

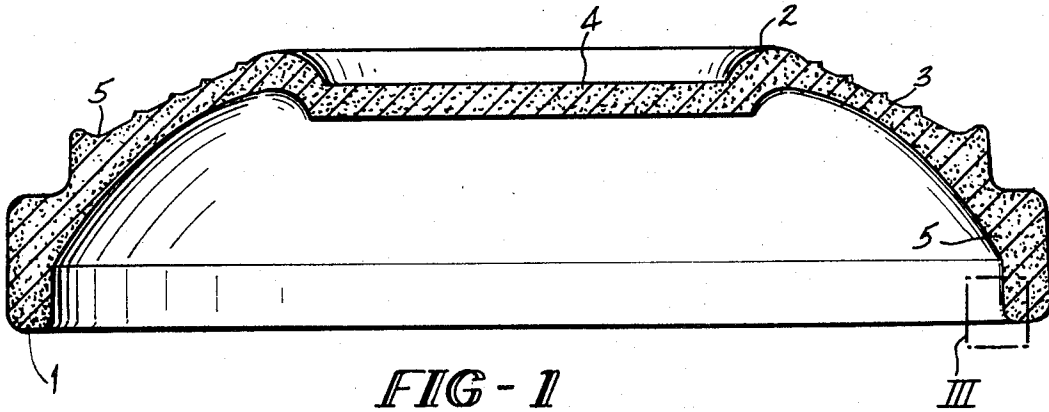
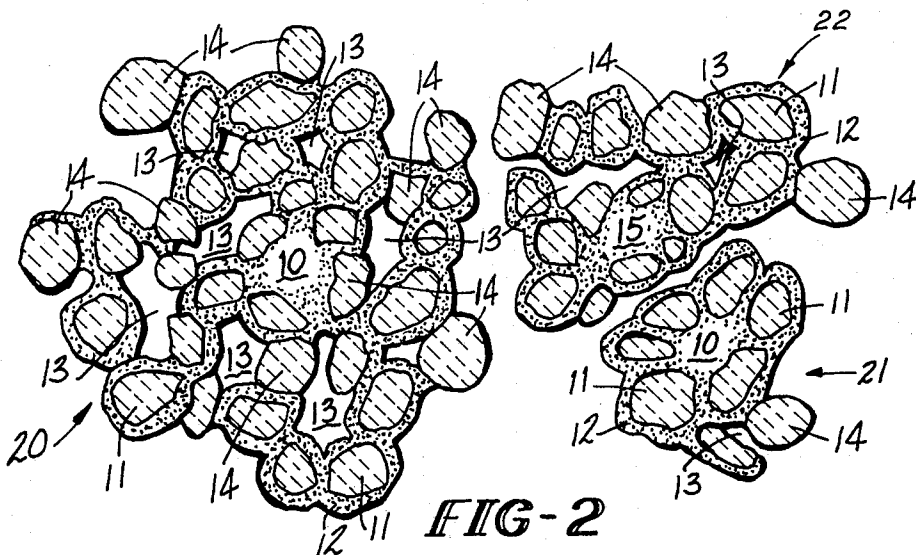
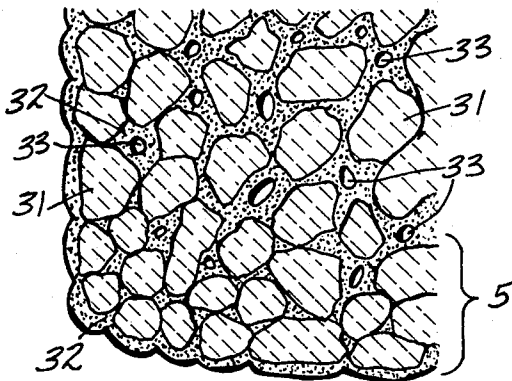
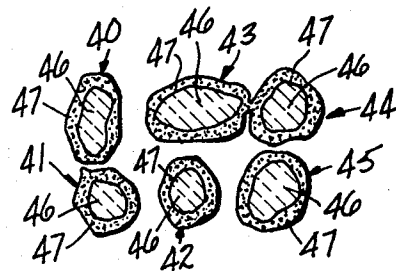
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METHOD FOR PRODUCING PROJECTABLE TARGETS

