Aug. 8, 1950 W. KEAY 2,518,021

LIQUID FUEL FURNACE

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Fig. 1.

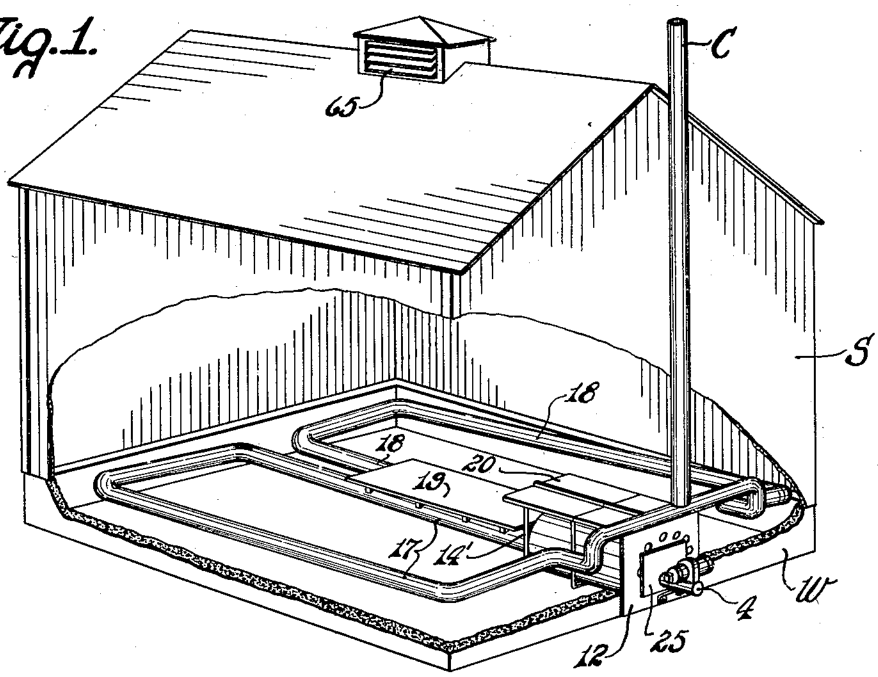

Fig. 2.

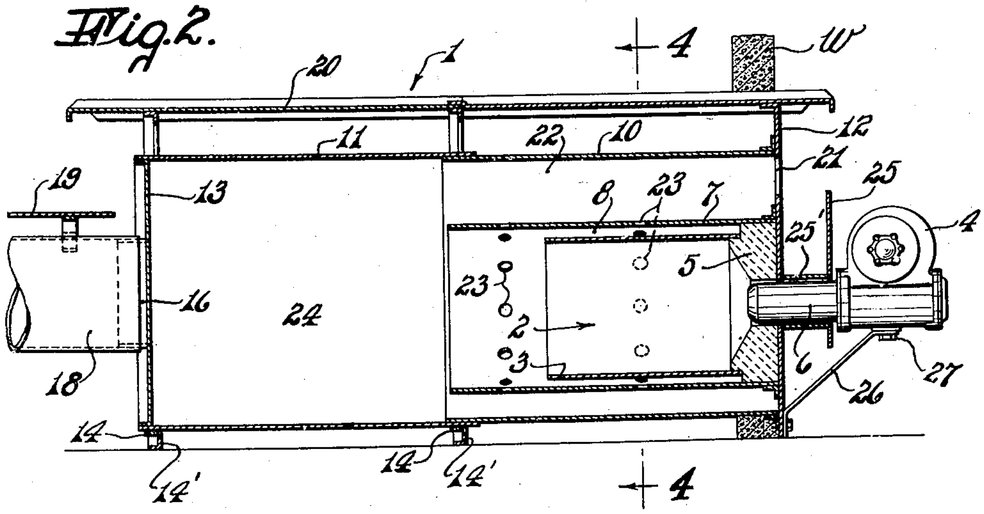

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Fig. 3.

