

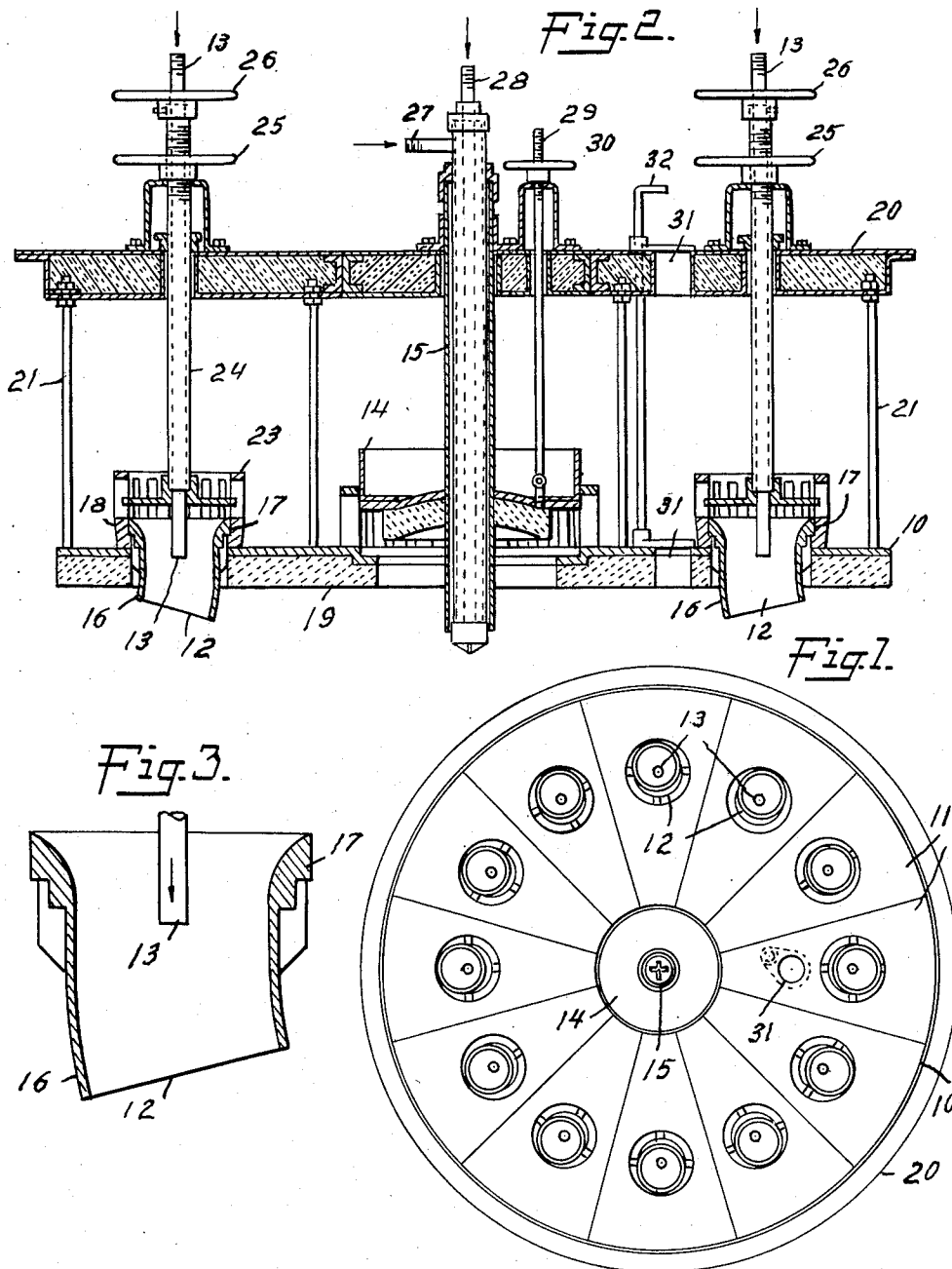
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APPARATUS