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METHOD FOR PRODUCING PROJECTABLE
TARGETS

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ABSTRACT OF THE DISCLOSURE

A method of making a projectable target of reduced pitch content by forming a molding powder of a plurality of granules, each granule comprising a filler material encapsulated with pitch, and compacting a predetermined amount of the molding powder under pressure to the size and shape of the target.

This invention relates to a method for producing frangible targets of the type adapted to be launched from throwing devices, such as that described in U.S. Patent No. 2,125,812, granted Feb. 23, 1960, and which once in flight are adapted to be broken to register a hit by at least one shot pellet.

This application is a continuation-in-part of our copending application Ser. No. 338,031, filed Jan. 16, 1964.

An object of this invention is to provide a method for producing targets more economically than targets heretofore available.

Another object is to provide a method for the fabrication of such projectable and frangible targets from an improved composition of molding powder enabling target production not only with speed and economy, but also with reproducible reliability as to their required conformity to accepted standards of projectability and frangibility.

Still another object is an improved process for making frangible targets by compaction of a powder in a tableting press rather than by the pouring and molding of a fairly viscous but fluid mix of hot bituminous material and filler in devices of the type shown in U.S. Patents Nos. 1,238,980 and 2,300,290, accompanied by evolution of considerable fumes and vapors.

Other objects and advantages will come to mind from a description of two embodiments when taken in connection with the accompanying drawing in which:

FIGURE 1 is an elevational view in cross section taken on a diameter of a target made by this invention;

FIGURE 2 is an enlarged cross-sectional view of some typical granules constituting the agglomerate used to make the target according to the first embodiment of this invention;

FIGURE 3 is an enlarged cross-sectional view diagrammatically showing the internal structure of a representative portion III of the target of FIGURE 1; and

FIGURE 4 is an enlarged cross-sectional view of typical granules constituting the molding powder used to make the target according to the second embodiment of this invention.

According to one embodiment of this invention, filler material, such as limestone of suitable fine granulation, has all of its particles at least partially and many thoroughly coated with a brittle binder such as a pitch of the proper character in the least amount found necessary to achieve some particle encapsulation and substantially complete agglomeration and to produce a relatively coarse highly cellular molding powder, the granules of which are adapted to be dry charged and readily flow under pressure in the forming die of a tableting press where the technique of briquetting is used in such a way

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that the granules are compacted to the size and shape of a target. In compaction substantially complete limestone particle encapsulation is achieved in a matrix of pitch. Although it may be done with some success using a hot mix, compaction preferably is done cold and is followed by sintering to produce targets having acceptable appearance and vulnerability to fracture by impact with shot pellets while at the same time having resistance to undue breakage in handling, shipping, and launching under all conditions of climate encountered.

Briefly, the particles of limestone while hot are thoroughly mixed with coarse pitch granules in a minimum amount found suitable. This mixture is then agglomerated and processed to a desired particle size distribution to make a powder which can be molded to shape and size of the target by pressure in contradistinction to melting and casting.

According to a second embodiment of this invention, each individual particle of filler material, such as limestone of suitable granulation, is substantially completely coated with a brittle binder such as pitch of the proper character to produce a molding powder comprised of a plurality of discrete, pitch covered, granules with substantially little, if any, agglomeration. The molding powder is adapted to be dry charged to a press and readily flow under pressure in the forming die of a tableting press where the technique of briquetting is used in such a way that the granules are compacted to the size and shape of a target.

