Union Pacific Railroad Company
Research & Mechanical Standards

Report of inspection made by Engineer of Road Tests Flebbe covering Southern Pacific Company's standing test plant, Sacramento, California, May 17 to 20, 1949.

On arrival at Southern Pacific Company's headquarters in San Francisco, May 17, it was arranged with Mr. D. R. Calleri, Mechanical Engineer, and Mr. P. V. Garin, Engineer of Tests, to proceed to Sacramento to observe the tests then in progress at the standing test plant. The test work is in charge of Mr. Garin and the standing test is under the supervision of Mr. J. G. Maurer.

The test in progress was a test of the Coen Company burner. The burner itself is an inside mixing, steam atomizing, pressure fed type which fires a conical flame. Details of construction were not available; however, atomization was accomplished by steam jets inside the burner nozzle which entrain and atomize the fuel oil and are arranged annularly to converge at a point approximately 12 inches from the burner nozzle. Fuel oil is fed to the burners at 16 to 43 PSI gauge depending upon the capacity at which the burners are working. Fuel oil is fed at temperatures preferably 180° F. or higher.

The burner arrangement consists of six main burners and two pilot burners arranged in directly opposed banks on opposite sides of the firepan. The firepan has sloping sides similar to the UPRR standard firepan and, therefore, the center of impingement of flames from opposing burners is on a vertical plane through the horizontal center line of the firebox but somewhat below it. The pilot burners are of smaller capacity than the main burners and are set close to the flash wall and have air openings independent of the other burners. The pilot burners are used for spot fires and low evaporation rates.

Burners are arranged in opposing pairs to obtain maximum turbulance of air and atomized fuel oil with resulting intimate mixing for good combustion.

Air for combustion, with the exception of that used by the pilot burners, is brought through an air duct to the burners where primary air is admitted and to the secondary air openings in the bottom of the pan under each pair of burners. The primary air admitted around the burners is given a swirling motion by a so-called diffuser which is a set of blades arranged to impart a swirling motion to the air

as it flows into the firepan around the burner. Secondary air is admitted through openings in the bottom of the firepan which are located in the vertical plane of each pair of burners. The effective opening for each pair of burners is approximately 2" x 28". Primary air is about 15% of the total air admitted. The amount of air admitted is controlled by a damper at the front of the air duct.

The air duct itself is formed by applying a secondary or false bottom to the firepan, the space between the false bottom and the firepan being approximately 6" deep.

Air to the pilot burners cannot be controlled as the openings are outside of the main air duct. All secondary air openings are designed as wide flattened nozzles in order to increase air velocity.

Although the test of the Coen burners is far from complete the results so far are very promising. Combustion is excellent as indicated by the CO_2 and O_2 charts as well as the front end temperatures. CO_2 was running approximately 15.0% with O_2 between .8% and 1.8%. Front end temperatures ranged from 450° to 700° F. depending upon operation. The exhaust nozzle has been opened up from an 8" diameter with basket bridge to 8-1/4" diameter with basket bridge and further increase in nozzle size was contemplated.

At present the Coen locomotive burners are in the experimental stage and in the present stage of development would not be practical for locomotive service. In phone conversation with Mr. Voorheis of the Coen Company, he stated that intentions were to develop the burner, air control system and fuel feed system to where the entire system would be very simple to operate and easily applied to locomotives.

Tests have not progressed far enough at present to determine the fuel saving which will be possible. Judging by results so far obtained the saving will be substantial.

Other burners to be tested include a rotary type, shown in attached photograph of drawing, the Great Northern multiple jet atomizer type and Rock Island multiple jet atomizer type. The last two are similar to the Thomas burner except for the multiple jet atomizers.

Several burners all similar to the Thomas burner have been tested but with no apparent difference in results. Atomization in all cases was poor, regardless of lip design and combustion was no better with one than with another.

Of the burners to be tested the Great Northern is considered the best of the conventional outside mixing type; however, the atomizer jet holes are straight drilled holes and consideration is being given to making expanding nozzles of them in order to increase the velocity of the atomizing steam.

The rotary type burner was given a preliminary test on an outside test rack to determine the size of flame and degree of atomization. Results were doubtful because conditions were in no sense comparable with conditions in a firebox and no conclusions were reached other than that atomization was good. Atomization was accomplished by a combination of rotary motion which discharges the fuel oil from the center nozzle tangentially and atomizing steam which picks up the fuel oil as it leaves the nozzle. A view of the nozzle and flame is shown in attached photographs. It is claimed that in case of rotor failure, the steam atomizer will atomize fuel oil enough for combustion.

Test work on burners is still incomplete and further information as to results of tests may be obtained at a later date.

Other information obtained in conversation with Mr. J. G. Maurer:

Fuel oil tank boil-over caused by excessive moisture in fuel oil which flashes into steam at critical temperatures. As result the Southern Pacific Company is developing closed type heater to be used exclusively.

Fuel oil firing temperature should be as high as possible without vaporization preferably close to 180° F.

Tests have been made where excessive smoke was obtained with a large excess of air showing in flue gas analysis.

First tests of SR-155 showed unsatisfactory results. Further road tests are being made with improved SR-155.

Front end sand evacuators consisting of tube extending from bottom of front end to stack have been tried with some success.

No front end development work has been done. Batelle has made a model study of exhaust nozzle and stack combinations under Southern Pacific sponsorship. Results were not available but could possibly be obtained through SP officials.

Studies of temperature differences at various points in the boiler have been made using side and top mounted boiler checks. Results showed very small differences between extreme temperatures when using top boiler checks but results with the side boiler checks showed differences enough between extremes to be detrimental to the boiler.

Attached are photographs showing general views of test plant as well as instrumentation and part of the control system.

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Gen'l Supt. MP&M
Omaha, May 27, 1949