Jan. 7, 1964 R. J. FRIEDRICH 3,117,064

SHOCK HEATER

Filed July 3, 1961

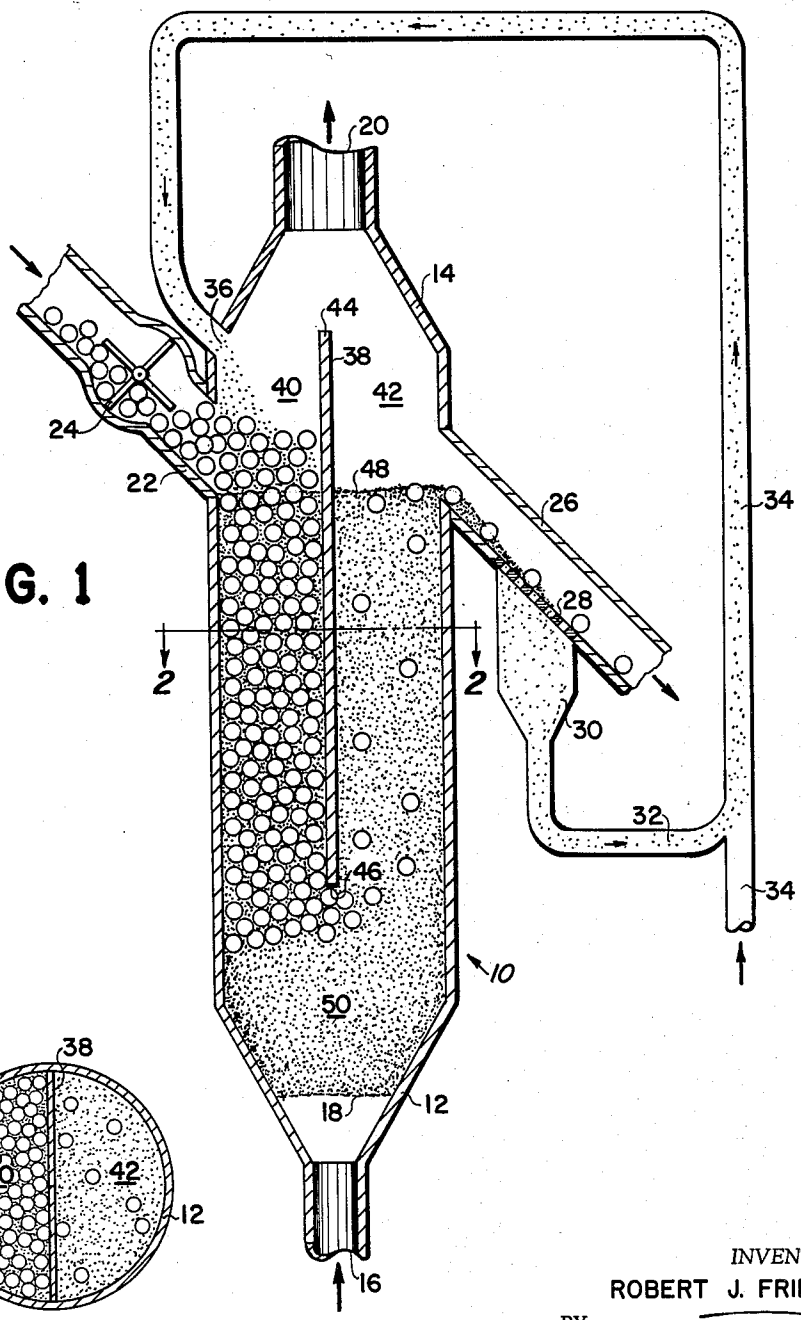


FIG. 1

FIG. 2

INVENTOR.
ROBERT J. FRIEDRICH
BY Stanley J. Price
HIS ATTORNEY

United States Patent Office 3,117,064 Patented Jan. 7, 1964

3,117,064

SHOCK HEATER

Robert J. Friedrich, Finleyville, Pa., assignor to Consolidation Coal Company, Pittsburgh, Pa., a corporation of Pennsylvania

Filed July 3, 1961, Ser. No. 121,485
10 Claims. (Cl. 202—14)

This invention relates to a method of heat treating heat sensitive particulate material and more particularly to a method of shock heating briquets prepared from caking coal and porous inert ingredients.