In accordance with the second embodiment, particles of limestone of proper granulation are mixed with particles of pitch in a minimum amount found suitable along with a solvent for the pitch. The solvent dissolves the pitch and disposes it on the surface of the limestone. The solvent is then evaporated leaving substantially discrete particles of pitch covered limestone which can be molded to the shape and size of the target by compacting in a suitable press.

The targets produced in accordance with both embodiments are saucer-shaped (FIGURE 1) having a weight of from about 95 to 105 grams, a diameter of about 4½ inches at the rim 1 and a height of about 1 inch at the annular ridge 2 formed at the top of arch 3 about a central portion 4 known as a "poker chip" upraised with respect to the rim but depressed with respect to the ridge. These have a somewhat thinner wall but a density of about 2.1 grams per cc. as compared to the wall thickness and 1.9 grams or less per cc. that is presently found in targets of this type. Each is quite a special kind of briquette having very critical properties of both coherence and frangibility.

Specifically, the pitch content of the target is at least about 8% by weight but not more than about 25%. Preferably, the pitch content is kept in a range between about 8 and 20%. A pitch content of about 8 to 15% by weight was found to be the best in a standard target weighing around 100 grams. For targets of the miniature class used with pellets shot from a 22 cartridge, the proportion of pitch is increased by not more than about 5 to 10%, not to exceed about 25%.

Heretofore, targets have been made of a bituminous material, such as coal tar pitch and a filler material, such as clay or ground limestone, but to obtain a mixture liquid enough to pour and also the requisite properties in the finished target it has been considered necessary to incorporate a relatively high proportion of pitch in the mixture despite the fact that the pitch is more costly than the filler. By the present invention the proportion of pitch can be considerably reduced.

Furthermore, molding by compaction of powder agglomerate or of substantially discrete particles according to this invention has been found to further reduce the cost

of the targets as compared to molding of a fluid admixture by the prior process comparable to injection molding or die casting. The compact is brought to a finished condition by sintering, which may be done in any suitable way but preferably by radiant heating such as by infra red quartz lamps, thus producing a fusion and capillarity of the pitch and a harder, rougher, and more cohesive but more brittle surface layer 5 on the finished product.

This occurs because sintering drives off excess volatiles mostly from the surface, without either melting or embrittling the whole target. The whole target is thus heat treated most intensely at the surface.

(I) First embodiment

In accordance with the first embodiment, the limestone particles used have a varied granulation preferably in a range of size distribution such that at least about 45% and as much as about 65% pass through from about a 200 mesh to about a 230 mesh screen but all through about a 20 mesh screen (U.S. Sieve Series). Too fine a limestone gives too fine a mixture too "dead" to mold well. Too coarse a limestone crushes excessively upon compaction and causes pitch exudate as well as poor mobility.

The pitch used is usually coal tar pitch having a suitable melting point and a substantially full content of naturally occurring low-boiling volatiles; this pitch is added in the form of relatively coarse particles having a granulation finer than about 10 mesh but mostly about 20 mesh (U.S. Sieve Series).

By pitch is meant a friable binder such as a hard coal tar pitch with (1) high resin content imparting the necessary hardness, brittleness, and cohesiveness and (2) relatively low tar oil content constituting around 20% of the pitch and which, if not lost, gives a content of low boiling oils found useful in the compaction process. Therefore, admixture of the pitch and limestone is done at as low as possible an elevated temperature in as short a time as possible. The resulting agglomerate should not be permitted to age. To avoid excessive crystal growth and/or loss of these volatile oils, residence time from mixing to compaction should not exceed about 75 hours. Pitch having a melting or softening temperature in the range of about 170° F. to about 350° F. may be used but a pitch having a melting point of at least 190° F. and still better up around 250° F. is preferred so as to provide volatiles and to produce a target stable enough at temperatures up to about 140° F. on the shelf and in the field. The 250° F. pitch spreads well not only when heated for agglomeration but also when pressed for molding.

