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For ALL Power Engineers • Steam, Electricity and All Other Power Engineering Services

COMPLETE CONTENTS

★ The Greens Bayou Station of Houston Lighting and Power Co. 54
By Louis Elliott

New Diesel Plant Saves $10,000 in First 4 Months' Operation 59

Central Control Rooms—Design & Operation 62
By B. F. Borgel

★ The Cyclone Furnace—Latest Thing in Coal Burning 64
By F. X. Gilg

Refining and Production of Fuel Oils 71
By Paul F. Schmidt

Power Generation News Reel 72

★ Don't Underestimate Cables and Potheads 74
By H. H. Ackmann

First 5000-kw Packaged Turbine Generator Simplifies Installation 80
By A. A. Woodward and R. R. Kaley

Power Usage Diagram Shows Steam Turbine's Part in Pulp Production 82

Can "The Glamor Girl"—the Spreader Stoker—Fire Large Boilers? 84
By J. S. Bennett and F. C. Messaros

Large Electronic D-C Motor Drives in Industry 86

Basic Power Plant Figuring 88
By William H. Engelman

The Honor of Dignified Willy 92
By John Raven

New Steam Generating Plant Serves Columbia Steel's New Cold-Reduction Mill 102

Steam Sampling Methods 104

Babcock & Wilcox Installs New Laboratory 106

NH_3 Liquid Level Control Increases Compressor Capacity and Improves Plant Operation 108

How Waste Heat Recovery Saves Btu's For Schramm 110

New Full Wave Reversing Educational Thy-Mo-Trol Drive Announced by G. E. 110

Regular Departments

Notes On This Issue 5

Engineers' Preview 7

Helpful Bulletins 35

New Equipment News 42

Construction News 50

Letters to the Editors 53
- Fisk Operator Liked It
- Boiler Horsepower
- Filter Paper
- The Grounded Neutral in the East

Questions and Answers 96
- How Often Should Standby Diesels Be Run?
- Wants Electromagnet to Remove Steel Shot From Boiler Headers
- Why Do Thrust Bearings Wear Out?

New Engineering Books 96

Coming Events 108

News from the Field 114

Obituaries 120

Catalog Library 122

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PLAINTIFF'S EXHIBIT WH-5

First 5000-kw Packaged Turbine Generator Simplifies Installation

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FIRST 5000-KW Westinghouse packaged power plant to be installed in the United States was brought into commercial service in 1948 by the Public Service Co. of Colorado at Grand Junction, Colorado. This type of steam-turbine generator unit was chosen, partly because of a favorable delivery date, but mainly because it fitted so conveniently into the available space in the existing turbine room.

Demand for electric energy in Grand Junction, Colorado, and the surrounding area had increased remarkably during the past several years. Output of the system had doubled during the last five-year period. In 1948 the maximum hour demand reached was 9500 kw.

Need for Packaged Unit

Until the installation of the 5000-kw packaged generating unit, the area was served by the following facilities showing the need for additional generating capacity.

(1) A 3300-kw hydro plant at Palisade, Colorado, the full capacity of which is available only during the spring and fall months. During the summer period output is ... because of irrigation nee... during the winter months. ... eration is limited by icing ...

(2) A 1400-kw hydro p... ing the Redlands Irrigation ... which a varying amount ... above its own pumping ne... to the Public Service Co. ... rado.

(3) A 3500-kw steam pla... in the City of Grand Junc... plant has provided the ... firming up the variable ... available from the hydro ...

