

Bullet Versus Armor

The Familiar Contest of the Sea Started Anew Upon the Land

By Edward C. Crossman

FROM the day the horrified jackies of our old navy watched their round shot bounce off the armored sides of the "Merrimac," ballistic sharks and armor experts have striven assiduously to produce the fabled condition of an irresistible force meeting an immovable body. The "Merrimac" was efficient not because her armor was anything but crude railroad iron, but simply because this sufficed to stop the inefficient missiles of the day. A tug with a modern 3-inch quick firer could have stood across Hampton Roads and whipped the hind sights off the poor old turtle-back without taking a scratch.

From that hour to this, and with the end not yet in sight, projectile maker has gone armor manufacturer one better, only to have the other "see and raise" him, with the process repeated in wearisome iteration. And now the argument has been transferred to land, becoming the case of the rifle and machine gun *versus* the steel shell for men, cars, planes and tanks.

After every war, authorities and near-authorities emerge with a full list of the conclusions drawn therefrom, which are final and admit no argument. Thus the Boer War did away with the bayonet. The British were very bitter about this weapon. What was the bally use, they asked, of a bloomin' bayonet when the bloody Boers didn't even allow them to get close enough to do fair rifle shootin'? And echo answered, "What"? Our M 1903 rifle had a bayonet installed only after much controversy, and then only because it could also be utilized as a cleaning rod. As a cleaning rod it was fairly efficient, as a bayonet it was a fair cleaning rod. However, before all the bayonets were beaten into pruning hooks and safety razors, the Japanese got into their Manchurian argument with Russia, and the bayonet hastily came back into its own.

The same optimistic attitude as to the capacities of the magazine rifle that nearly did away with the bayonet was also responsible for the abandonment of any other protection against modern bullets than Mother Earth. The big lead slugs of the 70's and 80's were entirely adequate to driving through the light armor of the cuirassiers; then the excessive penetration of the Krag and the Lee-Enfield, when these appeared, seemed definitely to put the quietus upon the armor side of the question. It is doubtful that even today armor would be revived as it has been, were it not for the many things of lighter penetration than bullets which are flying about our battlefields—shrapnel, shell splinters, grenade fragments, bayonet points. These things made light protection for the head very desirable; this, extended to the body in the form of a light cuirass affair, was then, because of the comparative immobility of the troops, thickened into protection against the bullets themselves, despite the weight thus added.

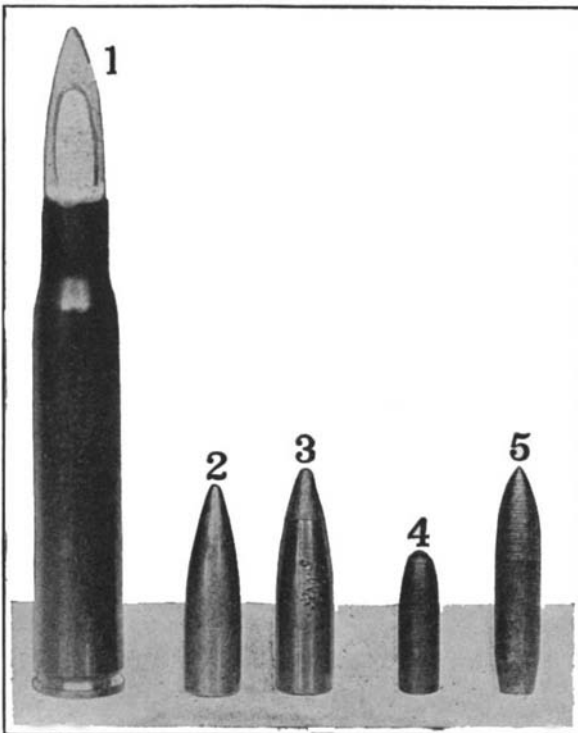
At the present time, therefore, we find a second coming of armor for man, gasoline horse and flying machine not equalled since the Middle Ages. The armored tank waddles imperturbably astride of machine gun positions and cleans out the operators therein, it saunters down street in the face of cracking infantry fire. Armor coats the engines and most of the crew of airplanes, it surrounds light motor cars, it covers the head of every soldier of the fighting nations outside of Russia. It has been tentatively taken up as body covering in the form of layers of canvas and steel or of woven steel links. In thickness merely enough to stop the plain infantry bullet, it forms the shield and the apron of every field gun. Most of these things, to be sure, are practicable only while the forces are in a state of relative deadlock; their weight would hamper troops on the march. But the fact of relative deadlock remains.