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Our invention relates to improvements in directional flame burners of the type useful in Deflorenz oil refinery heaters. In the operation of Deflorenz heaters or cylindrical furnaces of the all radiant, vertical tube type, it is of prime importance to provide flame control for proper heat distribution permitting control of heat input and balancing of heater outlet temperatures for split-coil or multi-heater operation. For this purpose, down-firing has been developed employing a specially designed directional flame control, oil and gas fired burner. The burner handles refinery gas, natural gas or heavy fuel oil. Each burner is equipped with 8 to 12 individual air nozzles, depending upon the size of the burner, rotatably disposed in a burner plate located at the head of the furnace throat. Space for charging preheated air to the nozzles together with flow regulating means is provided above the burner plate. The individual air nozzles are equally spaced on a common circle around the burner plate and are so constructed that they can be individually rotated through a complete arc of 360°. The nozzles are provided with a 15° curvature on the lower end so that control of the heat distribution in the furnace may be had as desired by the operator. Each nozzle is supplied with a single gas pipe so that the main burner actually is composed of 8 or 12 small gas burners depending upon the size of the furnace. The highly preheated air, i. e., 1000° F. or above, is forced through the nozzle under pressure where it is mixed with the fuel gas and the resulting mixture burned. Fuel oil, however, is burned with a single oil gun of the steam atomizing type located in the center of the burner plate. For oil firing, a substantial proportion of the combustion air is supplied through a central air register in which the oil burner is installed while air to the individual nozzles is reduced by dampers.

With directional flame burners of this type, it has been established that the shape and dimension of the air nozzles are critical in terms of proper heat distribution, maximum heat absorption and efficiency of operation.

Thus an overall length of at least 10 inches has been thought necessary for proper directional control and for good mixing and combustion in view of the high velocities and volumes of air and gas involved. On the other hand, the nozzles cannot be too long, or serious vibration and disturbing noise result. We have now found that when the diameter of the nozzle is limited to 7 inches maximum diameter, the distance of the internal gas pipe tip above the nozzle face is critical with respect to efficient mixing and combustion. We have further found that by reducing

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the length of the nozzle to 7½ inches maximum while maintaining a distance of 4¼ inches between the gas pipe tip and the nozzle face that mixing and furnace efficiency actually are improved to a significant and commercially valuable extent. At the same time capacities are improved through reduced skin friction resistance and good flame control is retained.

The nature of our invention and its mode of operation will be further described with reference to the accompanying drawings in which Figure 1 represents an underneath plan view of the burner plate as it appears from a position looking upward into the burner throat. Figure 2 represents a vertical section through a portion of the burner assembly cut away in a manner illustrating the structure of the nozzles, fuel and air supply system, and directional control system. Figure 3 represents a detail of the nozzle structure in section.

The burner assembly comprises a circular burner plate 10 which in actual construction preferably consists of a plurality of segments 11. Spaced around the burner plate 10 are a number of air-gas nozzles 12, each with a centrally positioned internal gas pipe 13. For efficient air-gas mixing and combustion with the shortened nozzles, the tip of the gas pipe must be 4¼ inches above the lower face of the nozzle tube, a critical position within the slight tolerances of fabrication. In the center of the burner plate is located the master air register and damper means 14 and a centrally located steam atomizing oil burner nozzle 15. Referring to Figures 2 and 3, it can be seen that the nozzles 12 are fabricated with a curved section 16 and an upper flanged section 17 forming a bearing surface coinciding with seating elements 18 on the upper surface of the burner plate. The nozzles advantageously are fabricated from high chrome heat resistant steel alloys for maximum nozzle life. The maximum length of the nozzle tube including the curvature and the 4¼ inches between gas pipe tip and nozzle face is 7½ inches to obtain the improved operational and economical advantages of our invention. The minimum length is fixed by the desirability of enough length above the gas pipe tip to establish air velocity while providing bearing surface for the rotatable mounting. The diameter may vary from 7 inches I. D. to about 4. The curvature for these conditions is 15°. The lower surface of the burner plate 10 is protected by a layer of refractory material 19 which by reason of the shortness of the nozzles 12 largely protects them from direct exposure to the high temperature of the furnace throat.

Located above the burner plate 10 is an insu-

lated cover section 20 supported by members 21 forming a cylindrical housing which communicates with the air supply system and functions as a distributing means for the combustion air to the individual air-gas nozzles. Each nozzle 12 is equipped with a slotted cylindrical member 23 which permits access of combustion air to the nozzle. Advantageously, the member 23 is in the form of a vertically adjustable damper controlled by means of sleeve 24 which functions to raise and lower the damping means under control of hand wheel 25. Each air nozzle 12 is rotatable by means of hand wheels 26 operating on the outer portions of sleeves 24. The oil burner is fitted with steam connection 27 and oil connection 28. The master damper control 14 is operated through rod 29 and wheel 33.