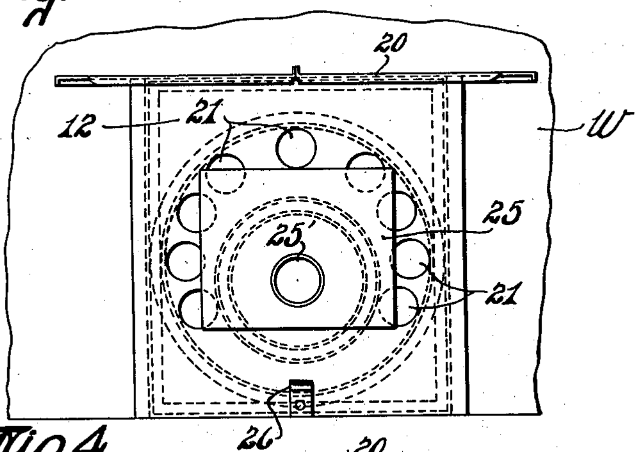


Fig. 4.

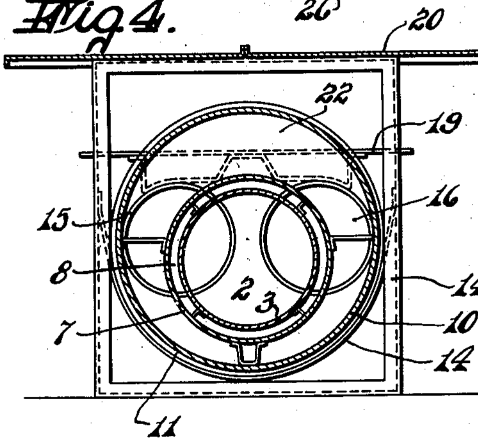


Fig. 6.

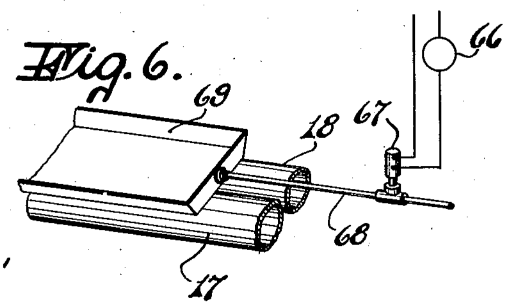
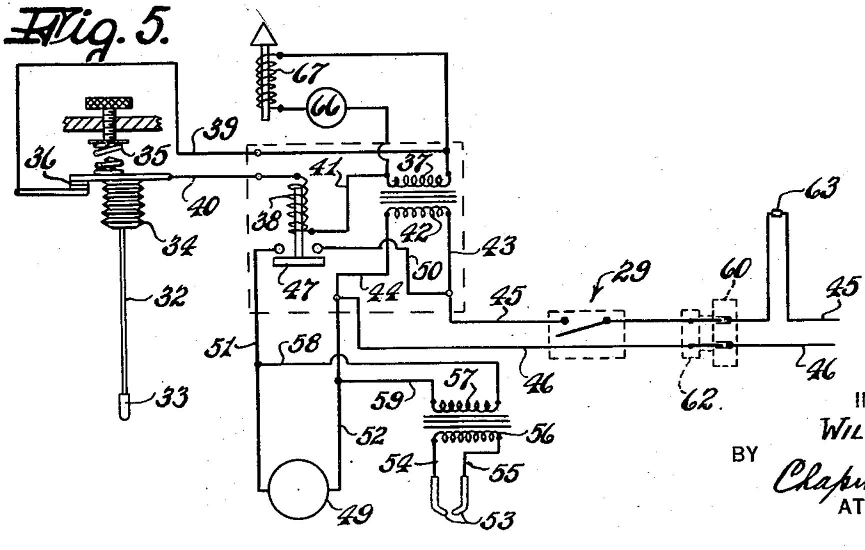


Fig. 5.