Our armored cars are reported to be covered with treated steel $\frac{1}{4}$ -inch thick, which is sufficient to keep out the ordinary bullet. The photograph shows the slight effect in this case. The armor of the field gun is $\frac{1}{2}$ -inch thick, and turns the service bullet at 100 yards, as proved by the two bullet marks on every gun-shield used in our Navy. Our service bullet gets through a scant half inch of mild steel. The special target-shooting pill makes the full half-inch; so does the German bullet. But against specially hardened armor steel any of these bullets might merely shatter, with no penetration worth speaking of. Knowing this, it was an easy matter to evolve armor and plates to keep the service bullet on the right side of the thing shot at.



Steel breastplate worn by German shock troops, specially equipped for assault work

But at this stage of the game the projectile maker took a hand again, and once more the race was started between armor and projectile; and its ultimate outcome is as problematical as ever.



Some Modern Rifle Ordnance

1—Sectional Clay Bullet. 2—U. S. Service Bullet. 3—The Clay Armor-Piercer. 4—Steel Slug from Clay Bullet. 5—Steel Slug from German Piercer.

Special armor piercing bullets were not new when war broke out, but the occasion for them had been limited to getting through the shields of field artillery, and infantry didn't often get close enough to field guns to make this need an urgent one. But after the first year

of the war, when snipers began to ensconce themselves behind armor shields and armored cars began to reinforce infantry at threatened points of the line, while airplanes demonstrated surprising immunity to machine gun fire, the ordnance experts began to take a keener interest in bullets that would not be so easily discouraged on meeting a stubborn steel plate.

The writer has had the privilege of testing several hundred rounds of ammunition loaded with the most successful armor piercing bullet yet evolved in this country, designed by Capt. W. L. Clay of our Ordnance Department, and made at Lowell, Mass., under the supervision of Captain Doe, formerly of our army. This bullet, (patent number 1202162), in common with most armor piercing bullets, uses the hardened steel core within a lead and cupro-nickel outer coating. It differs from any other bullet in that it is closed at the rear and filled from the front end of the jacket, giving higher penetration because of the lessened stripping tendency of jacket and lead. Also it has a softer nose than the tough cupro-nickel jacket. This enables it to bite on hardened steel surfaces very much inclined to its path instead of merely glancing off, as does the service bullet with its sharp nose and long shoulder.

This softer cap may be of lead alloy, copper, aluminum, or any other soft metal. In the case of the samples sent me for trial, it was merely soft lead. Inside is a hardened steel bullet in miniature, too hard even to file, and therefore resisting deformation on steel plates. In the samples it was left rather rounding at the forward end, so that enough of the leaden core would be driven forward, forming a cap to support the hard point and prevent it from shattering on the hard armor. In the bullet as finally redesigned, this point was made somewhat sharper.

The slug is .75-inch long and .218 calibre—the difference between this and .308, the diameter of the service bullet, being lead and jacket. The slug weighs 45 grains, the complete bullet 150, matching here the bullet of the service cartridge. Outwardly it is of the same form, but about $\frac{1}{10}$ -inch longer, to give service weight and of course to compensate for the lower specific gravity of the steel core. It feeds readily through rifle or machine gun. The soft point on the sample makes it look precisely like the various soft point bullets for sporting use of the Springfield.

