as the oil flows out of the inner bore it is caught by the whirling steam and atomized. It is considerable work to set this burner in place, as there are many changes to make in the brick work of the furnace. In order to atomize the oil thoroughly, the bridge wall of the furnace has to be reconstructed and a sort of grille work or fire brick put in its place. The grate bars are lowered about one foot in the fire-box, and a double row of fire brick laid on top in such a manner as to form an air chamber between them through which all air must pass in order to reach the furnace, the idea being that the air becomes heated before coming in contact with the fire. There are two of these burners under each boiler, each one being set in the fire door, and the door bricked up solid, except a small hole for looking into the furnace. When once set up it is rather difficult and expensive to change back to coal. The cross-blow burner is constructed somewhat differently from the straight-blow burner. It consists of a small casting with an overhanging top perforated with small holes arranged in a semi-circle on the underside. Just below these holes is a slot in the burner through which the steam issues in a sheet, and the oil being forced through these holes comes in contact with the steam and is atomized. This burner is put through a hole between the fire doors, using only one burner to a boiler. The grate bars are left in the same position as when coal is used, and are covered with a layer of fire brick laid in mortar. These bricks cover the entire grate except a few inches in front for air, and the bridge wall is left as used for coal. The furnace doors remain unchanged. The principle of an oil burner is that the steam comes in contact with the oil and atomizes and separates it as widely as possible. To convert a furnace from coal to oil will take from two to three days, and to convert to coal again from two to three minutes, where the cross-blow burners are used. After being once equipped for oil, however, and then converted to coal, it would be reconverted to oil again in about one hour.

In the use of fuel oil it is necessary in order to get economical burning, to have the oil flow to the burners at a steady pressure. Our first experiments demonstrated the necessity of this, as our fires were often put out through unsteady pressure. With a steady pressure of steam at the burners, if the oil pressure decreases, the steam is likely to blow out the fire, while if it increases, more oil comes through the burners than could be properly atomized, the result being, 1st, The fire smokes badly; 2nd, the excess oil runs away in the ash pit, causing liability to explode; 3rd, it fills the tubes with a soot that is much harder to remove than coal soot; 4th, the oil that is not atomized and flows away is lost. In order to insure a steady pressure of oil it is necessary to provide an auxiliary air chamber. Connected to this air chamber is a small safety valve which, in case the pressure runs above the point required, returns the excess oil to the storage tanks. To start the burners it is simply necessary to turn on the steam and a small supply of oil, and throw a piece of burning waste into the fire box, and we immediately have a full fire. To regulate it properly it is necessary to adjust the supply of both steam and oil until the fire burns without any smoke; and, if properly regulated we get a complete combustion of the oil and avoid almost entirely the presence of soot in the tubes and smoke from the stack. It is also possible, by simply increasing the supply of both steam and oil, to force the boiler to any extent. Care must be taken, however, in selecting burners to get one that thoroughly atomizes and distributes the oil so as not to confine the fire to any one part of the shell and burn the boiler.

The boilers are provided with peep holes in the back to enable the fireman to see the condition of his fire. Care must be taken to watch the fires very closely, and in case they go out for any reason to shut off the oil immediately, as the gas from the oil, combined with the air in certain proportions, is very explosive. Cases of this kind have been known where an explosion has occurred which took the damper up the chimney and blew out the front of the boiler. The statement has been made that it takes about four per cent. of the steam generaed to operate the oil apparatus. We have made no experiment to demonstrate the accuracy of this figure, but our observations go to show that this percentage is large. In a small plant like this, which is subject at times to a total shut-down, in case the steam of all boilers goes down, it is impossible to start the fire, in which case an auxiliary steam generator must be employed, or the fire brick be removed from the grates and coal be used to get up steam.

In installing this apparatus it is necessary to comply with certain rules and regulations of the insurance companies in order to prevent an increase in insurance rates. These rules, however, are not in any way unreasonable, but are necessary to afford ample protection to the plant. Their principal requirements are: 1st. That the storage tanks shall be buried four feet under the ground and ten feet from the building; or, if located more than one hundred feet from the building, may be put above the ground or only partially buried, in which case they must be surrounded by a brick or earth embankment forming a reservoir of sufficient capacity to hold double the contents of the tank. 2nd. They must have a gas-tight manhead at the top. 3rd. They must not be filled in excess of ninety-eight per cent. of their capacity. 4th. They must have a two-inch vent pipe. 5th. The highest point in storage supply must be at least two feet below the level of the furnace where oil is to be burned, thereby preventing gravity feed to the boilers.

What the saving has been per horse power of kilowatt hour as compared with the use of coal it is impossible for us to tell, as prior to the present ownership of this plant, which changed hands last fall, no records have ever been kept of the kilowatt output or the tons of coal used per month, so that comparisons are impossible to obtain. There is no question, however, but that there is a very large saving in the use of fuel oil. It is claimed by the advocates of fuel oil that four barrels of oil, forty-two gallons to a barrel, are equal to one ton of good bituminous coal. Experiments have been made by the Water Works Company at El Paso, and some very accurate figures have been obtained. The results of these tests show that the cost of burning fuel oil is exactly half the cost of burning coal, the coal costing $5 per ton, and fuel oil costing 70 cents per barrel. The coal used prior to the installation of fuel oil was San Antonio coal from New Mexico.

## SPECIFICATIONS FOR MATERIAL AND WORKMANSHIP FOR STEEL STRUCTURES.

### MATERIAL.

1. Steel shall be made by the open-hearth process.

| Chemical and Physical Properties | Structural Steel | Rivet Steel | Steel Castings |
|---|---|---|---|
| Phosphorus Max { Basic... | 0 04 per cent. | 0 04 per cent. | 0.05 per cent. |
| Phosphorus Max { Acid.... | 0.08 " | 0.04 " | 0.08 " |
| Sulphur maximum..... | 0 05 " | 0.04 " | 0.05 " |
| Ultimate tensile strength | Desired | Desired | Not less than |
| Pounds per square inch..... | 60000 | 50000 | 65000 |
| Elongation: min. % in 8". { | 1,500,000* Ult. tensile str'gth | 1,500,000 Ult. tensile str'gth | |
| " " " 2"..... | 22 | | 18 |
| Character of Fracture ..... | Silky | Silky | Silky or fine granular |
| Colds bends without fracture. | 180° flat† | 180° flat‡ | 90° |

*See paragraph 11. †See paragraphs 12, 13 and 14. ‡See paragraph 15.

2. The yield point, as indicated by the drop of beam, shall be recorded in the test reports.

3. Tensile tests of steel showing an ultimate strength within 5,000 pounds of that desired will be considered satisfactory, except that if the ultimate strength varies more than 4,000 pounds from that desired, a retest shall be made on the same gauge, which, to be acceptable, shall be within 5,000 pounds of the desired ultimate.

4. Chemical determinations of the percentages of carbon, phosphorus, sulphur and manganese shall be made by the manufacturer from a test ingot taken at the time of the pouring of each melt of steel and a correct copy of such analysis shall be furnished to the engineer or his inspector. Check analyses shall be made from finished material, if called for by the purchaser, in which case an excess of 25 per cent. above the required limits will be allowed.

5. Plates, Shapes, and Bars: Specimens for tensile and bending tests for plates, shapes and bars shall be made by cutting coupons from the finished product, which shall have both faces rolled and both edges milled to the form