For many years industry has been seeking a method of preparing high strength low density uniform size lumps of coke from caking coals, particularly high volatile caking coals. Virtually all coke employed by industry today is prepared in expensive by-product coke ovens which require for preparation of satisfactory coke an extensive exposure of caking coal to high temperature conditions. High volatile caking coals are, in general, unsuitable for use as a coke oven feed material unless blended with low and/or medium volatile coals.

In copending U.S. application Serial No. 61,318, filed October 7, 1960 entitled "Method for Preparing Coked Briquets From Caking Coals," now Patent No. 3,018,226 there is described a method of preparing briquets from caking coals which permits preparation of satisfactory coked briquets. One essential step in the method described is the shock heating of the pressed briquets to convert the briquets into coked forms possessing a continuum of carbonaceous structure, low density and high strength. The shock heating step includes maintaining the briquets at a temperature of between 900 and 1250° F. for a sufficient period of time before being subjected to further thermal treatment.

The process described in the above-mentioned copending U.S. application describes preparing under pressure briquets of finely divided caking bituminous coal and porous inert ingredients. The formed briquets are thereafter subject to shock heating whereby the outer surface of the briquet is virtually instantaneously raised to a temperature in the range of 900 to 1250° F. The outer surface of the briquet is maintained at that temperature until the entire briquet has attained a temperature in the range of 900 to 1250° F. It is preferable during the initial stages of the shock heating to maintain the briquets in touching relation with each other and without relative movement one to the other. After the briquets have been heated they are then calcined at temperatures in excess of 1550° F. to volatilize the material further and to graphitize the carbonaceous continuum of the briquet. After calcining, the briquets are cooled to a temperature below the kindling temperature of the briquet as quickly as possible and the cooled briquets are recovered as product.

This invention is directed primarily to a new and improved method of shock heating the pressed briquets and providing an improved and more efficient continuous method for heat treating a fragile heat sensitive material.

With my improved method a dense phase fluidized bed of inert material is maintained in a heat treating vessel. An inventory of raw briquets is introduced into the heat treating vessel adjacent the top portion of the dense phase fluidized bed of inert material. The inventory of raw briquets is confined to a section of the heat treating vessel and, because of the slight difference between the apparent density of the raw briquets and the fluidized density of the dense phase fluidized bed of inert material, the briquets descend into the dense phase fluidized bed of inert material and a substantial portion of the briquets remains below the top surface of the fluidized bed in heat exchange relation with the inert material in the fluidized bed. The raw briquets are contiguous and form

a unitary mass. There is no substantial relative movement of the briquets one to the other. The mass of briquets is maintained below the top surface of the fluidized bed for a predetermined period of time. A second inventory of briquets is introduced into the heat treating vessel and, because of their weight, move the first inventory or mass of briquets downwardly through the dense phase fluidized bed to a point in the heat treating vessel where the briquets are permitted, because of their buoyancy, to rise to the top surface of the dense phase fluidized bed. The treated briquets are withdrawn from the upper surface of the fluidized bed. It should be appreciated that, although described as a semi-continuous process, a continuous feeding of the raw briquets to the heat treating vessel is also within the scope of this invention. The critical factor involved is maintaining the briquets below the top surface of the dense phase fluidized bed of inert material a predetermined time until the entire briquet reaches a predetermined temperature.

My improved method for treating heat sensitive particulate material employs the advantages of the fluidized bed type heat exchanger. The fluidized bed heat exchanger may be defined as a vessel having an inventory of particulate solid particles suspended therein by means of a fluidizing gas passing upwardly therethrough. The particulate solid particles so suspended define a fluidized bed which exhibits many characteristic properties of a liquid confined in a heat exchange vessel. The fluidized bed acts as a heat reservoir and exhibits a rapid rate of heat transfer. This rapid rate of heat transfer is ideal for shock heating or instantaneously heating the outer surface of a raw briquet to form a hardened shell thereon and minimize cracks and fissures in the outer surface of the briquet. More important, the shock heating prevents the clustering of the individual briquets as occurs when slow heating rates are employed such as in conventional indirectly heated calciners or coke ovens. The relatively constant temperature and uniform rate of heat exchange between the heated fluidized inert material and the briquet provides an ideal manner of uniformly heating the entire briquet while the surface temperature remains substantially constant. The difference between the apparent density of the briquets and the fluidized density of the fluidized bed of inert material provides a means for conveniently discharging the heat treated briquets from the heat treating vessel. With my improved method the briquets are retained in contiguous relation and without relative movement one to the other during the heat treating operation. This provides for minimum abrasion of the briquets.

