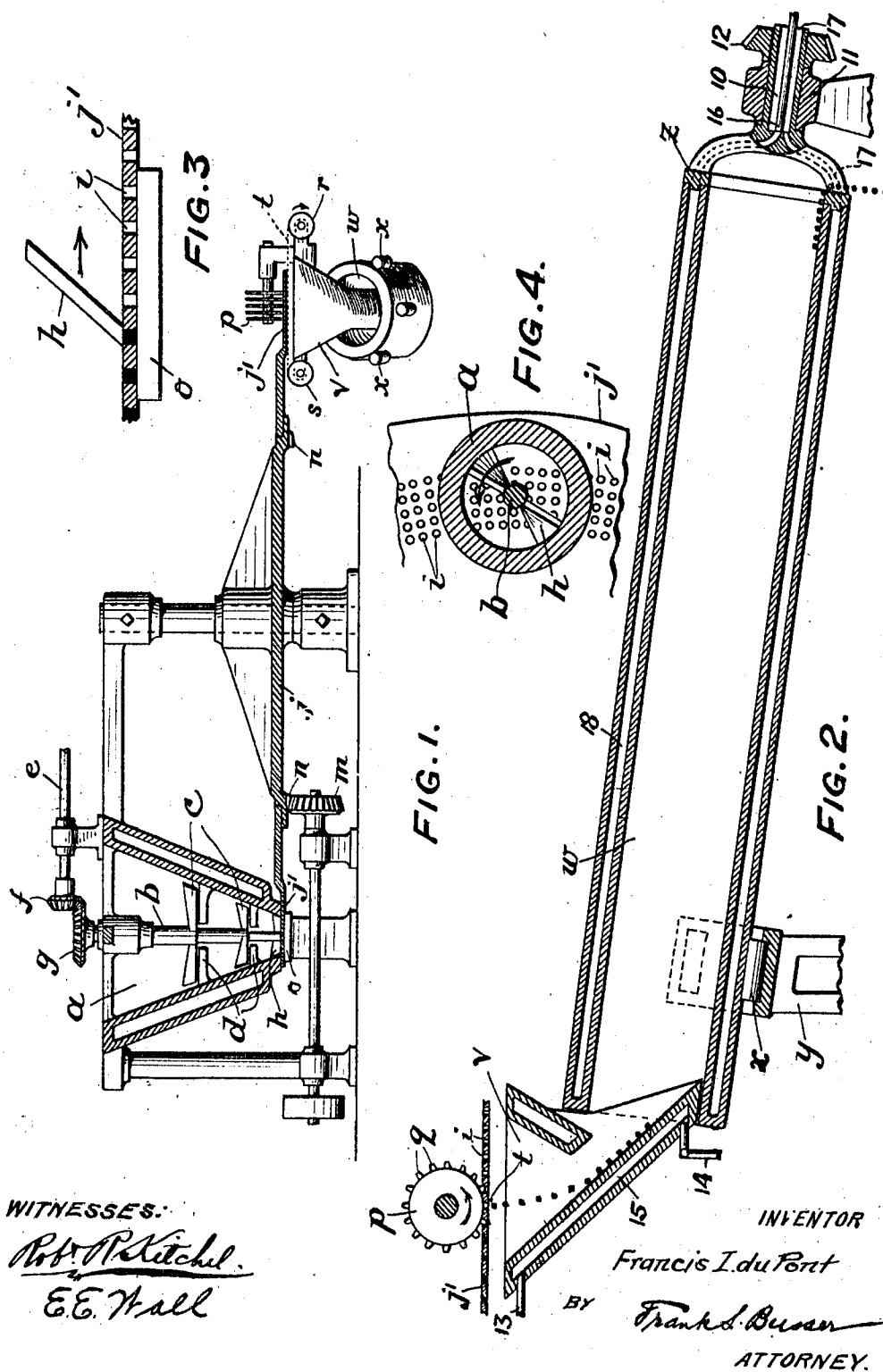


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 APPARATUS FOR FORMING EXPLOSIVE POWDER INTO SPHERICAL GRAINS.
 APPLICATION FILED AUG. 13, 1913.

1,106,138.

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WITNESSES:

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APPARATUS FOR FORMING EXPLOSIVE POWDER INTO SPHERICAL GRAINS.

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Specification of Letters Patent.

