,500	0
2:00	156	7,000	7,000	0
3:00	144	6,500	6,500	0
4:00	150	6,800	6,800	0
5:00	192	8,700	8,700	0
6:00	144	6,500	6,500	0
7:00	156	7,000	7,000	0
8:00	240	10,800	10,800	0
9:00	324	14,600	14,600	0
10:00	396	17,800	17,800	0
11:00	426	19,200	19,200	0
12:00	426	19,200	19,200	0
1:00 PM	402	18,100	18,100	0
2:00	456	20,600	20,600	0
3:00	456	20,600	20,600	0
4:00	408	18,400	18,400	0
5:00	456	20,600	19,800	800
6:00	348	15,700	15,400	300
7:00	288	13,000	13,000	0
8:00	368	16,500	15,400	0
9:00	330	14,900	14,900	1,100
10:00	294	13,200	13,200	0
11:00	222	10,000	10,000	0
12:00	192	8,700	8,700	0
			<hr/>	<hr/>
			318,700	2,200

April 10, 1935

Hour	Kw.	Kw. x 45	Heating (exhaust)	Atmosphere (exhaust)
1:00 AM	144	6,500	6,500	0
2:00	144	6,500	6,500	0
3:00	144	6,500	6,500	0
4:00	144	6,500	6,500	0
5:00	174	7,800	7,800	0
6:00	132	5,900	5,900	0
7:00	156	7,000	7,000	0
8:00	228	10,300	10,300	0
9:00	318	14,300	14,300	0
10:00	402	18,100	18,100	0
11:00	384	17,300	17,300	0
12:00	384	17,300	17,300	0
1:00 PM	348	15,600	15,600	0
2:00	402	18,100	18,100	0
3:00	396	17,800	17,800	0
4:00	378	17,000	17,000	0
5:00	324	14,600	14,600	0
6:00	240	10,800	10,800	0
7:00	240	10,800	10,800	0
8:00	330	14,800	13,600	1,200
9:00	324	14,600	12,700	1,900
10:00	270	12,100	12,100	0
11:00	216	9,700	9,700	0
12:00	180	8,100	8,100	0
			284,900	3,100

April 30, 1935

Hour	Kw.	Kw. x 45	Heating (exhaust)	Atmosphere (exhaust)
1:00 AM	132	6,000	6,000	0
2:00	144	6,500	6,500	0
3:00	144	6,500	6,500	0
4:00	144	6,500	6,500	0
5:00	144	6,500	6,500	0
6:00	156	7,000	7,000	0
7:00	138	6,200	6,200	0
8:00	222	9,900	9,900	0
9:00	336	15,100	15,100	0
10:00	378	17,000	17,000	0
11:00	414	18,600	18,600	0
12:00	414	18,600	18,600	0
1:00 PM	384	17,300	17,300	0
2:00	462	20,800	20,800	0
3:00	480	21,600	21,600	0
4:00	492	22,200	22,200	0
5:00	462	20,800	20,800	0
6:00	462	16,300	16,300	0
7:00	276	12,400	12,400	0
8:00	312	14,100	14,100	0
9:00	300	13,500	13,500	0
10:00	252	11,300	11,300	0
11:00	216	9,700	9,700	0
12:00	162	7,300	7,300	0
			311,700	0

May 3, 1935

Hour	Kw.	Kw. x 45	Heating (exhaust)	Atmosphere (exhaust)
1:00 AM	138	6,200	6,200	0
2:00	144	6,500	6,500	0
3:00	150	6,800	6,800	0
4:00	144	6,500	6,500	0
5:00	150	6,800	6,800	0
6:00	168	7,600	7,600	0
7:00	138	6,200	6,200	0
8:00	222	10,000	10,000	0
9:00	324	14,600	14,600	0
10:00	408	18,400	18,400	0
11:00	432	19,500	19,500	0
12:00	444	20,000	20,000	0
1:00 PM	396	17,900	17,900	0
2:00	414	18,600	18,600	0
3:00	456	20,600	20,600	0
4:00	396	17,800	17,800	0
5:00	528	23,800	23,800	0
6:00	408	18,400	18,400	0
7:00	252	11,300	11,300	0
8:00	312	14,100	14,100	0
9:00	300	13,500	13,500	0
10:00	270	12,200	12,200	0
11:00	228	10,300	10,300	0
12:00	180	8,100	8,100	0
			<hr/>	<hr/>
			315,700	0

May 16, 1935

Hour	Kw.	Kw. x 45	Heating (exhaust)	Atmosphere (exhaust)
1:00 AM	150	6,800	4,800	2,000
2:00	162	7,300	4,800	2,500
3:00	150	6,800	5,700	1,100
4:00	150	6,800	5,700	1,100
5:00	150	6,800	6,600	200
6:00	150	6,800	6,800	0
7:00	156	7,000	7,000	0
8:00	222	10,000	10,000	0
9:00	288	13,000	13,000	0
10:00	366	16,500	16,500	0
11:00	366	16,500	16,200	300
12:00	324	14,600	14,600	0
1:00 PM	282	12,700	12,700	0
2:00	288	13,000	9,200	3,800
3:00	300	13,500	9,200	4,300
4:00	306	13,800	10,100	3,700
5:00	270	12,200	9,200	3,000
6:00	216	9,700	6,600	3,100
7:00	216	9,700	8,300	1,400
8:00	258	11,600	8,300	3,300
9:00	276	12,400	8,300	4,100
10:00	240	10,800	7,400	3,400
11:00	204	9,200	4,800	4,400
12:00	162	7,300	4,800	2,500
			<hr/>	<hr/>
			210,600	44,200

May 27, 1955

Hour	Kw.	Kw. x 45	Heating (exhaust)	Atmosphere (exhaust)
1:00 AM	120	5,400	0	5,400
2:00	144	6,500	0	6,500
3:00	138	6,200	0	6,200
4:00	132	6,000	1,300	4,700
5:00	126	5,700	5,700	0
6:00	120	5,400	4,800	600
7:00	120	5,400	5,400	0
8:00	198	8,900	6,600	2,300
9:00	288	13,000	11,000	2,000
10:00	336	15,100	10,100	4,000
11:00	342	15,400	8,300	7,100
12:00	336	15,100	4,800	10,300
1:00 PM	306	13,800	3,900	9,900
2:00	324	14,600	3,000	11,600
3:00	318	14,300	3,000	11,300
4:00	318	14,300	3,900	10,400
5:00	282	12,700	2,200	10,500
6:00	228	10,300	3,000	6,700
7:00	246	11,100	400	10,700
8:00	258	11,600	400	11,200
9:00	270	12,100	2,200	9,900
10:00	234	10,500	1,300	9,200
11:00	186	8,400	3,000	5,400
12:00	186	8,400	1,200	7,200
			85,500	163,100

steam than the present requirements in the ratio of 1173 to 1106. Therefore in the analysis more steam is shown as exhausted to the atmosphere than is actually the case. It will be shown later that steam exhausted to the atmosphere greatly increases the cost of generation. Thus the analysis tends to give a safe figure.

STEAM AND COST COMPUTATION

The next step is to find from the balance figures the fuel cost of generation. The cost and value of the proposed steam is based on the relative cost and value of the present steam.

STEAM AND COST DATA

Present steam

115 pounds gauge 2 per cent moisture	1173 BTU/lb.
Return temperature 120 degrees	88 BTU/lb.
	<hr/>
Available for heating	1085 BTU/lb.

Proposed steam

200 pounds gauge 2 per cent moisture	1182 BTU/lb.
Return temperature 120 degrees	88 BTU/lb.
	<hr/>
Available for heating	1094 BTU/lb.

Exhaust Steam

45 pounds steam rate

$$\frac{3413}{45} = 76 \text{ B.T.U. per pound used in generator}$$

$$1182 - 76 = 1106 \text{ B.T.U. per pound}$$

15 pounds gauge 6 per cent moisture 1106 BTU/lb.

Return temperature 120 degrees 88 BTU/lb.

Available for heating 1018 BTU/lb.

Assuming feedwater 200 degrees - 168 B.T.U. per pound

Present steam 115 pounds

Supplied at boiler 1173 - 168 = 1005 B.T.U. per pound

Proposed steam 200 pounds

Supplied at boiler 1182 - 168 = 1014 B.T.U. per pound

Ratio

$$\frac{\text{cost of 200 pounds steam}}{\text{cost of 115 pounds steam}} = \frac{1014}{1005} = 1.0089$$

$$\frac{\text{B.T.U. available for heating 200 lbs.}}{\text{B.T.U. available for heating 115 lbs.}} = \frac{1094}{1085} = 1.0082$$

Cost of heating with proposed steam

$$\frac{\text{Pounds necessary} \times 1.0089}{1.0082} \times \text{present cost}$$

This shows that if the plant were operated at 200 pounds pressure (no turbines) the cost of heating would remain the same since the

factors practically cancel out. When it becomes necessary to by-pass steam to supply the heating load there will be no additional charge against generation.

The following figures are to find the present cost of steam. The data were obtained from the budgets of the heating plant.

July 1, 1936 - June 30, 1937

Cost of coal	\$41,913.
pounds of steam	172,100,000
Fuel cost per 1000 pounds steam	\$.243

July 1, 1935 - June 30, 1936

Cost of coal	\$43,757.
Pounds of steam	166,600,000
Fuel cost per 1000 pounds steam	\$.262

July 1, 1934 - June 30, 1935

Cost of coal	\$42,122.
Pounds of steam	158,700,000
Fuel cost per 1000 pounds steam	\$.265

Average fuel cost per 1000 pounds steam	\$.256
--------------------------------------------	---------

Thus 1085 B.T.U. available for heating has a value of \$.000256, and 1000 B.T.U. has a value:

$$\frac{.000256}{1.085} = \$.000236$$

1000 pounds of steam exhausted from the turbine has a value for heating of:

$$1018 \times .000236 = \$.240$$

Value for heating of 1000 pounds of steam at 200 pounds gage, 2 per cent moisture.

$$1094 \times .000236 = \$.258$$

Cost of 1000 pounds of steam 200 pounds pressure, 2 per cent moisture.

$$1.0089 \times .00256 = \$.258$$

The charge against generation of the steam used for generating is the difference between the cost of the steam and the value of the exhaust for heating.

\$.258 cost per 1000 pounds

.240 heat value of exhaust per 1000 pounds

\$.018 per 1000 pounds chargeable to generation

This figure applies when the exhaust steam is used for heating. When the exhaust steam is not used for heating but thrown away, a different and larger charge is made against generation. The entire fuel cost of producing the steam at 200 pounds and 2 per cent

moisture (.258/1000 lbs.) is used, adding to this the value of the water which is about \$.01 per 1000 pounds. This means that for each 1000 pounds of steam used for generation and exhausts to the atmosphere a charge of \$.268 is made against generation.

The following is a review of the charges to be made against generation.

Days when heating steam demand is greater than exhaust steam available.

Charge against each 1000 pounds of steam used \$.018
for generation.

Days when heating steam demand is less than exhaust steam available.

Charge against generation of each 1000 pounds \$.018
of steam used for generation and used for
heating.

Charge against generation of electricity for \$.268
each 1000 pounds of steam which is used for
generation, but exhausts to atmosphere.

Referring to the data sheets, pages 58 to 63 it was possible to find for each day chosen the total exhaust steam used for heating and exhausted to the atmosphere. The data were then arranged in monthly

groups and an average of each group found. This average was assumed to represent the average day of that month, and then multiplied by the days in that month to represent the month.

The following table shows how the exhaust steam was used and finds the average.

EXHAUST STEAM		
September	Used for Heating	to Atmosphere
19	83,800	147,980
30	248,400	25,950
	<hr/>	<hr/>
	332,200	173,930
Ave.	166,100	86,860
<hr/>		
October		
5	239,150	7,420
19	183,320	68,640
31	260,500	48,980
	<hr/>	<hr/>
	682,970	125,040
Ave.	227,680	41,680

EXHAUST STEAM

<u>November</u>	Used for Heating	to Atmosphere
7	295,590	18,430
19	294,810	6,860
30	268,260	0
	<hr/>	<hr/>
	858,660	25,290
Ave.	286,220	8,430
 <u>December</u>		
2	333,440	1,300
14	314,010	20,800
28	284,590	5,400
	<hr/>	<hr/>
	932,040	27,500
Ave.	310,680	9,200
 <u>January</u>		
3	272,270	2,200
22	306,340	3,100
31	284,900	0
	<hr/>	<hr/>
	863,510	5,300
Ave.	287,840	1,767

EXHAUST STEAM

February	Used for Heating	to Atmosphere
2	312,400	0
13	330,000	44,200
27	325,000	188,100
	<hr/>	<hr/>
	967,400	207,500
Ave.	322,500	69,100

March

The following data show the fuel cost of generation using the average daily distribution of the exhaust steam and the cost figures on page 68.

2	293,800	1,300
16	287,500	20,800
29	329,900	5,400
	<hr/>	<hr/>
	911,200	27,500
Ave.	303,700	9,200

April

3	318,700	2,200
10	284,900	3,100
30	311,700	0
	<hr/>	<hr/>
	915,300	5,300
Ave.	305,100	1,800

FUEL COST EXHAUST STEAM

Month	Used for Heating	to Atmosphere
May		
Average Day	315,700	0
16	210,600	44,200
27	85,500	163,100
	<hr/>	<hr/>
	611,800	207,300
Ave.	203,900	69,100

The following data show the fuel cost of generation using the average daily distribution of the exhaust steam and the cost figures on page 68 .

February

Average Day	
Steam used for heating 1000 lbs.	322.5
Cost at .018	\$ 5.80
Steam exhausted to atmosphere 1000 lbs.	0
Cost at .288	0
Daily cost	\$ 5.80
Per day cost (30 days)	\$ 174.00

FUEL CHARGE AGAINST ELECTRICITY

January

Average Day

Steam used for heating 1000 lbs.	287.8
Cost at .018	\$ 5.20
Steam exhausted to atmosphere 1000 lbs.	0
Cost at .268	0
Daily cost	\$ 5.20
Monthly cost (31 days)	\$ 160.00

February

Average Day

Steam used for heating 1000 lbs.	322.5
Cost at .018	\$ 5.80
Steam exhausted to atmosphere 1000 lbs.	0
Cost at .268	0
Daily cost	\$ 5.80
Monthly cost (28 days)	\$ 163.00

FUEL CHARGE AGAINST ELECTRICITY

March

Average Day

Steam used for heating 1000 lbs.	303.7
Cost at .018	\$ 5.45
Steam exhausted to atmosphere 1000 lbs.	9.2
Cost at .268	\$ 2.48
Daily cost	\$ 7.93
Monthly cost (31 days)	\$ 246.00

April

Average Day

Steam used for heating 1000 lbs.	305.1
Cost at .018	\$ 5.50
Steam exhausted to atmosphere 1000 lbs.	1.8
Cost at .268	\$ 4.80
Daily cost	\$ 10.30
Monthly cost (30 days)	\$ 310.00

FUEL CHARGE AGAINST ELECTRICITY

May

Average Day

Steam used for heating 1000 lbs.	203.9
Cost at .018	\$ 3.68
Steam exhausted to atmosphere 1000 lbs.	69.1
Cost at .268	\$ 18.50
Daily cost	\$ 22.18
Monthly cost (15 days)	\$ 340.00

September

Average Day

Steam used for heating 1000 lbs.	166.1
Cost at .018	\$ 3.00
Steam exhausted to atmosphere 1000 lbs.	86.9
Cost at .268	\$ 23.00
Daily cost	\$ 26.00
Monthly cost (15 days)	\$ 390.00

FUEL CHARGE AGAINST ELECTRICITY

October

Average Day	227.7
Steam used for heating 1000 lbs.	227.7
Cost at .018	\$ 4.10
Steam exhausted to atmosphere 1000 lbs.	41.7
Cost at .268	\$ 11.20
Daily cost (31 days)	\$ 15.30
Monthly cost (31 days)	\$ 475.00

November

Average Day	286.2
Steam used for heating 1000 lbs.	286.2
Cost at .018	\$ 5.35
Steam exhausted to atmosphere 1000 lbs.	8.4
Cost at .268	\$ 2.25
Daily cost	\$ 7.60
Monthly cost (30 days)	\$ 230.00

FUEL CHARGE AGAINST ELECTRICITY

December

Average Day

Steam used for heating 1000 lbs. 310.7

Cost at .018 \$ 5.60

Steam exhausted to atmosphere 1000 lbs. 0

Cost at .268 0

Daily cost \$ 5.60

Monthly cost (31 days) \$ 174.00

Total fuel cost of generation \$2,488.00

$$\frac{1000}{45} = 22.2 \text{ kilowatt hours of energy could be}$$

obtained from each 1000 pounds. Thus the cost per kilowatt hour is:

$$\frac{.268}{22.2} = .012 \text{ per kilowatt hour}$$

The following figures show the average cost per kilowatt hour of energy generated during the winter months.

It will be assumed that the fuel cost of generation for the eight months of 1935 would have been \$2,500. Examining the load curve of electricity it is seen that there is about an 8 per cent increase each year. It will be assumed that that increase will mean a 10 per cent increase in the total fuel cost of generation. Thus in 1936 the fuel cost would be \$2,750. and in 1937 about \$3,000.