The accuracy of the Clay bullet, while slightly below that of the service bullet, is higher than that of the regular French model, and ample for war use. At 200 yards it makes groups of about eight inches for ten shots, and at 1,000 yards it develops some ten per cent of fliers, but not enough inaccuracy in the remainder to make its shooting inferior to the regular ammunition from a practical standpoint.

In mild steel, which as stated is no test of comparative effects, the Clay bullet got through an inch—a trifle above 100 per cent more than the service bullet. Lengthening the range and using lighter plates gave an even more favorable comparison. Where falling off in velocity seemed to remove most of the wallop of the service bullet, the Clay armor-piercer continued to get through. At 700 yards against $\frac{3}{8}$ -inch boiler plate, which the service bullet merely dented, the Clay slug slipped through neatly.

The mild steel developed a peculiarity of the Clay projectile that remains still unexplained. On a piece an inch thick and a trifle tougher than the first sample, slug after slug stuck after getting almost through—pulled up with three quarters of its length projecting from the back side of the plate, gripped by some action that prevented its final egress. In theory at least, when a steel shell goes through a plate with half its length, finishing the penetration is so much a matter of touch and go that a few yards' difference in range might be expected to put it through, or see it not so far in; but the theory didn't work out. Altering the range 50 yards or so altered the phenomenon not a particle. At 750 yards some of the slugs stuck even in the comparatively thin $\frac{3}{8}$ -inch plate. This stubborn refusal to go clean through seemed to demonstrate either a welding effect, or else a wedging of the steel in one direction by the slug head, and then a closing up on the body before the slug finished penetration. A trial with a cupped point of full diameter of the slug *à la* drill should throw some light on the matter.



Italians, equipped with tank armor, advancing in the teeth of furious machine-gun fire

On hardened steel, as near armor specifications as we could obtain, the effect of the piercer bullet was even more marked. At the muzzle it romped through $\frac{1}{4}$ to $\frac{3}{8}$ -inch hardened steel, on which the service bullet merely spattered; at 400 yards it got through $\frac{1}{4}$ -inch, though this was possibly not quite up to Government quality. The trials demonstrated that the making of steel for this light armor is in itself a ticklish job. One piece, $\frac{1}{4}$ -inch thick and glass hard, shattered to bits under the bullet's blow. On such steel as this the service bullet does not even offer to go through, merely putting a wide and very shallow dent in the plate; it gives just a blow, without drilling tendency. This is true even on the light $\frac{1}{2}$ -inch field-gun armor.

I am satisfied that at 500 yards the Clay bullet will get through the present shield and apron of our field gun, and that at 300 yards it would ruin our tanks with their quarter-inch protection. The light shrapnel helmet stops it at long range, and so does the airplane armor; but the bullet will go through the former at 2,000 yards and through the latter at 1,000. The British tanks are very heavily armored, and it is doubtful if even this type of bullet will go through.

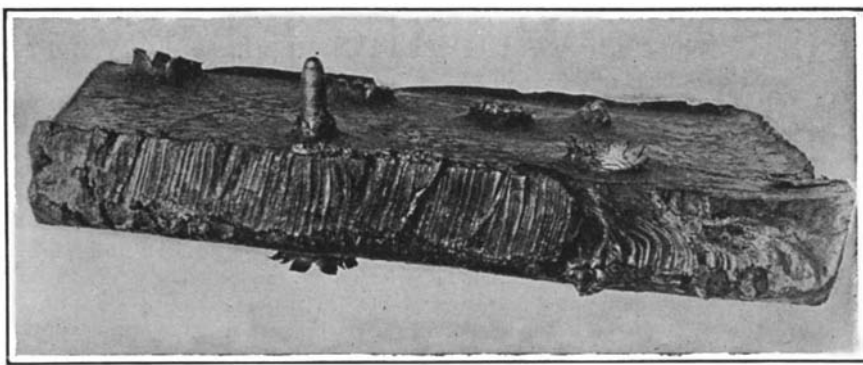
The Germans are not behind us in the development of armor-killing projectiles. Before me lies a German piercer bullet from the Ypres salient, with which a sniper was killed through a quarter-inch of armor steel. This is a whale of a bullet, far too long to feed through the magazine of a rifle or machine gun without some change of parts. It consists of the usual hardened steel slug, leaden wall, and surrounding steel jacket; but the slug alone is as long over all as our complete service bullet, weighing 86 grains against the 45 of the Clay slug. It is very sharp pointed, although the taper is not long; and it is boat-shaped, having a tapering tail of only .20 inch. While it has hit steel, so that the lead core is nearly all missing, the fragments remaining weigh 147 grains, giving a mass around 200 grains for the finished bullet.

