

June 26, 1951

J. G. HOOP

2,558,088

BELL FURNACE WITH INTERNAL FAN

Filed Feb. 16, 1949

2 Sheets-Sheet 1

Fig. 1.

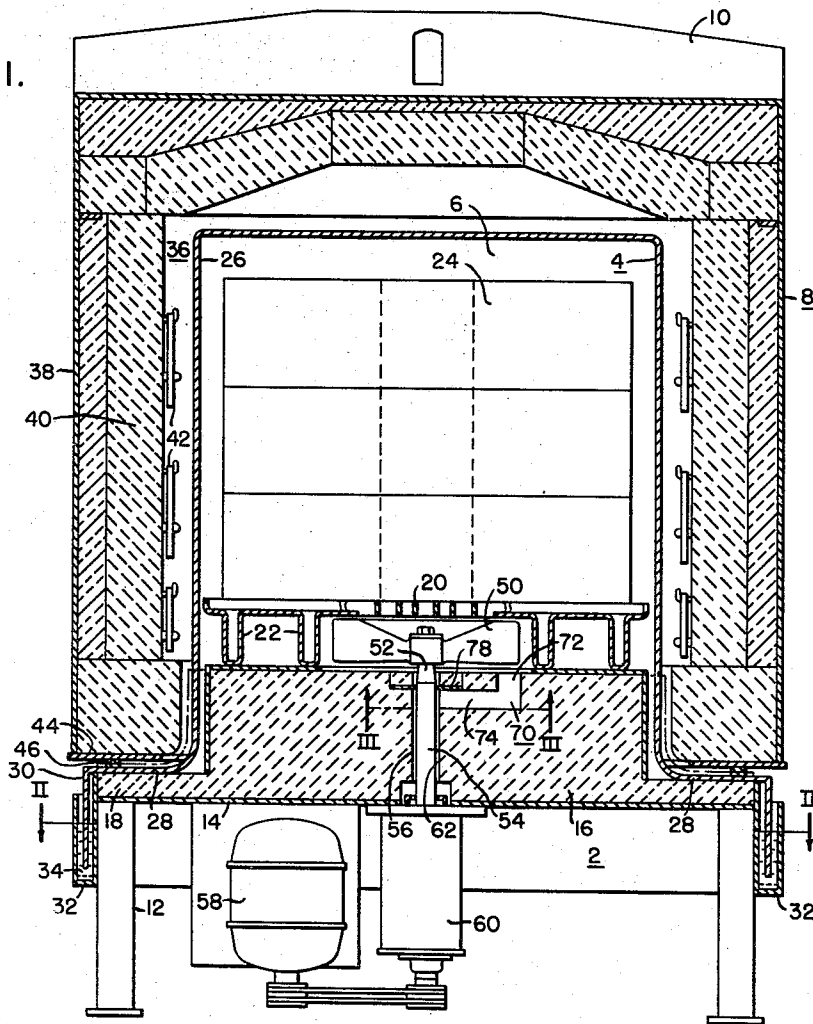


Fig. 3.

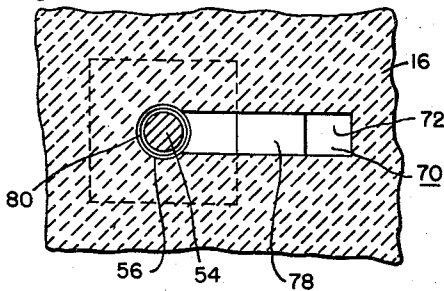
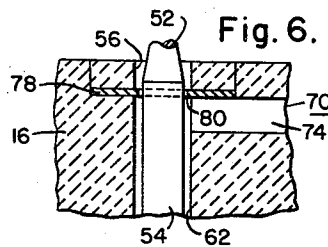


Fig. 6.



WITNESSES:

Robert Baird
Wm. L. Groome

INVENTOR

John G. Hoop.

BY

B. L. Zangwill
ATTORNEY

June 26, 1951

J. G. HOOP

2,558,088

BELL FURNACE WITH INTERNAL FAN

Filed Feb. 16, 1949

2 Sheets-Sheet 2

Fig. 2.

