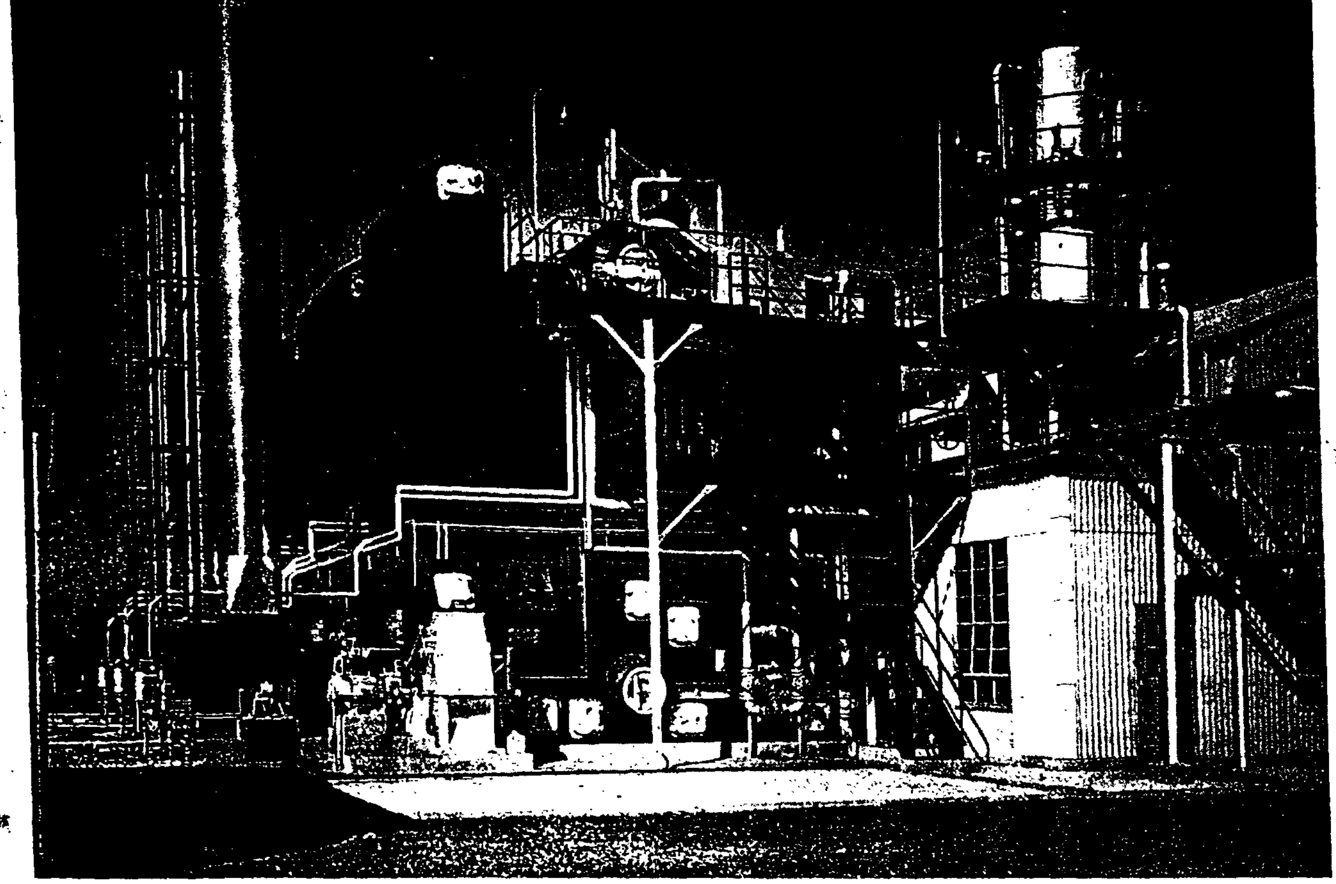
PLAINTIFF'S EXHIBIT
RS-239

TYLERTOWN GAS COMPRESSOR STATION



Steam turbines are now driving gas compressors at Station No. 7 of the Transcontinental Gas Pipe Line Corp. This new plant has three steam generators, three turbine compressors, two turbine generators and auxiliaries to make up a compact package unit

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COMPRESSOR STATION No. 7, located near Tylertown, Mississippi, is one of three Transcontinental Gas Pipe Line Corporation's steam-turbine driven centrifugal compressor stations that were put into operation during the summer of 1951.