This elephantine piece of ammunition is without doubt a terrific drill for armor, probably much more so than the Clay bullet. But it has the serious drawback that it is not at all adapted to work with the regular ordnance and its ballistics will be a thing apart, where the Clay bullet shoots to the sight graduations on our rifle and machine guns. It is apparently used in special rifles for snipers, resighted for it, or in special machine guns altered to handle the long cartridge—perhaps in both. Even though the infantry rifle were made to chamber it, it would not shoot to the sight markings, either the vertical ones or the lateral zero.

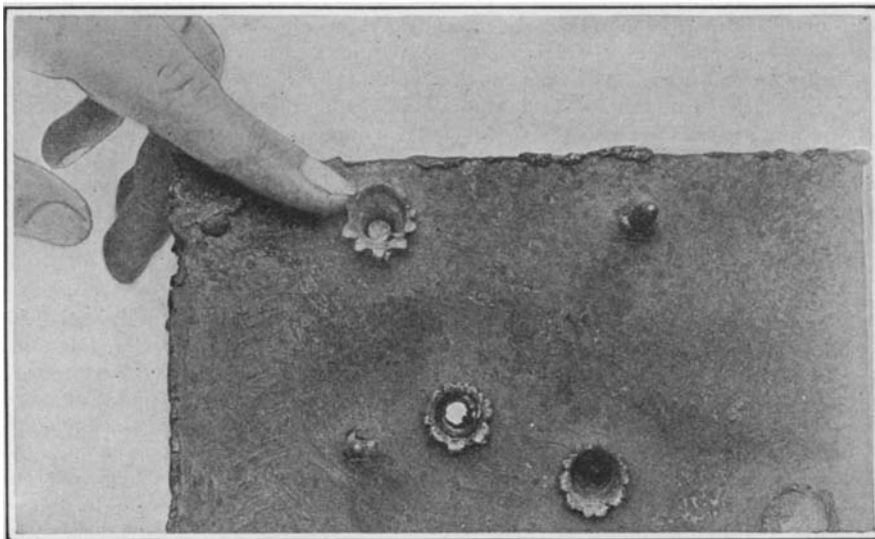
The one general objection to all these armor piercing bullets is that, after completing penetration, they are reduced to tiny steel shot of .218 to .24 calibre; the remainder of the bullet disappears into thin air on impact with the steel. The wounding power of a steel slug of such size and weighing but 46 grains is less than that of the familiar .22 long rifle, in spite of the advantage in velocity at the short ranges. But in spite of this, these bullets will greatly reduce the enthusiasm for steel bullet stoppers; even a .218 hole in one's anatomy is more discouraging than none at all.

The Protective Value of Convoying

THE gradual breakdown of submarine warfare is not attributable to any one anti-submarine device but to the cumulative effect of many such. If there is a measure that stands out as pre-eminently successful in cutting down losses, it is the



Inch steel punched through by a soft-nose shot, which is held half way out on the other side



Steel core bullet that didn't quite get through; base shown embedded in the hole

introduction, or rather the reintroduction, of the convoy system—for convoying was well known and extensively practiced in the days of Nelson and the sailing frigate.