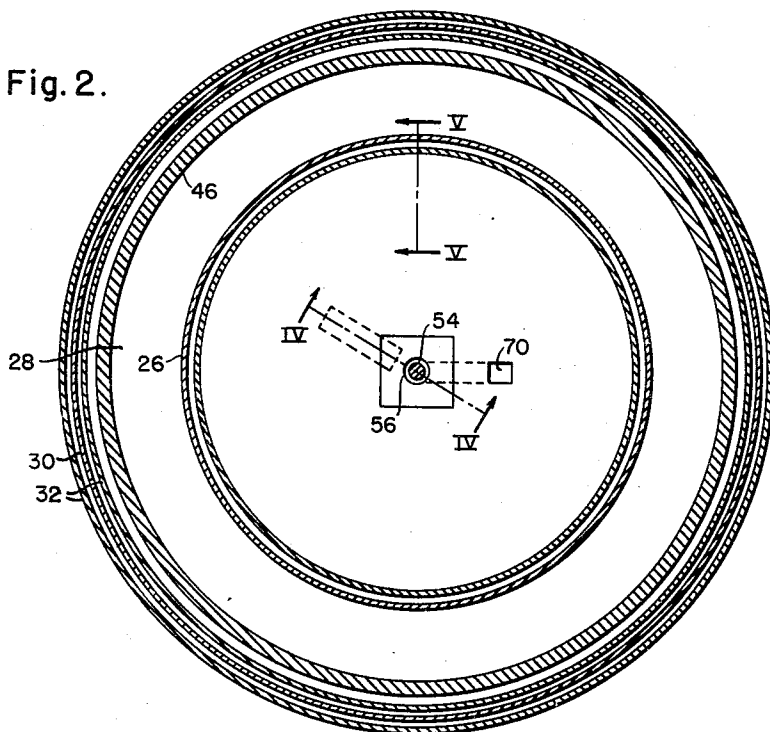


Fig. 4.

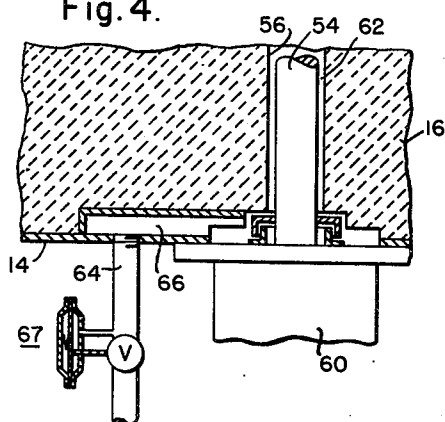
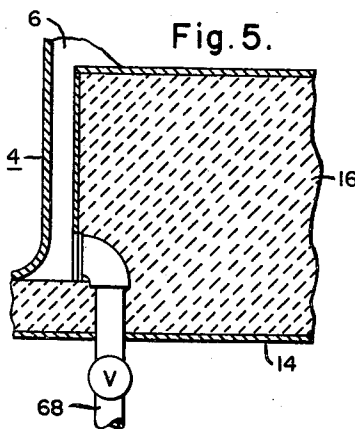


Fig. 5.



WITNESSES:

Robert C. Baird
Wm. L. Goosse

INVENTOR

John G. Hoop.

BY

B. L. Zangwill
ATTORNEY

UNITED STATES PATENT OFFICE

2,558,088

BELL FURNACE WITH INTERNAL FAN

John G. Hoop, Meadville, Pa., assignor to Westinghouse Electric Corporation, East Pittsburgh, Pa., a corporation of Pennsylvania

Application February 16, 1949, Serial No. 76,827

14 Claims. (Cl. 263—40)

1

My invention relates to bell furnaces of a type comprising a gas-impervious inner cover or hood and a base which provide a charge-space adapted to contain a special or protective heat-treatment atmosphere, and a fan inside the hood for circulating the atmosphere therein. The atmosphere may have a composition intended to prevent deleterious effects upon the charge such as might occur if the atmosphere were air, or a composition intended to react with the charge in a desired manner.

The type of fan used in these furnaces generally is a high-speed, centrifugal fan driven by a drive-shaft which extends downwardly from the fan and through the furnace-base. A gas-seal is provided between the fan and base to prevent contamination of the atmosphere inside the hood by leakage of air along the drive-shaft.