Accordingly, the principal object of this invention is to provide an improved method of heat treating heat sensitive particulate material.

Another object is to provide an improved method of heat treating briquets in a manner that the briquets are maintained in contiguous relation and without relative movement one to the other.

Another object of this invention is to prevent clustering of briquets prepared from caking coal and porous inert ingredients as they are heated.

A further object of this invention is to provide an improved method of heat treating a heat sensitive particulate material in a dense phase fluidized bed of inert material.

These and other objects of this invention will be more particularly pointed out and distinctly claimed in the following specification, the appended claims, and the accompanying drawings.

In the accompanying drawings, to be taken as part of this specification, there is clearly illustrated a preferred embodiment of this invention, in which drawing FIGURE 1 is a sectional view in elevation illustrating apparatus that may be employed to practice my improved process.

FIGURE 2 is a section taken along the line 2—2 of FIGURE 1.

Referring to the drawings and particularly to FIGURE 1, the numeral 10 generally designates a heat treating vessel which may be substantially cylindrical in shape and having a conical lower portion 12 and a conical upper portion 14. A gas inlet 16 is provided at the bottom of the vessel. A grid or screen 18 extends across the vessel adjacent the inlet 16. There is provided an outlet 20 at the top of the vessel 10 through which the gas and entrained vapors are withdrawn. There is an inlet conduit 22 through which briquets or heat sensitive fragile material is introduced into the heat treating vessel 10. A lock hopper type of valve means 24 is provided in conduit 22 to regulate the feed of the briquets into the heating vessel 10 and prevent the escape of gas and vapors through conduit 22. A briquet withdrawal conduit 26 extends from heat treating vessel 10 preferably at an inclined angle as illustrated so that the briquets and a portion of the inert material flow by gravity therethrough. The conduit 26 has a plurality of openings 28 of a predetermined size to permit the smaller inert particulate material to pass therethrough and the briquets thereover. Although not shown, valve means may be provided in conduit 26 to control the rate of withdrawal of the inert particulate material and the treated briquets from vessel 10. The valve means may be similar to valve means 24 in conduit 22 and serves to prevent the fluidizing gas and vapors from escaping through conduit 26.

A collector means 30 is positioned below the openings in conduit 26 to recover the particulate inert material which passes through openings 28. The collector 30 is connected by means of conduit 32 to a return conduit 34. The return conduit 34 is connected to a source of gas under pressure which conveys the inert material withdrawn through apertures 28 back to the heat treating vessel 10 through opening 36. The gas entering conduit 34 may be, if desired, a combustion supporting gas that will burn the abraded carbonaceous particles and heat the inert material as it is conveyed through the conduit 34.

A vertical plate 38 is positioned within the vessel 10 and extends thereacross as illustrated in FIGURE 2 to form a first chamber 40 and a second chamber 42. The plate 38 has a top edge 44 which extends above the conduits 22 and 26, and bottom edge 46 which is substantially below the conduit 22. There is formed by means of plate 38 a third chamber generally designated by the numeral 50 which is below both chambers 40 and 42 and which connects these chambers to each other.

Within the vessel 10 there is an inventory of inert particulate material such as sand, quartz or the like. The inert particulate material is of such a size that it will form a dense phase fluidized bed with a top portion 48 which extends slightly above the lower portion of the discharge conduit 26. The height of the fluidized bed of inert material is dependent upon the size of the particulate material and the velocity of the gas entering through inlet 16 as well as the total inert inventory and the recycle rate through conduit 34. The inert particulate material is maintained at a temperature of between 900 and 1250° F. by means of employing an oxygen free fluidizing gas at an elevated temperature. The heat of the gas is transferred to the inert material to thereby provide a heat sink of heated inert particles in a fluidized state. It should be understood that heat may be provided to the vessel in other ways such as through the side wall of the vessel or the like. The exterior walls of the vessel may be provided with an insulating material or the like to minimize heat loss by radiation.