While steam turbines have been utilized extensively during the last half century for utility and industrial installations, they have never before been employed as prime movers for gas compressor stations. At Station No 7, steam boilers, centrifugal compressors and steam turbines were installed by the design engineers in a manner that was an unusual departure from the accepted transmission pipe line practice.

Possible advantages in such a design over the conventional reciprocating engine type compressor station are: (1) lower installation cost per horsepower through the elimination of massive engines and foundations for the prime movers, (2) elimination of reciprocating parts with resulting minimum wear, vibration and pulsating gas flow, and (3) reduced operating personnel. Although fuel gas consumption will be slightly greater the steam-turbine, centrifugal compressor station should be favorable from the standpoint of total operating and fixed charges.

The compressor station is made up of two main structures, the power plant and the compressor building. The power plant partially houses three automatically fired boilers together with two 800 kw generators, which furnish current for auxiliary equipment. The compressor building houses the three turbine-driven blowers, each of which can develop approximately 5000 hp under full load.

In addition to the two principal

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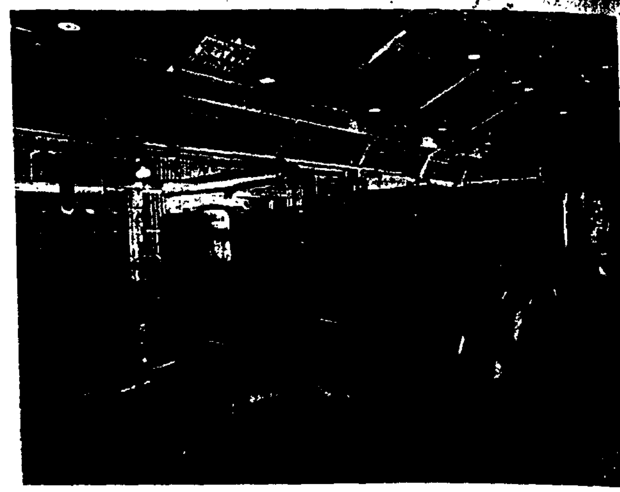
Each of these steam turbine driven gas compressors develops 5000 hp under full load. Units are connected in series



Two of the compressor units are now covered with insulation, the third component will be in the immediate future

buildings, the station has a water-treating building—which houses equipment capable of furnishing a maximum of 20 gpm demineralized water—meter and regulator building, a combination office, shop and warehouse building, cooling tower and water storage facilities.

Principal Equipment

Equipment consists of three boilers, three multistage impulse condensing steam turbines, driving three centrifugal gas compressor units, with horizontal, two pass condensers; two horizontal shaft, multistage steam turbines driving a-c generators; one 140,000 lb per hr spray type vertical shell deaerating feedwater heater; one water demineralizer; and a cooling tower.

Gas pumping equipment comprises three identical turbine compressor units for series operation. Each unit consists of an overhung, single stage, centrifugal compressor directly driven through a spacer type flexible coupling by the impulse turbine, which exhausts into the surface condenser. The condenser box structure forms the support for the turbine compressor components.

These three units are equipped with a common pressure control system that functions primarily to maintain constant station discharge pressure. It also serves to divide the load equally among the three units, thereby enabling each unit to operate in its most efficient range.

With all three units operating, the station is designed for an inlet pressure of approximately 520 psia and a discharge pressure of approximately 800. Design capacity is 603.10 MM standard cu ft per day at 60 F and 14.73 psia pressure base.