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To all whom it may concern:

Be it known that I, FRANCIS I. DU PONT, a citizen of the United States, residing at Wilmington, county of New Castle, and State of Delaware, have invented a new and useful Improvement in Apparatus for Forming Explosive Powder into Spherical Grains, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, which form a part of this specification.

The object of my invention is to provide a machine for practising a process of manufacturing black powder in granular form invented jointly by Ernest du Pont and myself and forming the subject matter of an application for patent filed of even date herewith, Serial No. 784,477. To carry out the said process, the ordinary ingredients of black powder, for example, 73 parts of niter, 16 parts of charcoal and 11 parts of sulfur, are, while in a dry state, thoroughly mixed with water to render the mass pasty. The mass is then subdivided into particles of approximately uniform size and weight and the particles are brought into moving contact with a heated surface, which has the effect of shaping the particles so that they tend to assume the form of balls or spheres.

The object of my invention may be more specifically stated to be the provision of a machine whereby, after the black powder ingredients are mixed and, by means of water, converted into a pasty condition, the process may be carried out entirely automatically.

In the drawings, which show a preferred embodiment of my invention: Figure 1 is a side elevation of a portion of an apparatus embodying my invention; Fig. 2 is a side view showing the remaining portion of the apparatus (shown partly in end view in Fig. 1); Figs. 3 and 4 are enlarged detail views showing how the propeller blades fill the holes in the plate.

The explosive ingredients, in the form of a pasty mass by previous admixture with water as hereinbefore explained, are introduced into a conical receptacle or hopper *a* which is preferably steam-jacketed. Within the receptacle *a* is a vertical revoluble shaft *b* having a number of radial propeller blades *c* more or less inclined to the vertical. Projecting inward from the walls of the receptacle *a* are a number of radial blades or

wings *d*, which just clear the blades *c*. Thereby rotation of the mixture within the receptacle is prevented or obstructed and the same is forced down toward the open bottom of the receptacle. Any suitable means for rotating the shaft *b* may be employed, as, for instance, a driving shaft *e* having a bevel gear *f* in driving engagement with a bevel gear *g* on the shaft *b*. On the extreme lower end of the shaft are inclined blades *h*, similar to the blades *c* but performing the special function of pressing the material through holes *i* in a flat horizontally extending revoluble annular plate *j*, which is virtually the rim portion of a relatively large wheel *j*, rotatable on a vertical axis, and driven by means of a bevel gear wheel *m* engaging a rack *n* arranged on the lower face of the wheel in concentric relation to the wheel's axis and between said axis and the rows of holes *i*. The holes *i* are arranged in rows in concentric relation to the axis and to each other and extend entirely around the wheel near its periphery. The portion of the wheel which, at any given time, covers the outlet of the receptacle *a*, closes said outlet, so that no material can escape from the receptacle except through the holes *i*. The blades *h* press the material into the holes *i* similarly to the manner in which a nail hole is filled with putty by means of a knife, as may be clearly seen by reference to Fig. 3. The holes *i* extend completely through the plate *j* from face to face thereof, but the material is prevented from being forced out of the lower ends of the holes by means of a stationary plate or guard *o*, which immediately underlies that part of the wheel which, at any given time, is beneath the outlet of the receptacle *a*.

At a suitable distance (measuring circumferentially along the rows of holes in the wheel *j*) from the mouth of the receptacle *a* (say 180 degrees therefrom) is arranged a wheel, or series of wheels, *p*, turning on a horizontal axis within a vertical plane extending radially of the axis of the wheel *j*. The wheel, or series of wheels, *p*, is of substantially the thickness of, or slightly thicker than, the width of the annular perforated portion of the wheel *j*, and is provided, on its periphery, with a number of ejectors *q*. These ejectors are shown as fingers or projections arranged in rows corresponding to the number of rows of holes *i*