If the University were to generate during the summer months all of the turbine exhaust steam would have to be exhausted to the atmosphere. It would be possible to install condensers, but the investment and operating cost would be too large when it is considered that they would be used only a short period each year. If the exhaust is to the atmosphere a charge of \$.268 per 1000 pounds of steam is chargeable against generation for fuel and water. Assuming a 45 pound steam rate,

$\frac{1000}{45} = 22.2$ kilowatt hours of energy could be obtained from each 1000 pounds. Thus the cost per kilowatt hour is:

$$\frac{.268}{22.2} = \$.012 \text{ per kilowatt hour}$$

The following figures show the average cost per kilowatt hour of energy purchased during the summer months of 1936 from the Rochester Gas and Electric Corporation.

Month	Total electric bill	Total Kw.hrs.	Cost/kw.hr.
May	\$2,454.	199,200	\$.012
June	2,047.	164,400	.012
July	1,800.	136,800	.013
August	1,770.	147,000	.012
September	1,732.	144,000	.012

This shows that there is no gain to be obtained by generating through this period. When it is considered that if generation is not carried on in the summer, repairs and general maintenance can be done with ease and without hurry and confusion, it is obvious that it is advantageous to purchase energy during that period rather than to generate it.

The hospitals, which would be supplied with electricity by the generators, must never be without power for more than a few seconds. For this reason a stand-by connection to the Rochester Gas and Electric is necessary. The cost of this stand-by would be chargeable to generation and it was found to be \$256.50 per month for a 500 kilowatt capacity. This figure is based on Rate 3. It was found after a conference with the Rochester Gas and Electric Corporation that, with generation and a stand-by connection, it would be more economical to purchase energy on Rate 3. With generation in the peak month, there is no peak demand charge made on the summer

bills. The following examples show that there would be a small saving on the summer bills. Advantage of this saving will not be taken in comparing the costs. The summer bills will be assumed to be the same as on Rate 9. In the period May 15 to September 15, 1936 the cost of energy purchased was about \$7,000. and the entire yearly bill \$27,000.

May 17 - June 17

Demand 444 Kw.

Energy 164,400 Kw.hrs.

Rate 3

Off Peak demand	100 kw.	\$127.50
-----------------	---------	----------

Same energy and demand on Rate 3	344 at \$.50	172.00
----------------------------------	--------------	--------

Energy Charge

200 x 444 = 88,800 at 1.30 cents	1160.00
----------------------------------	---------

75,600 at .65 cents	415.00
---------------------	--------

Consumer Charge

6.50

Same energy and demand on Rate 9	2047.00
----------------------------------	---------

Saving Rate 3 over Rate 9	166.0
---------------------------	-------

July

Demand 504 KVA 396 Kw.

Energy 136,800 Kw.

Rate 3

Off Peak demand	100 kw.	\$127.50
-----------------	---------	----------

	302 kw.	151.00
--	---------	--------

Energy Charge

80,400 at 1.30 cents	1042.00
----------------------	---------

55,600 at .65 cents	362.00
---------------------	--------

Consumer Charge	6.50
-----------------	------

 \$1688.00

Same energy and demand on Rate 9	1799.00
----------------------------------	---------

Saving Rate 3 over Rate 9	111.00
---------------------------	--------

In a similar manner,

Month	Rate 3	Rate 9	Saving
August	\$1730.00	\$1770.00	\$40.00
September	1696.00	1732.00	36.00

INVESTMENT

TURBINES

Tentative bids from the turbine manufacturer indicate that \$34,000 is a safe figure to allow for the total cost of turbines and generators. In addition \$200 should be allowed for the necessary oil filters.

ELECTRICAL EQUIPMENT

The changes and additions to the present electrical equipment are relatively few. As mentioned before, the existing transformers and other distribution material are owned and maintained by the University. Generation would necessitate additional switches, relays, meters and control apparatus. The following list of equipment was obtained by the writer in cooperation with the chief electrician of the University, assisted by a General Electric representative. Some of this equipment is at present on hand. In the cost figure no allowance has been made for existing bus bars, insulators and meters which might be used in the proposed plan. The total expenditure for electrical control and distribution is estimated as \$8,000.

SWITCHBOARD REQUIREMENTS FOR ONE GENERATOR

(Manual Synchronizing)

1 central panel 28 inches wide, 90 inches high

1 A.C. voltmeter		
1 A.C. ammeter		
1 D.C. voltmeter		
1 D.C. ammeter		
2 Transfer switches		
1 Synchronizing switch		
1 Concentric rheostat handle (rheostat with generator field switch)		
	Total cost	\$600.
3 Rectangular IAC relays with test block		309.
3 Instantaneous trip coils		43.
1 Solenoid operated oil circuit breaker G.E. FK-143 with rectifier		585.
3 Current transformers		105.
2 Potential transformers		74.
1 Voltage regulator 500 KVA		450.
	Grand total	<u>\$2116.</u>

Bus Bar material for three generators

50 - 15,000 volt insulators	\$500.00	
225 ft. 1/4" x 3" copper at \$.20/lb. (2.894 lbs./ft.)	135.00	
Asbestos tape for wrapping bars (estimated)	100.00	
10 double throw single pole disconnects back connected 15,000 volts	513.50	
200 ft. 5/8" copper rod for ties from single pole double throw switches to bars. 1.13 lbs/ft. at \$.20/lb.	45.00	
		<hr/> \$1293.50
1 synchroscope		142.00
Switchboards - 3 at \$2116.		6348.00
		<hr/> \$ 7783.50
Assumed cost		\$ 8000.00

TURBINE BUILDING

The turbine room, which must be added to the steam plant, is shown in the drawing on page 116. The structure must be without rigid connection to the existing building thus avoiding differential settling. The only connection would be by a wooden ramp. The turbine building must also be sufficiently removed from the existing steam tunnels. The excavation should be 6 feet deep and the building and turbine foundations should rest on a concrete mat.

In the interest of safety the transformer and other electrical equipment, which is at present in a room off the heating plant, should be removed from there. A special shed-like structure should be placed on the outside of the turbine building to house this equipment and the proposed oil switches and relays which are an explosion and fire hazard.

The building must be designed with sufficient strength to carry the dead weight of the turbo-generator sets and any forces set up by critical vibration. The head room should be sufficient to permit the use of chain falls. The recommended building dimensions allow for one additional turbo-generator set of the same size as the 400 kilowatt unit. In the event of extreme expansion it will be possible to increase the size of individual units without serious loss of space.

The cost of this building is based on the volumetric capacity and an estimated cost per cubic foot of \$.35. The building as shown has a total volume of 40,300 cubic feet. The total estimated cost is:

$$.35 \times 40,300 = \$14,000.$$

BOILER AND HEATING CHANGES

The boilers which are now in operation at the steam plant are built for 200 pounds pressure. At present they have safety valves which operate at 125 pounds. If these valves were changed to 200 pounds and the piping below the water line changed to serve this pressure, the boilers would be in suitable form for operation with the turbines. In addition, piping must be run to the turbines and back to the heating mains. Some changes in the present heating equipment will be necessary, but will require little material. The estimated cost of safety valves, additional piping and heating changes is \$3,000.

BACK PRESSURE CONTROL

The turbines are to operate on a fluctuating back pressure, which will depend on the heating load. Thus a back pressure control is necessary. This may be either of the differential type or the flow type. In this project \$2,000. is allowed for these control devices.

A steam separator is the only additional steam equipment. This device is used to remove the moisture from the steam before it enters the turbines, thus prolonging their life. A sum of \$500. is allowed for this.

INVESTMENT

Turbines	
2 - 400 Kw. units at \$12,700 each	- \$25,420.
1 - 200 Kw. unit at 8,100	- 8,100.
	<hr/>
	\$34,000.
Oil filter	200.
Turbine building	14,000.
Electrical equipment (switchboard, meters, etc.)	8,000.
Safety valves, additional piping and heating changes	3,000.
Back pressure control	2,000.
Steam separator	500.
	<hr/>
	\$61,700.
Contingencies	4,300.
	<hr/>
Total estimated investment	\$66,000.

OPERATING COSTS

LABOR

At the present time there are on duty twenty-four hours a day at the steam plant, an engineer and a fireman. During the hours 8:00 A.M. to 4:00 P.M. there are also on duty a chief engineer and several laborers. The engineers' duties are supervision and checking regularly the refrigeration machine at the hospital. This refrigeration system is soon to be de-centralized and that duty will be removed.

The engineers are a group of intelligent men and it is felt that they would soon learn how to operate the turbo-generator sets efficiently. Their chief responsibility would be synchronizing machines before putting them on the line, and checking the division of load between generators. These are routine jobs which require only slight practice.

It will be assumed, therefore, that no additional labor will be necessary to carry on this proposed generating project.

ENERGY AND FUEL COSTS

As noted on page 78 the fuel cost of generation was \$2750. for the period September 15 to May 15th. The cost of energy purchased during the remaining four months of the year was \$7000. The stand-

by charge is \$256.50 per month or about \$2100. for the eight month period.

INTEREST AND DEPRECIATION

As set forth on page 87 the investment is \$66,000. At present the University can borrow money at rates considerably below 4 per cent, but that figure is used in computing the charge against investment which is \$2640. per year.

The University does not have a depreciation charge against any of its present buildings, but in this report 3 per cent is charged against the turbine room. This item is \$420.

The investment inclusive of building is \$52,000. This is for turbo-generator sets and other equipment on which depreciation is figured at 8 per cent. This yields a charge of \$4160. against generation. If this sum is set aside in a sinking fund and credited with the interest earned (4 per cent annually) it will take ten years and three months to amortize the investment. Thus at the end of that period \$52,000. may be used to replace the turbines or to add new units without upsetting the financial structure.

OTHER OPERATING COSTS

\$1000. is set as the annual maintenance charge. As noted on page 79, major repairs and overhauling will be done during the

summer when the plant is idle. For this reason, probably little or no additional labor will be added to the pay roll.

The yearly cost of oil and waste is estimated at \$300.

Insurance cost for a building and machinery of this type is estimated at \$250.

OPERATING COSTS

Electrical energy cost

Fuel cost of generation (Sept. - May)	\$2750.	
Cost of 500 Kw. stand-by	2100.	
Cost of power purchased (May - Sept.)	7000.	
	<u>\$ 11,850.</u>	\$12,000.
Interest at 4 per cent on investment	2640.	
Depreciation at 3 per cent on \$14,000.	420.	
Depreciation at 8 per cent on \$52,000.	4160.	
Maintenance	1000.	
Oil, waste, etc.	300.	
Insurance	250.	
	<u>\$ 8770.</u>	\$ 9,000.
		<hr/>
Total cost of electrical energy (with generation)		\$21,000.

CONCLUSION

It should be stated here that operating with self-generation and with a stand-by hook up the University and hospital would be assured of an uninterrupted supply of energy. In the event of its own power station failing it would be able to fall back on the Rochester Gas and Electric system. At present when the Rochester Gas and Electric system fails most of the University buildings are without power. The present 28 kilowatt emergency generating set is entirely inadequate, as has been demonstrated several times.

The total operating cost for a year period with generation has been computed as \$21,000. The same energy if purchased from the Rochester Gas and Electric Corporation would cost \$27,000. Thus, by generating during the period September 15th to May 15th and purchasing during the other four months, a saving of \$6,000. can be realized. It is felt that the actual saving will be greater rather than less than this computed figure. This indicates that it would be economical for the University to generate its own energy for part of the year.

SKETCH OF STEAM
PLANS

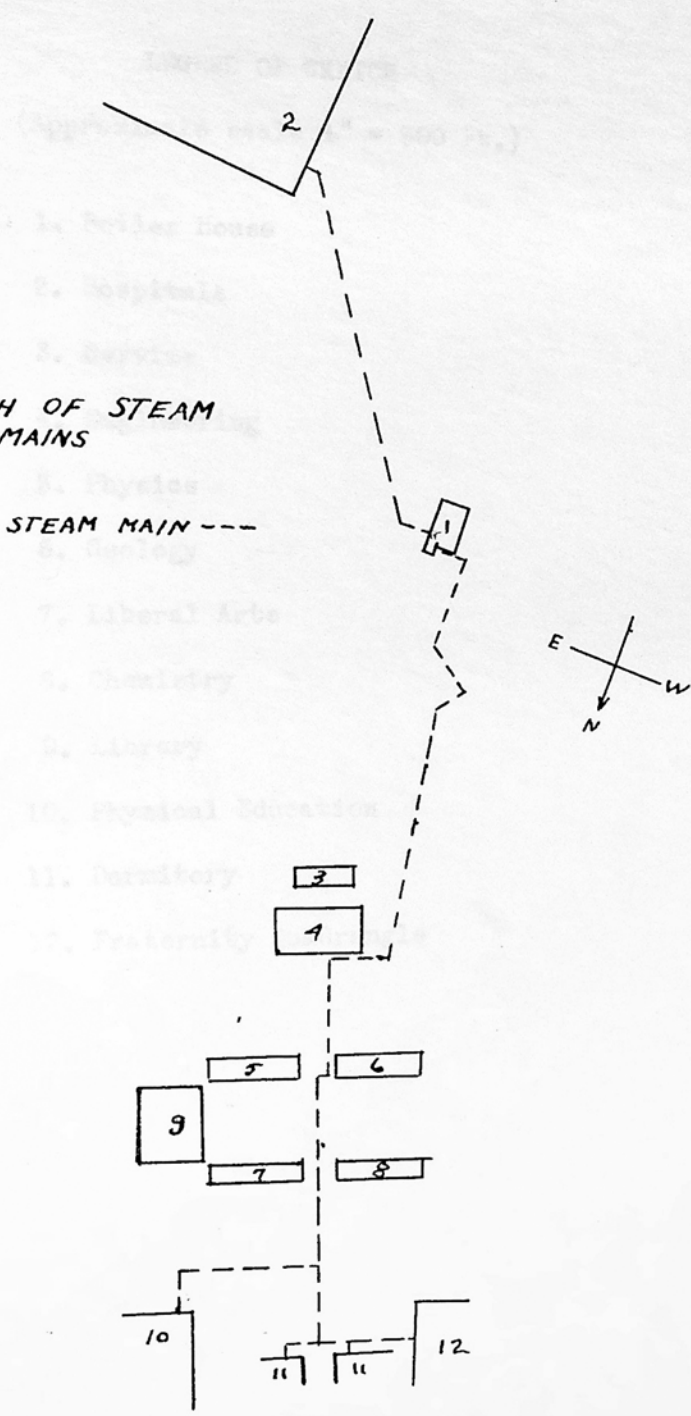
STEAM MAIN ---

A P P E N D I X



SKETCH OF STEAM
MAINS

STEAM MAIN ---



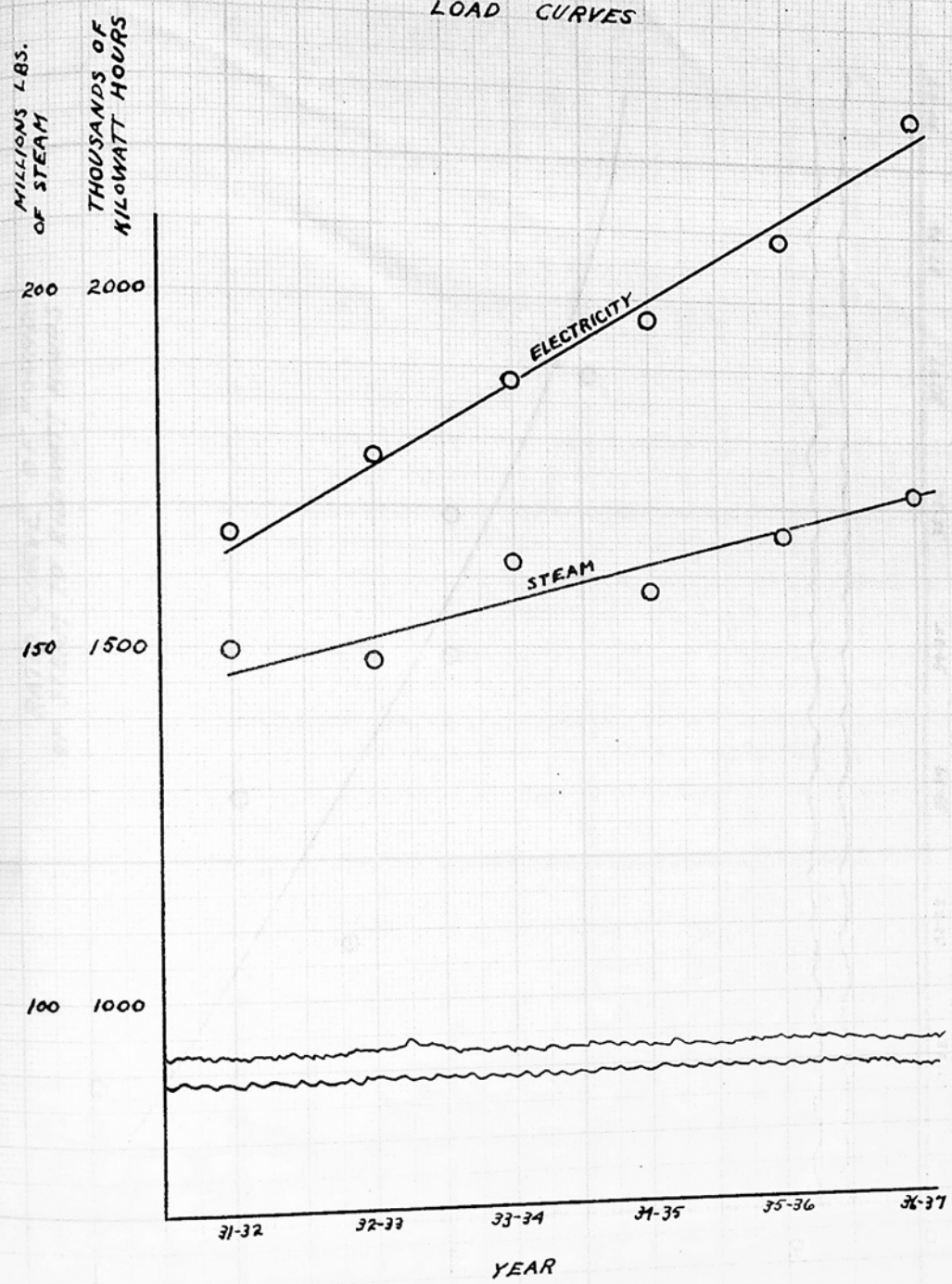
- 1. Boiler House
- 2. Hospital
- 3. Service
- 4. Physics
- 5. Chemistry
- 6. Library
- 7. Liberal Arts
- 8. Chemistry
- 9. Library
- 10. Physical Education
- 11. Dormitory
- 12. Faculty