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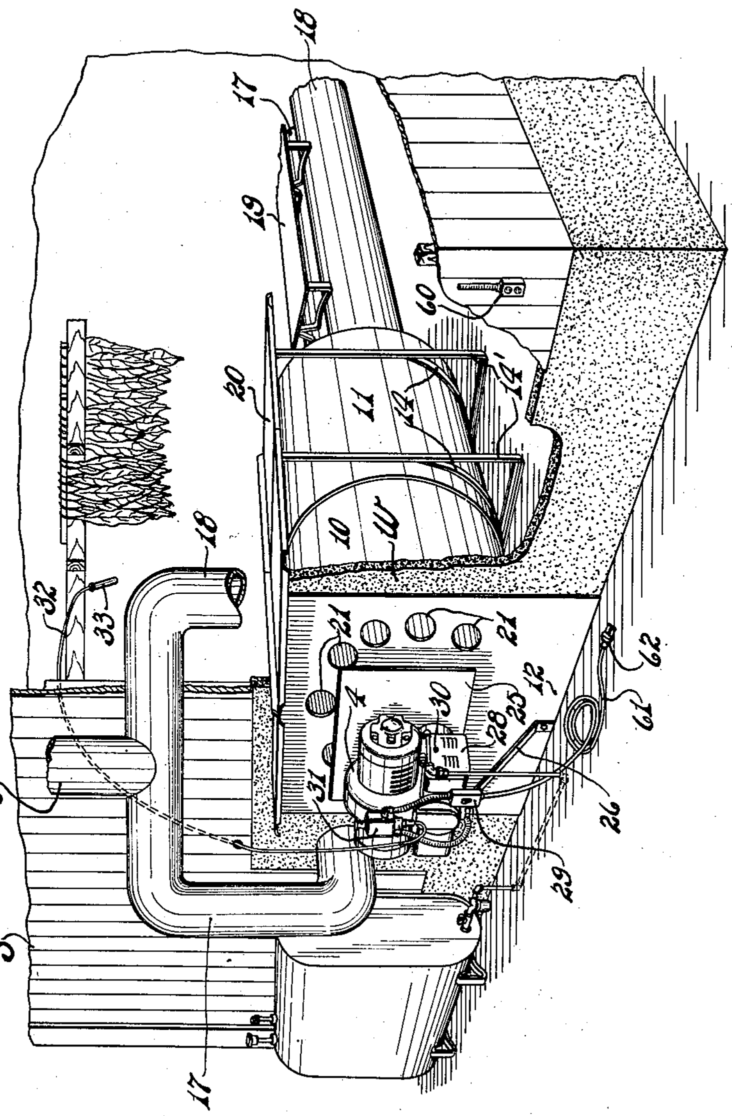

Fig. 7.

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LIQUID FUEL FURNACE

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Application August 12, 1948, Serial No. 43,836

1 Claim. (Cl. 263—19)

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This invention relates to an improved heating system or apparatus adapted for use in curing or drying sheds, as for example in sheds for curing tobacco.

The buildings commonly used for curing tobacco are made of wood. They are usually mere one room sheds of large volume like barns. The large volume needs to be heated only during the short tobacco curing period. The problem in heating such buildings for this special purpose is quite different, in some aspects, from the problem in heating buildings of other kinds particularly from the aspect of efficiency. The heating period is very short, the building is usually poorly constructed for efficient heating operations, and there is always a fire risk in the heating period due to such buildings being filled with tobacco. While considerable work has been done, evidenced more in the published art than in actual practice, the heating systems or apparatus for tobacco curing buildings are in a crude state of development as compared to the systems and apparatus for heating other buildings.

The object of the present invention is to provide an improved heating system or apparatus, which will significantly advance the art in the special field of drying and curing, particularly with respect to the economy of the first cost of equipment, the installation cost, the operating cost, the maintenance cost, and in the relation of such cost factors to the results the user will get in his special field.

Among the advantages of the invention are that the furnace structure with its accessory heat-distributing conduits are relatively inexpensive and can be built as individual heating equipment, one in each curing shed. A number of these low cost furnaces can be serviced one at a time by a single automatic electrically-operated oil burner, which is the expensive part of the apparatus and can be shifted easily from a furnace in one building to furnaces in other buildings and thus used in an economical way. Another advantage is that the nature of the furnace construction is such as to enable the efficient operation of the desired type of oil burner, i. e. one operable at high temperature, above 500°, without overheating parts of the inexpensive furnace or its flues which may all be made of inexpensive sheet metal construction.

Other objects and important characteristics will appear in the specification and be pointed out in the claim.

An illustrative example of the invention is shown in the accompanying drawings, in which:

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Fig. 1 is a perspective view of a tobacco curing shed with two walls partially broken away to show the improved system or apparatus;

Fig. 2 is a sectional elevational view of the furnace with the burner attached;

Fig. 3 is a front view of the furnace with the burner and flues removed and only a fragment of the barn indicated;

Fig. 4 is a cross sectional view taken on line 4—4 of Fig. 2;

Fig. 5 is a wiring diagram of the control system for the burner with a safety device and humidity control added;

Fig. 6 is a fragmentary perspective view, partially diagrammatic, indicating additional apparatus for increasing the humidity in the barn when used in conjunction with the heating apparatus; and

Fig. 7 is a fragmentary perspective view of the new structure shown in Fig. 1 but drawn to a large scale.