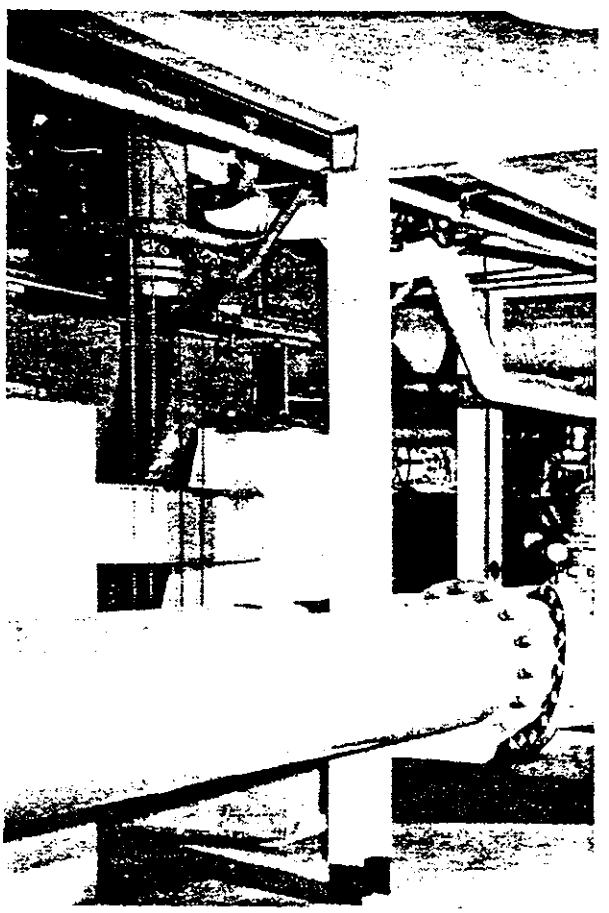


Fig. 1. Eight piers support the 5000-kw turbine generator instead of the more complicated foundations needed for separate mounting

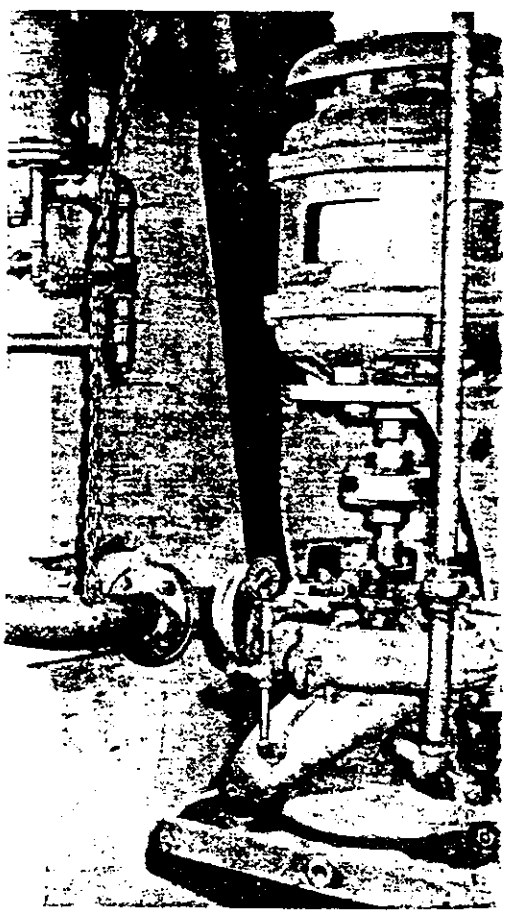


Fig. 2. Auxiliaries such as this two-stage condensate ... mounted on the condenser, simplifying installatio...

Most of the exception of the 3500-kw unit at Grand Junction, were subject to variations beyond the control of the Public Service Co. Additional firm power was needed quickly to insure an ample supply of power at load peaks. It was desirable that the new unit fit into the existing generating station with a minimum amount or rearrangement of existing facilities. The packaged power unit appeared to have these advantages.

Unit Requires Only Simple Supports

Principal departure from conventional steam turbine design employed in the packaged unit is in the supporting structure. Eight comparatively small piers, such as shown in Fig. 1, support the entire turbine generator unit with the single exception of the circulating pump. Much less excavation and foundation work was found necessary with this method of installation, since existing floor elevations did not have to be maintained. This type of unit was also eminently suited for conforming to the minimum headroom requirements of the Grand Junction Station.

Mounting the auxiliaries on the condenser provides an extremely compact unit weighing in all only 85 tons. These auxiliaries consist of: two air coolers, oil cooler, dual two-stage air ejector with inter and after condensers, vertical two-stage condensate pump (Fig. 2) and a low-pressure, feedwater heater. The turbine, generator, and direct-connected exciter are mounted directly on the upper condenser deck. Axial and lateral expansion is controlled by the use of flexible steel members as shown in Fig. 1. A flexible diaphragm is provided between the turbine exhaust flange and the condenser shell.

Although it was possible to ship the condenser, turbine and generator completely assembled as a unit, conditions at Grand Junction were such as to necessitate shipment of the main parts separately. However, reassembly of the unit was much simpler and faster than is the case with a conventional unit. After the condenser was in position on the supporting piers, the turbine, generator, and exciter were located by using the same dowels that were used for the original assembly in the manufacturer's shops. No change was required to obtain the correct coupling alignment.