LEGEND OF SKETCH

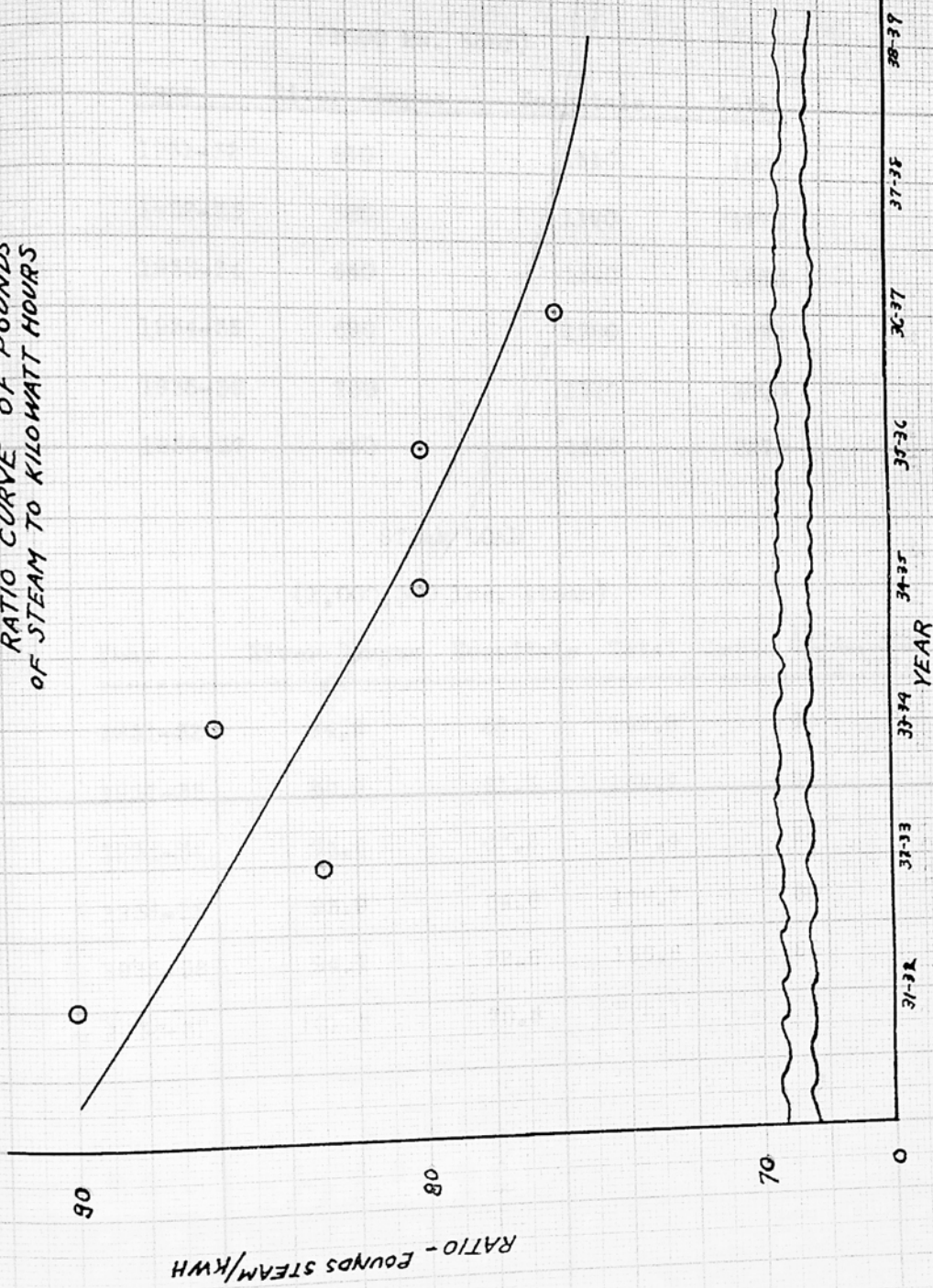
(Approximate scale 1" = 500 Ft.)

1. Boiler House
2. Hospitals
3. Service
4. Engineering
5. Physics
6. Geology
7. Liberal Arts
8. Chemistry
9. Library
10. Physical Education
11. Dormitory
12. Fraternity Quadrangle

LOAD CURVES



RATIO CURVE OF POUNDS
OF STEAM TO KILOWATT HOURS



RATIO - POUNDS STEAM/KWH

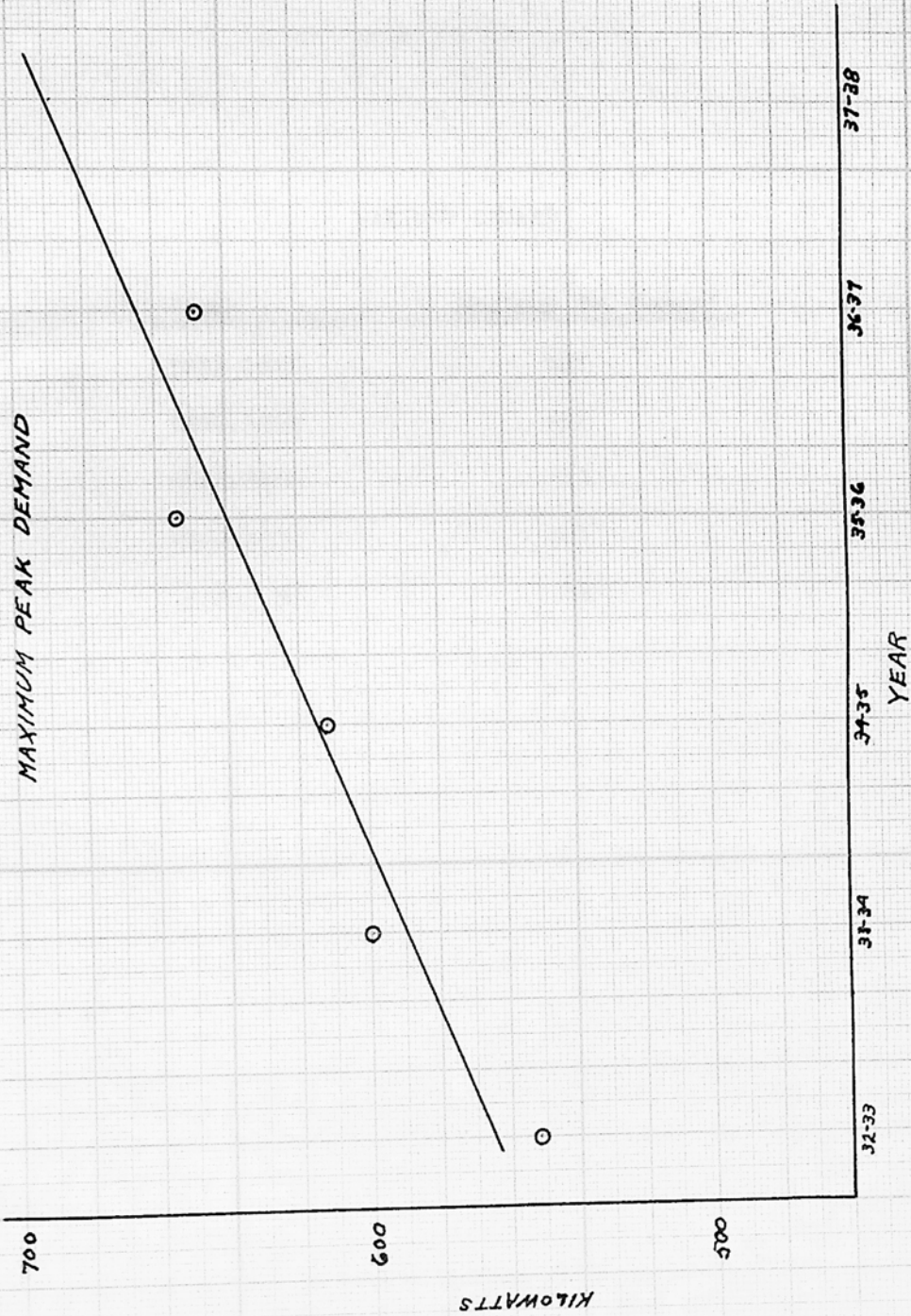
YEAR

ELECTRIC LOAD
(1000 kw. hour)

Year	River Campus	Hospitals	Total
1931-32	550	1110	1660
1932-33	580	1190	1770
1933-34	640	1240	1880
1934-35	690	1280	1970
1935-36	780	1310	2090
1936-37	860	1410	2270

STEAM LOAD
(1,000,000 lbs. steam)

Year	River Campus	Hospitals	Total	Ratio	$\frac{\text{lbs. steam}}{\text{kw. hrs.}}$
1931-32	84.9	65	149.9		90
1932-33	86.8	61.3	148.1		83
1933-34	94.6	67.8	162.4		86
1934-35	93.9	64.8	158.7		80
1935-36	94.1	72.5	166.6		80
1936-37	101.3	70.8	172.1		76

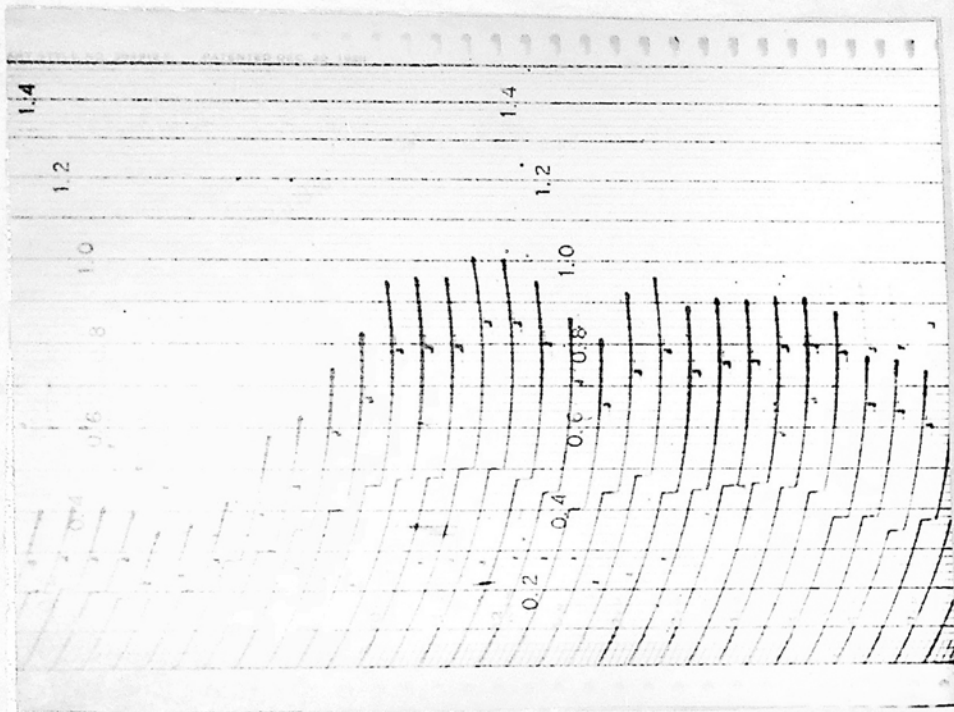


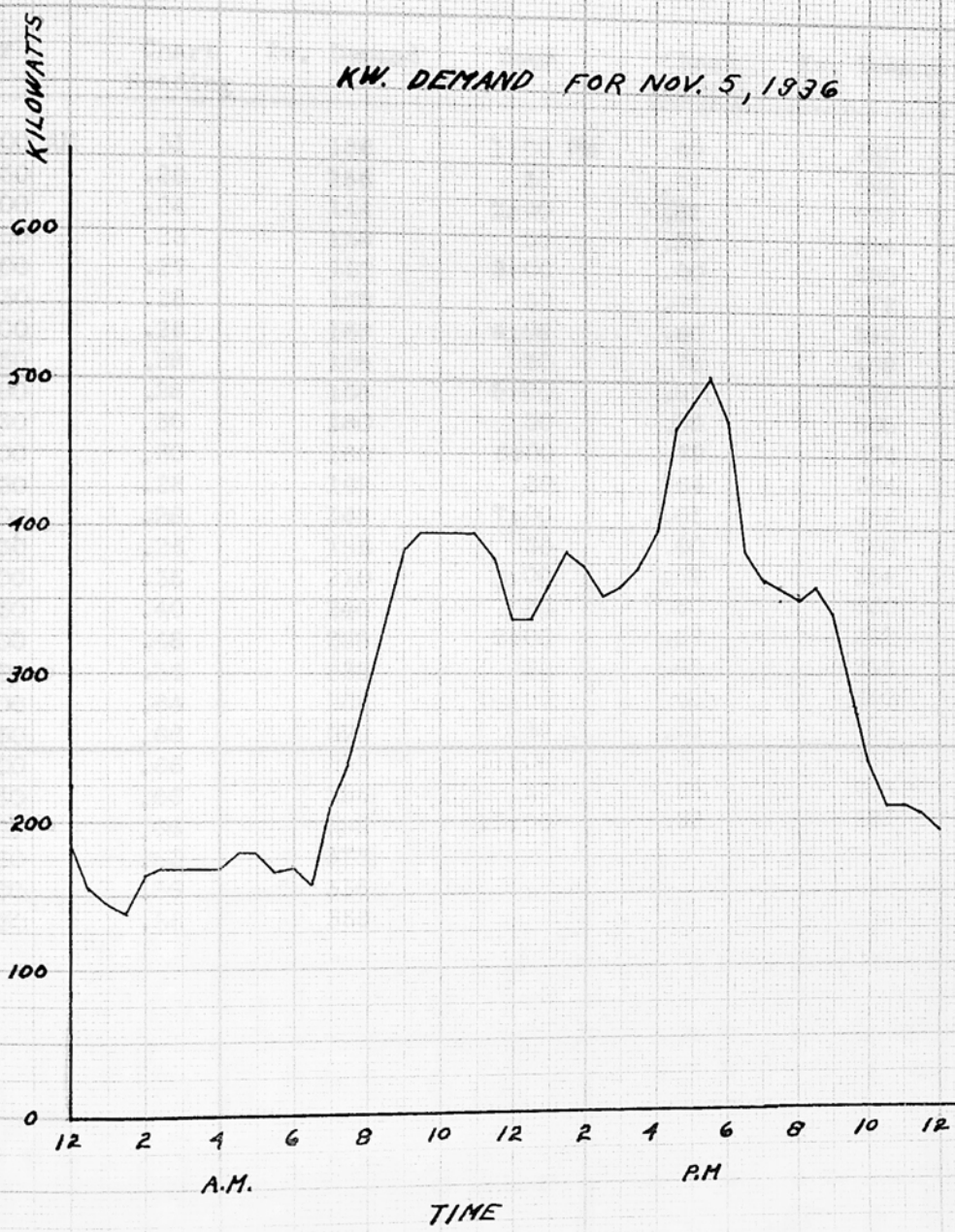
P.O. and K. Demand Meter Chart
(Photograph)

MAXIMUM DEMAND

<u>Year</u>	<u>Maximum Kw. Demand</u>
1932-1933	552
1933-1934	600
1934-1935	612
1935-1936	654
1936-1937	648

R.G. and E. Demand Meter Chart
(Photograph)