The improved furnace structure is best shown in Fig. 2 and is generally designated by reference numeral 1. It includes an inner combustion chamber 2, which is formed within a horizontally-disposed tube 3 and into one end of which an automatically-operated thermostatically-controlled gun-type oil burner 4 fires. The tube 3 is directly exposed to the flame from the burner and is preferably made of stainless steel or other suitable heat resisting material. The tube 3 is supported at its front end by a refractory member 5, which closes such end except for a central opening into which the outlet end of the air tube 6 of the oil burner 4 fits. The rear end of tube 3 is open. The member 5 also supports the front end of a tube 7 which surrounds tube 3 in spaced coaxial relation. An annular space 8 is formed between these tubes. The inner tube 3 communicates through its open rear end with the interior of tube 7 which is somewhat longer than tube 3 and has an open rear end. The tubes 3 and 7 form a radiator located within the shell of the furnace for heating air introduced into the furnace shell as will later appear.

The furnace shell consists of two tubular sections 10 and 11, the adjacent ends of which partially overlap, and front and rear end walls 12 and 13, respectively. The end walls 12 and 13 respectively close the front end of section 10 and the rear end of section 11. The front wall 12, Fig. 3, is a square plate which supports the refractory member 5 and is suitably fixed to tube 10 as indicated. The rear wall 13 is a circular plate, which is suitably fixed in the rear end of tube 11. The described furnace shell is inserted through an opening in a wall *w* of the tobacco curing shed S and rests upon two slings 14, secured one to each of two square skeleton frames 14', mounted on the floor of the shed. The large square front plate 12 (Fig. 3) serves to close the opening in wall *w*. The furnace shell has two outlets 15 and 16 (Fig. 4) formed in the end wall 13, and these outlets are respectively connected to two distributing conduits 17 and 18 which extend horizontally around the shed S just above the floor thereof, as shown in Fig. 1, and finally connect with a chimney C. Supported upon and above these conduits 17 and 18 and overlying the first few feet, and thus the hottest part thereof, is a shield 19. A shield 20 overlies the shell of the furnace and is suitably supported therefrom as indicated. These shields 19 and 20 avoid the fire hazard of tobacco leaves falling on surfaces hot enough to ignite them. These shields provide precaution in addition to that incorporated in the construction of the furnace itself.

For such precaution in the furnace and for other reasons to be described, holes 21 (Fig. 7) are provided in the front plate or cover 12 of the furnace to admit air to the space 22 (Fig. 2) between the outer tube 7 and the shell 10, 11 of the furnace. When the burner 4 is started a draft is established in the conduits 17 and 18 due to the action of the burner fan and natural draft and such draft will cause air from outside the curing shed S to flow through holes 21 and space 22, preventing high temperatures from the inner combustion chamber from being transmitted to the furnace casing. In addition, the tube 7 which surrounds the inner combustion chamber, has a series of holes 23 through its peripheral wall to induce some of the air, which is drawn through holes 21 in the front plate 12 to pass through these secondary openings 23 into annular space 8 and cool the wall 3 of the inner combustion chamber 2. All of the induced air and all the products of combustion from the combustion chamber 2 mix in a mixing chamber 24 formed in shell 11 beyond the end of the combustion chamber. The mixed air and gases flow out of the furnace into the conduits 17 and 18 which are spread throughout the shed S, as shown in Fig. 1, and which connect to the chimney C outside shed.

The induced air flows along the outer wall of tube 7 and along part of the outer wall of tube 3 and absorbs heat from these tubes, effecting a desirable heat exchange, whereby the tubes 7 and 3 are kept cooler than they otherwise would be, while the temperature of the air is raised. Except for this heat exchange, heat would escape at a relatively high rate through shell 10 into the curing shed, creating near the furnace a localized area of high temperature. The induced air improves the distribution of heat by carrying off heat from the radiator to mix with the stream of hot gaseous products of combustion of the burner to be distributed by the conduits 17 and 18 over the area of the tobacco shed. The arrangement enables a more uniform distribution of the heat to be effected. The addition of the air to the products of combustion of the burner increases the volume per unit of time of heating medium that flows in the distributing conduits. It is desirable to add air to the products of combustion to make the heating medium have a sufficient rate of flow in volume per unit of time to carry off the heat from the burner as fast as it is produced without having the temperature in the shed near the burner become excessive. Also, the flow must be in sufficient volume per unit of time so that the heating medium will be able to exchange heat to the shed at the remote ends of the conduits 17 and 18. The ideal condition would be that where all the heat from the heating medium had been given up as such medium enters the chimney C. It would not do for such medium to absorb heat from the tobacco shed, as might occur if the heating medium was not supplied at a sufficient rate to carry heat to the remote ends of the conduits 17 and 18.