In operation, the burner is lighted off using available refinery gas by means of lighting ports 31 with the master damper 14 closed. As the heater is brought up to temperature, the air supply through individual air registers 23 supplemented as necessary through master register 14 is preheated by exchange with the flue gases to 1000° F. and higher. Usually, as soon as gas is available from the unit in which the heater is functioning, the fuel supply is charged over and the unit is brought up to full firing rate. Tube temperatures, particularly in the critical regions, are followed and heat distribution adjusted as necessary by rotation of individual nozzles 12 to develop the proper heat absorption. At least 10 per cent excess air is desirable to handle surges in fuel supply, but it is important to minimize excess air for furnace efficiency and capacity. When fuel oil is burned through the single oil gun centrally located in burner plate 13, as much of the combustion air as possible is supplied through the center air register 14 in which the oil burner is installed with a minimum amount of air through the individual nozzles 12. Since the flame burst temperature for fuel oil is considerably above that of fuel gas, the combination of this condition with the central air supply may result in excessively high nozzle metal temperatures. The very short relationship with respect to diameter of the new air-gas nozzles of our invention is particularly advantageous under these conditions in avoiding oxidation of the lower curved portions of the nozzles. For if the metal is destroyed by oxidation, of course the control of flame pattern and thus heat distribution in the furnace becomes increasingly difficult with resulting poor operation. The nozzles of our invention are protected by the refractory layer attached to the burner plate and there is no need therefore to resort to the various insulating expedients which are unsatisfactory in function and difficult and expensive to maintain.

The air-gas nozzle assemblies of our invention are more efficient in operation because less excess air is required and surprisingly better mixing results in the short fat annulus. Higher capacities are obtained due to reduced frictional resistance in the shortened nozzles. The value of the new type air-gas nozzle assembly is illustrated in a series of tests conducted over a period of seven weeks on the number-1 heater of a typical pressure coil thermal cracking still. The furnace data for the new type nozzle assembly were obtained over a period of seven weeks' operation and are compared with operation with the old style nozzle assemblies over the directly preceding seven week period. The heater was the first of 2 serially connected heaters in a split coil 2 heater

design. The number-1 heater contained 120 4-inch by 35-foot tubes of 4-6 chrome alloy metal. The total heating surface was 4,050 square feet. During the run, the heater throughput averaged 18,500 barrels gas oil per hour. The oil temperature into the heater typically averaged 585° F. and the outlet temperature was maintained at about 875° F. The average furnace load was 44 million B. t. u.'s per hour. The furnace temperature ranged from 1150° to 1250° F. and the flue gas temperature ran about 1130° F. The new type nozzles were quite sensitive to control and it was the opinion of the operators that control was somewhat better with the new type than with the old type.

The unit was brought up to a rate of 41.0 million B. t. u. per hour with a 76 per cent efficiency, using a fuel gas with a heating value of approximately 2200 B. t. u. per cubic foot. While operating at the level and with a high B. t. u. fuel gas the flame was entirely non-luminous. The flame was quite similar to that which is produced when burning natural gas with a heating value of around 1000 B. t. u. per cubic foot. This would indicate that extremely rapid, highly efficient combustion was taking place through the burners. Tube temperatures showed that the heat distribution throughout the furnace was very uniform. The short nozzles permitted the flames to fan out in the furnace throat so as to produce excellent firing without sacrifice of control or damage to the furnace throat or nose tile. In addition, the furnace efficiency averaged 1.3% higher, or 76.7% against 75.4% over the test periods. The amount of excess air required was lowered from an average of 29.83% to 33.56%. Thus the air-fuel mixing characteristics were unexpectedly better and valuable heater economies were effected. In addition to these operational advantages, the new type air-gas nozzle assembly is cheaper to fabricate, has an almost indefinite service life, requires no external insulation, materially reduces the labor and repair costs on the heater, and provides better controllability over the entire heater "on stream" period.

We claim:

In a multiple nozzle, directional flame control, oil and gas fired burner for cylindrical, vertical tube radiant type oil refinery heaters in which each nozzle comprises a tubular air-gas nozzle symmetrically and rotatably mounted in a burner plate and equipped with means for individual rotation through 360°, an improved air-gas nozzle assembly which essentially comprises an air duct of about 4 inches to 7 inches maximum inside diameter by 7½ inches maximum length having an upper open end forming an air inlet said duct being constructed with an angle of curvature from its inlet axis of about 15° at its lower end, a gas pipe coaxially mounted within the inlet with the tip of the gas pipe ¼ inches above the lower face of the duct, means for supplying air under pressure down through the duct, and means for supplying gas down through the gas pipe.

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