A 12 to 15% pitch:85 to 88% limestone mixture is preferred where fine limestone of size distribution all less than about 20 mesh and largely of less than 200 to 230 mesh is used. A 15% pitch:85% limestone mixture appears to be one of the best. This, however, does not preclude smaller amounts of pitch in the target, especially when the limestone is somewhat coarser because of the presence of a higher proportion of particles in the 200 to 100 mesh range, for example, largely less than 100 mesh.

The molding powder, developed by agglomeration includes considerable encapsulation of the limestone and also many pitch-rich nuclei; it consists of rather coarse granules of agglomerate mostly of about 20 to 50 mesh size, few, if any, finer than about 100 mesh and only a few of 10 to 20 mesh size. This makes for better flow under pressure than a fine powder in which the limestone may be more uniformly and more thinly coated with pitch but which is too "dead" to move properly in the die even when heated. Pelletization is used to advantage.

The approximate structure of the rough granules of the resulting molding powder as shown in FIGURE 2 may be described as involving (1) a somewhat depleted nucleus or core 10 high in pitch surrounded by (2) a mantle of many thinly pitch-encapsulated limestone particles 11 attached to the core and each entrained in a matrix 12 of pitch becoming thinner the farther it runs from the core.

The mantle also includes (3) pores 13 and (4) many partially encapsulated particles 14, particularly where the agglomerate has become a large cluster as in a large granule 20. A smaller granule 21 may consist of the core 10 of pitch coated with what amounts to a single layer of pitch encapsulated limestone particles 11 except for an occasional partly encapsulated limestone particle 14, many of which exist in the form of an appendage, which occurs on all the granules and which also contributes to the desired roughness of the granules. Granules such as 20 and 21 are those which have remained pretty much as they were agglomerated in the mixture. Other granules such as 22 are those which were fractured either in mixing, pulverizing, or screening so that the pitch rich area 15 does not appear exactly as a nucleus or core because it is offset to one side, being a subdivision of the core of a larger cluster originally.

All of the molding powder granules are characterized by much surface roughness and irregularity of shape. The mantle portion, particularly in the larger clusters, is characterized by the presence of fairly high proportion of open voids 13. These, together with the surface roughness, make the density of the resulting agglomerate granule and molding powder quite low despite the high proportion of limestone.

The bulk density of the molding powder is about 1.0 to 1.5 grams per cubic centimeter.

As shown in FIGURE 2 the irregular granules are of various sizes in a distribution range largely within 20 mesh and 50 mesh; preferably practically all pass on a 10 mesh screen and all are retained on a 100 mesh screen. In any event, the molding powder is coarse compared to the granulated limestone so that about 90% or more by weight is retained on a 200 mesh screen, when some fines are included.

The surface roughness, irregularity of shape, presence of voids, and the size of granules in the agglomerate make for a good molding powder of superior cold flow and cohesiveness under pressure.

In processing according to the first embodiment, agglomeration of the limestone filler particles with pitch binder is done in a pelletizer or mixer. First, the limestone is placed in the mixer where it is heated to at least about 260° to 300° F. but above the 170° to 350° F. softening point of the pitch at a temperature depending not only upon the pitch melting point but also upon the fineness of the filler. Granules of pitch are then added and mixing, preferably in a closed system so as not to lose volatiles, is continued at a temperature from about 400° to 450° F. until all of the white of the limestone disappears to the naked eye, and clusters of black and dark grey appear. The hot limestone sticks to and sinks into the pitch until agglomerates are formed about nuclei of pitch. Each nucleus is a core which during mixing heats up, oozes out to form a limestone rich mantle, and feeds the mantle of the growing clusters for further agglomeration after which some pulverizing of the agglomerate occurs in the mixer. As the mixture becomes more homogeneous upon further mixing, thinning out of the matrix and depletion of the nuclei, the growth of the clusters stops and fines may occur. Further mixing, hence, is stopped when practically all of the limestone particles are at least partially encapsulated, but before too many fines develop.