When the thin wall sheet metal conduits are all heated for a long length, convection and radiation transfers of heat can more effectively be carried out to secure more uniform distribution of heat, just as a room can be more satisfactorily heated by the same amount of heat from radiant heating pipes distributed in its wall surfaces than by a single small hot heater in one corner of the room. By a proper ratio of induced air, heat of combustion, length of heat-distributing conduits and height of chimney, very great economy of operation can be effected. In the particular apparatus illustrated the maximum temperature of the furnace and flues has been 700° F., the protective shields never reaching 500° F. Less than a 500° F. surface temperature of the furnace casing has been held with a firing rate of four gallons of oil per hour. In practice a 1.75 to 3.5 gallons per hour rate is contemplated for use.

It will be noted that the flow of induced air does not affect the operation of the oil burner. Such air does not mix with the oil but only with the products of combustion of the burner after such products leave the combustion chamber 2. The air-oil ratio of the burner is therefore not changed in any way by the flow of air induced to enter holes 21 and passages 8 and 22.

Oil burner 4 is of the pressure-atomizing gun type such as is commonly used to heat homes. This type of burner is so well known that no attempt will be made to describe its parts. While the rotary type oil burner used in industrial heating plants could be used, at the present time the expense of such burners is prohibitive.

A front plate 25 (Fig. 2) connected to and spaced from the large square front end plate 12 of the furnace by a short length of tubing or thimble 25' protects the burner and its controls from heat radiation. The thimble receives the air tube 6 at the firing end of the burner. The burner is supported on a bracket 26 to which it is secured by cap screws 27. The burner can easily be removed by removing these screws after the oil pipe and electrical supply wires have been disconnected. This allows the farmer to conveniently move the one burner from shed to shed and to heat his house with the burner during the winter following the tobacco curing season.

The normal burner controls are mounted on the burner as in the box 28 indicated in Fig. 7, and also the single pole manual switch 29 for the burner. Included in the normal controls may be any one of the usual burner safety devices (not shown) to shut down the burner in the event of flame failure. A manual reset button to restart the burner is shown at 30. In curing shade grown Connecticut Valley tobacco, where curing temperatures do not exceed 100° F., a conventional bi-metallic house thermostat (not shown) may be used. However, for curing in the South, where higher temperatures prohibit one from entering the barn to set the thermostat, a temperature or "curing" control 31 (Fig. 7) is shown mounted on the front of the burner and connected by a tube 32 to a bulb 33 hung inside the barn.

Bulb 33 contains a suitable fluid which expands and contracts as the temperature rises and falls. When the temperature within the barn exceeds a predetermined degree the fluid will have expanded sufficiently to operate a bellows 34 (Fig. 5) against the pressure of an adjustable spring 35 to open a normally closed switch 36 thereby stopping the burner 4. Conversely, when the temperature in the barn drops below a predetermined degree, the fluid will contract, allowing the bellows to collapse and spring 35 to close switch 36 and start the burner.

The electrical connections for the burner are shown conventionally in Fig. 5. For convenience of illustration, the usual safety control for stopping the burner on failure of combustion has been omitted. The switch 36 closes on a demand for heat from the burner 4, establishing a low voltage circuit, which is supplied from the secondary 37 of a transformer and which includes a relay coil 38, the switch 36, the secondary 37 and the wires 39, 40 and 41 that connect these elements in series. The primary 42 of this transformer is connected by wires 43 and 44 to supply wires 45 and 46, respectively. The relay coil 38 when energized, operates a switch 47 to close a circuit to the motor 49 and to the ignition means. The motor circuit may be traced as follows, from supply wire 45, wire 50, switch 47, wire 51, motor 49 and wire 52 to supply wire 46. The ignition electrodes 53 are connected by wires 54 and 55 to the secondary 56 of an ignition transformer, the primary 57 of which is connected by wires 58 and 59 to wires 51 and 52, respectively, and thus in parallel with the motor 49 so as to be energized and deenergized simultaneously therewith.