The fan recirculates the atmosphere in order to maintain a uniform distribution of temperature and atmosphere throughout the charge, and frequently to obtain faster heating and cooling of the charge as well. The atmosphere recirculated by the fan inside the charge-space comprises gas already in the charge-space and fresh gas fed to the charge-space. The fan may receive fresh gas at a central portion thereof, near its drive-shaft, and discharges the gas into the space under the hood, at an increased pressure, from peripheral points thereof; and the heating bell helps to keep the hood in place on the furnace-base against the pressure of the gas-atmosphere inside the hood.

The gas-pressure inside the hood depends on the pressure of the incoming fresh gas; and if the pressure of this fresh supply-gas is made high enough to maintain a positive pressure at the drive-shaft seal, then the average gas-pressure inside the hood may become so high as to cause the hood to lift from the furnace-base when the furnace bell is removed. If the gas-pressure of the supply-gas is reduced to avoid such incidents, then a negative pressure may be created on the inside of the drive-shaft seal; and undesirable air-leakage or other effects may be the result, depending on the type of drive-shaft seal used for sealing the charge-space against entry of air along the fan drive-shaft. For example, if the fan drive-shaft seal is an ordinary air seal, such as for example, one of the packing gland type, air may leak into the charge-space, if the seal is not in perfect condition. Or, if the seal is an oil seal, such as shown, for example, in the Davis Patent 2,265,027, dated December 2, 1941, then the differential gas pressure for

2

which the seal is designed may be seriously disturbed.

An object of my invention is to overcome the aforesaid difficulties in a simple and inexpensive manner.

A further object of my invention is to provide a bell furnace of a type described having means therein for readily controlling the predominating gas pressure in the charge-space inside the hood.

In accordance with preferred aspects of my invention, a positive plenum gas-pressure is maintained on the charge-space side of the seal for the fan drive-shaft, but the average pressure under the hood is kept low enough so as not to lift the hood when the heating bell is removed. In the presently preferred embodiment of my invention, this is accomplished by by-passing a portion of the fan discharge through a short passage or duct in the furnace which leads the by-passed portion back to a point between the intake of the fan and the drive-shaft seal. This returned by-passed portion of the atmosphere is at the positive pressure desired at the seal. However, an orifice-like means is provided between the by-pass and the intake of the fan which reduces the gas-pressure of the gas flowing to the fan inlet so that the pressure at the intake of the fan will not be excessive.

Objects, features and innovations of my invention in addition to the foregoing will be discernible from the following description of a preferred form thereof. This description is to be taken in conjunction with the accompanying drawings, the figures of which are generally to scale but not necessarily to the same scale. In the drawings, in which some details have been omitted for clarity:

Figure 1 is a vertical sectional view centrally through a bell furnace embodying my invention;

Figs. 2 and 3 are horizontal sectional views substantially on the lines II—II and III—III respectively of Fig. 1;

Figs. 4 and 5 are vertical sectional views substantially on the lines IV—IV and V—V respectively of Fig. 2; and

Fig. 6 is an enlarged sectional view of a detail. In many respects the bell furnace of my preferred embodiment follows the customary design in providing a base structure 2 that cooperates with an inner cover or hood 4 to provide a gas-tight charge-space 6. The charge-space is heated by an outer heating bell 8. Generally, in such furnaces the bell can be removed by raising it from the hood and base, and to this end the

3

top of the bell is provided with an apertured bar 10 or some equivalent device by which the bell may be raised from and lowered to its operating position about the hood. Positioning devices for properly mating the bell and base may also be employed. Similarly, the hood can be raised from and lowered on the base.

The base structure, in general, comprises a structural steel framework, represented by the reference numeral 12, underlying a base-plate 14 which is preferably iron or steel of heavy stock and, therefore, gas tight. A refractory and insulating wall 16 of tile is suitably supported on the base-plate 14 and comprises a horizontal portion which completely covers the base plate and an inner raised portion. The stepped effect of the hearth-wall 16 provides an outer annular wall-portion 18. The inner raised portion of the hearth-wall 16 supports an open metallic hearth-casting 20 having spaced legs 22. The hearth-casting 20 is a heat-resistance skeleton framework on which a charge 24 is supported. The charge may be a plurality of superimposed, centrally-open coils of metal.