The agglomerated mixture is granulated to a desired size. Most of this may occur in the mixer as the agglomerate is cooled and the mixing continued. Then only the coarse granules need be separated as by screening through about a 10 to 20 mesh screen on about a 50 to 100 mesh screen and further pulverizing the coarser granules. The fines, if produced, are separated for reuse to make more agglomerate. Alternatively, the entire mixture can be put through a separate granulating process and screened.

The molding powder is fed to the die of a tableting press where compaction to size and shape is done at pressures of from about 6½ to about 8½ tons per square

inch at temperatures well below the melting point of the pitch, preferably at from normal room temperatures to about 120° F., using 250° F. pitch. A press force of from about 100 to about 125 tons applied over a target of a diameter of 4¼ inches is satisfactory for cold compaction, done in a suitable briquetting press.

Upon ejection of the "green" target from the press, it is heated for a short time of from half a minute to about two minutes and thus sintered. The surface is most thoroughly sintered by heating to a temperature of at least 350° F. but not in excess of 600° F. Where the molding powder and die are used at room temperature, sintering is conducted for about one and a half minutes at temperatures approaching 550° F.

It will be appreciated that for achieving desired factors of appearance, stability, cohesiveness, and frangibility, it is necessary to adjust the proportions of ingredients, the granulation, temperature of the molding powder, the press force, and the temperatures and time of sintering until exactly the right balance of these factors is obtained.

An alternate processing procedure is to feed the hot molding powder as soon as agglomerated, and before too many fines form, to a hot die in the press to be compacted hot without further need for granulating and sintering. Cold compaction followed by suitable sintering, however, is preferred. This gives better control of the composition and flow in the dies, allows screening out fines, and avoids high loss of volatiles and growth of graphite-like crystallites too soon. For either hot or cold compaction it is contemplated that the same novel composition of agglomerate and target be used.

In compaction the voids 13 in the agglomerate (FIGURE 2) tend to be expressed from or greatly reduced in the clusters 20, 21, and 22 which in turn are deformed and flow under pressure so as to close up the irregular gaps occurring between them as the granules of the molding powder move in the die. In this action the pitch helps drive out and reduce the voids in the clusters and closes the gaps between them as it is extended to complete the encapsulation of all particles and to form the network of matrix 32 and its cells 33, each closed.

As shown in FIGURE 3, this makes in the target a fairly dense structure of limestone particles 31 crushed together except for a cellular matrix 32 of pitch which substantially completely fills the interstices between the particles except for an occasional small void or cell 33 in the matrix. In the surface 5, particles 31 are crushed together most closely and some even broken and the pitch 32 is finally sintered to cause fusion and enrichment of the brittle resin content there.

The finished target is so densified that no less than about 85 to 95% of its volume is made up of the limestone-pitch mixture and the balance voids 33.

In the finished target, because of heating during agglomeration and sintering and discard of fines from the agglomerate, the proportion of pitch is not much different than at the start and changes, if at all, by no more than about 0.5 to 1.5%. For example, starting with 15% pitch in the mixer, the pitch content in the target is around not less than about 14.5 to 13.5%.

The targets have a density of from about 1.95 grams per cc. to about 2.25 grams per cc. and both the limestone and the pitch become more uniformly distributed in the compacted target having a minimum of pitch for the purpose.

It will be recognized that the molding powder granules of pelletized limestone and pitch include (1) a fairly wide distribution of non-uniform sizes of the limestone, predominantly fine particles in the range set forth, (2) a skeletal matrix of the pitch, and (3) various sizes of irregular-walled voids or pores generally interconnected and open to give porosity. The granules of the molding powder itself are not of uniform size but of a continuous wide range of generally coarse size, although the powder includes many finer granules in this distribution range,

which are comparable to some of the coarser limestone particles. This pelletized mixture is of advantageous mobility and formability in the target die. It produces targets which compare favorably to those heretofore made using fluid pitch vehicle filled with from as little as 35% to as high as about 65% limestone by weight.