When it was decided to reintroduce convoying, there was practically no experience to draw upon; for it was evident, at once, that dispositions of ships in a convoy which were effective in the days of sail power might be altogether unsuited to this age of steam power. Various formations were tried, and the present effective practice was ultimately developed.

On the colored cover of this issue and in the accompanying diagram, is shown the wedge or V-shaped formation, in which the convoyed merchantships steam in two echeloned lines. The disposition, both of the war and merchant vessels, is, at first sight, rather com-

plicated; but actually is not so. It is most admirably adapted for getting an early sight of a submarine and putting it out of commission, or driving it away from the path of the convoy.

At the head of the convoy is a destroyer; following this is a light cruiser which acts as a flagship. This, in the case of our own Navy, is frequently an armored cruiser of the former "Colorado" or the "Tennessee" type. Then, astern of the cruiser is a torpedo boat which tows at the end of a light, but very strong steel wire, a captive balloon. This craft forms the point of the "V" formation; and behind it are placed the two diverging lines of merchantships which follow each other, not bow to stern but disposed diagonally. At the stern of each ship is towed a spar or buoy which serves to tell each succeeding ship how far it is astern of the ship ahead—an absolutely necessary precaution at night or in thick weather. Down through the center of the "V" is a line of armed trawlers; and another line steams on the outer side of each column of merchant ships. Slightly astern of the convoy and at about the center of the base of the "V" is a destroyer or torpedo boat which tows another observation balloon. Finally, to complete the protection, several destroyers steam in a zig-zag course well out on each wing of the convoy.

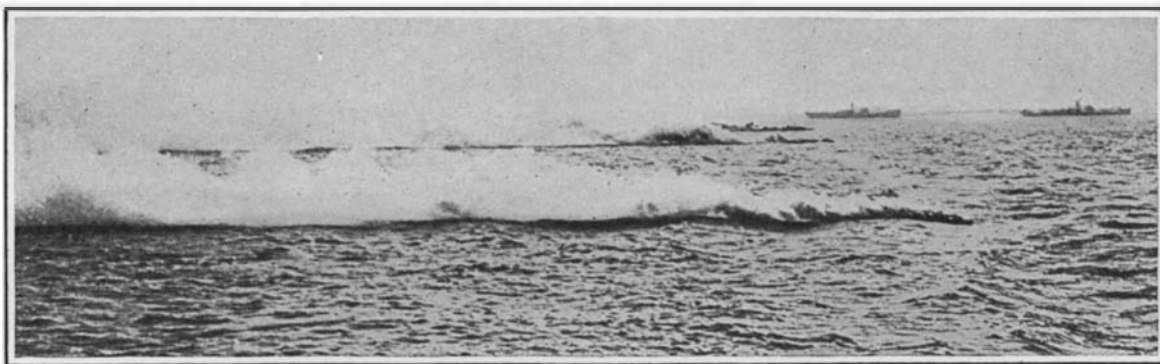
The efficiency of the system was recently alluded to by Sir Eric Geddes in the House of Commons. He stated that one result of the convoy system has been to drive the enemy closer to the shore, thus rendering the open sea safer for navigation. During the first months of the unrestricted submarine war 50 per cent of the losses (of merchantships) occurred more than fifty miles from land, and only 21 per cent within 10 miles of the shore. Today the losses outside the 50-mile limit have fallen to one per cent, while the losses close to land have risen to 61 per cent. This transfer of attacks nearer the coast gives increasing opportunities for attacking the enemy by patrolling surface craft and airplanes, and enables us to save many vessels which otherwise would have been lost.