As an example of one application of my method, raw briquets, that is, briquets prepared by the formulation and method discussed in copending U.S. application Serial No. 61,318, filed October 7, 1960, now Patent No. 3,018,226, are introduced through conduit 22 into chamber 40. The fluidized density of the fluidized bed of inert material is preferably about 70 pounds per cubic foot. The apparent

density of the raw briquets is preferably about 54 pounds per cubic foot. As the briquets are introduced into the chamber 40 there is a tendency for the briquets to float on the upper surface 48 of the fluidized bed. As additional briquets are introduced into chamber 40 their cumulative weight is such that the bottom-most layers of briquets move downwardly below the top surface of the fluidized bed and are submerged in the heated fluidized bed of inert material. The addition of other raw briquets through conduit 22 causes the lowermost briquets in the mass to progress further downwardly through the fluidized bed of inert material. It should be noted at this point that the fluidized bed of inert material has substantially the same temperature throughout so that the briquets, although progressing downwardly through the dense phase fluidized bed, are subjected to substantially the same temperature. As the briquets progress downwardly from chamber 40 into chamber 50 the agitating action of the fluidized bed and the difference in gravities between the fluidized bed and the briquets causes the briquets to move upwardly through chamber 42 to the top surface of the fluidized bed and to float thereon.

A predetermined amount of particulate material is continuously withdrawn from the vessel 10 through outlet 26. The withdrawn inert material carries the treated briquets therewith and both the inert material and treated briquets progress by means of gravity downwardly through inclined outlet conduit 26. The inert material passes through apertures 28 into collector 30. Abraded carbonaceous particles are also carried with the inert material into collector 30 and then the inert material is returned to the heat treating vessel 10 through conduit 34 to inlet 36. As previously discussed, the carrier gas which returns the inert material from collector 30 to the vessel 10 may be a combustion supporting gas which will burn the abraded carbonaceous material withdrawn with the inert material through apertures 28.

It is highly desirable to provide a method of heat treating the fragile briquets in a manner that the briquets are in contiguous relation and there is a minimum movement of the raw briquets relative to each other. After the briquets have been heat treated and a firm shell is formed on the briquet surface, the movement of the briquets relative to each other is not of major importance.

To introduce the briquets through conduit 22 into the heat treating vessel 10 in a manner that there is a minimum of movement between the raw briquets, a periodic introduction of a batch or contiguous mass of briquets may be employed. The briquets may also be introduced continuously through conduit 22 into the heat treating vessel 10. It will be appreciated that it is highly desirable to maintain minimum movement of the raw briquets relative to each other and thereby minimize breakage and abrasion losses.

My improved process has been described in connection with the shock heating of raw briquets of carbonaceous material and inert material. It should be understood, however, that my improved process is equally applicable to the heat treating of other heat sensitive solids wherein it is desired to maintain the heat sensitive particulate material at a desired temperature for a predetermined period of time while there is a minimum relative movement of heat sensitive particulate material.

My improved process may also be employed in heat treating carbonaceous material at temperatures above the temperatures heretofore described. For example, my improved process may be employed to calcine the shock heated briquets in another vessel at a higher temperature. My improved process provides a means for transferring heat to the carbonaceous material while maintaining accurate control of the time the material is subjected to the heating process.

According to the provisions of the patent statutes, I have explained the principle, preferred construction, and mode of operation of my invention and have illustrated

and described what I now consider to represent its best embodiment. However, I desire to have it understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically illustrated and described.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A method of heat treating heat sensitive particulate material which comprises maintaining an inventory of inert particles at an elevated temperature in a heat treating zone, passing a gas upwardly through said heat treating zone at a velocity sufficient to maintain the inert particles in a fluidized condition so that said inert particles comprise a unitary dense phase fluidized bed, introducing heat sensitive particles into said heat treating zone, submerging said heat sensitive particles in said dense phase fluidized bed of inert particles, maintaining said heat sensitive particles submerged in said dense phase fluidized bed of inert particles for a predetermined time and in contiguous relation without substantial movement of said heat sensitive particles relative to each other, and thereafter withdrawing said heat sensitive particles from said heat treating zone.