(II) Second embodiment

In accordance with the second embodiment, the limestone particles used may have a varied granulation preferably in a range such that 99.5% will pass through a 40 mesh screen and only 10% pass through a 200 mesh screen (U.S. Sieve Series). It has been found generally that coarser granulations are favored. If the granulation is too fine, there is too much surface area for proper pitch distribution.

The pitch used is of the type described in the first embodiment and is usually coal tar pitch having a suitable melting point and a substantially full content of naturally occurring low-boiling volatiles. The pitch is added to the limestone in the form of relatively coarse particles, preferably having a granulation such that they will pass through a 10 mesh and most through a 20 mesh screen (U.S. Sieve Series). A 5 to 15% by weight pitch: 85-95% by weight limestone mixture is preferred. More specifically, good results have been obtained with a 9% pitch:91% limestone mixture.

The pitch should have a melting or softening temperature in the range of about 130° F. to 350° F. However, it is to be borne in mind that if too low a melting point is used, the pitch will tend to creep with the result that the targets will deform and collapse when stacked at ambient temperature. It has been found that pitch having a melting point of 250° F. yields satisfactory results.

In processing according to this embodiment, the appropriate amounts of granulated limestone and pitch are placed in a mixer. After the pitch and limestone have been mixed for a short period of time, preferably about five minutes, a solvent for the pitch is added. Suitable solvents include xylene, toluene, carbon tetrachloride, trichloroethylene, and perchlorethylene.

The amount of solvent to be added depends upon the amount of pitch in the mixture. Enough solvent should be present to substantially completely dissolve all the pitch. It has been found that when a 9% pitch:91% limestone mixture is used, the amount of solvent should be about 9% by weight of the pitch and limestone.

After the solvent is added, the mixing is continued until the mixture is dark black in color; generally this takes about 15 minutes. The mixture is then dumped into a vacuum recovering apparatus where, while the mixing is continued, the vaporized solvent is recovered for recycling. The mixing should be continued until substantially all of the solvent is removed. It has been found that if residual solvent remains in the amount of about .7% by weight of the initial amount of solvent, it aids in the subsequent compacting operation.

As shown in FIGURE 4, the above-described process results in a plurality of discrete pitch covered limestone granules 40 to 45. Generally each granule includes a single limestone particle 46 having a coating of pitch 47 thereon. There is substantially no agglomeration as in the first embodiment and consequently there are no voids. It is to be understood that there may be some adherence between granules, such as between granules 43 and 44 in FIGURE 4.

The molding powder so produced is then fed to the die of a tableting press where compaction to the size and shape of the target is done in the manner explained in connection with the first embodiment. After compaction, the "green" target is sintered for a short time of from half a minute to about two minutes by heating to a temperature of at least 350° F. but not in excess of 600° F.

It will be appreciated that the process of the second

embodiment does not require additional screening after the coating operation. The size of the resulting granules of the molding powder is controlled by the size of the limestone particles used to form the granule. In addition, through the use of the pitch solvent, it is not necessary to heat and then cool during the mixing of the pitch and limestone with the result that a less expensive mixer can be utilized and the overall cycle time shortened.

What is claimed is:

1. In the manufacture of projectable targets of the frangible type, a method comprising: forming a molding powder comprising a plurality of granules, each of said granules comprising a filler material encapsulated with pitch, said pitch constituting from about 8 percent to about 25 percent by weight of said molding powder, compacting a predetermined amount of said molding powder under pressure to the size and shape of a target at a temperature below the melting point of said pitch, and thereafter sintering the compacted target.