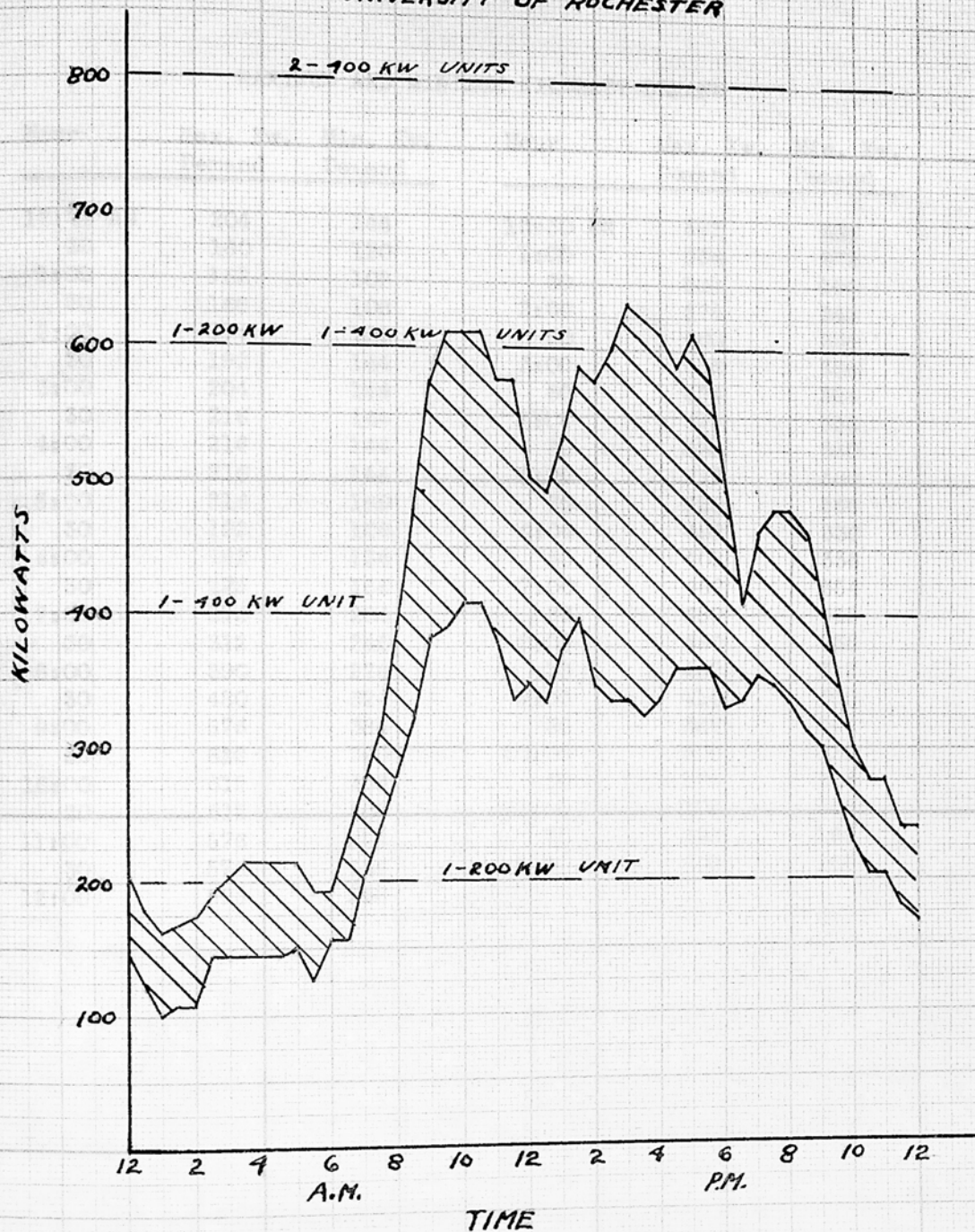


NOV 5 1936 10:00 AM EASTERN STANDARD TIME

KILOWATT DEMAND FOR NOVEMBER 5, 1936
FROM ROCHESTER GAS AND ELECTRIC CHART

Hour	Chart Reading	Kw. Demand	Hour	Chart Reading	Kw. Demand
12:00 AM	.31	186	1:00 PM	.60	360
30	.26	156	30	.64	384
1:00	.24	144	2:00	.62	372
30	.23	138	30	.59	354
2:00	.27	162	3:00	.60	360
30	.28	168	30	.62	372
3:00	.28	168	4:00	.66	396
30	.28	168	30	.78	468
4:00	.28	168	5:00	.81	486
30	.30	180	30	.84	505
5:00	.30	180	6:00	.79	474
30	.28	168	30	.64	384
6:00	.28	168	7:00	.61	366
30	.26	156	30	.60	360
7:00	.35	210	8:00	.59	354
30	.40	240	30	.60	360
8:00	.48	288	9:00	.57	342
30	.56	336	30	.48	288
9:00	.64	284	10:00	.40	240
30	.66	396	30	.35	210
10:00	.66	396	11:00	.35	210
30	.66	396	30	.34	204
11:00	.66	396	12:00	.32	192
30	.63	378			
12:00	.56	336			
30	.56	336			

KILOWATT DEMAND
OF
UNIVERSITY OF ROCHESTER



MAXIMUM AND MINIMUM KILOWATT DEMAND

Hour	Max. Kw. Demand	Min. Kw. Demand	Hour	Max. Kw. Demand	Min. Kw. Demand
12:00 AM	204	144	12:30 PM	492	336
30	180	120	1:00	534	372
1:00	162	102	30	588	396
30	168	108	2:00	576	348
2:00	174	108	30	600	336
30	192	144	3:00	636	336
3:00	204	144	30	624	324
30	216	144	4:00	612	336
4:00	216	144	30	588	360
30	216	144	5:00	612	360
5:00	216	150	30	588	360
30	192	126	6:00	492	330
6:00	192	156	30	408	336
30	228	156	7:00	462	354
7:00	276	204	30	480	348
30	312	240	8:00	480	336
8:00	390	276	30	462	312
30	480	324	9:00	414	300
9:00	576	384	30	348	264
30	612	390	10:00	300	228
10:00	612	408	30	276	204
30	612	408	11:00	276	204
11:00	576	378	30	240	180
30	576	336	12:00	240	168
12:00	504	348			

-2-

SECOND

One...200 KW at 80% power factor unit, including a Type GAT single stage Terry Turbine having a two-row action wheel.

Performance as shown on curve K-8459
Weight approximately 12,500#
Price, net, F.O.B. Hartford, Conn.....\$8,100.00

To show the arrangement and approximate dimensions of these units we attach B/P E-2244 and D-402 X.

We have not attempted to go into a great deal of detail at this time but will be pleased to submit formal proposal with full detailed specifications at any time or to supply any specific information you may desire.

Yours very truly,

THE TERRY STEAM TURBINE COMPANY

By

Arthur E. Jones.

Arthur E. Jones Company
District Representatives

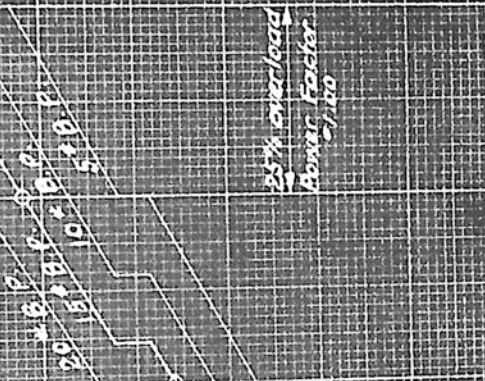
AEJ:j
Encs.
CC-Hfd.

24000
20000
16000
12000
8000
4000

Steam Flow
Pounds

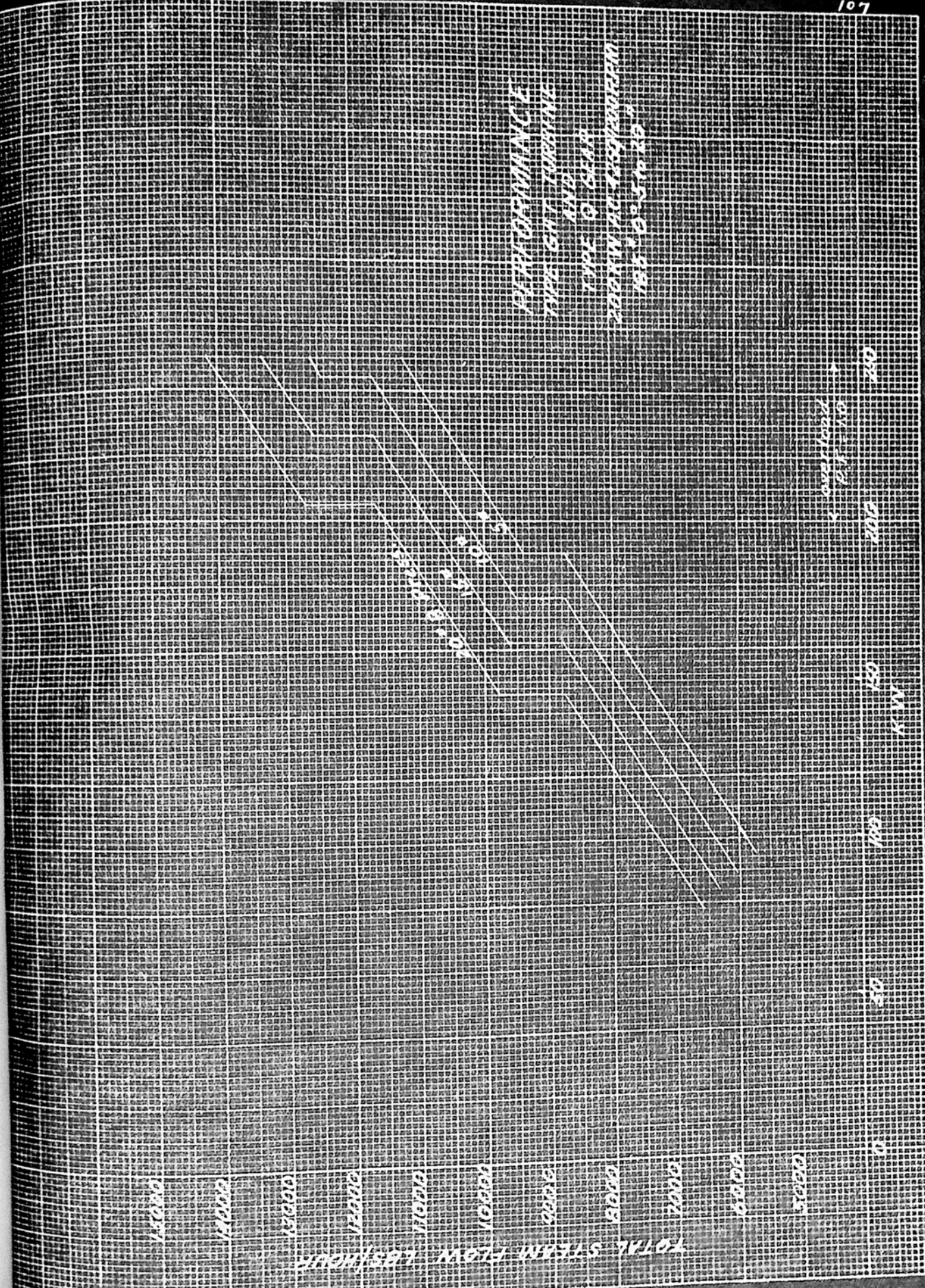
500
400
300
200
100
0

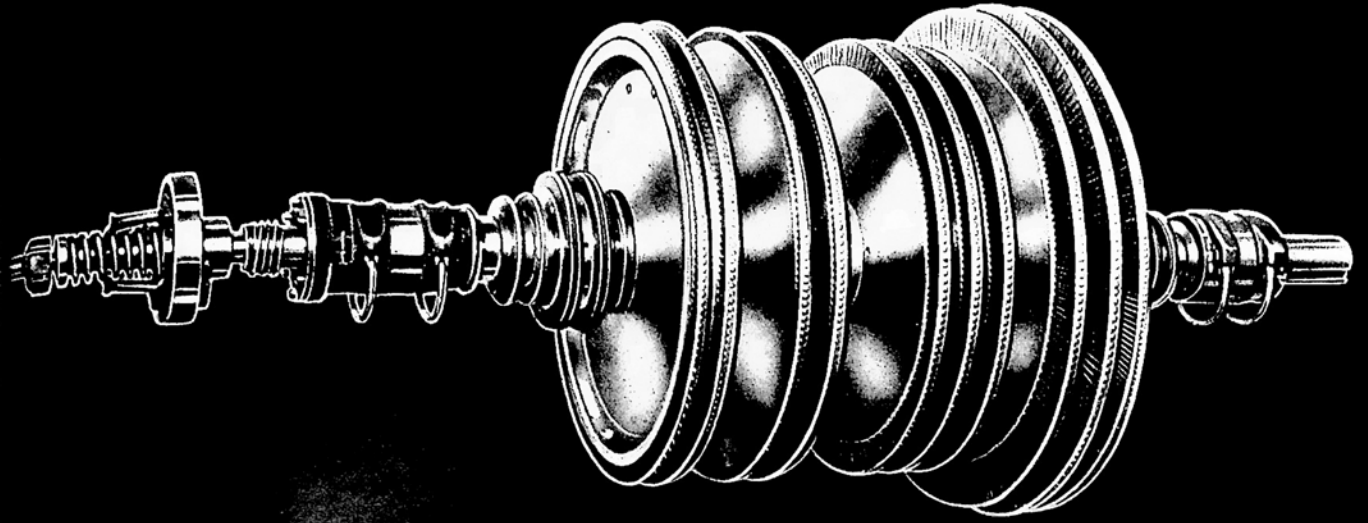
Kilowatt



ZFR - 6
 400 KW AC
 4250 / 1200 R.P.M.
 185° 0' - {
 5' / 18' / 15' / 20'

Guarantee Points





THE TERRY MULTI-STAGE TURBINE

BULLETIN S-114



The Terry Steam Turbine Co.

Terry Square, Hartford, Conn.

The TERRY MULTI-STAGE TURBINE

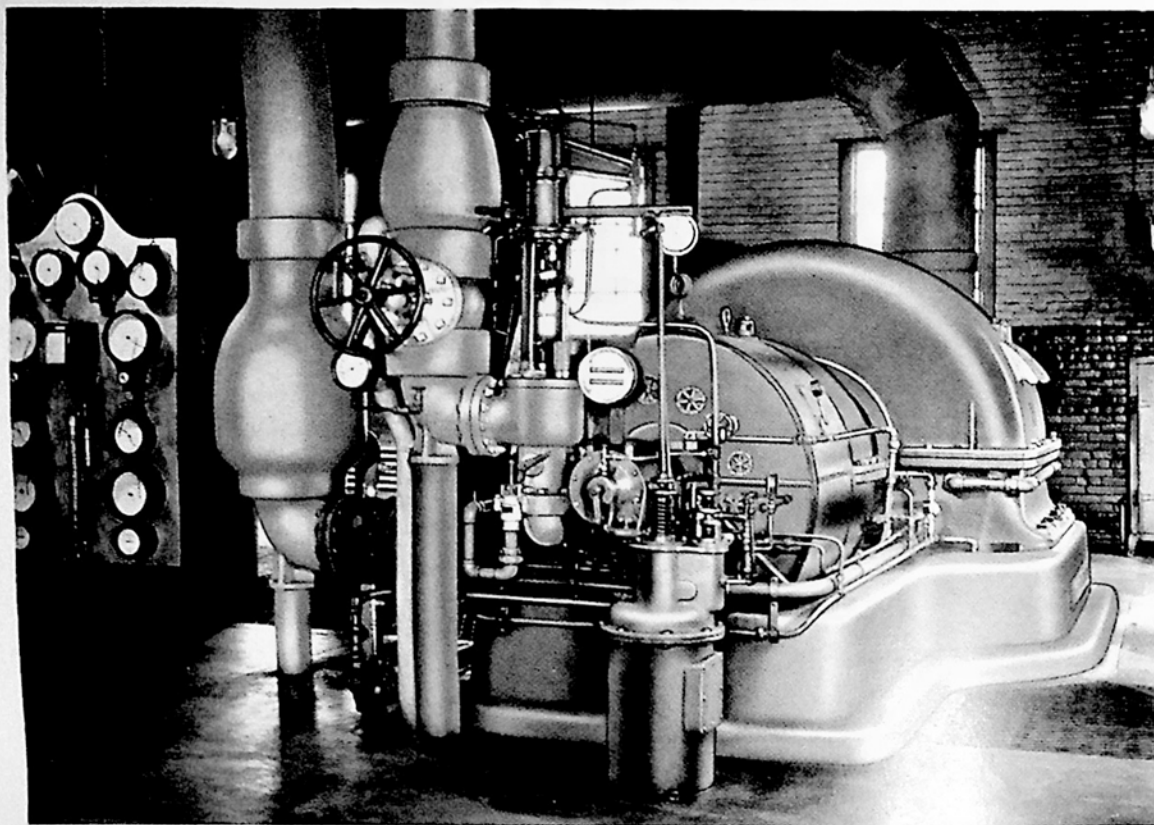


FIG. 1

1,900 H. P. mixed pressure bleeder turbine, type GHF, driving gas booster.

THE Terry multi-stage turbine is a thoroughly reliable, efficient and compact machine. Its design is the result of over thirty-five years of successful experience in the manufacture of turbine drives exclusively.