New Danish Heat-Insulating Material

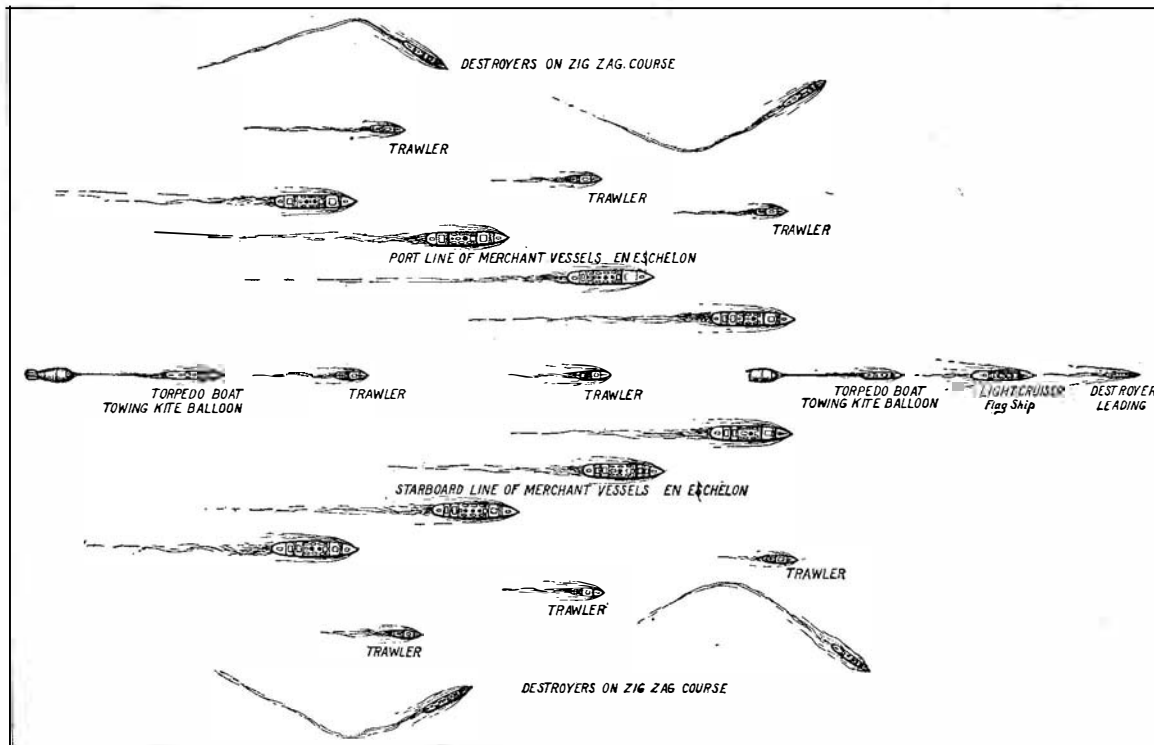
THE Board of Trade Journal quotes the Danish press to the effect that a new company, with a paid-up share capital of 500,000 crowns (\$134,000 at normal exchange) has been formed to manufacture *molersten* (heath clay stone), a material which can be used for insulation.

Several attempts had previously been made by the State Testing Department to utilize the loam obtained from heath clay beds on the island of Mors, in the Lym-Fjord, for the manufacture of insulation materials for use in air flues, steam boilers, etc. The experiments were continued with good results by a Norwegian engineer, and he has now succeeded in producing a *molersten* which is made porous by undergoing special treatment. The clay is mixed with what is termed expanded cork, i. e., cork dust which, before being mixed with the clay, has been heated. By first undergoing the heating process the cork occupies a larger space in the clay mass than otherwise would be the case. The cork is kneaded into the clay, and the whole mass is then molded and subjected to heat. By this means the *molersten* is made highly porous and is found to be much better adapted for insulation purposes in ordinary practice than any other kind of stone.

Large clay beds on Mors have already been acquired, so that the manufacture of *molersten* can commence as soon as the factory which is being constructed is completed.



Smoke boxes thrown overboard to hide a convoy from the submarines



This sketch based on a drawing in the Sphere shows the position of ships in a convoy