2. The method of claim 1 wherein said pitch is coal tar pitch and said filler material is limestone.

3. The method of claim 2 wherein said coal tar pitch has a melting point of about 250° F.

4. In the manufacture of projectable targets of the frangible type, the method comprising: agglomerating fine particles of a filler material with from about 8 to about 25 percent by weight of pulverized pitch of a predetermined melting point within the range from about 170° F. to about 350° F. to form a molding powder by mixing said filler with said pitch at a temperature above the melting point of the pitch and cooling said resulting mixture to a temperature from ambient to about 120° F., reducing the agglomerates to a predetermined size range and separating out the fines, and compacting said molding powder under pressure to the size and shape of a target, and sintering said compacted target.

5. The method of claim 4 wherein said compacting is done at a temperature below the melting point of said pitch.

6. The method of claim 5 wherein said filler material is limestone and said pitch is coal tar pitch.

7. The method of claim 6 wherein said limestone is preheated to a temperature above the melting point of said pitch before said pitch is mixed therewith.

8. The method of claim 7 wherein the melting point of said pitch is 250° F.

9. In the manufacture of projectable targets of the frangible type, the method comprising: mixing together particles of a granulated filler material with from about 5 to about 15% by weight of a granulated pitch and a solvent for said pitch until said pitch is dissolved in said solvent, removing substantially all of said solvent from said pitch while continuing to mix to produce a molding powder containing a plurality of discrete filler particles coated with pitch, compacting said molding powder under pressure to the size and shape of a target, and sintering the compacted target.

10. The method of claim 9 wherein the compacting is done at a temperature below the melting point of the pitch.

11. The method according to claim 10 wherein said filler material and said pitch are mixed together prior to the addition of said solvent.

12. The method according to claim 10 wherein said pitch is coal tar pitch and said filler material is limestone.

13. The method according to claim 12 wherein said limestone particles have a size distribution such that

99.5% will pass through a 40 mesh screen and not more than about 10% will pass through a 200 mesh screen.

14. The method according to claim 13 wherein the amount of pitch is 9%.

15. The method according to claim 14 wherein said solvent is added in the amount of about 9% by weight of said pitch and said filler material.

16. The method according to claim 15 wherein said molding powder contains residual solvent in the amount of about 0.7% by weight of the original amount of solvent.

17. The method according to claim 14 wherein said limestone and pitch are mixed together before the addition of a solvent for about 5 minutes, said solvent is added in the amount of 9% by weight of said pitch and limestone, the mixing of said pitch, limestone, and solvent is continued for about 15 minutes, and substantially all of said solvent is removed by vacuum distillation while the mixing is continued.

18. In the manufacture of projectable targets of the frangible type, the method comprising: forming a molding powder of a plurality of mobile granules, each of said granules comprising agglomerated particles of a filler material all at least partially encapsulated in pitch and having pores therein, said filler material being present in said molding powder in the amount of from about 8 to about 25 percent by weight of said pitch, said pitch having a predetermined melting point within the range from about 170° F. to about 350° F., and then compacting a plurality of said granules under pressure to the size and shape of said target, and sintering the compacted target.

19. The method of claim 18 wherein the pitch is coal tar pitch constituting from about 12 percent to about 15 percent of the weight, the granules have a bulk density of about 1.0 to 1.5 grams per cc. and a size distribution less than about 20 mesh and mostly larger than about 100 mesh, and wherein compacting of said granules is to a target density of about 1.95 to 2.25 grams per cc., the filler being limestone.

20. The method of claim 18 wherein the pitch has a melting point of about 250° F. and the agglomerating and compacting is done within not more than about 72 hours.

21. The method of claim 18 wherein compacting is done dry at a temperature below said predetermined melting point and is followed by sintering of the compacted target.

22. The method of claim 21 wherein compacting is done at a pressure of from about 6½ to about 8½ tons per square inch.

23. The method of claim 22 wherein the sintering is by infra red at a surface temperature of not more than 550° F. within two minutes.

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