in the wheel *j*, and are spaced apart to correspond to the spacing apart of the holes *i*, and are adapted to engage the holes *i* somewhat similarly to the manner in which a sprocket wheel engages a sprocket chain. It will thus be understood that the wheel *p* will be driven by reason of its engagement with the perforations in the wheel *j* and need not be otherwise positively driven. It will also be understood that the fingers *q*, as they are projected into the holes *i*, necessarily push out the separate plugs of powder with which the holes have been filled. Preferably the fingers are only of such length as to force the plugs to the lower edge of the holes but not to actually detach them from the wheel, to which they cling by reason of the pasty consistency of the material. To insure the complete detachment of the plugs there is provided a knock-off, preferably in the form of a thread *t*, arranged immediately below the wheel *j* and just in advance of the axis of the wheel *p*. To maintain the thread in a clean condition it is caused to pass from a spool *s* to a spool *r*, the latter being slowly rotated from any suitable driving means. The plugs thus detached from the wheel *j* fall down into a hopper *v* and thence pass into an inclined cylindrical vessel *w*. See Fig. 2. The wall of the vessel *w*, and also the wall of the hopper *v* and particularly the part of the latter upon which the pieces drop, must be heated and to this end are shown as steam-jacketed. The receiving end of the vessel *w* is elevated above the level of the discharge end and is rotatably supported upon rollers *x* on a stand *y*. The open lower end of the vessel *w* has extending therefrom a two-armed spider *z* secured to a hollow shaft 10 extending axially of the vessel *w*. The shaft 10 turns in a bearing 11 and has secured to it a bevel gear 12, which engages any appropriate driving mechanism.

At the left hand side of Fig. 2 are shown a steam-inlet pipe 13 and a steam-discharge or drip-pipe 14, both connected to the steam jacket 15 in the wall of the hopper *v*. At the right hand side of Fig. 2 are shown pipes 16 and 17 performing similar functions. The inlet pipe 16 extends from the jacket 18 in the wall of the vessel *w* through one arm of the spider *z* and thence, through the hollow interior, and along the axis, of the shaft 10. The discharge pipe 17 extends from the jacket 18 through the other arm of the spider *z* and thence through the hollow interior of the shaft 10.

The powder plugs discharged from the wheel *m* by the ejecting wheel *p* and the knock off *t* are each in the shape of short cylinders. Preferably they are not in a substantially heated condition and to enable them to cool somewhat after they are pressed into the holes *i*, the ejecting means

are arranged at a considerable distance from the outlet of the receptacle *a*. It has been discovered that when plugs of this shape, or of any irregular shape, are dropped upon a heated surface and agitated thereon, they tend to assume a spherical form. When, therefore, the powder grains are discharged from the lower end of the vessel *w*, they are rounded and substantially uniform in size. If the material is especially stiff, the grains will less readily tend to assume a perfect spherical form, but even in this case a rounding of the edges will be effected with a resultant good product. It will be understood, therefore, that the invention is not limited to a machine, or apparatus in which the resultant product necessarily approximates a spherical form.

The rolling of the grains or plugs upon a heated surface not only rounds them as above described, but this rolling contact is maintained until they are thoroughly dry. The apparatus also provides for a sufficient circulation of air to carry off the moisture, which is expelled from the particles by means of the heat conducted and radiated from the heated surface.

By reason of the fact that the shaping and drying of the powder grains are entirely effected by the simple operation of conveying the grains to a heated moving surface, the operation may be carried out on a large scale at a small expense.

It will be understood that the invention is not limited to the details of structure shown in the drawings and hereinbefore described, as the same may be varied from, to the extent permitted by the claims, without departing from my invention.

Having now fully described my invention, what I claim and desire to protect by Letters Patent is:

1. In a machine for forming explosive powder into grains whose shape tends to be spherical, the combination with means adapted to separate the explosive into separate particles, and means presenting a moving heated surface adapted to receive the separate particles and form them into balls.

2. In a machine for forming explosive powder into grains whose shape tends to be spherical, the combination with means adapted to separate the explosive into a multiplicity of particles of non-spherical shape, and means presenting a moving heated surface adapted to receive the separate particles and reshape them into approximately spherical form.

3. In a machine for forming explosive powder into grains whose shape tends to be spherical, the combination with means adapted to separate the explosive into separate particles of non-spherical shape, and means presenting a moving heated surface adapted to receive the separate particles

and subject them to a rolling motion (whereby they are rounded) and simultaneously dry them.

4. In a machine for forming explosive powder into grains whose shape tends to be spherical, the combination with means adapted to separate the explosive into a multiplicity of cylindrically shaped particles, a receptacle adapted to receive the particles, means to rotate, and means to heat the receptacle, whereby the particles are simultaneously subjected to heat and to a rolling action, resulting in reshaping the particles into approximately spherical form.

