The average duty for all of these conditions is 114,562,000 feet-pounds per million B.t.u.'s which is equivalent to a duty of 134,000,000 feet-pounds per 1,000 pounds of steam.

Attention is called to the fact that different duties are obtained with different temperatures of circulating water. This is due to the fact that if the turbine is designed properly, better economies will be obtained with low circulating-water temperatures, owing to an increased vacuum. The average circulating water temperatures for this station throughout the year are 50° for the winter and 80° for the summer. In order to compare bids on this unit the following information was embodied in the specifications:

"One million foot-pounds of duty will be valued at \$2,000. That is, if bidder A guarantees 5,000,000 footpounds higher duty than bidder B, \$10,000 will be added to B's bid for comparison with A's bid."

Bidders were instructed to submit curves showing duties guaranteed when pumping 80,000,000, 100,000,000 and 110,000,000 gallons with circulating water temperatures of 50° and 80° and heads of 45, 60 and 65 feet.

During four-fifths of the time each year the pump operates, it is estimated that it will be called on to deliver from 80,000,000 to 110,000,000 gallons under heads varying between 60 and 65 feet. During the remaining one-fifth of the year, it is assumed this pump will deliver from 80,000,000 to 110,000,000 gallons under a 45-foot head. It was further assumed that the unit will deliver 100,000,000 gallons for one-half of each year under all head conditions and the remaining half it will deliver either 80,000,000 or 110,000,000 gallons in equal parts.

The process may be represented diagrammatically as follows:

100,000,000 GALLONS DAILY Duty at 50° + Duty at 80° for 45-ft. head  $\times 1 = \dots$ 2 Ditto for 60-ft. head  $\times 2 = \dots$ Ditto for 65-ft. head  $\times 2 = \dots$ 5) Sum Duty A 80,000,000 GALLONS DAILY 4 Duty at  $50^{\circ}$  + Duty at  $80^{\circ}$  for 45-ft. head  $\times I = \dots$ Ditto for 60-ft, head  $\times 2 = \dots$ Ditto for 65-ft. head  $\times 2 = \dots$ 5) Sum Duty B 110,000,000 GALLONS DAILY Duty at  $50^{\circ}$  + Duty at  $80^{\circ}$  for 45-ft. head  $\times I = \dots$ Ditto for 60-ft. head  $\times 2 = \ldots$  . Ditto for 65-ft. head  $\times 2 = \dots$ 5) Sum Duty C 2 × Duty A + Duty B + Duty C Resultant Duty = 4

All of the above conditions must be verified by complete shop tests before the unit is shipped. These shop tests must be on the turbine, gears and pump assembled complete. The shop tests must show duties at least those guaranteed by the contractor and checked by the city's representatives.

After the unit is installed it will be subjected to an endurance test of ten days of twenty-four hours each.

The physical data of the unit and auxiliaries is as follows:

### Turbine

by governor regulations......6 above and 15 below Percentage of speed obtainable above and below normal by

hand-regulated nozzle Approx. 6 above and 20 bel	ow
Net weight of turbine without bedplate, pounds 24.	000
Diameter and length of bearings, inches	14
Diameter of shaft in rotor, inches	10
Diameter of steam admission, inches	6
Diameter of steam exhaust, inches	36

## **Reduction Gear**

Net weight of reduction gear complete without bedplate,
pounds
Diameter of driven gear, inches
Diameter of pinion, inches
Width of face of gear in pinion, inches 29 1/4
Tooth pressure per inch, face of gear and pinion, when
pump is delivering 110,000,000 gallons per day at 65-
foot head, pounds
Gear ratio 10.56 to 1
Angle of gear tooth, degrees
Mechanical efficiency of gear, per cent
Horse-power consumed by gear under maximum con-
ditions

#### Pump

Net weight of pump without bedplate, pounds 40,000
Net weight of bedplate for complete unit, pounds. 15,000
Diameter of impellers, inches
Diameter of shaft at impeller, inches
Diameter and length of bearings, inches One 61/2 x 18
One 5 1/4 x 18
Length of shaft between bearings, feet 81/3
Revolutions per minute, maximum 352
Diameter of water suction, inches
Diameter of water discharge, inches
Efficiency of pump, per cent, (for normal conditions) 81

## Condenser

Condensing surface, square feet	. 2,825
Diameter of tubes, inches	. I
Gauge of tubesNo. 18	B.W.G.
Length of tubes, feet	. 12
Number of steam passes	. I
Number of water passes	. 2
Size of exhaust-steam inlet, inches	. 36
Net weight of condenser, pounds	. 20,800
Diameter of condenser shell, feet	. 5
Length of shell, feet	. 143/4
Air Pump	
Revolutions per minute	. 115
Size of inlet, inches	. 5
Size of outlet, inches	. 3
Method of driving air pumpBy steam c	ylinders
Weight of air pump complete, pounds	6,400

# **Condensate** Pump

Size of pump, inches	21/2
Revolutions per minute	1,800
Size of inlet, inches	2 1/2
Size of outlet, inches	21/2