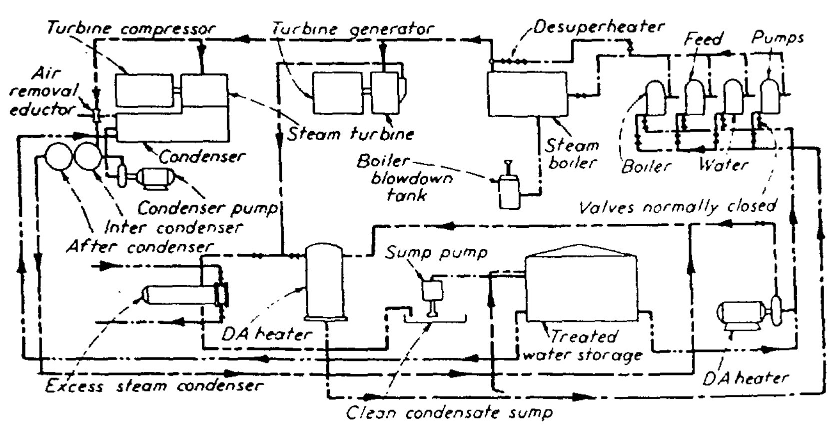
Each turbine is designed as a package unit and is provided with a hydraulic servomechanism through which the steam admission valves are operated. This hydraulic servomechanism acts in response to either of two governors. The primary governor consists of discharge pressure regulator. The secondary governor consists of an oil pump driven from the turbine shaft extension. The control system is designed so either the primary or secondary governor will control, depending upon which governor is calling for the slower speed at the time. In addition to the primary and secondary governors, each turbine is provided with a throttle trip valve and an overspeed governor.

Cooling Unnecessary

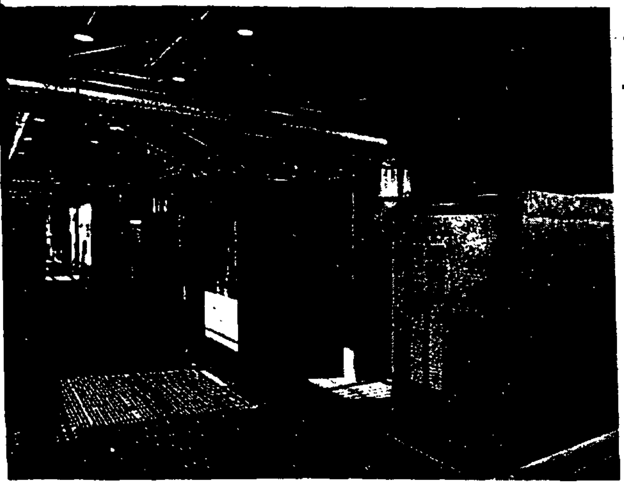
Compressors are identical in all respects. Each is a horizontal single stage, single suction machine with a 24 in. suction inlet and 20 in. discharge outlet. Dust particles and liquid entrained in the gas are passed through the centrifugal compressor without harm, thus eliminating the need for gas scrubbers. The combination of compressor station characteristics is such that discharge gas temperature is not high enough to damage pipe coating or cause undue stress in the pipe wall. Thus gas scrubbers and cooling facilities that are required at reciprocating engine stations were eliminated at this station.

Lube System

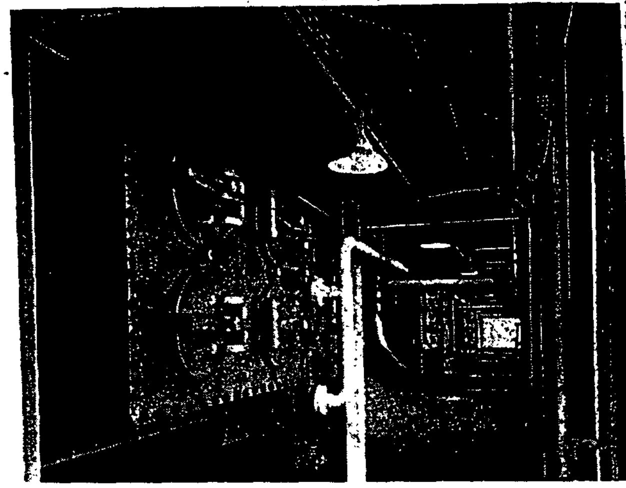
Each turbine compressor unit has a combination closed pressure oil system, which actually comprises several independent systems all interconnected. Oil is normally fed to the various bearings and control devices by the main oil pump, which is driven from the turbine shaft extension. The oil reservoir is a covered 500 gal tank mounted along the turbine under the floor plates. One section of the tank is partitioned off and baffled for degasifying oil returned from seal oil leakage



Flow diagram of operation indicates that the system has an exceptionally good steam balance. Only one per cent makeup water is required