The detail construction of the Terry multi-stage turbine depends to a large extent upon the plant operating conditions. In other words, each Terry multi-stage turbine is individually designed and proportioned so as to operate most efficiently under the specified requirements. It is built in a wide range of frame sizes or types and can therefore be designed for the accommodation of relatively large or small quantities of steam at high or low pressures. The operation can be:

- (1) Straight condensing.
- (2) Straight non-condensing.
- (3) Condensing bleeder.
- (4) Non-condensing bleeder.
- (5) Low pressure condensing.
- (6) Mixed pressure condensing.
- (7) Mixed pressure bleeder.
- (8) Double bleeder.

All parts are of extreme ruggedness and the turbine lends itself to use with the highest commercial steam pressures and superheats as well as with high back pressures and high bleeder pressures. Steel parts are available for use when required. The horsepower capacity depends, of course, upon the steam pressure, back pressure, speed and other factors, but in general the Terry multi-stage turbine covers a range from around 200 H. P. to over 2,000 H. P.

It is of the impulse type and in most cases employs a multiple velocity stage followed by a suitable number of Rateau stages. In those instances where a straight Rateau design will give better results the machine may be constructed in that manner.

There is no tendency for the steam to leak around the blade tips since no expansion takes place during the passage of the steam through the wheel buckets. This makes possible the use of very liberal blade clearances. For the same reason the rotor is in equilibrium and the necessity for balancing against large axial thrusts is eliminated.

Casing

The casing is of heavy construction and is so designed that the correct number and diameter of stages can be used to fit exactly the conditions under which the machine will operate. It is split horizontally and the steam inlet and exhaust are located in the lower half. This permits easy access to the interior for inspection of the rotor without disturbing the piping or alignment.

The smallest frame, the type GAF, is supported on feet as shown in Figure 12. All other Terry multi-stage turbines are supported at the center line so that variations of temperature and pressure do not affect the position of the shaft. The exhaust space is provided with an extra large sentinel relief valve.

Lagging

Lagging can be supplied when specified. This consists of a thick layer of magnesia and a covering of carefully fitted sheet iron over the steam chest and high pressure section. The magnesia is securely anchored in place and will not loosen under all ordinary conditions of service. The application of the lagging is so made that it does not interfere with the dismantling of the turbine. It reduces radiation and gives the turbine an unusually neat appearance.

Blades

The blades are made by a special process which results in accurate angles and hard, smooth surfaces. They are of heavy section with sharp edges. The blade material is a high grade stainless steel manufactured to our own specification. This material was selected because of its ability to resist the corrosive and erosive action of the steam as demonstrated by tests. It is a much better material than the ordinary stainless steels, nickel steels and the like which are commonly used for this purpose. A sectional shroud is riveted to the outer edge of the blades and gives added rigidity. The blades are firmly held in a dovetail groove in the rim of the wheel and are renewable.

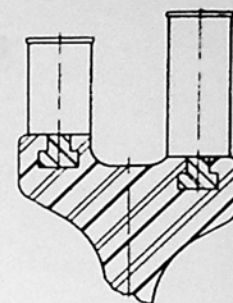


FIG. 2

Blade Fastening

Wheels

The wheels are made from forged steel discs machined all over. Each disc is supplied with an integral hub which serves both as a spacing ring and gland collar. This construction reduces the width per stage and thereby

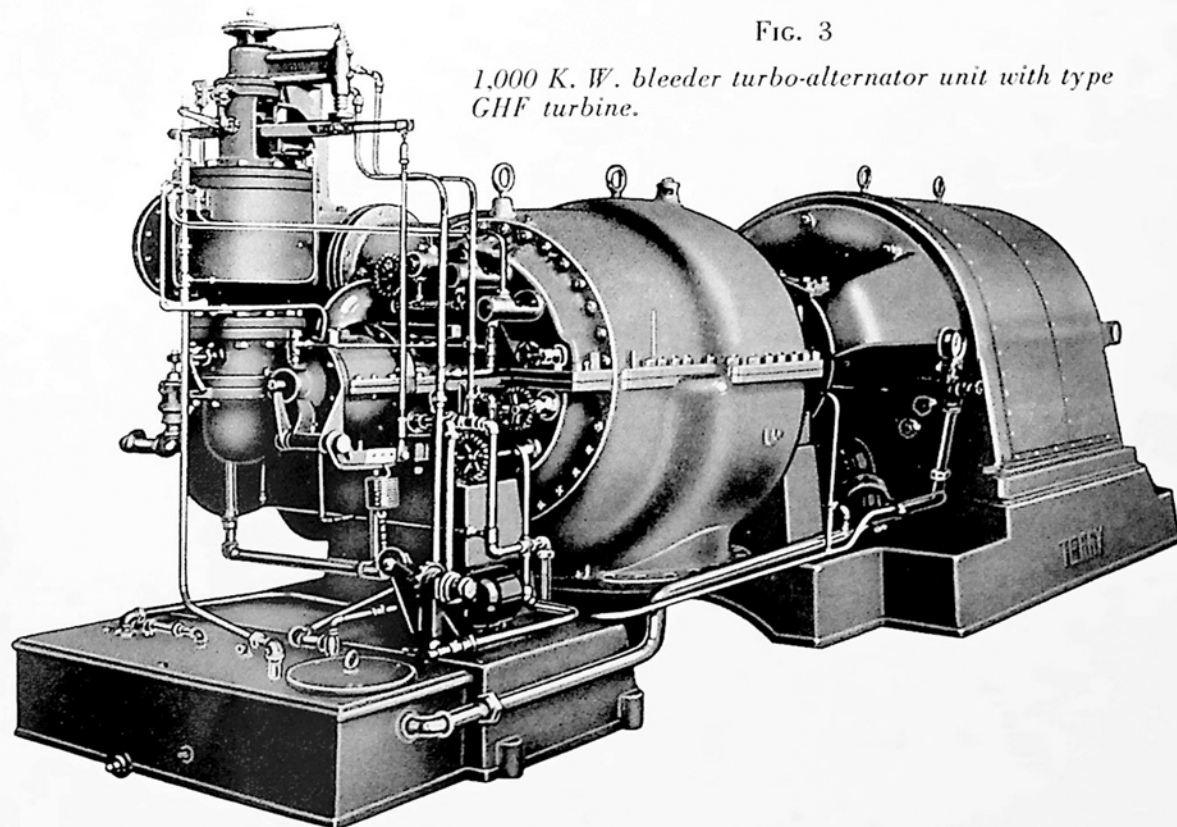


FIG. 3

1,000 K. W. bleeder turbo-alternator unit with type GHF turbine.

lessens the shaft span. The wheels are keyed and pressed on the shaft and are held firmly against an enlarged section by locked wheel nuts so that it is impossible for them to move axially. Each wheel is carefully balanced individually and the entire rotating element is again balanced after assembly. The dynamic balance is obtained by running the complete rotor at rated speed in its own bearings.

Shaft

The shaft is made from special carbon steel or alloy steel and is ground on all surfaces. A tapped hole is provided in the end of the shaft to facilitate drawing on the coupling.

Nozzles

The nozzles in the high pressure section are made separate from the steam ring and are secured in place by locked bolts. They are accurately drilled and reamed for the correct area and expansion ratio. The nozzle material is selected for its suitability for use under the specified steam conditions.

Diaframs

The diaframs are made either of semi-steel or steel, depending upon the operating requirements. The blades in the diafram are made of stainless steel. The nozzles are cast directly in the diaframs. The utmost care is used in their design and manufacture. Each nozzle is

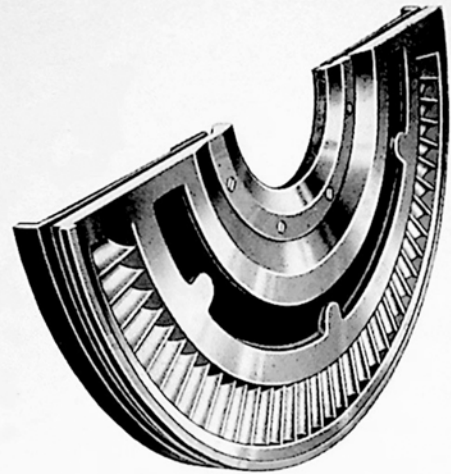


FIG. 4
Lower half diafram.

checked with special gauges to insure true areas and proportions. The two halves of the diaframs are prevented from moving in relation to each other by a tongue and groove joint.

Bearings

The bearings are of liberal dimensions and are horizontally split so that they may be rocked out of position without disturbing the casing or rotor. The shells are made of semi-steel and are lined with the highest grade tin base babbitt. The babbitt is securely anchored in place. The bearings are so accurately machined that hand scraping is neither required nor permitted. Each

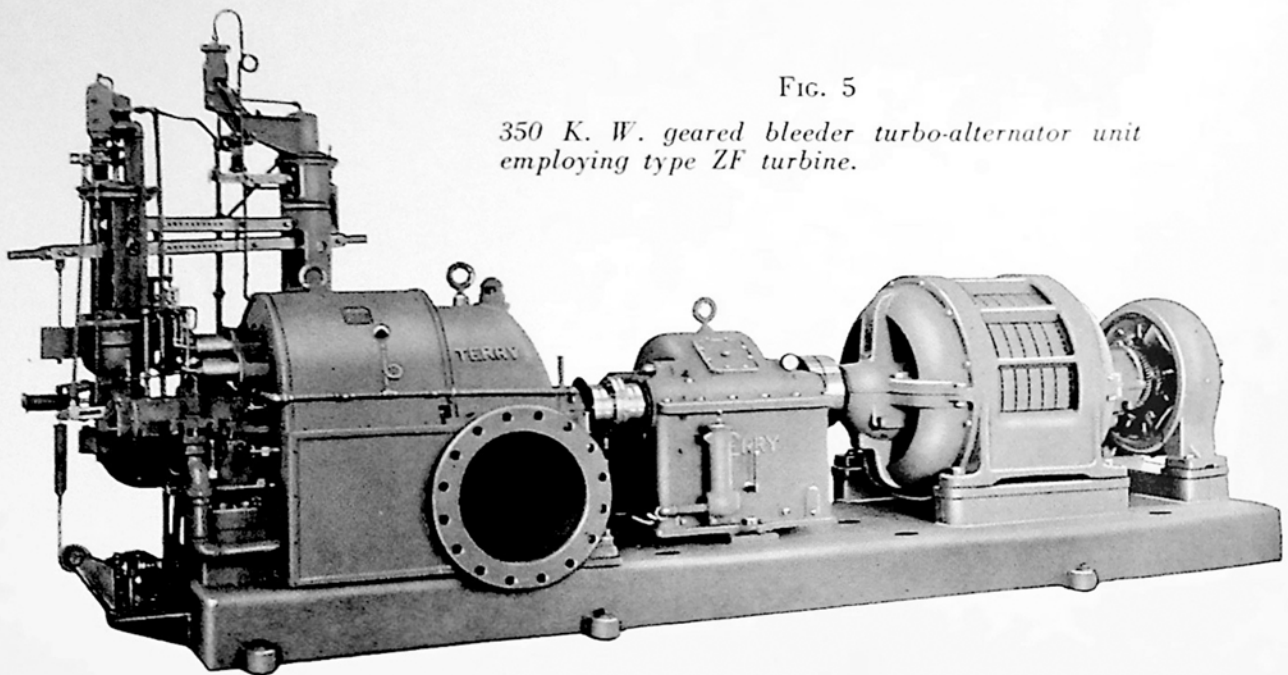


FIG. 5
*350 K. W. geared bleeder turbo-alternator unit
employing type ZF turbine.*

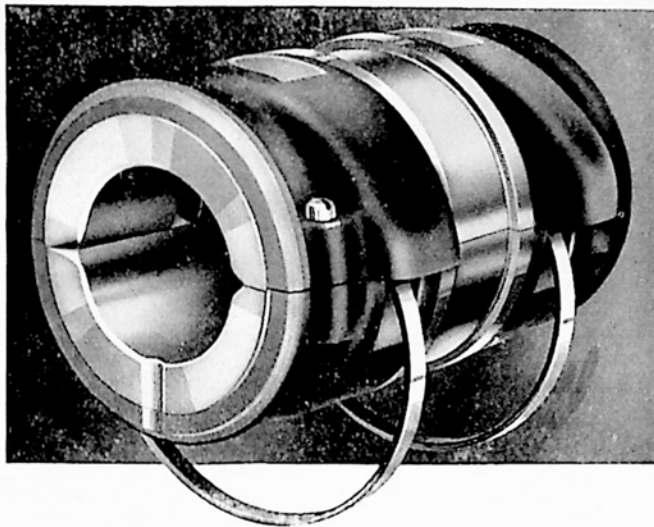


FIG. 6
Bearing.

bearing is provided with two solid machine made brass oil rings. Slingers or deflecting collars are mounted on the shaft near the ends of the bearing so as to prevent water from getting into the bearing oil reservoirs and also to prevent the oil from getting out.

The Thrust Bearing

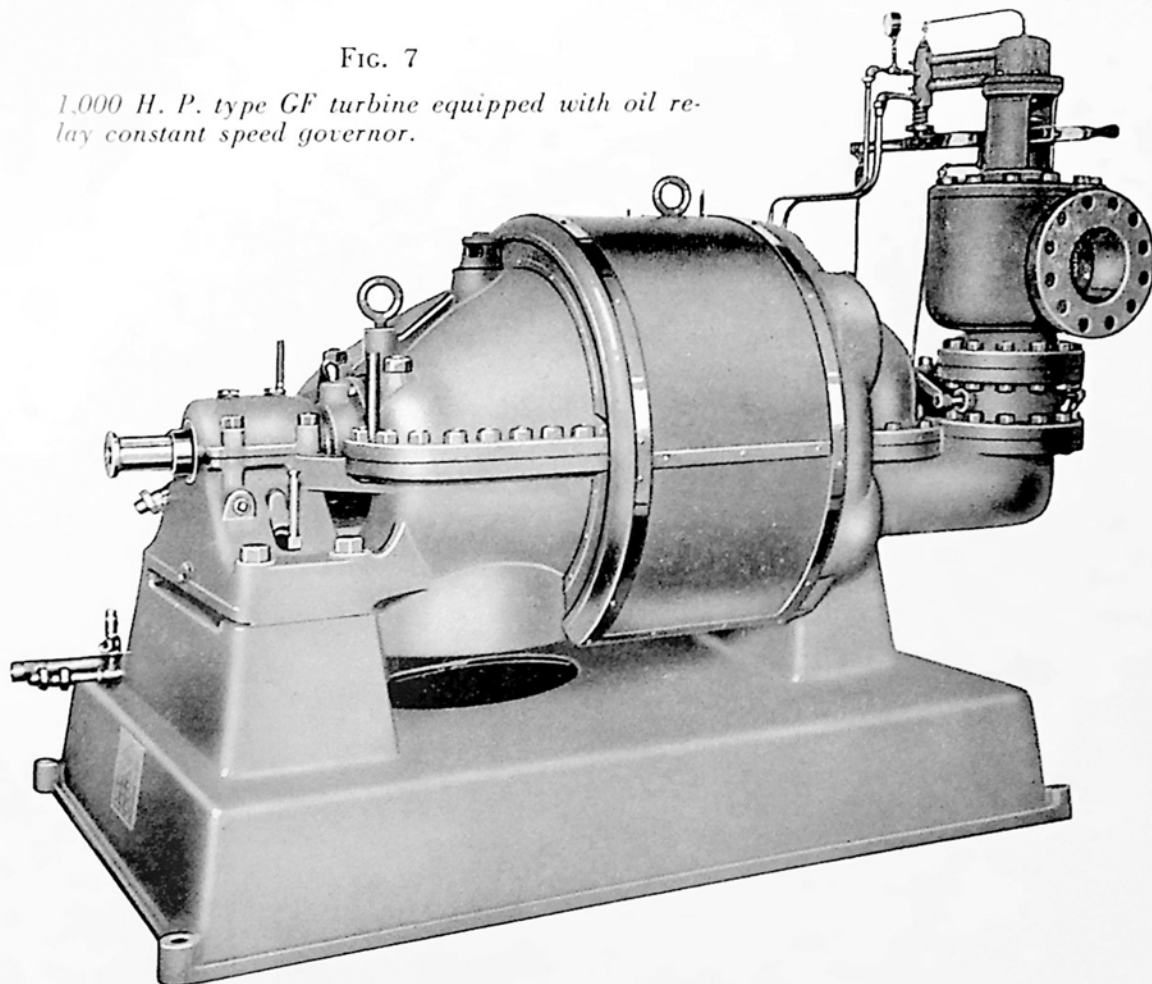
There is practically no end thrust in a turbine of this type. To keep the rotor, however, in its correct location in relation to the nozzles, a ball bearing type thrust of ample proportions is mounted on the shaft near the governor end. It is copiously lubricated by overflow from the main bearing.

The Interstage Glands

On the type ZF frame the interstage glands are of the carbon ring type. These employ a special four segment ring held in contact by a divided garter spring. Each part of the garter spring secures two of the segments to one-half of the diafram. Thus, when the upper half of the diafram is removed it brings with it the two upper segments of the carbon ring. This insures that the carbon ring will not be damaged when lowering the diafram into position.

FIG. 7

1,000 H. P. type GF turbine equipped with oil relay constant speed governor.