2. A method of heat treating heat sensitive particulate material which comprises maintaining an inventory of inert particles at an elevated temperature in a heat treating zone, passing a gas upwardly through said heat treating zone at a velocity sufficient to maintain the inert particles in a fluidized condition so that said inert particles comprise a unitary dense phase fluidized bed, introducing heat sensitive particles into said heat treating zone, submerging said heat sensitive particles in said dense phase fluidized bed of inert particles, maintaining said heat sensitive particles submerged in said dense phase fluidized bed of inert particles for a predetermined time, maintaining said heat sensitive particles in contiguous relation without substantial movement of said heat sensitive particles relative to each other while submerged in said dense phase fluidized bed of inert particles, thereafter permitting said heat sensitive particles to rise through said dense phase fluidized bed of inert particles and float on the top surface thereof, and withdrawing said heat sensitive particles from said heat treating zone adjacent the top surface of said dense phase fluidized bed of inert particles.

3. A method of heat treating heat sensitive particulate material which comprises maintaining an inventory of inert particles at an elevated temperature in a heat treating zone, passing gas upwardly through said heat treating zone at a velocity sufficient to maintain the inert particles in a fluidized condition so that the inert particles comprise a unitary dense phase fluidized bed having a predetermined fluidized density, introducing heat sensitive particles into said heat treating zone adjacent the top of said dense phase fluidized bed of inert particles, said heat sensitive particles having an apparent density less than the fluidized density of said fluidized bed, positioning said heat sensitive particles below the top surface of said dense phase fluidized bed of inert particles, maintaining said heat sensitive particles below the top surface of said dense phase fluidized bed of inert particles for a predetermined time, maintaining said heat sensitive particles in contiguous relation without substantial movement of said heat sensitive particles relative to each other while submerged in said dense phase fluidized bed of inert particles, releasing said heat sensitive particles so that said heat sensitive particles rise through the dense phase fluidized bed of inert particles and float on the top surface thereof, and withdrawing the heat sensitive particles from said heat treating zone adjacent the top surface of said dense phase fluidized bed of inert particles.

4. A method of treating heat sensitive fragile particulate material which comprises maintaining an inventory of inert particles at an elevated temperature in a heat treating zone, passing gas upwardly through said heat treating zone at a velocity sufficient to maintain the inert particles in a fluidized condition so that the inert particles comprise a unitary dense phase fluidized bed having a predetermined fluidized density, introducing an inventory of heat sensitive fragile particulate material into said heat treating zone adjacent the top of said dense phase fluidized bed of inert particles, said heat sensitive fragile particulate material having an apparent density less than the fluidized bed density, maintaining said heat sensitive fragile particulate material in particle-to-particle contact and without relative movement of said heat sensitive fragile particles relative to one another while moving said heat sensitive particles downwardly through said fluidized bed of heated inert material a predetermined distance to thereby transfer heat from said inert particles to said heat sensitive fragile particles, thereafter permitting said heat sensitive particles to rise through said dense phase fluidized bed of inert particles and float on the top surface thereof, and withdrawing the heat sensitive particles from said heat treating zone adjacent the top surface of said dense phase fluidized bed of inert particles.

5. A method of shock heating fragile briquets of carbonaceous material which comprises maintaining an inventory of inert particles at a temperature of between 900 and 1250° F. in a heat treating zone, passing a gas upwardly through said heat treating zone at a velocity sufficient to maintain said inert particles in a fluidized condition so that said inert particles comprise a unitary dense phase fluidized bed having a predetermined fluidized density, introducing an inventory of fragile briquets into said heat treating zone adjacent the top of said dense phase fluidized bed of inert particles, said briquets having an apparent density less than the fluidized density of said dense phase fluidized bed, maintaining said briquets in briquet-to-briquet contact and without relative movement of said briquets relative to one another, moving said briquets below the top surface of said dense phase fluidized bed, maintaining said briquets below the top surface of said dense phase fluidized bed for a predetermined time to thereby transfer heat from said inert particles to said briquets, thereafter permitting said briquets to rise through said dense phase fluidized bed of inert particles and float on the top surface thereof, and withdrawing said briquets from said heat treating zone adjacent the top surface of said dense phase fluidized bed of inert particles.

