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WAD

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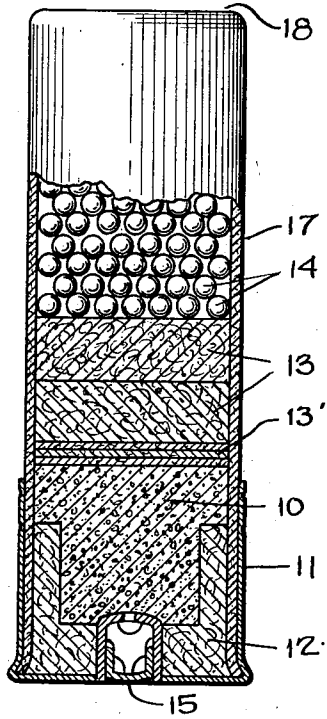


Fig. 1

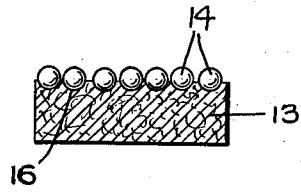


Fig. 2

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WAD

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This invention relates to a lubricant which must remain in place under varying conditions, such as when subjected to elevated temperatures, and to which extraneous objects will not stick; and in particular relates to a lubricant suitable for use on shot shell wads and other ammunition components. The description that follows will be directed particularly to shot shell wads, but it is to be distinctly understood that a lubricant made in accordance with this invention may be used generally and also for other ammunition components.

Conventionally, a shot shell includes a head of metal and a body composed of a paper tube which contains the powder, wads over the powder, shot, and a closure for the tube. There are other components which need not be mentioned at the present moment. The wad or wads located between the powder and the shot may be referred to as the shot shell filler wad or wads. Usually there is a plurality of wads between the shot and the powder, although for the purpose of this invention the number is immaterial. Among the purposes of the filler wad may be enumerated:

(1) Sealing of the hot powder gases from the shot;

(2) Provision of a lubricating oily film on the bore of the barrel to separate the lead pellets from the steel bore and thus prevent leading; and

(3) Separation of the shot from the powder.

One of the important requirements of the wad is that it not combine physically or chemically with any of the other elements of the shot shell.

The wads are lubricated at the edges, but inevitably some of the lubricant will find its way upon the faces of the wad. It is obvious that by having the lubricant on the edge of the wads that it will be transferred to the barrel as the wad passes therethrough. It has been found that the sharp impact of the wad upon the shot as the shell is fired will drive the wad into the shot pellets. If the lubricant is sticky or has a high tensile strength, a considerable portion of the shot will remain attached to the wad after it leaves the gun. This means that part of the shot has lost its usefulness and that the filler wad becomes a hazard. One of the objects of the invention is to provide a lubricant for the filler wad which will not cause the shot to stick thereto and which, at the same time, will not run under conditions of high temperature and spoil the powder charge. Other objects of the invention will appear from the description.

In the drawing:

Fig. 1 is an elevation, partly in section, of a conventional shot shell showing the relation of the shot pellets and shot shell filler wads to the other components of the shot shell.

Fig. 2 is a fragmentary view of the filler wad directly underneath the shot shell pellets show-

ing the manner in which the pellets are indented into the wad as the shell is fired.

Referring now particularly to Fig. 1, 10 is the powder, 11 the head, usually of metal, 12 the base wad, 14 the shot shell pellets, usually composed of lead or an alloy thereof, and 15 the conventional primer. The filler wads are indicated at 13 and 13'. Filler wads 13 may be of punched felt or any of the usual materials, such as that disclosed for example in the patent to Woodford, No. 2,026,765. 13' may be of cardboard or similar material. When the gun is fired the primer is first set off, which in turn ignites the powder 10 and starts the movement of the wads 13 and 13' with the pellets 14 out of the shell and through the barrel of the gun. The paper tube 17 of the shot shell may have any type of desired closure at the end 18, such as a paper wad, or may have the ends of the tube turned inwardly to form a closure. As the wads 13 leave the paper tube they will expand to the diameter of the bore of the gun. Due to the sudden movement of the wads 13 and the inertia of the shot shell pellets 14, the pellets lying next to the wad will be indented therein, such as shown at 16 in Fig. 2. The fibers of the wad 13 will tend to engage the surfaces of the shot shell pellets 14.