The hood 4 is generally a gas-tight metal structure which cooperates with the furnace base 2 to completely encase any charge on the hearth-casting 20. In the illustrated embodiment of my invention, the hood has an upper upright portion 26 in the shape of an inverted cup, and has a lower part with an outwardly directed, in this case horizontal, skirt member 28 that rests on the annular wall portion 18 of the furnace-base 2. The skirt member 28 is provided with a peripheral downwardly extending flange 30 about its complete periphery. The flange 30 projects into a trough 32 which is gas-tightly welded to the base-plate 14 and also extends completely around the periphery of the base-plate. The sealing trough 32 contains a sealing medium 34 into which the edges of the flange 30 are immersed for gas-tightly sealing the charge-space 6.

The bell 8 generally follows the contour of the upper part of the hood but is somewhat larger so as to provide a heating space or chamber 36 therebetween. The bell comprises an outer gas-tight metal casing 38 and firebrick walls 40 that carry heating means 42 shown as electrical resistors in this embodiment. The bell 8 also has an annular bottom plate 44 which rests on a supporting ring 46 that in turn is carried on the skirt member 28 of the hood 4, the skirt member itself resting on the annular wall portion 18 of the base-wall 16, as previously described.

The charge 24 in the charge-space 6 inside the hood is generally enveloped by a special or protective atmosphere which is either inert to the charge or may have a composition to carry out certain desired reactions therewith. Such an atmosphere is circulated inside the charge-space by a centrifugal fan 50 located centrally over the base-wall 16 and below a perforated central part of the hearth-casting 20. The fan 50 is secured to the tapered top end 52 of a vertical drive-shaft 54 that passes through a hole 56 in the base-wall 16 and base-plate 14. Suitable driving means, shown as comprising an electric motor 58, rotates the drive-shaft 54 at any desired speed. A gas seal for the bottom of the hole 56, between the drive-shaft 54 and the base-plate 14, is provided by any suitable seal 60 which may, for example, follow the construction shown in the aforesaid Davis Patent 2,265,027.

The wall sides of the wall 16 which form the hole 56 are spaced from the drive-shaft 54 to

4

provide a gas-passage 62 through which atmosphere at the desired pressure may be fed to the furnace. To this end, a gas-supply pipe 64 (Fig. 4) is gas-tightly secured to the base-plate 14, and discharges the gas desired for the inside of the charge-space 6 into a communicating passage 66 that opens into the lower part of the gas-passage 62 of the hole 56, so that the incoming gas can flow upwardly through the gas-passage. The pressure of the incoming gas is automatically controlled at a suitable value by an adjustable pressure control regulator 67 in the gas-supply pipe 64. Such incoming gas enters the bottom of the central intake portion of the fan 50 and discharges from the peripheral portions of the fan at an increased pressure. The discharged gas, at such increased pressure, moves horizontally through the skeleton framework and spaced legs of the hearth-casting 20, upwardly along the outside of the charge 24 and the inside of the surface of the hood 4, then downwardly through the center of the charge 24, and then back into the top of the central intake portion of the fan 50. A small part of the recirculating atmosphere is continuously bled from the charge-space 6 through a valve-controlled vent pipe 68, shown in Fig. 5. Accordingly, the atmosphere inside the hood will, for the most part, be gas recirculating in orbits within the charge-space 6, supplemented by fresh gas from the gas-supply pipe 64. This atmosphere will be at a higher pressure than the gas fed into the communicating passage 66 by the gas-supply pipe.

In accordance with my invention, I provide a by-pass duct-passage through which some of the gas discharged from the fan can return almost directly back to the intake of the fan. This by-passed gas is returned to the fan at a point near the inner furnace side of the seal 60 for the drive-shaft 54. Specifically, this is done by a small duct or channel 70 provided in the top part of the base-wall 16. This duct or channel 70 comprises an upstanding portion 72 having an opening in the top surface of the base-wall 16. This opening is in line with and exposed to peripheral portions of the fan 50 from which the gas is discharged at increased pressure. The duct or channel 70 also comprises a horizontal portion 74 having an opening at the gas-passage 62 of the hole 56, at a point between the fan 50 on the one hand, and the seal 60 and gas-supply pipe 64 on the other.