On all other Terry multi-stage turbines, labyrinth type interstage glands are used. These are horizontally split and fastened securely to the diaframs so that when the upper half of the diafram is removed it brings with it the upper half gland.

End Glands

The end glands are of the carbon ring type. Each ring is composed of three segments held together by a non-corrosive metal garter spring and prevented from rotating by stops. The glands are enclosed in a separate casing which is provided with a leak-off space. For condensing operation an effective steam seal prevents loss of vacuum from air leaks.

Overspeed Governor

All Terry multi-stage turbines are provided with a simple speed limiting governor which functions independently of the main speed governor. It is operated by a pivoted weight mounted on the back of the main governor disc. Normally this weight is held in place by the compression force of a coil spring. If the turbine reaches a predetermined speed, usually about 10% above normal, centrifugal force overcomes the action of the spring, causing the weight to strike a trigger. This releases a spring loaded emergency valve and immediately shuts off the steam supply.

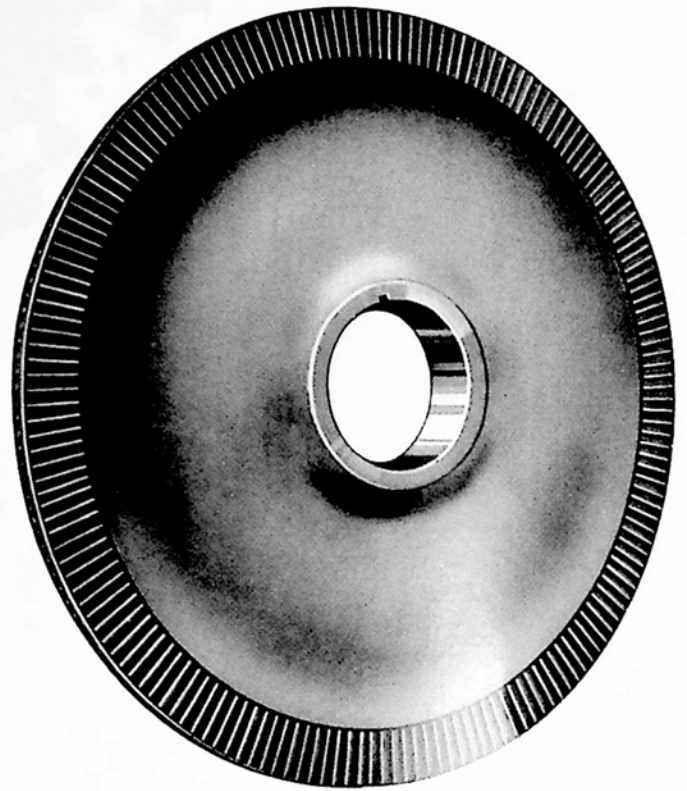


FIG. 8
Turbine Wheel

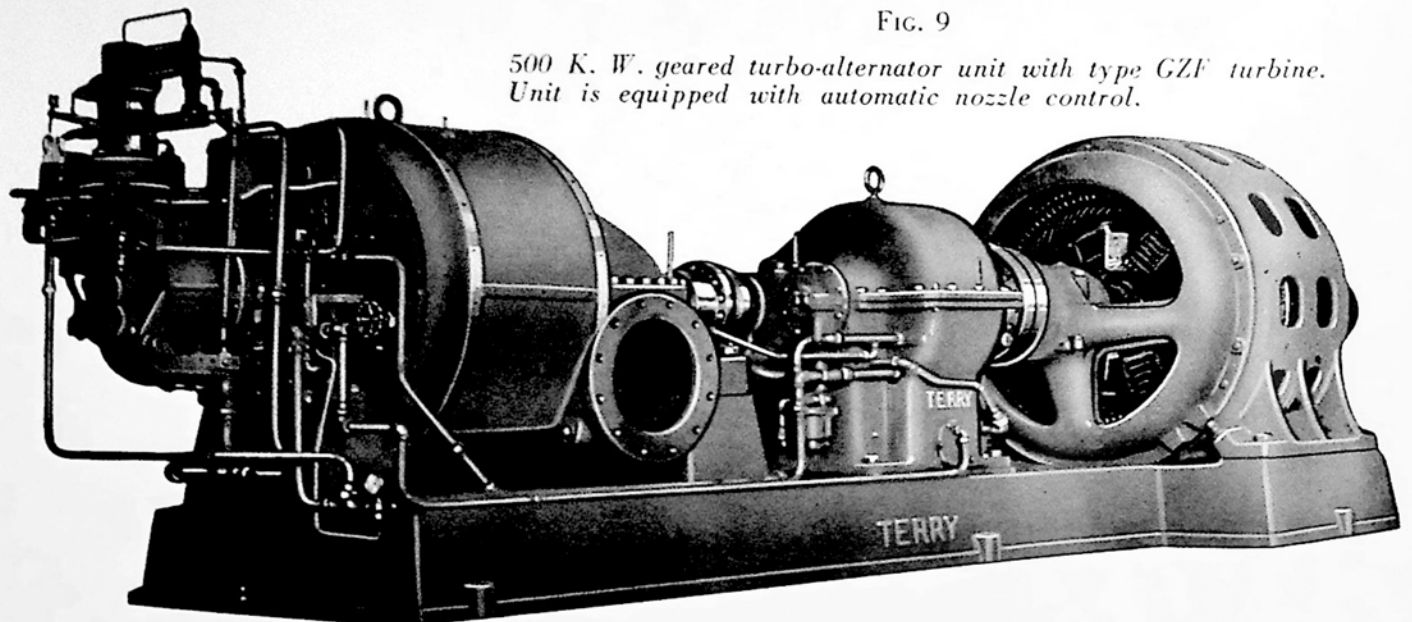


FIG. 9
500 K. W. geared turbo-alternator unit with type GZF turbine. Unit is equipped with automatic nozzle control.

Governors

Four types of speed governors are available for use with the Terry multi-stage turbine. They include:

(A) Mechanical direct acting constant speed governor. This is of the centrifugal type and is mounted directly on the turbine shaft. It is positive, yet sensitive, and operates with little friction. It is connected to the governor valve through simple levers.

(B) Oil relay constant speed governor. This type of governor is usually recommended for use on the larger turbine frames and in cases where especially fine regulation is required. In this mechanism (see Figure 13) the governor actuates a small pilot valve which is supplied with oil under pressure from a gear type pump. The pilot valve admits the oil above or below an oil piston which controls the governor valve opening. The piston is of ample diameter, which assures absolute speed control under all conditions.

(C) Variable speed governors. These are available in two types—direct acting and oil relay operated.

The former is ideally adapted for use on the smaller machines when they are used for driving fans, pumps and the like. It consists of an oil pump arranged to discharge oil back to the oil reservoir through an orifice. The resulting pressure between the pump and the orifice actuates a spring loaded diafram which controls the turbine governor valve. Adjustment of the orifice needle valve determines the speed at which the turbine must operate to hold sufficient pressure on the diafram.

Where very close regulation is required or where large valves are used, the oil relay variable speed governor is

employed. In this (see Figure 14) a pilot valve is introduced into the system which has the advantage of a small travel for the full range of the governor. The governor is unusually accurate and stable throughout the whole operating range and at the same time is highly dependable and relatively simple.

When desired, remote speed control can be furnished with these variable speed governors. These controls are electrically operated and make it possible to vary the speed of the turbine from some distant point.

Speed Changer or Synchronizer

This device may be used with either the mechanical or oil relay constant speed governor and permits the turbine speed to be raised or lowered through a 10% range while in operation. It is usually employed on turbines that drive alternating current generators so that the unit may be synchronized with other sources of power, but it may also be used on turbines used for other purposes. For special conditions the range may be increased to 20%. The operation can be either manual at the turbine, or when specified, motor operated from a remote point.

Governor Valve and Steam Strainer

The Terry bushing type governor valve is so designed and constructed that it requires only a small force to move it. The valve and seats are renewable and may be removed without breaking the steam pipe connections. The valve rides in a bushing or cage which is secured in place by the valve bonnet or cover.

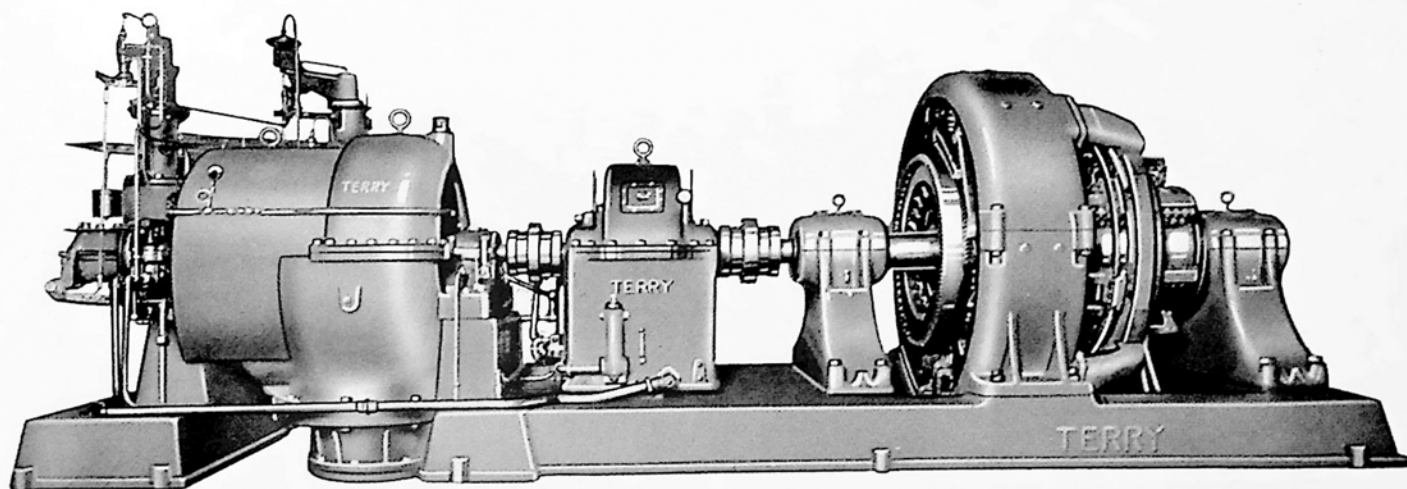


FIG. 10

750 K. W. mixed pressure turbo-generator unit using type GHF turbine.

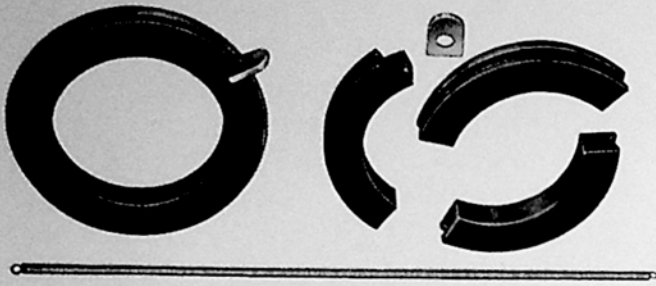


FIG. 11
Carbon ring gland.

Surrounding the valve proper is a large annular space containing a cylindrical strainer. This strainer serves to protect the valves, nozzles and blading from damage by large foreign matter carried over in the steam. It is made from perforated metal and is rigidly held in place. The strainer can be inspected by removing the governor valve bonnet.

Nozzle Control Valves

Hand operated nozzle control valves can be supplied. These are desirable where the turbine may be called upon to operate at partial loads or with reduced steam pressure, or to operate at back pressures higher than

normal. Automatic nozzle control is also available and can be furnished when specified.

Lubrication

The smaller Terry multi-stage turbine frames are provided with ring oiled bearings. Each bearing is equipped with two solid machine made brass oil rings.

The larger units have, in addition to the ring oiling, a forced feed lubricating system which supplies oil under pressure to each bearing. The system is entirely self-contained and includes a positive acting oil pump driven by spiral gears from the main shaft, and an oil strainer and a water-cooled oil reservoir. The pump is so arranged as to insure positive priming. When Terry reduction gears are supplied in connection with the turbine, oil is obtained from the reservoir in the gear case. All parts of the lubricating system are accessible and easily inspected.

General

All parts are manufactured on the limit gauge method, which assures accuracy and perfect interchangeability. The Terry multi-stage turbine, like all Terry apparatus, is a rugged and efficient machine.

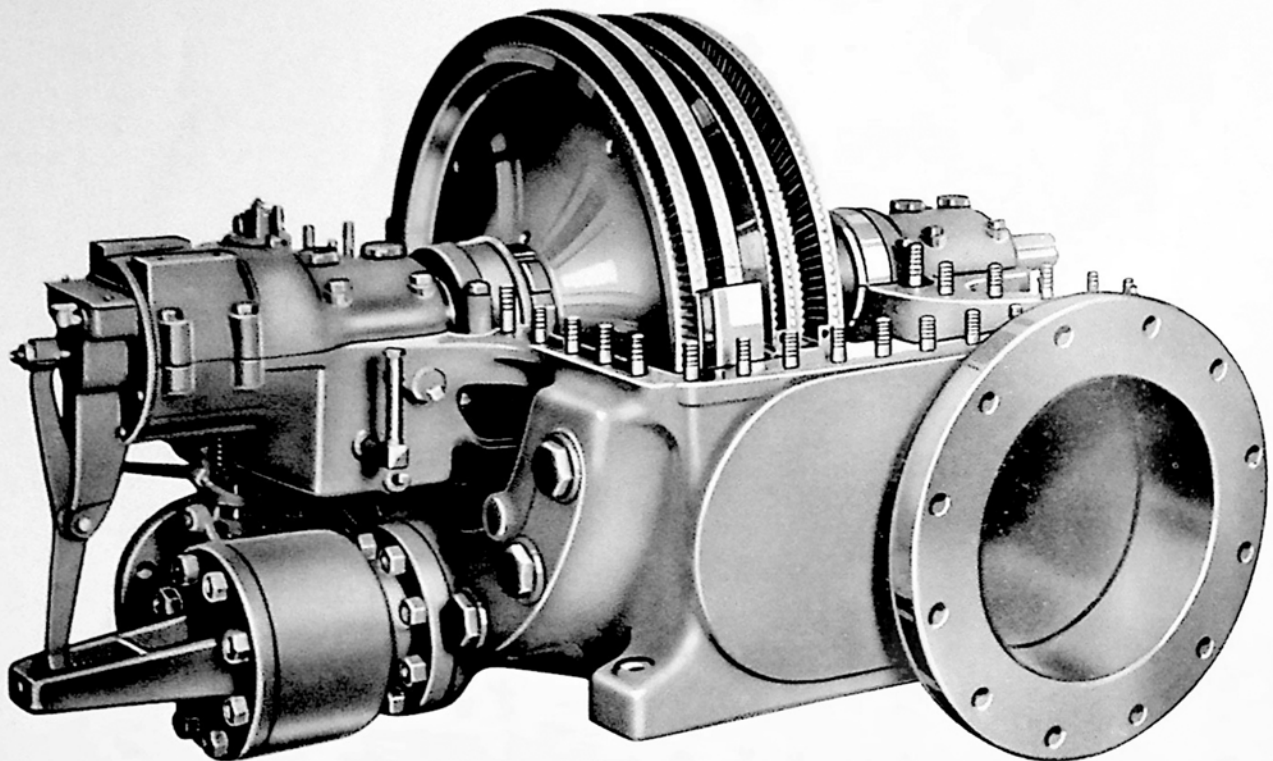


FIG. 12
Type GAF turbine with cover removed.