5. In a machine for forming explosive powder into grains whose shape tends to be spherical, the combination with a moving plate having holes, filling means to force the explosive into said holes, a revoluble wheel provided with fingers adapted, in the movement of the plate, to enter said holes and force the plugs outwardly, and means presenting a moving heated surface adapted to receive the plugs and form them into balls.

6. In a machine for forming explosive powder into grains whose shape tends to be spherical, the combination with a moving plate having holes, filling means to force the explosive into said holes and thereby separate the explosive into plugs, means adapted to enter said holes and force the plugs outwardly, a knock-off adapted to detach the plugs from the plate, and means presenting a moving heated surface adapted to receive the plugs and form them into balls.

7. In a machine for forming explosive powder into grains whose shape tends to be spherical, the combination with a moving plate having holes, filling means to force the explosive into said holes and thereby separate the explosive into plugs, means adapted to enter said holes and force the plugs outwardly, a thread extending under and transversely of the direction of movement of the plate and adapted, in the movement of the plate, to detach the plugs therefrom, and means to move the thread in the direction of its length.

8. In a machine for forming explosive powder into grains whose shape tends to be spherical, the combination with a moving plate having holes, filling means to force the explosive into said holes and thereby separate the explosive into plugs, means adapted to enter said holes and force the plugs outwardly, a thread adapted to underlie the plate and, in the latter's movement, detach the plugs from the plate, means to move the thread in the direction of its length, and means presenting a moving heated surface adapted to receive the plugs and form them into balls.

9. In a machine for forming explosive

powder into grains whose shape tends to be spherical, the combination with a moving plate having holes, filling means to force the explosive into said holes and thereby separate the explosive into plugs, a revoluble wheel provided with fingers adapted, in the movement of the plate, to enter said holes and force the plugs outwardly, a thread adapted to underlie the plate and, in the latter's movement, detach the plugs from the plate, and means presenting a moving heated surface adapted to receive the plugs and form them into balls.

10. In a machine for forming explosive powder into grains whose shape tends to be spherical, the combination with a moving plate having holes, filling means to force the explosive into said holes and thereby separate the explosive into plugs, a wheel above the plate and whose axis extends parallel to the plate and at substantially right angles to the direction of movement of the plate at the point of the latter's passage beneath the wheel, said wheel having radial fingers spaced to correspond to the arrangement of the holes in the plate and adapted, as the plate moves, to enter the holes and thereby cause the wheel to revolve and force the plugs outwardly, and means presenting a moving heated surface adapted to receive the plugs and form them into balls.

11. In a machine for forming explosive powder into grains whose shape tends to be spherical, the combination with a moving plate having holes, filling means to force the explosive into said holes and thereby separate the explosive into plugs, ejecting means to discharge the plugs from the holes in the plate, a hopper adapted to receive the discharged plugs, an inclined revoluble cylinder whose upper end communicates with the discharge mouth of the hopper, and means to heat the inner wall of the cylinder and the wall of the hopper upon which said plugs fall.

12. In a machine for forming explosive powder into grains whose shape tends to be spherical, the combination with a receptacle for the explosive having an open bottom, a vertical shaft within the receptacle, blades on the shaft and coating blades on the inner wall of the receptacle extending inward toward the shaft, a wheel rotatable on a vertical axis, a plate carried by the wheel and extending concentrically of the wheel's axis and adapted, in the rotation of the wheel, to travel under and close the mouth of said receptacle, holes extending through the plate, a blade carried by said shaft and located close to the rotating plate and adapted to force the explosive into said holes, a stationary guard plate located underneath the rotating plate, a revoluble wheel arranged above the rotating plate and provided with fingers adapted, in the rotation of the plate,

to enter said holes and force the plugs outwardly, a knock-off thread adapted to underlie the plate and, in the latter's rotation, detach the plugs from the rotating
5 plate, means to move the thread in the direction of its length, a hopper located beneath the knock-off thread and adapted to receive the detached plugs, a revoluble inclined cylinder whose upper end communicates with
10 the discharge mouth of the hopper, and

means to heat the inner wall of the cylinder and the wall of the hopper upon which said plugs fall.

In testimony of which invention, I have hereunto set my hand, at Wilmington, on 15 this 7th day of August, 1913.

FRANCIS I. DU PONT.

Witnesses:

HOWARD GERDAR,
M. M. HAMILTON.