Gas at increased pressure enters the restricted duct or channel 70 through its upstanding portion 72, passes through the channel, and enters the gas-passage 62 for return to the intake of the fan 50. The pressure of this by-passed gas is reduced by the duct 70. For further reducing the gas-pressure of the gas flowing to the intake of the fan, so as to keep the pressure under the hood from being excessive, a gas-flow-restricting means is provided between the fan 50 and the discharge opening of the horizontal portion 74 of the duct 70. This restricting means comprises a metal plate 78 which is embedded in the tile of the base-wall 16, and is provided with a hole 80 that is defined by walls of the metal plate 78 which are close to the drive-shaft 54. The hole 80 has a smaller diameter than the hole 56 in the base-wall 16; and the clearance between metal-plate and the drive-shaft 54 is in the nature of a pressure-lowering orifice in the duct-passage comprising the channel 70 and the part of the gas-passage 62 leading from the channel to the fan-intake. Preferably, this clearance is as small as conveniently possible in order to form

5

a very narrow orifice. A minimum clearance means a large drop in pressure across the orifice, and also a small by-pass flow. Because of the orifice, the back pressure at the fan can still be kept low; but on the underside of this orifice, the pressure is kept high enough to prevent air leakage into the furnace through the drive-shaft seal, or, in the specific embodiment shown, to prevent serious disturbance of the pressure balances in the drive-shaft seal 60.

It is also to be noted that the gas-passage 62 is comparatively narrow, and has a significant length between the discharge opening of the horizontal portion 74 of the duct 70, and the communicating passage 66 for the gas-intake.

The adjustable pressure-control regulator 67 in the supply pipe 64 maintains the space between the orifice plate 78 and the seal 60 at the desired positive pressure. However, the gas flowing through the orifice has its pressure reduced to that existing at the fan inlet. The fan inlet pressure may actually be below atmospheric pressure while that at the drive-shaft seal 60 is above atmospheric pressure. Because of the higher pressure at the drive-shaft seal, air leakage into the furnace through the seal is inhibited even when the seal has become somewhat loosened because of wear.

A particular embodiment of my invention comprised a bell furnace of the type described having a charge-space of approximately 58 inches internal diameter and a height of approximately 56 inches from the top of its base-wall to the top of its hood. The duct or channel in the base had a cross-section approximately $2\frac{1}{2}$ by $1\frac{1}{4}$ inches, an overall length of approximately 12 inches, and a maximum depth of 4 inches in its upright portion. The base-wall had a height of 16 inches, and was provided with a central hole 3 inches in diameter for receiving a shaft of $1\frac{1}{8}$ inches in diameter. The metal plate restrictor means was located 2 inches from the top of the base-wall and had a central hole $2\frac{3}{8}$ inches in diameter. Gas supplied at a pressure of 1.0 inch of water produced an average pressure of 2% inches under the hood. Without the duct or channel, the same gas supply gave an internal pressure of $4\frac{1}{2}$ inches under the hood.

While I have described my invention in a form which I now prefer, it is obvious that its principles are applicable to other similar bell furnaces and in different structures, modifications and embodiments.

I claim as my invention:

1. A bell furnace of a type described comprising the combination with a base, a removable outer heating bell, a removable inner hood cooperating with said base to form a charge-space, a gas-seal between said hood and base, a centrifugal fan in said furnace for circulating atmosphere in said charge-space, a drive-shaft passing through said base and connected to said fan, a gas-seal between said base and drive shaft, and gas-supply means having a supply pipe discharging into said charge-space; of means comprising a by-pass duct-passage having an intake opening exposed in said charge-space, and a discharge opening at the central intake portion of said fan.

2. An invention including that of claim 1 but further characterized by said duct-passage having a gas-flow-restricting means therein.

3. An invention including that of claim 2 but characterized by said duct-passage comprising a channel in said base.

4. A bell furnace of a type described comprising

6

the combination with a base, a removable outer heating bell, a removable inner hood cooperating with said base to form a charge-space, a gas-seal between said hood and base, said base having a vertical hole therein, a drive-shaft passing through said hole, having a centrifugal fan at its upper end and a driving means at its lower end, a gas-seal at the bottom of said hole, and a gas-supply pipe means having an outlet at said hole above said seal; of means providing a by-pass duct having an intake end at a peripheral discharge portion of said fan and a discharge end opening into said hole above said seal.

5. An invention including that of claim 4 but further characterized by a flow-restricting member in said hole, said flow-restricting member being about said shaft and above said outlet and said discharge end of the duct.