In some cases, as much as 10% of the pellets in the shell become imbedded in the filler wad, and such wads when fired from a gun held in a horizontal position travel more than 100 yards before coming to rest. It is quite apparent that such a missile is dangerous as well as a detriment to the shot pattern. It has been the practice previously to use refined paraffin waxes and crude scale paraffin wax as a wad lubricant. Refined paraffin waxes are low in their oily constituents and, as a result, are hard and give a comparatively incompressible edge to the filler wad. When the wad is forced into position in the shell, an undesirable bulging of the shell may occur because the wad is purposely made oversize so as to give better sealing qualities. Crude scale wax contains a certain percentage of low melting oil constituents, and because of the low melting points of the oily constituents, the wads are not satisfactory after storage at elevated temperatures, for example 110° to 120° F. These temperatures are frequently exceeded for long periods when in storage, such as when in the usual corrugated iron warehouse or in the holds of freighters in warm climates. The low melting constituents liquefy and run into the powder with the result that the pressure and velocity obtained upon firing of the shell are so affected that "squib loads" frequently occur.

Various substances have been used to modify the crude scale wax, such as, for example, an amorphous or microcrystalline petrolatum wax. The addition of the amorphous or microcrystal-

line petrolatum wax reduces the running, but the shot sticks to the wad upon firing. A test was run to determine the amount of shot sticking with various combinations of paraffin and crude scale wax, as indicated in the following table:

Table I

Number of pellets on wad	80% crude scale wax 20% microcrystalline petrolatum wax	100% 135° F. paraffin	99.75% 135° F. paraffin, .25% oil
1.....	1	6	2
2.....	1	6	10
3.....		6	5
4.....	2	4	8
5.....		22	6
6.....	1	4	4
7.....	5	4	4
8.....	2	6	6
9.....	4	8	7
10.....	3	8	7
11.....	4	6	4
12.....	7	6	4
13.....	5		7
14.....	5	2	5
15.....	4	2	2
16.....	6	2	1
17.....	5		3
18.....	10	6	1
19.....	7		2
20.....	5		
21.....	4		1
22.....	5		
23.....	3		1
24.....	3		1
25.....	2		
26.....			
27.....	1		
28.....	3		1
29.....			
30.....	2		

It is to be noted that 100 out of 100 wads fired lubricated with 80% crude scale 20% microcrystalline wax had shot pellets stick thereto. When the wads were lubricated with 100% 135° F. paraffin wax, 94 out of 100 wads fired had shot pellets sticking thereto. It was then thought that if an oil were added to the combination that the tensile strength of the refined paraffin might be reduced to such an extent that the shot would not stick to the wad.

The so-called "tensile strength" of a wax is apparently a function of the crystalline structure and oil content. Many paraffin waxes have a plate-like structure and the oil in the wax tends to collect between the plate-like crystals, thus forming weak planes of cleavage. It follows therefore that a large percentage of oil will reduce the tensile strength.

Referring to Fig. 2, the shot pellets are impressed into the wad as it is fired and, if the tensile strength of the wax is high enough, the pellets will not break away therefrom and particularly because of the fact that the fibers of the wad tend to hold the shot pellets in place in conjunction with the high tensile strength wax. The fibers of the wad grasp the body of the pellet, and if the wax is of a high tensile strength, it will be apparent that the pellet will not be disengaged therefrom with ease. If the lubricant has a low tensile strength the fibers will more readily give and allow the pellet to be disengaged from the wad.

A combination of 99.75% 135° F. paraffin wax and .25% oil was tried, and it was found that 92 out of 100 wads fired still had shot sticking thereto. It is evident, therefore, that none of these lubricants were satisfactory as far as shot sticking is concerned.

