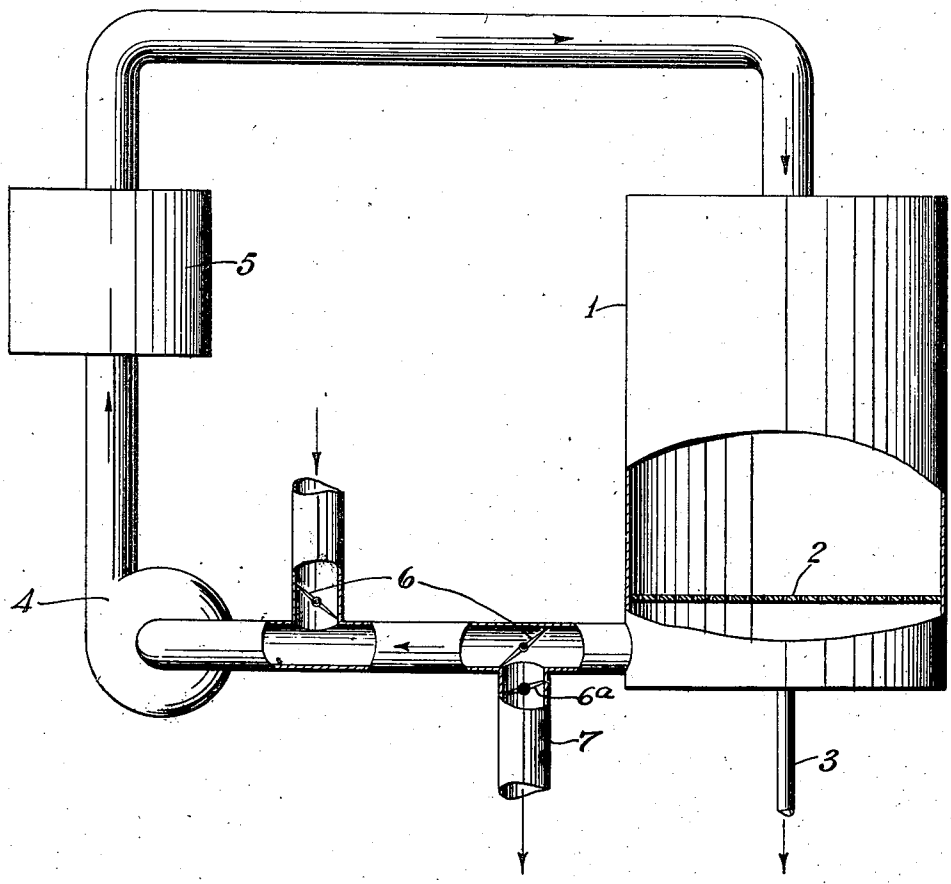
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DRYING OF SMOKELESS POWDER

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DRYING OF SMOKELESS POWDER

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This invention pertains to the manufacture of smokeless powder, and more particularly to an improved method applicable to the art of finishing smokeless powders.

In general, the manufacture of smokeless powder involves a thorough mixing of the various ingredients thereof, including nitrocellulose. To facilitate the production of a substantially uniform material, as well as to decrease the hazard of operation, solvents such as ether, alcohol, acetone, and the like, or mixtures thereof, are added to the other ingredients prior to said mixing operation. The colloided mass resulting is formed into grains of the desired size, usually by extrusion in the form of strings of desired cross-section, and cutting said strings to the proper length. The green powder is then subjected to a solvent recovery operation during which most of the solvent is removed, the recovery of which is effected by various methods. Usually, after the solvent recovery operation, the powder is dried further in order to reduce the residual solvent content therein to the value deemed necessary for suitable ballistic performance. In certain types of powders, this is done by leaching the powder in water at elevated temperatures, the water serving to displace most of the solvent in the powder. The water-wet powder is then dried by means of air until the absorbed moisture content has been reduced to a value which is approximately in equilibrium with normal atmospheric conditions.

During the water leaching process for reducing the solvent content, the powder grains develop a more or less opaque appearance. It is common knowledge to those skilled in the art, that, if the opaqueness of the powder exceeds a certain limit, the powder will not regain the desired translucent appearance during the final air drying operation. Since the degree of opaqueness which the powder attains during the water leaching process varies directly with the solvent present in the powder, the processing of the smokeless powders heretofore has involved either continuing the solvent recovery operation beyond the point where it is economical to recover the solvent, or subjecting the powder to a preliminary drying prior to the water leaching treatment, in order that the solvent content be reduced below the critical limit, said limit varying with changes in composition and granulation of the powder.

The object of the present invention is an improved method of producing smokeless powder Another object is a method which permits the production of a satisfactory smokeless powder when the residual solvent content is decreased by water leaching without necessitating preliminary drying prior to said leaching treatment. A further object is a method of drying powder after it has been leached in water, which yields a satisfactory powder even though the solvent content of said powder exceeds the limits heretofore considered critical. Other objects will become apparent as the invention is described more fully hereinafter.