The barn or curing shed may be conveniently wired with an exterior plug-in receptacle 60 (Fig. 7). The burner may be supplied with a length of extension cord 61 leading from the service switch 29 and a plug 62 to fit the receptacle 60 on the outside of the barn. A fusible plug 63 (Fig. 5) of low melting temperature may be interposed in one line conductor 45 behind the receptacle 60. The fusible plug is preferably located centrally within the barn and serves as a safety device, shutting off the current when the temperature in the barn becomes high enough to melt the fuse. With this type burner and the apparatus described, there is little danger of fire. Control of the equipment is nearly perfect with automatic, even flow of heat assured. The apparatus cools down quickly after being shut down, soon allowing the barn to be emptied and refilled for another cure.

In contrast to the "pot" type or range type burners now in common use for heating tobacco curing sheds and which burn kerosene or #1 oil, the high pressure atomizing burner 12 burns cheaper #2 oil, making the cure cost less. The even, well-regulated temperatures assured by the new heating system disclosed, result in tobacco which has retained more of its natural sugars and is richer, finer in color, and improved in texture. With the improved equipment there is no more need for scalding, blistering and greenish-black colored tobacco caused by too rapid an increase in heat while the leaf is still full of moisture, nor is there any need for scorching due to too high temperatures. The objectionable oil fumes, which saturate the tobacco when "pot" type or range burners are used, are carried out the flues and never contact the leaf. The end result is that it costs the farmer less to do the job and brings him the greater value of a more consistently high grade tobacco cured leaf.

In common practice and ordinary cures, the humidity of the barn will be within the satisfactory range if the barn or shed is closed up sufficiently tight before the cure is begun, the moisture in the tobacco evaporating as the artificial heat increases, being sufficient to maintain the proper humidity. For wet seasons it may sometimes be necessary to open barn ventilators 65 (Fig. 1) to remove moisture laden air and reduce the excessively high relative humidity. In dry seasons, however, farmers sometimes find it necessary to increase the relative humidity and they wet the barn floor and walls with water to do so. The apparatus diagrammatically indicated in Fig. 6 may be provided to automatically and more conveniently add moisture to the air within the barn. Such apparatus gives the farmer a much greater control over the two conditions affecting the cure, i. e. temperature and relative humidity.

As shown in Fig. 6, a commercial humidostat 66, adapted to be set for any desired range of relative humidity, controls an energizing circuit for a solenoid operated valve 67 located in water line 68 to control the flow of water into special evaporating pans 69 or merely onto flue shields 20, opening the valve on excessively low humidity conditions within the barn and closing the valve, when the predetermined humidity has been reached. The humidostat 66 is preferably connected into the wiring system as shown in Fig. 5 and may hang in the barn near the curing control bulb.

With the heating and humidifying apparatus disclosed the tobacco farmer has a unit which will save him labor and attention. Curing is much more efficient than when done by prior art apparatus. The burner and the temperature in the barn are automatically controlled by the adjustable temperature controls conveniently mounted on the front of the burner outside the barn. Fire hazard is reduced to practically none at all.

While the new apparatus has been described as it is used in curing tobacco, it is also useful for other drying or dehydrating uses with such crops as apples, sweet potatoes, onions, fruits or even lumber which the farmer may wish to kiln dry.

Having fully disclosed the invention, I claim:

A furnace, adapted for use in curing or drying sheds and comprising, a tubular member forming within it a combustion chamber and having its rear end open and its front end closed except for a central opening adapted to receive the outlet end of the air tube of an oil burner for introducing a burning stream of oil and air into said chamber, a second tubular member surrounding the first member in spaced relation therewith and having a plurality of openings therethrough, said second member having a closed front end and being longer than the first member and terminating with an open rear end located beyond the open rear end of the first member, a furnace casing comprising a shell surrounding said tubes and front and rear walls having respectively air inlet openings and at least one outlet opening therein, said casing being longer than the second tubular member and extending rearwardly beyond the open rear end of such member to provide a mixing chamber for hot products of combustion and air which latter is adapted to be induced by the flow of such products to enter through said inlet openings and flow through the space between the second member and shell and through the openings in the second member and the space between the first and second members into said mixing chamber, leaving the latter as a hot stream of mixed air and gases through said outlet opening.

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