Details of 5000-kw Packaged Unit

The package turbine generator set, supplied complete by Westinghouse Electric Corp., consists of the following elements:

The turbine, which is the condensing impulse type, is designed to operate at 400 psig throttle pressure, 750 F total temperature, exhausting at 1½ in. Hg absolute. The generator is rated at 5000 kw, 0.8 pf, 6250 kva, 4150 v, 3 phase, 60 cycles. A

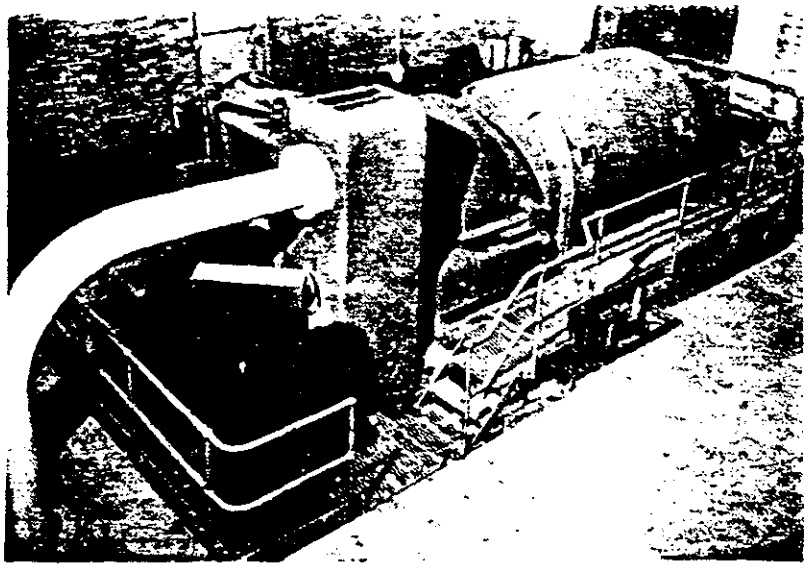


Fig. 3. Turbine, generator, and exciter are also mounted on the condenser, making a complete package that can be shipped as a single unit

radial-flow type surface condenser having 6,000 sq ft of surface is used.

It is equipped with one 6300-gpm centrifugal circulating pump; one 128-gpm vertical 2-stage condensate pump and one 2-stage, twin element steam jet air ejector unit; one low-pressure bleed heater.

The direct-connected 33 kw, 125 v, d-c enclosed exciter is provided with a two-piece removable housing. Cooling air is obtained from the main-generator air cooling system and is returned to the coolers through filters. The exciter brushes can be changed easily and without special tools while the unit is carrying load. This is a desirable feature from an operating standpoint.

The assembled unit is shown in Fig. 3.

The unit has been serving the needs of the system in a very satisfactory manner since its initial operation. For the past 12 months the unit has been in quite continuous operation, totalling 8035 hrs. System conditions, which dictate the maximum use of hydro generation and transmission "take," result in a low load factor for steam-plant operation. Total generation of the above unit for the annual period amounted to 24,999,000 kw hr with a maximum hourly output of 5800 kw.

Where New Unit Gets Its Steam

Steam supply for the new packaged generating unit is provided by a new steam generating unit capable of producing 60,000 lb of steam per hour at 450 psi. Older boilers generating at 150 psi had previously supplied the 3500-kw unit and three old, smaller units. The new boiler is now used for both the new and old generating units. When the 5000-kw packaged unit operates, the old units are shut down. When the packaged unit is shut down, the 3500-kw unit and the three small units are operated from the new boiler, which continues to operate at 450 psi, by reducing the pressure to 150 psi through desuperheating arrangements.

New steam generating equipment consists of one Type F, H. Babcock & Wilcox boiler and superheater, with initial capacity of 60,000 lb steam per hour and future capacity of 85,000 lb steam per hour. The boiler is designed for 450 psig drum pressure. It has four circular horizontal burners for pulverized coal or oil firing. It is of the dry-bottom ash removal type, and is equipped with a B & W air heater, and two type E-21 B & W pulverizers.

Forced-draft and induced-draft fans were furnished by the American Blower Corp., and are arranged for V-belt drive. Capacity of the forced draft fan is 75,000 lb per hr of 80 F air at 950 rpm; induced-draft fan will handle 93,000 lb per hr of 420 F flue gas at 1170 rpm.

A Multiclone dust collector is installed between the gas outlet of the boiler and the inlet of the air heater.

Ashes are removed from the boiler and dust collector with United Conveyor Corp. conveyor equipment.

The boiler feedwater is heated and deaerated by a Worthington 80,000 lb per hr, horizontal, single-element type deaerating heater. From this, 2 Allis-Chalmers type MM, 4-stage centrifugal boiler feed pumps, driven by 85 hp type ZS Terry turbines supply the feedwater to the boiler. Each pump is designed to deliver 100 gpm at 1320 ft total head.

Condenser circulating water cooling is provided by a two-section 5500 gpm Marley, Model 18, B 1 induced-draft, double-flow cooling tower.