THE TERRY MULTI-STAGE TURBINE

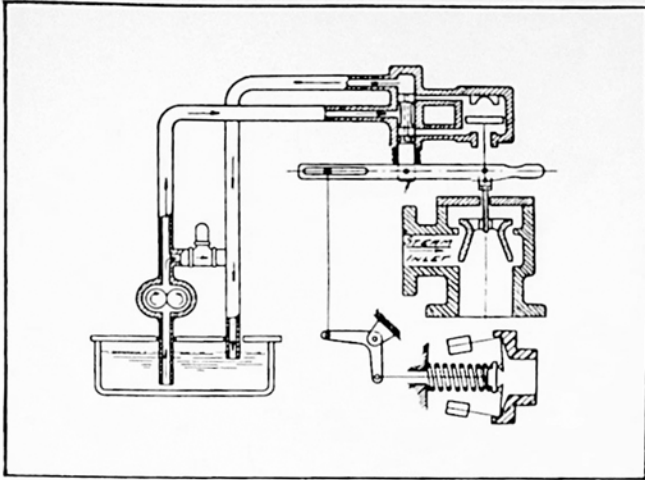


FIG. 13

Constant Speed Oil Relay Governor

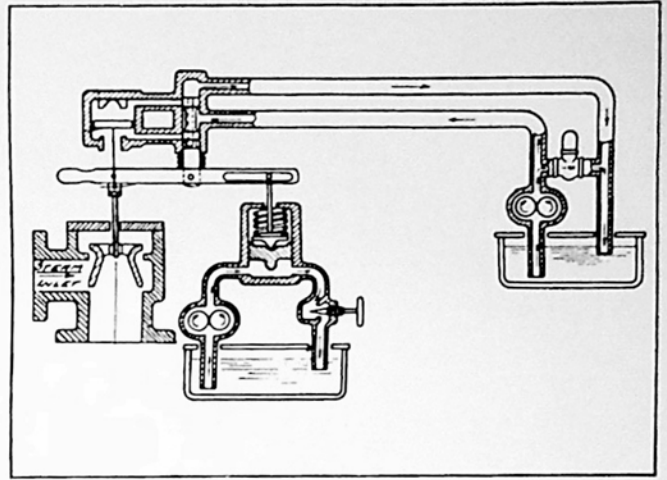


FIG. 14

Variable Speed Oil Relay Governor

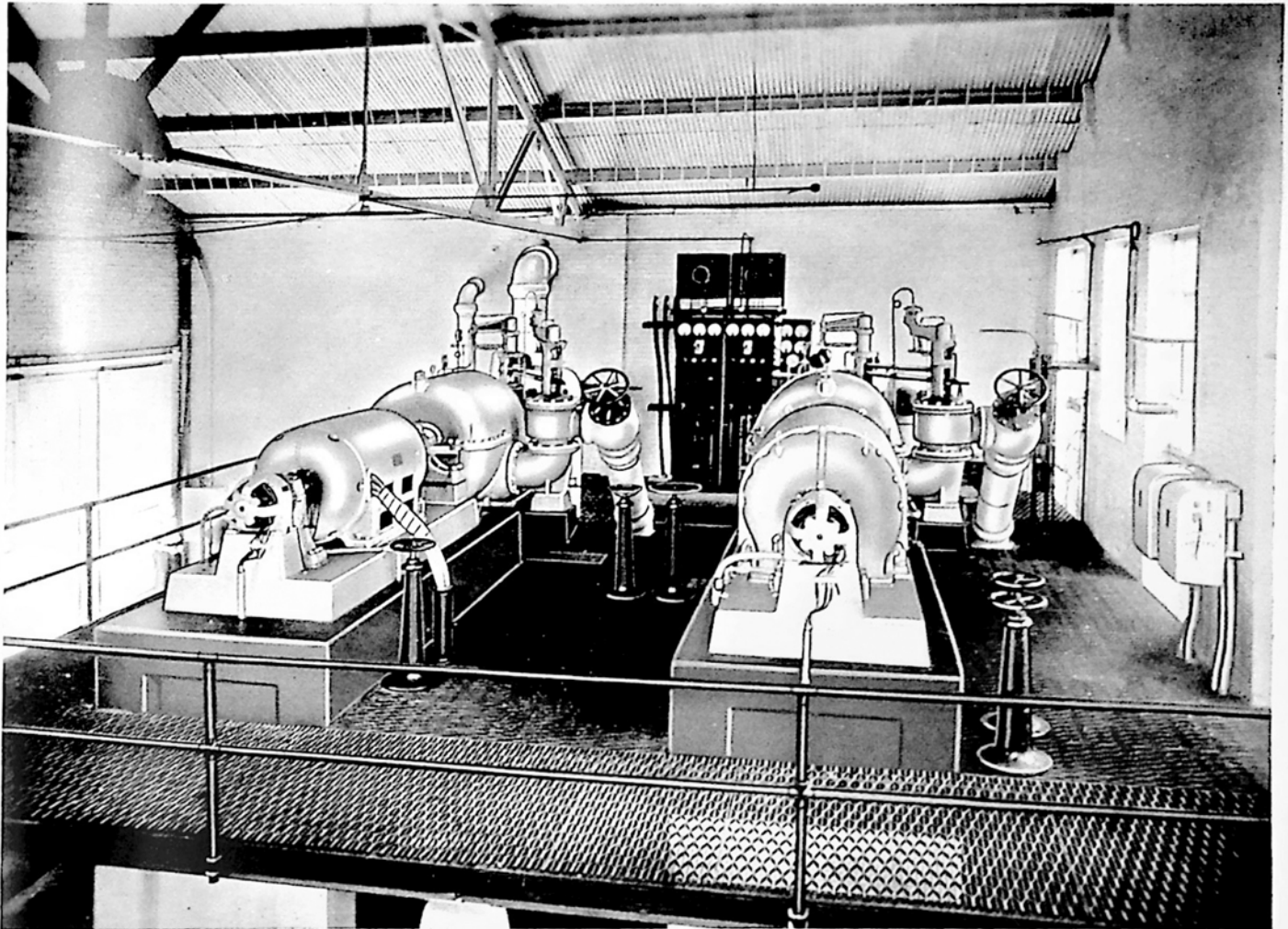


FIG. 15

300 K. W. and 500 K. W. mixed pressure turbo-alternator units using type GHF turbines.

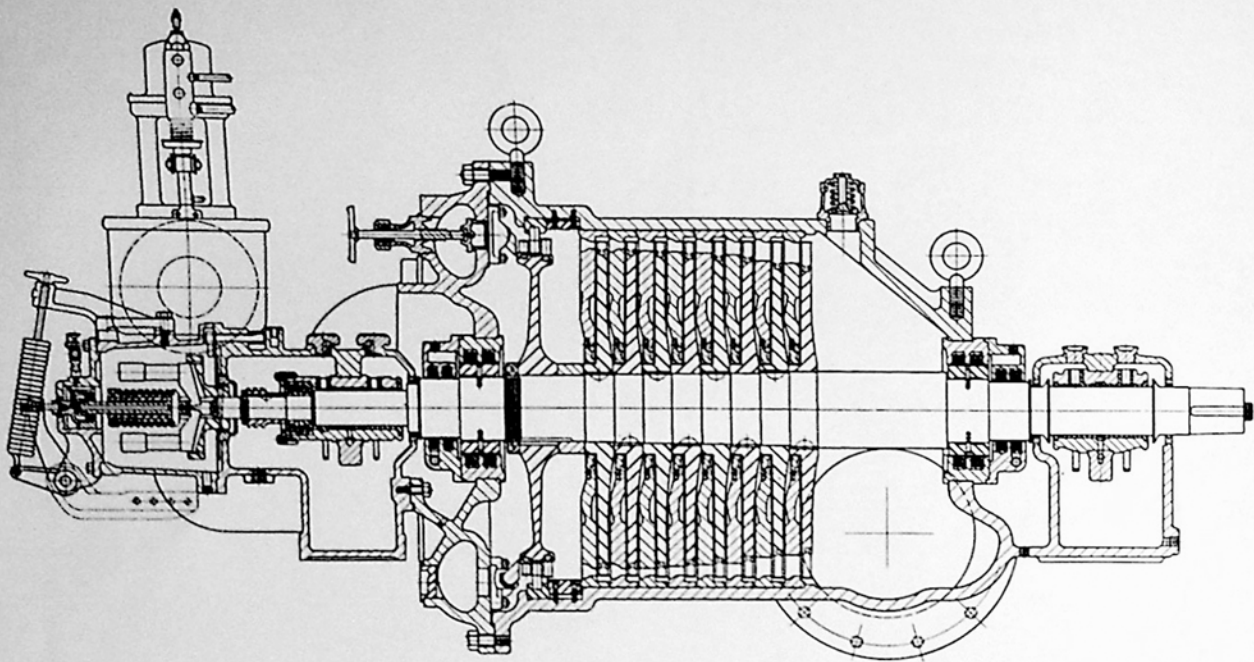


FIG. 16

Approximate Section Through Nine Stage Type GF Turbine

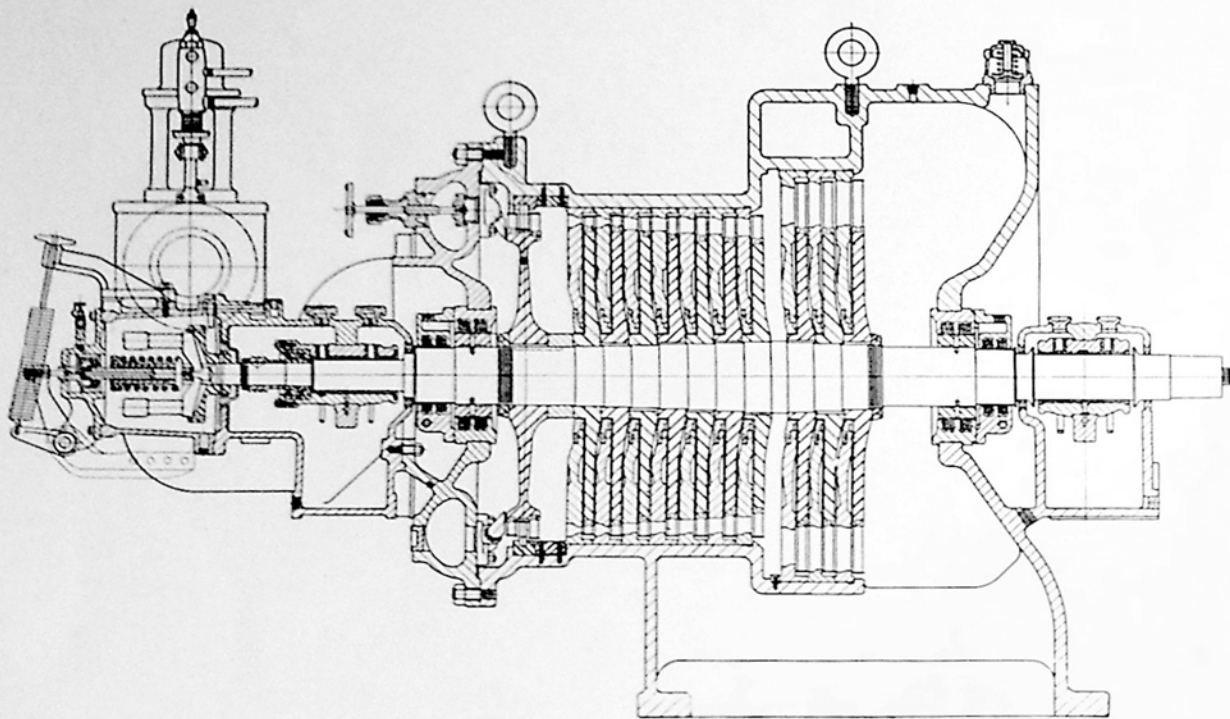


FIG. 17

Approximate Section Through Eleven Stage Type GHF Turbine

THE TERRY MULTI-STAGE TURBINE

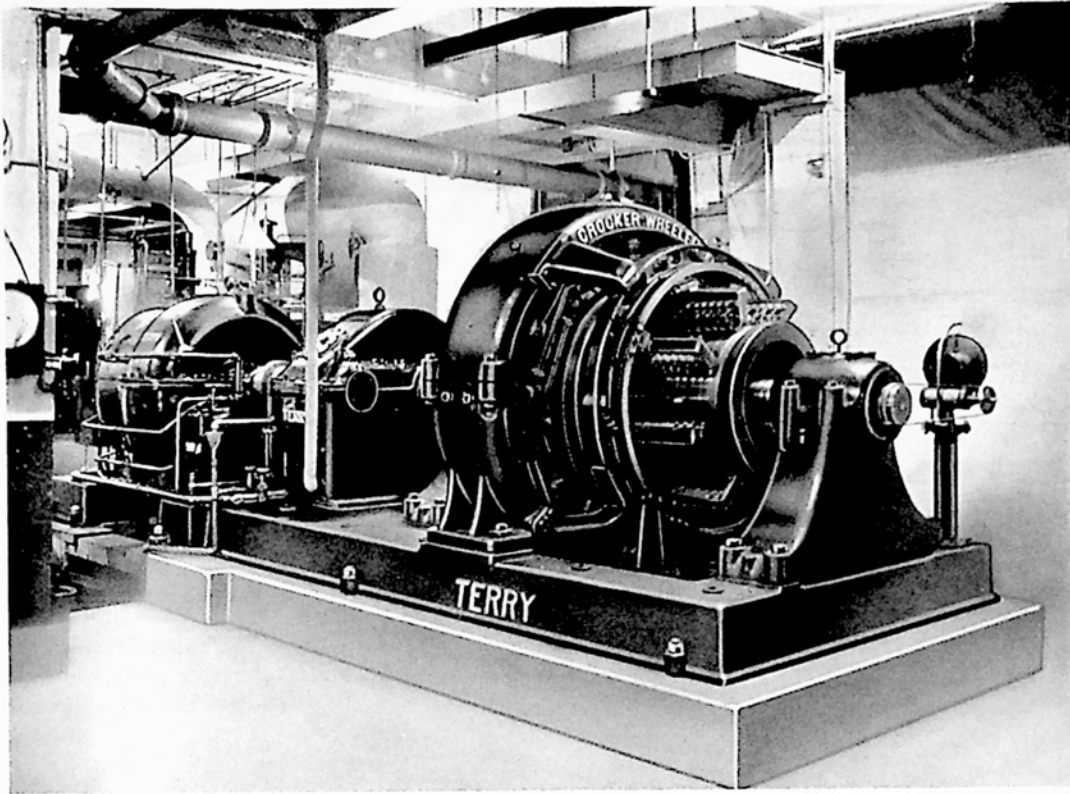
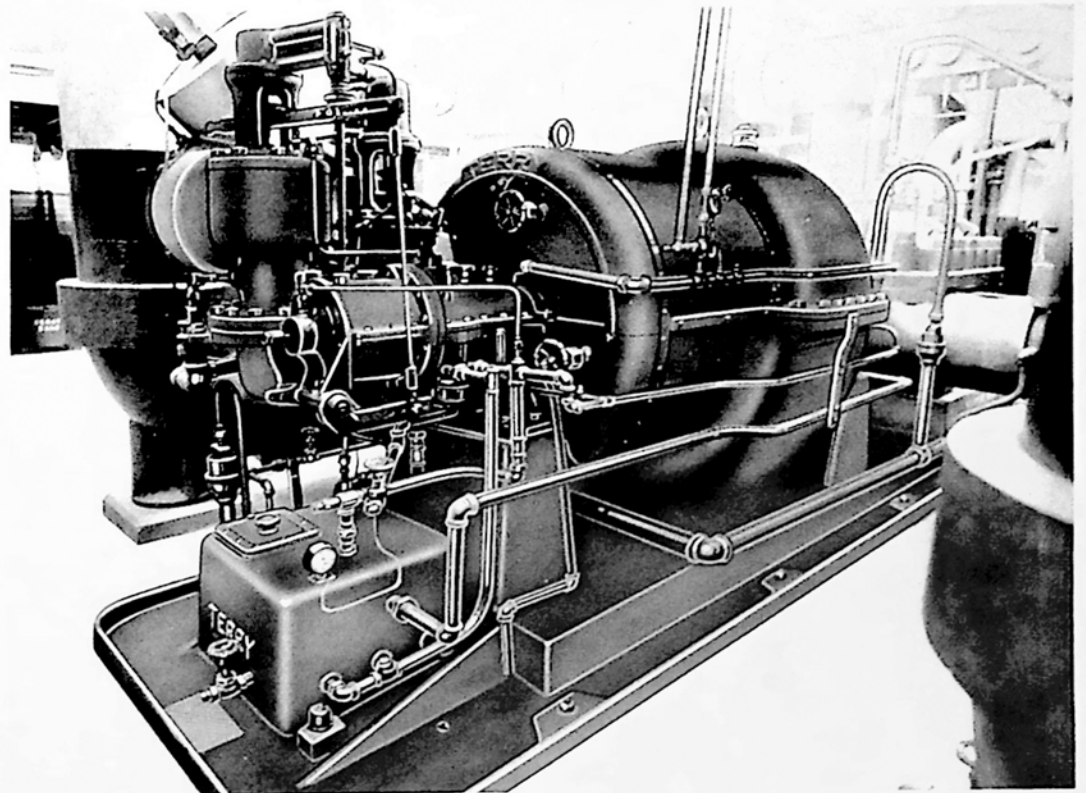


FIG. 18
750 K. W. mixed pressure
bleeder geared turbo-genera-
tor unit employing type
GHF turbine.

FIG. 19
900 H. P. type GHF tur-
bine driving boiler feed
pump.



THE TERRY STEAM TURBINE COMPANY

TERRY SQUARE

HARTFORD, CONNECTICUT, U. S. A.

THE TERRY STEAM TURBINE CO.

TERRY SQUARE, HARTFORD, CONN.

U. S. A.

STEAM RATES

SERVICE CLASSIFICATION NO. 30

Applicable to Use of Service (From Curves)

All purposes, in Entire Territory.

Character of Service: 400 Kilowatt Unit

Continuous, Direct Current - 120-240 volt, 3 phase

120-240 volt, 3 phase, 3 wire, 4/0
 120-240 volt, 3 phase, 3 wire, 3/0

Load	20 lb. Back Pressure	15 lb. Back Pressure	10 lb. Back Pressure	5 lb. Back Pressure
400	45.5	41	38.6	35
350	46.0	43	38.8	36
300	49.3	44	41.4	38
250	50.8	48	45.0	39
200	57.0	50	46.0	42.5
150	61.0	58	53.0	49
100	80.0	74	68.0	62

Rate: (Per Month)

Direct Current Charge:

Consumer Charge: \$ 3.06 gross, \$ 3.00 net

Demand Charge:

First 25 Kw. 25
 Next 50 " 30
 Next 75 " 73

Kilowatt-hour Charge:

First 200 hours' use of the Off-Peak Demand, per kWh.