We have found that the foregoing objects are attained by drying the powder in such manner that a gradual removal of the moisture is effected at high temperatures. Such removal of moisture quite surprisingly permits the formation of translucent grains of powder even though the solvent content of the powder subjected to the leaching treatment exceeds the value heretofore deemed critical. This desirable result is augmented appreciably if, after the moisture content of the powder has been reduced to the desired value, the heating of the powder is continued for a predetermined period in a closed system, so that the moisture content is kept constant. This continued heating of the powder, while maintaining a constant moisture content, not only tends to improve the appearance of the grains but likewise prevents finished powder of satisfactory appearance from becoming opaque during long storage periods.

A comprehensive study of powders subjected to water leaching has revealed that the moisture content of the powder thus treated is influenced by the amount of solvent present in the powder at the time it is placed in the water; that is to say, an increase in solvent content of the powder causes it to absorb more water during the leaching process. This increased moisture content, however, does not prevent the final production of a translucent grain, even though the grains become more opaque during the leaching treatment than powders of lower solvent content. That a gradual removal of moisture at high temperatures during the final drying of the powder should achieve such results is very unexpected, since those skilled in the smokeless powder art have believed that powder grains became opaque because the water, in displacing the water-soluble solvent, e. g. alcohol, caused some very small amounts of nitrocellulose held in solution with said solvent to be precipitated, thereby causing the grains to become opaque. Moreover, it was felt that, once precipitation of the nitrocellulose occurred, it could never be eliminated, because

the solvent content of the usual powder grain when removed from the water is too low to dissolve and redistribute said precipitated nitrocellulose. That this theory is not absolutely correct will become apparent as the invention is described hereinafter.

The powder to be treated in accordance with our process is placed in a suitable receptacle, and air heated to the operating temperature is forced through the powder by means of a blower or fan, and then returned to the suction of the blower to be recirculated. This procedure is continued until the entire powder bed has been raised to a suitable operating temperature. A small portion of the moisture-laden air is then discharged and an equivalent volume of outside air is introduced into the system. The rate of drying thus may be readily controlled by adjusting the proportion of outside or new air to be recirculated, the drying being continued until the desired moisture content has been attained.

Apparatus adapted for carrying out the invention is illustrated in the accompanying drawing, which shows a schematic plan of the various equipment involved. The numeral **1** represents a receptacle adapted to receive the powder to be treated, said receptacle having near the top a baffle or other means (not shown) to distribute the drying medium. The false bottom **2** serves to retain the powder, yet permits flow of gases therethrough. After the powder has been charged into the container **1**, circulation of the air in the direction indicated is effected by the blower, the dampers **6** being shut so that the system is closed. The desired operating temperature is attained by means of the heater **5**. Any liquid moisture exiting from the base of the powder bed is drained through the line **3**, which is provided with a trap or other suitable means for this purpose. The damper **6***a* is disposed in the exhaust pipe **7** to permit the same to be completely closed.

Our preferred procedure contemplates heating the air to the maximum permissible temperature and passing said air down through the powder. This downward flow is advantageous because it removes efficiently any moisture which may be entrained therein. The vapor-laden air exiting from the base of the powder bed is recirculated until the grains at the bottom part of the bed have attained the desired temperature; then, the system is gradually purged by exhausting the moist air from the system and introducing thereinto air from the atmosphere, the rate of purging of the system being established by a heat balance involving the particular operating conditions employed. This purging operation is continued until the powder has been reduced to the requisite moisture content. Then, the exhaust and intake vents are closed, and heating of the powder is continued for a period sufficient to produce a translucent powder which will not become opaque during subsequent storage.

The details of operation are illustrated in the following examples.

Example 1

The power employed in this test consisted of a 1200-lb. charge adapted for use in a 155-mm. gun (.055" web). Following the solvent recovery operation, this powder had received the water leaching process but had not been accorded the preliminary air dry treatment. After the powder had been charged into the container, the system was closed, the heater turned on, and air was circulated at 1000 cu. ft. per minute. The air entering the powder chamber was heated to a temperature of 55° C. and this temperature maintained constant. At the end of two hours, the temperature at the bottom of the powder bed was 43.5° C. At this time the dampers were adjusted to discharge 100 cu. ft. per minute of moist air and pull in an equivalent amount of outside air. This intake of new air was such that the temperature of the air leaving the powder did not change noticeably for 4 hours, then gradually rose to about 50° C. after a total elapsed time of 19 hours. At this point the vents were closed, and circulation continued for an additional 26 hours, following which the powder was cooled rapidly by blowing cold air through the bed.