6. A heat-treating atmosphere furnace comprising a pair of refractory members forming a charge-space, said members being vertically separable, the lower member carrying a peripheral sealing trough means, the upper member being unsecured and having a peripheral edge in said sealing trough means, a drive-shaft passing through a hole in said lower member, a centrifugal fan in said charge-space near said lower member, said fan being connected to said drive-shaft, a seal for said hole, between said drive-shaft and said lower member, an orifice-forming means about said drive-shaft and located at a point in said hole intermediate said fan and seal, gas-supply pipe means having a discharge at said hole, said discharge being below said orifice-forming means but above said seal, and a by-pass channel having an intake near the peripheral portion of said fan and a discharge at said hole, the last said discharge being below said orifice-forming means but above said seal and the first said discharge.

7. A base-structure for a bell furnace of a type described, said base-structure comprising a base having a lower metal base plate, said base further having an upper non-metallic refractory wall, said base having an upstanding central hole through said base-plate and said wall, a drive-shaft in said hole clearing the sides of said wall and forming a gas-passage therewith, a fan secured to said drive-shaft above said wall, a gas-seal between said drive-shaft and base-plate, restrictor means associated with and spaced from said base-plate restricting the area of said gas-passage, a gas-supply pipe means for discharging a gas to said gas-passage at a point between said restrictor means and said seal, said wall having a channel having an opening into said gas-passage at a point between said restrictor means and gas seal, and an opening exposed to a peripheral portion of said fan.

8. A base structure for a bell furnace of a type described, said base structure comprising a base having a lower metal base-plate, said base further having an upper non-metallic refractory wall, said base having an upstanding central hole through said base-plate and said wall, a drive-shaft in said hole clearing sides of said wall and forming a gas-passage therewith, a fan secured to said drive-shaft above said wall, a gas-seal between said drive-shaft and base-plate, and means associated with said base providing a duct-passage having an opening exposed to a peripheral portion of said fan, and another opening at said fan-intake, thereby providing a short-circuiting by-pass for gas driven by said fan.

9. An invention including that of claim 8 but

7

further characterized by said wall having a supply-passage communicating with said gas-passage, and a supply pipe gas-tightly secured to said base-plate and adapted to feed gas to said supply-passage.

10. An invention including that of claim 8 but further characterized by a restricter means in said duct-passage.

11. An invention including that of claim 10 but further characterized by said duct-passage comprising a channel in said base-wall and the upper part of said gas-passage, and said restricter means comprising a metal plate carried by said base-wall in said upper part of said gas-passage, said metal plate having a hole around said drive-shaft.

12. A bell furnace of a type described comprising, in combination, a base, a removable outer heating bell, a removable inner hood cooperating with said base to form an enclosed charge-space, said base having a hole passing through it, means for permeating said charge-space with a controlled atmosphere at a pressure-value above ambient atmospheric air, said means comprising a fan having a drive shaft passing through said hole, a gas-seal between said base and drive-shaft, and means for maintaining the gas-pressure at the inner side of said seal at a pressure-value intermediate that of the first said pressure-value and ambient atmospheric air.

13. A base-structure for a bell furnace of a type described, said base-structure comprising a base having a lower metal base-plate, said base further having an upper non-metallic refractory wall, said base having an upstanding central hole passing through said base-plate and said wall, a drive-shaft in said hole clearing sides of said wall

8

and forming a gas-passage therewith, a fan secured to said drive-shaft above said wall, a gas-seal between said drive-shaft and base-plate, a duct-passage comprising an intake opening in the top of said wall, and an outlet opening in said wall at said hole, and a channel in said wall extending between said openings.

14. A base-structure suitable for a bell furnace of a type described, said base-structure comprising a base having a lower metal base-plate, said base further comprising an upper non-metallic refractory wall, said base having an upstanding central hole passing through said base-plate and said wall, a drive-shaft in said hole clearing sides of said wall thereat for forming a gas-passage therewith, a fan secured to said drive-shaft above said wall, a gas-seal between said drive-shaft and base-plate, a by-passing channel in said wall having an intake near the peripheral portion of said fan and a discharge at said hole below said fan, and a gas-supply pipe means having a discharge at said hole, the last said discharge being below the first said discharge but above said gas-seal.

JOHN G. HOOP.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,499,627	Thelen	July 1, 1924
1,581,911	Bogaty	Apr. 20, 1926
1,976,557	Haskell	Oct. 9, 1934
2,265,027	Davis	Dec. 2, 1941
2,439,127	Dailey et al.	Apr. 6, 1948