All additional consumption, per kWh.

200 Kilowatt Unit

Alternating Current, 3 phase, 4/0
 Consumer Charge:

Load	20 lb. Back Pressure	15 lb. Back Pressure	10 lb. Back Pressure	5 lb. Back Pressure
200	57.5	52.5	50	47
150	65.0	57.0	53	50
100	73.0	68.0	64	59

Kilowatt-hour Charge:

First 200 hours' use of the actual OFF-Peak Demand, per kWh.

All additional consumption, per kWh.

(Continued on next leaf)

P. S. C. No. 3

110
Electricity

(GAS, ELECTRICITY, STEAM OR WATER)

Rochester Gas & Electric Corporation
(NAME OF ISSUING CORPORATION OR MUNICIPALITY)

Fourth ORIGINAL LEAF NO. 15
Third REVISED LEAF NO. 15
SUPERSEDING LEAF NO. _____

SERVICE CLASSIFICATION NO. 3

Applicable to Use of Service for:
All purposes, in Entire Territory.

Character of Service:

Continuous, Direct Current - 120-240 volt, 3 wire;
Alternating Current - 60 cycle
120-240 volt, 3 wire, single phase 240 or 480 volt, 3 wire, three phase
120-208 " " " " 120-208 " 4 " " "

Rate: (Per Month)

Direct Current Service:

Consumer Charge:

\$ 3.06 gross, \$ 3.00 net

Demand Charge:

First 25 Kw., per Kw.
Next 50 " "
Over 75 " "

	Peak Demand		Off-Peak Demand	
	Gross	Net	Gross	Net
First 25 Kw., per Kw.	\$1.887	\$1.85	\$2.040	\$2.00
Next 50 " "	1.479	1.45	1.632	1.60
Over 75 " "	.561	.55	.612	.60

Kilowatt-hour Charge:

First 200 hours' use of the Off-Peak Demand, per Kwh.

All additional consumption, per Kwh.

	Gross	Net
First 200 hours' use of the Off-Peak Demand, per Kwh.	1.479¢	1.45¢
All additional consumption, per Kwh.	.816¢	.80¢

Alternating Current Service:

Consumer Charge:

\$ 3.06 gross, \$ 3.00 net

Demand Charge:

First 25 Kw., per Kw.
Next 50 " "
Over 75 " "

	Peak Demand		Off-Peak Demand	
	Gross	Net	Gross	Net
First 25 Kw., per Kw.	\$1.734	\$1.70	\$1.836	\$1.80
Next 50 " "	1.377	1.35	1.428	1.40
Over 75 " "	.510	.50	.510	.50

Kilowatt-hour Charge:

First 200 hours' use of the actual Off-Peak Demand, per Kwh.

All additional consumption, per Kwh.

	Gross	Net
First 200 hours' use of the actual Off-Peak Demand, per Kwh.	1.326¢	1.30¢
All additional consumption, per Kwh.	.663¢	.65¢

(Continued on next leaf)

June 30, 1934

Date of issue May 29, 1934

Date effective _____

Issued by _____

(MONTH DAY YEAR)

(NAME OF OFFICER, TITLE, ADDRESS)

J. P. Hartenkamp, Vice-President, Rochester, N.Y.

P. S. C. No. 3111
Electricity

(GAS, ELECTRICITY, STEAM OR WATER)

Rochester Gas & Electric Corporation
(NAME OF ISSUING CORPORATION OR MUNICIPALITY)

Third ORIGINAL LEAF NO. 16
 Second REVISED LEAF NO. 16
 SUPERSEDING LEAF NO. 16

SERVICE CLASSIFICATION NO. 3 (Cont'd)

Coal Cost Adjustment:

The energy charge in any month will be increased or decreased \$,0002 net per Kwh. for each whole 40% increase above or decrease below \$5.00 per net ton in the average cost of coal, f.o.b. cars, Rochester, N. Y.

Power Factor Adjustment:

For 60-cycle, alternating current service, Customers having a demand in any month of 150 Kw. or over, the Off-Peak Demand for billing purposes in that month will be taken as 80% of the Off-Peak Demand in kilovolt-amperes, as determined by the Company.

Minimum Charge:

An amount equal to the monthly Consumer Charge and Peak & Off-Peak Demand Charges for a demand of 20% of the service capacity contracted for.

Determination of Demand:

"Demand" is the measured or estimated maximum average consumption over any period of one half-hour occurring during the month.

Peak Demand:

During the four Peak Months, which shall begin with the first reading after the 15th of October and continue for four consecutive monthly readings thereafter, the Peak Demand shall be taken as the maximum demand occurring during each month.

During the remaining or Off-Peak Months, the Peak Demand shall be considered as the average of the maximum demands of the preceding four Peak Months, irrespective of any change in service capacity contracted for.

Off-Peak Demand:

In each month of the year, the Off-Peak Demand shall be taken as the maximum demand occurring in the month, and therefore, in the Peak Months, the Off-Peak Demand is the same as the Peak Demand.

If any Customer begins taking service in one of the Off-Peak Months, his Peak Demand for the Off-Peak Months shall be estimated by the Company and an adjustment made, after the following peak period, based on the Customer's established Peak Demand.

Terms of Payment:

All bills will be rendered gross and discounted to net if paid within the discount period.

Term:

Service may be discontinued upon three days' notice.

(Continued on next leaf)

Date of issue March 24, 1937

(MONTH DAY YEAR)

Date effective April 26, 1937

(MONTH DAY YEAR)

Issued by Herman Russell, President, Rochester, N. Y.

(NAME OF OFFICER, TITLE, ADDRESS)

Rochester Gas & Electric Corporation
(NAME OF ISSUING CORPORATION OR MUNICIPALITY)

ORIGINAL LEAF No. _____
REVISED LEAF No. 17
LEAF No. 17
SUPERSEDING Third " Second

SERVICE CLASSIFICATION NO. 3 (Cont'd)

Special Provisions:

1. OFF-PEAK OPTION SERVICE:

(a) Consumer Charge & Demand Determination:

If the Customer so elects and pays a Consumer Charge of \$6.63 gross, \$6.50 net per month, the method of determining the demand shall be modified as follows:

Peak Demand:

Shall be the measured or estimated maximum demand occurring during the Peak Hours, as hereinafter defined.

Off-Peak Demand:

Shall be the measured or estimated maximum demand occurring during the Day Hours, as hereinafter defined, plus one-third of the excess above this demand (or, during the Peak Months, above the Peak Demand if that be greater) taken during the Economy Hours, as hereinafter defined.

In no case, however, shall the Off-Peak Demand during the Peak Months be considered as less than the Peak Demand.

(b) Hours - Economy, Day and Peak:

	Peak Months			Off-Peak Months	
	ECONOMY Hours	DAY Hours	PEAK Hours	ECONOMY Hours	DAY Hours
Monday)	Midn.- 7 AM	7 AM - Noon		Midn.- 7 AM	7 AM - Noon
thru)	Noon - 1 PM	1 PM - 4 PM	4 PM - 7 PM	Noon - 1 PM	1 PM - 5 PM
Friday)	7 PM - Midn.			5 PM - Midn.	
Saturday	Midn.- 7 AM	7 AM - Noon	None	Midn. - 7 AM	7 AM - Noon
	Noon - Midn.			Noon - Midn.	
Sunday)					
and *)	Midn.- Midn.	None	None	Midn.- Midn.	None
Holiday)					

* New Year's Day, Decoration Day, Fourth of July, Labor Day, Thanksgiving Day, and Christmas.

(Continued on next leaf)

Date of issue May 29, 1934 Date effective June 30, 1934
(MONTH DAY YEAR) (MONTH DAY YEAR)
Issued by J. P. Haftenkamp, Vice-President, Rochester, N. Y.
(NAME OF OFFICER, TITLE, ADDRESS)

P. S. C. No. 3Electricity
(GAS, ELECTRICITY, STEAM OR WATER)Rochester Gas & Electric Corporation

(NAME OF ISSUING CORPORATION OR MUNICIPALITY)

ORIGINAL LEAF No. _____

Fifth REVISED LEAF No. 18SUPERSEDING Fourth " LEAF No. 18**SERVICE CLASSIFICATION NO. 3 (Cont'd)**

Special Provisions: (Cont'd)

2. REDUCED WINTER SERVICE.

- (a) A Customer purchasing electricity under the terms of this Classification may, upon written application to the Company, reduce his service capacity for one continuous period of not more than eight months during any year, provided this period includes the four Peak Months.
- (b) A Customer purchasing electricity under the Off-Peak Option Service of this Classification and whose Peak Demand during the current Peak Months has not exceeded 7 1/2 kilowatts may, upon written application to the Company, reduce his service capacity, at any time, for one continuous period of not more than eight months during the year.
- (c) During the period of reduced service under (a) or (b), the Customer will be billed under Classification #3, or, if he so elects and if his service capacity is reduced to 7 1/2 kilowatts or less, he may be billed on Service Classification No. 2.

3. PRIMARY ALTERNATING CURRENT SERVICE.

- (a) Subject to the approval of the Company, and provided the Customer will purchase primary service and at his own expense provide, install and maintain transformers and protective devices of a size and type approved by the Engineers of the Company, the following reductions on the net bill as calculated on this Service Classification, will be given:

For	4,150 volt service, 3 phase, 60 cycle	- 5%	reduction
"	11,000 " " " " " "	- 6%	"

- (b) Subject to the approval of the Company, when a customer desires part of his service at primary voltage and part at secondary voltage (for which the Company supplies the transformer installation), the Company will meter the entire use at primary voltage, make an allowance covering transformer losses, and bill at the secondary voltage rate.

Date of issue May 29, 1934
(MONTH DAY YEAR)Date effective June 30, 1934
(MONTH DAY YEAR)Issued by J. P. Haftenkamp, Vice-President, Rochester, N. Y.
(NAME OF OFFICER, TITLE, ADDRESS)

P. S. C. No. 3

Electricity
(GAS, ELECTRICITY, STEAM OR WATER)

Rochester Gas & Electric Corporation
(NAME OF ISSUING CORPORATION OR MUNICIPALITY)

ORIGINAL LEAF No. _____

Eight REVISED LEAF No. 26

SUPERSEDING Seventh LEAF No. 26

SERVICE CLASSIFICATION NO. 9

Applicable to Use of Service for:

All purposes for any consumer guaranteeing a minimum billing demand of not less than 200 kilowatts.

Character of Service:

Continuous, 240, 480, 4150 or 11,000 volt, 3 wire, 3 phase, 60 cycle, alternating current.

Rate: (Per Month)

Demand Charge:

		Gross	Net
First	500 Kw. of Billing Demand, per Kw.	\$ 2.04	\$ 2.00
Next	500 " " " "	1.53	1.50
Over	1,000 " " " "	1.02	1.00
- plus -			

Energy Charge:

First	500,000 Kwh., per Kwh.	.714¢	.7¢
Next	500,000 " " "	.612¢	.6¢
Over	1,000,000 " " "	.510¢	.5¢

Minimum Charge:

The minimum monthly charge will be the demand charge for the established billing demand.

Determination of Demand:

The Billing Demand for each month shall be the measured maximum average rate of use over a period of one-half hour occurring during the month but in no case shall the billing demand be taken as less than 200 kilowatts, or less than 50% of the service capacity contracted for by the customer, or less than 50% of the highest measured demand previously established in the preceding eleven months.

Terms of Payment:

All bills will be rendered gross and discounted to net if paid within the discount period.

Term:

One year and thereafter until terminated by 30 days' written notice.

Special Provisions:

(a) Coal Cost adjustment:

The Energy Charge in any month will be increased or decreased \$.0008 net per kilowatt hour for each whole 30 cent increase above or decrease below \$ 3.50 per net ton in the average cost of coal f.o.b. cars, Rochester, N. Y.

(b) Power Factor adjustment:

The Demand Charge in any month will be increased or decreased \$1.00 net per Kw. for each Kw. by which the measured average power factor during the period of maximum billing demand is in excess of or less than 80%. The increase or decrease shall be divided by 50%, but in no case shall the demand charge be less than the demand charge which would apply if the power factor were 80%.

Date of issue _____
(MONTH DAY YEAR)

Date effective _____
(MONTH DAY YEAR)

Issued by _____
(NAME OF OFFICER, TITLE, ADDRESS)

P. S. C. No. 5Electricity
(GAS, ELECTRICITY, STEAM OR WATER)Rochester Gas & Electric Corporation
(NAME OF ISSUING CORPORATION OR MUNICIPALITY)

ORIGINAL LEAF No. _____

Seventh REVISED LEAF No. 27SUPERSEDING Sixth LEAF No. 27SERVICE CLASSIFICATION NO. 9 (Cont'd)

(c) Adjustment for 4,150 and 11,000 volt service:

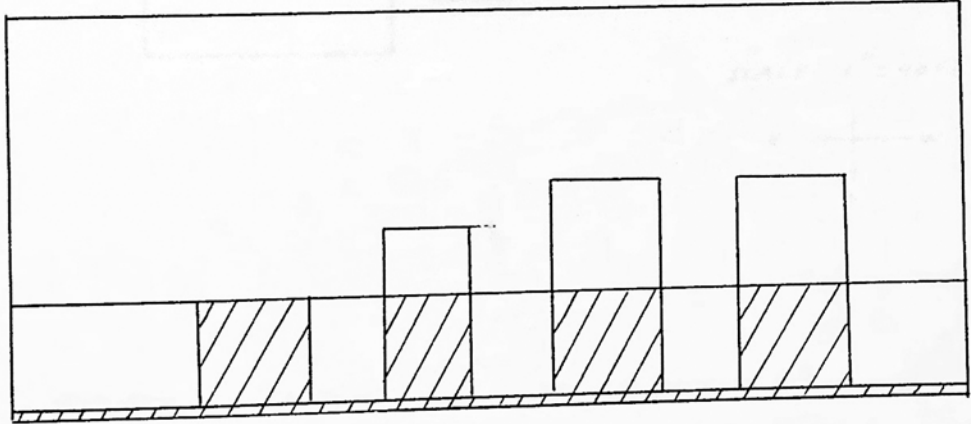
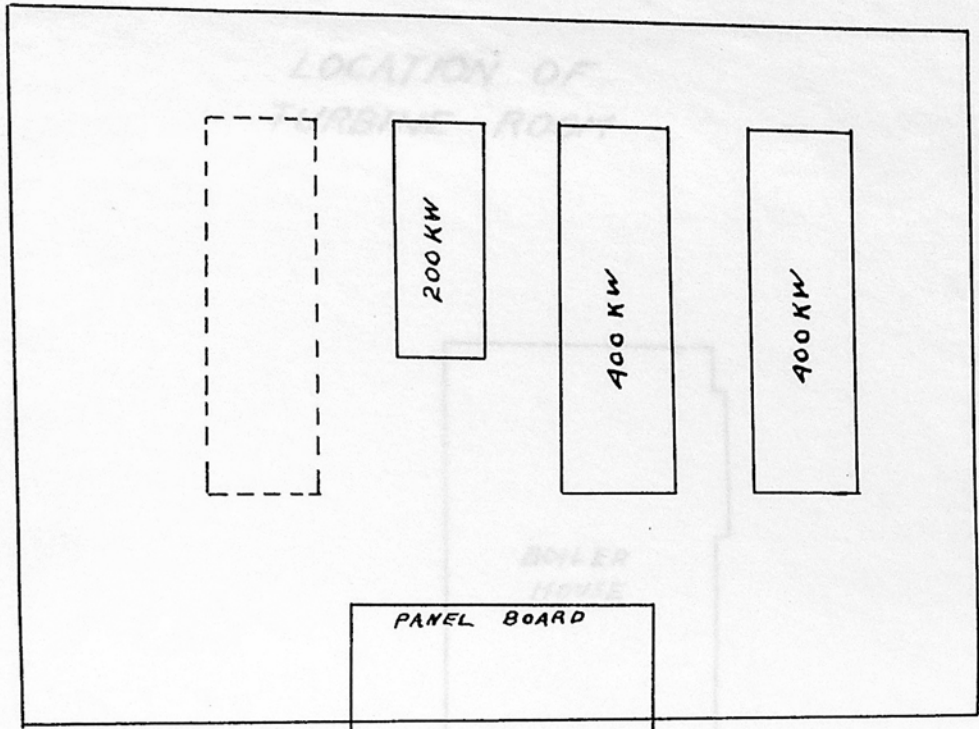
For customers who furnish and maintain at their own expense suitable transformers and protective devices, approved by the Company's engineers, and who take all of their requirements at the specified voltage, the following reduction will be allowed on the total net monthly bill:

For 4,150 volt service	-	3 %	reduction
" 11,000 "	"	5 %	"

For customers who take all of their requirements at 4,150 volts, the Company will install and maintain one set of transformers in a location approved by the Company's engineers and allow a reduction of 1% on the total net monthly bill.

Date of issue _____
(MONTH DAY YEAR)Date effective _____
(MONTH DAY YEAR)Issued by _____
(NAME OF OFFICER, TITLE, ADDRESS)

OUTLINE OF TURBINE ROOM



SCALE 1" = 10 FT

LOCATION OF
TURBINE ROOM