A sample taken at the end of 19 hours was translucent but became opaque on standing approximately one week. However, a sample taken at the completion of the foregoing test remained clear and was at least as satisfactory in appearance as this type of powder is when it has been accorded the preliminary air drying treatment, then leached and dried in the usual manner.

Example 2

Three thousand lbs. of 155-mm. (.055" web) powder were taken, following the solvent recovery operation, and subjected to a preliminary drying and then leached in water. This charge was then introduced into the drying chamber, and air heated to 55° C. was passed into the powder for 2 hours, the air vents being closed. At this point, the powder at the bottom of the bed had attained a temperature of 42.0° C. The vents were then opened and 100 cu. ft. per minute of moist air were discharged, this procedure being continued for 25 hours. During the purging of the system, the temperature of the powder at the bottom of the bed rose to 48.5° C. The vents were again closed and circulation continued for an additional 48 hours, following which the powder was cooled by blowing cold air therethrough. Analyses showed that this powder had the desired moisture content. In addition, it was far superior in appearance to powder of the same composition which is dried in the usual manner.

Thus our invention permits the production of a powder satisfactory in appearance without necessitating that said powder be dried prior to the water-leaching treatment. The elimination of the preliminary drying operation is very advantageous because said operation is costly as well as time consuming. Likewise, it is no longer necessary to extend the solvent recovery operation to the same length as deemed necessary heretofore, because the increase in permissible solvent content means that the solvent content of the powder to be leached can be reduced without impairing the physical appearance of the powder grains. Moreover, the powder grains produced are characterized by substantially uniform moisture content which, of course, is very desirable, because it tends to obviate variations in the ballistic performance of the powder.

It will be obvious to those skilled in the smokeless powder art that many variations may be made without departing from the spirit and scope of our invention. Thus, the apparatus for carrying out our process may include, as an embodiment, a dry house of the type in current use, said dry house being modified in order that it be adapted for carrying out the invention. Con-

sequently we intend to be limited only in accordance with the following claims.

We claim:

1. A method of drying smokeless powder, which comprises heating a charge of said powder to a predetermined temperature by recirculating a hot drying medium through said charge, retaining substantially all of the vapors evolved during said heating period, exhausting the vapor-laden medium being recirculated and introducing an equivalent volume of outside air while maintaining the powder charge at substantially constant temperature, and then continuing recirculation of drying medium for a predetermined period.

2. A method of drying smokeless powder, which comprises placing a powder charge in a closed system, heating said charge to a predetermined temperature by heating the air in said system and recirculating said air through the powder, retaining substantially all of the vapors evolved from said powder during the period required to attain said predetermined temperature, exhausting slowly the vapor-laden air at the same rate at which an equivalent volume of outside air is drawn into the system while maintaining the powder charge at substantially said predetermined temperature, and then continuing recirculation of the air for a predetermined period.

3. A method of removing water from smokeless powder, which comprises recirculating the hot drying medium in a closed system through a bed of powder until said powder attains a desired temperature, retaining substantially all the vapors evolved from the powder during said recirculation, gradually purging the system by exhausting the vapor-laden drying medium to the atmosphere and introducing an equivalent volume of outside air into said system while maintaining the powder bed at substantially constant temperature, then recirculating the drying medium for a predetermined period at said temperature, and then cooling the powder to substantially atmospheric temperature by blowing cold air therethrough.

4. A method of removing water from smokeless powder, which comprises recirculating a hot gaseous medium in a closed system through a bed of powder until said powder attains a desired temperature, retaining substantially all of the vapors evolved from the powder during said recirculation, gradually removing the vapors evolved by exhausting the vapor-laden drying medium to the atmosphere and introducing an equivalent volume of outside air while maintaining the powder bed at substantially constant temperature, continuing the removal of the vapor-laden drying medium until said powder attains the desired moisture content, and then recirculating the drying medium for a predetermined period.

5. A method of finishing smokeless powder, which comprises steeping said smokeless powder in water at an elevated temperature, separating said powder from the water, and heating said powder to a predetermined temperature by recirculating a hot drying medium therethrough in a closed system, retaining substantially all the vapors evolved during said recirculation, exhausting to the atmosphere the vapor-laden medium being circulated and introducing an equivalent volume of outside air while maintaining the powder charge at substantially constant temperature, and then recirculating the drying medium for a predetermined period.

6. A method of removing water from smokeless powder, which comprises recirculating a drying medium through a bed of said powder in a closed system, heating said drying medium to a predetermined temperature immediately prior to its contact with the powder bed, retaining substantially all the vapors evolved from said powder until the powder bed has attained a predetermined temperature, exhausting the vapor-laden medium being recirculated to the atmosphere and introducing an equivalent volume of outside air while maintaining said powder bed at substantially constant temperature, and then recirculating the drying medium for a predetermined period.

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