It was then suggested that an unlubricated wad be placed directly under the shot, but even though no shot sticking occurred, there was a considerable lowering in pressure, velocity and

patterning of shot compared to the usual lubricated filler wads. There was also a tendency for the hot combustion gases to leak past the filler wad and weld together the shot pellets so that they would not scatter properly after leaving the gun. It is desirable to have the shot scatter evenly so that the pattern obtained will not have holes therein. Shot sticking to a wad will detract from this pattern, and the wad itself instead of falling away will continue, due to its increased weight, and may seriously affect the results.

In the search for a means of reducing shot sticking, oleostearine was tried and, in accordance with Table II, none of the 100 wads fired had any shot sticking thereto. Difficulty, however, was experienced in the running of the lubricant into the powder, so it was thought that the use of a microcrystalline petrolatum wax might prevent such running and yet not cause shot sticking. However, as shown in Table II, such was not the case, and a 95% oleostearine, 5% microcrystalline petrolatum wax lubricant had 33% of the wads fired with shot sticking thereto.

Table II

Number of pellets on wad	Oleostearine-microcrystalline petrolatum wax	
	100% stearine, 0% M. P. W.	95% stearine, 5% M. P. W.
1.....		12
2.....		6
3.....		4
4.....		2
5.....	0 out of 100	2
6.....		2
7.....		2
8.....		2

A combination of oleostearine and what is believed to be a hydrogenated animal fat, sold on the market as "Armour Product #1," were combined in the proportions of 80% oleostearine and 20% hydrogenated animal fat; and the surprising result was reached that none of the 98 wads found out of the 100 fired had shot pellets sticking thereto, as shown in Table III.

Table III

Oleostearine percent-H. A. F. percent	Oleostearine-hydrogenated animal fat, Armour product #1		
	80-20	60-40	0-100
Wads having shot sticking.....	0	0	29
Wads found out of 100 fired.....	98	98	96

Likewise, with a 60% oleostearine and 40% hydrogenated animal fat combination, none of the 98 wads out of the 100 fired had shot pellets sticking thereto. However, when the hydrogenated animal fat was used by itself as a lubricant, 29 out of 96 pellets found out of 100 fired had shot sticking to the wad. This shows that for some reason the combination of oleostearine and hydrogenated animal fat gave a wad lubricant which prevented the shot from sticking.

The next question that arose was that as to whether or not such a combination would run under elevated temperature storage and thereby adversely affect the powder. The best practical test for determining the running of a lubricant is to load the wads into shells and store the shells for a period of time at an elevated temperature. Such a test is lengthy and costly, and it has been found that a good index of the running characteristic

of the lubricant may be obtained by the use of a so-called "running number." The running number is obtained by placing a small disc of the material of about 1.45 cm. diameter on a filter paper of 9 cm. diameter, and placing the paper in an oven at 120° F. for a given period of time. If there is no running there will be no indication of a grease spot formed on the filter paper. If, however, there is running, a grease spot will appear, and the longest diameter of the grease spot and the diameter at right angles thereto are measured and the product thereof taken as the running number. Such a running test was made for a crude scale and microcrystalline petrolatum wax combination and for a crude scale and hydrogenated animal fat combination, with the results shown in Table IV.

Table IV

Crude scale wax-microcrystalline petr. wax			Crude scale wax-hydrogenated animal fat (Armour product #1)		
C. S. W.	M. P. W.	Running No.	C. S. W.	H. A. F.	Running No.
100	0	57.0	100	0	57.0
90	10	23.5	90	10	>81
80	20	11.2	80	20	>81

It is to be noted that the hydrogenated animal fat increased the running of the crude scale wax to such a point that it entirely covered the filter paper, which obviously would not give a satisfactory lubricant. The use of the hydrogenated animal fat, however, with stearine improves the running properties very appreciably, and particularly at elevated temperatures above that which is normally considered necessary for ammunition.

The following Table V shows the results of storage at varying temperatures of shot shells for two weeks at room temperatures, 115°, 120°, 125° and 130° F. The average pressures and velocities were obtained for shot shells with wads lubricated entirely with oleostearine and for wads lubricated with an 80% oleostearine and 20% hydrogenated animal fat lubricant. It is to be noted that at 120° F. storage, the shot shells having wads lubricated with 100% stearine were not satisfactory inasmuch as many of them had such low pressures and velocities that they did not record, as noted in the table. At 125° F., the 80% oleostearine, 20% hydrogenated animal fat lubricated wad shells were still satisfactory, and inasmuch as 120° F. storage is the usual test, it indicates that a wad so lubricated can withstand the 125° F. test, giving it a 5° margin of safety.