6. A method of shock heating fragile briquets of carbonaceous material which comprises maintaining an inventory of inert particles at a temperature of between 900 and 1250° F. in a heat treating zone, passing a gas upwardly through said heat treating zone at a velocity sufficient to maintain said inert particles in a fluidized condition so that said inert particles comprise a unitary dense phase fluidized bed having a predetermined fluidized density, introducing an inventory of fragile briquets into said heat treating zone adjacent the top of said dense phase fluidized bed of inert particles, said briquets having an apparent density less than the fluidized density of said dense phase fluidized bed, maintaining said briquets in briquet-to-briquet contact and without relative movement of said briquets relative to one another, moving said briquets below the top surface of said dense phase fluidized bed, maintaining said briquets below the top surface of said dense phase fluidized bed until the briquets are heated throughout to a temperature of between 900 and 1250° F., thereafter permitting said briquets to rise through said dense phase fluidized bed of inert particles and float on the top surface thereof, and withdrawing said briquets from said heat treating zone adjacent the top surface of said dense phase fluidized bed of inert particles.

7. A method of shock heating fragile briquets of carbonaceous material which comprises maintaining an inventory of inert solid particles in a heat treating zone of a temperature of between 900 and 1250° F., said heat treating zone being separated into a first chamber, a second chamber and a third chamber, said third chamber

being below and connecting said first chamber to said second chamber, passing a gas upwardly through said heat treating zone at a velocity sufficient to maintain the inert particles in a fluidized condition so that said inert particles comprise a unitary dense phase fluidized bed having a predetermined fluidized density, introducing an inventory of fragile briquets into said first chamber adjacent the top of said dense phase fluidized bed of inert particles, said briquets having an apparent density less than the fluidized density of said dense phase fluidized bed, maintaining said briquets in contiguous relation without substantial movement of said briquets relative to each other, moving said briquets below the top surface of said dense phase fluidized bed in said first chamber, moving said briquets downwardly through said dense phase fluidized bed in said first chamber at a predetermined rate to thereby transfer heat from said inert particles to said briquets, thereafter introducing said briquets from said first chamber into said third chamber, introducing said briquets from said third chamber into said second chamber thereby permitting said briquets to move upwardly through said dense phase fluidized bed of inert particles in said second chamber and float on the top surface of said dense phase fluidized bed in said second chamber, and withdrawing said briquets from said second chamber adjacent the top surface of said dense phase fluidized bed of inert particles.

8. The method set forth in claim 6 which includes withdrawing a portion of said inert particles from said heat treating zone with said briquets, separating said inert particles and abraded carbonaceous material from said briquets and introducing said separated inert particles and said abraded carbonaceous material into a conduit and conveying said inert particles and said abraded carbonaceous material in a combustion supporting gas to said heat treating zone, said abraded carbonaceous material being burned in the presence of said combustion supporting gas to thereby heat a portion of said inert particles.

9. A method of shock heating fragile briquets of carbonaceous material which comprises maintaining an inventory of inert particles in a heat treating zone, passing a gas at an elevated temperature upwardly through said heat treating zone at a velocity sufficient to maintain said inert particles in a fluidized condition so that said inert particles comprise a unitary dense phase fluidized bed having a predetermined fluidized density, said gas being at a sufficiently high temperature to maintain said inert particles in said unitary dense phase fluidized bed at a temperature of between 900 and 1250° F., introducing an inventory of fragile briquets into said heat treating zone adjacent the top of said dense phase fluidized bed of inert particles, said briquets having an apparent density less than the fluidized density of said dense phase fluidized bed, maintaining said briquets in briquet-to-briquet contact and without relative movement of said briquets relative to one another, moving said briquets below the top surface of said dense phase fluidized bed, maintaining said briquets below the top surface of said dense phase fluidized bed for a predetermined time to thereby transfer heat from said inert particles to said briquets, thereafter permitting said briquets to rise through said dense phase fluidized bed of inert particles and float on the top surface thereof, and withdrawing said briquets from said heat treating zone adjacent the top surface of said dense phase fluidized bed of inert particles.

10. The method set forth in claim 9 wherein said unitary dense phase fluidized bed has a fluidized bed density of about 70 pound per cubic foot and said fragile briquets have an apparent density of about 54 pound per cubic foot.

References Cited in the file of this patent

UNITED STATES PATENTS

2,343,780	Lewis	Mar. 7, 1944
2,638,684	Jukkola	May 19, 1953
2,871,004	Gorin	Jan. 27, 1959