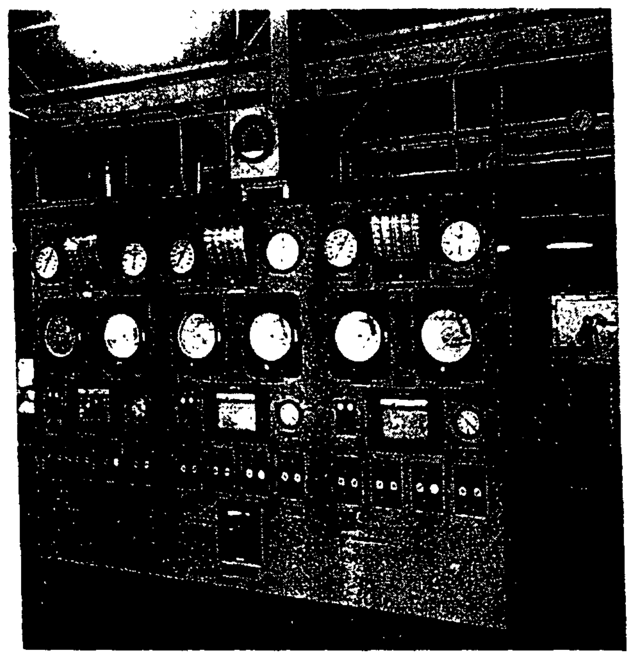


Turbines are provided with a hydraulic servomechanism that limits the steam through a proportioning valve



These surface condensers act as a structural foundation for each of the turbine-compressor components

An auxiliary oil pump sends oil from the reservoir through a check valve into the discharge line of the main oil pump. Rotating speed is controlled by a pressure governor, and an oil pressure of approximately 70 psi is maintained in the main oil system. At this pressure a sufficient amount of oil is passed through the accumulator to lubricate the unit during starting and stopping operations. As soon as the main oil pump reaches a speed at which 75 psi pressure is developed in the main oil system, the pressure governor shuts off the steam supply to the turbine driving the auxiliary oil pump. Should the main oil pump be shut down for any reason, the pressure governor will admit steam to the turbine driven auxiliary oil pump so as to maintain pressure in the oil system.



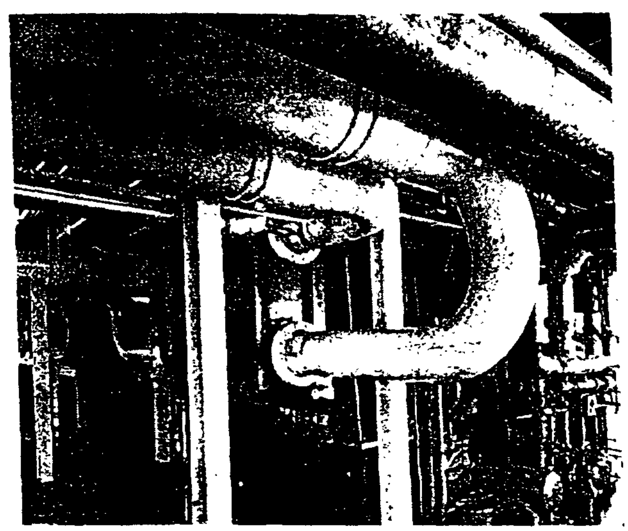
Boiler house control panel indicating and recording instruments, which keep a constant record of all power generating data

Overspeed Control

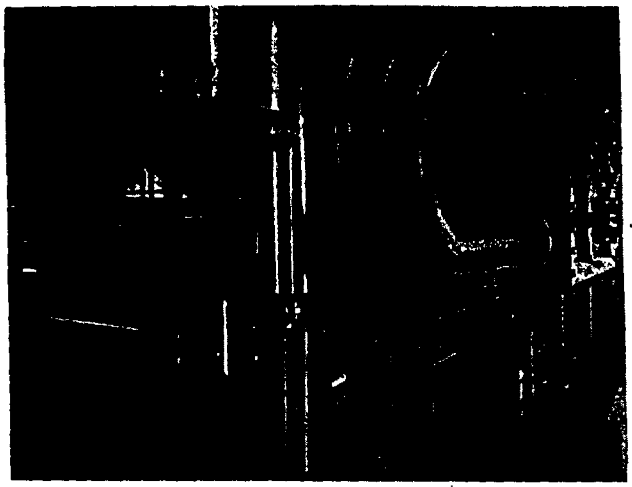
Lubricating oil is also employed to shut down the turbines in case of overspeed and to seal high pressure gas inside the cases of turbine blowers. Oil for sealing gas in the blower case is supplied by a separate motor driven gear pump, which takes suction from the lubricating oil system. This oil circulates through the seal and bearing nearest the impeller at a slightly higher pressure than that of the turbine blower gas, thus providing a positive control of blower leakage.