Table V

	Two weeks storage temperature				
	Room	115° F.	120° F.	125° F.	130° F.
Average pressure, lbs./sq. in.:					
100% stearine.....	9,400	8,800	(1)	(1)	(1)
80% stearine, 20% hydrogenated animal fat.....	9,600	8,800	7,300	5,700	(1)
Average velocity, ft./sec.:					
100% stearine.....	846	829	(1)	(1)	(1)
80% stearine, 20% hydrogenated animal fat.....	876	861	822	774	(1)

¹ Many of shells stored at this temperature had such low pressures and velocities that their pressures and velocities did not record minimum pressure which will record, 3,000; minimum velocity 690).

Certain other of the hydrogenated fats are available and have been used, although the results are not as good as with the hydrogenated animal fat. A hydrogenated vegetable oil or fat in combination with oleostearine is a good anti-running agent, although there are some shot sticks. It is not quite as good as the hydrogenated animal fat although it will perform satisfactorily. It has been found that a vegetable oil which gives mostly the glycerides of palmitic and stearic acid upon hydrogenation exhibits the desired properties. Tallow is made mostly of the glycerides of palmitic, stearic and oleic acids. Oleostearine is usually made by pressing out of tallow all of the liquid glycerides possible (mostly glyceryl oleate), thus leaving behind largely a mixture of the glycerides of palmitic and stearic acids. All of the liquid glycerides, of course, are not removed by pressing, so that some small quantities must remain in the finished oleostearine. In the hydrogenation of the animal fat it may be that chemically the result is generally similar to oleostearine, although this is not precisely known. However, the behavior of the oleostearine and the hydrogenated animal fat and combinations thereof are not the same, and applicant has discovered that such a combination of oleostearine and a hydrogenated fat produces a satisfactory wad lubricant to which shot will not stick and which does not give excessive running, thereby giving satisfactory results in shot shells.

The physical characteristics of a hydrogenated animal fat which is satisfactory may be as follows:

Free fatty acids.....	1.0% max.
Color.....	2.0 red max.
Iodine.....	#10.0 max.
Titre.....	59.0 to 62.0° C.
Open tube melting point.....	61.0 to 64.0° C.
Base.....	Animal fat
Saponification.....	#192 to 198

In addition to the use merely as a lubricant, the composition of this invention may also serve as a binder for certain types of wads such as, for example, a roofing felt wad. In such a case, the wad would be impregnated substantially completely with the lubricant. It is to be distinctly understood therefore that the word "lubricant," where used in the claims, also includes its use as a binder or a means to increase the impermeability of the wad to passage of gas therethrough.

By this invention a lubricant has been found which will not run and to which extraneous objects will not stick. Many modifications may be made and the specific compositions are merely by way of example so that the scope of the invention is not intended to be limited except as defined by the appended claims.

What is claimed is:

1. A shot shell wad having a lubricant impregnating the surface of said wad, said lubricant rendering said wad substantially non-shot sticking and being substantially non-running, and composed substantially of 80% oleostearine and 20% of a hydrogenated animal fat, said fat being substantially solid and having a melting point greater than 120° F.

2. A shot shell wad having a lubricant impregnating the surface of said wad, said lubricant rendering said wad substantially non-shot sticking and being substantially non-running, and composed of oleostearine and between ap-

proximately 20% to 40% of a hydrogenated animal fat, said fat being substantially solid and having a melting point greater than 120° F.

3. A shot shell wad having a lubricant impregnating the surface of said wad, said lubricant rendering said wad substantially non-shot sticking and being substantially non-running,

said lubricant being composed of between approximately 20% and up to 40% glycerides of hydrogenated fatty acids, said glycerides of the hydrogenated fatty acids being substantially solid and having a melting point greater than 120° F., and glycerides of natural fatty acids.

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