Bearing Lube

A turbine driven auxiliary centrifugal oil pump is provided that supplies oil to the various bearings and control devices whenever the delivery of the main oil pump is insufficient for the operating requirements. The turbine wheel and pump impeller are mounted on a common shaft and the casings and supporting frame built one



All the condenser water circulating pumps are turbine driven. Water circulation is controlled by constant pressure instruments in these condensers



Oil cooler, left, is part of a combination pressure oil unit for the turbine-compressor that operates at 75 psi

Two 800 kw turbine generators furnish electrical power for auxiliary equipment. Feedwater pumps are automatic

into another so as to form a single unit.

Boiler Capacity

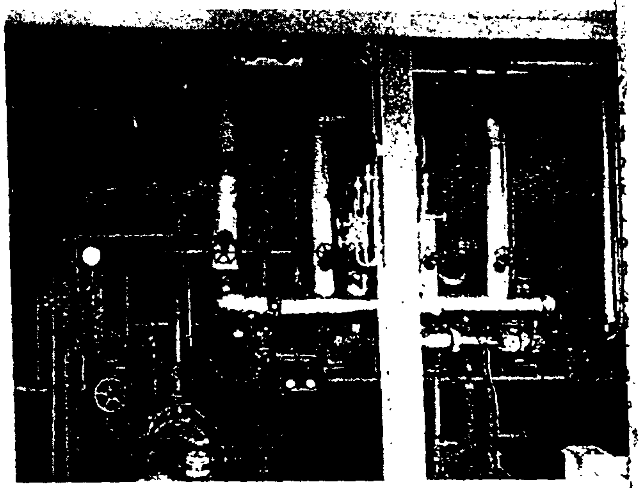
Each boiler is capable ot delivering 48,000 lb of steam per hr for short period operation and 43,000 lb per hr for continuous operation at 625 psig and 750 F TT. Since demineralized feedwater is utilized, the designers made every effort to recover as much steam and condensate as possible. As a result, the total makeup for this station is approximately one per cent of the boiler steam flow.

This power plant was designed with as many automatic features as practical in order to minimize operating labor. Fuel gas and air supplied to the firebox and feedwater supplied to the boiler are automatically adjusted to varying load conditions in order to maintain constant steam pressures. Greater fuel economy can be achieved with this automatic control than by hand operation.

Steam Control

An indicating pressure controller located in the outgoing steam supply line is the master instrument in this hookup. Any fluctuation in load conditions is first indicated by a steam pressure change. Thus, the pressure controller performs the first step in adjusting boiler output to the load.

For example, a sudden increase in load will cause a decrease in steam pressure. The instrument will automatically increase the flow of fuel gas and air to the combustion chamber. Additional combustion causes increased pressure in the firebox, and the induced-draft damper is automatically opened, allowing combustion products to flow to the boiler stack. An automatic valve allows more feedwater to flow to the boiler to compensate for increased steam demand. As more steam is generated, a controlled amount of water is fed to the de-superheater to maintain temperature. Thus the boiler automatically adjusts itself to the increased load conditions. As a result of the extensive automatic design, only one man is required to operate the entire power plant.



Air ejector equipment for each surface condenser is identical. All primary pumping units are driven by means of steam turbines

These are some of the basic features of the first steam-turbine driven centrifugal compressor installation in the natural gas pipe line industry. The station has not operated for a sufficient length of time to evaluate the merits of this type of equipment as compared with other prime movers. Extensive studies are being made now and such comparative information will be available for publication in the future

LIST OF PRINCIPAL EQUIPMENT

Boilers	Riley Stoker Corp.
Gas compressor	De Laval Steam Turbine Co.
Gas compressor steam turbine	De Laval Steam Turbine Co.
Gas compressor condenser	Allis-Chalmers Mfg. Co.
Generator	Ideal Electric & Mfg. Co.
Generator steam turbine	De Laval Steam Turbine Co.
Feedwater heater	Elliott Co,
Demineralizer	Cochrane Corp.
Cooling towers	The Marley Co.
Gas pressure controls	Askania Regulator Co.

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