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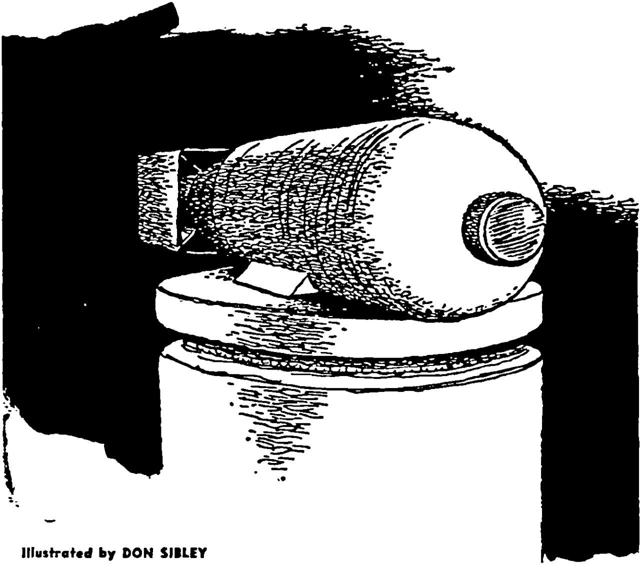


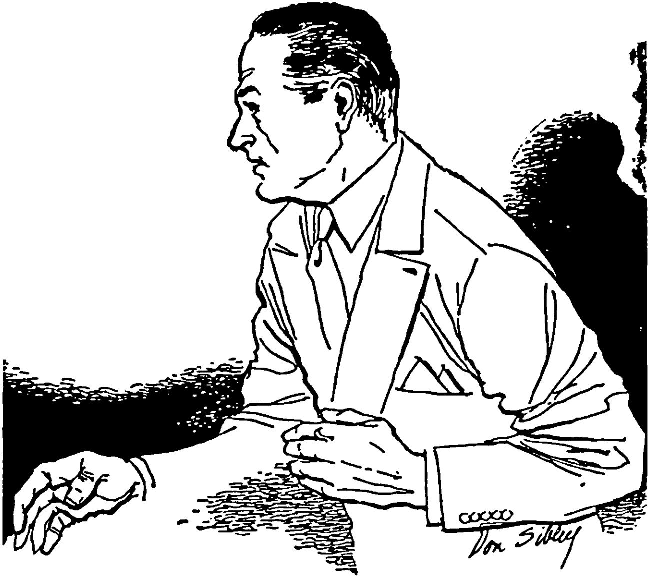
Illustrated by DON SIBLEY

Twenty-Foot Miss

By WILLY LEY

Artillery shells once had your number on them or they didn't. That was before Felix the Heat-Seeker & Co.

IT HAPPENED about six years ago in a research laboratory on the Atlantic Coast. Somebody of importance, a VIP in military parlance, had announced his visit. He arrived in time for lunch, and the engineers, talking in relays, used the opportunity to fill the VIP with technical lore. Among other things, he was told that they



would show him "Felix the Heat-seeker." When the time came he was ushered into an empty room. In the center of that room there was a turntable and on the turntable rested a bomb, staring at the visitor through a lens in its nose. Feeling slightly uneasy, the VIP took a few steps to the right. The bomb swung around on the turntable, pointing at him again, staring. He moved to the left. The bomb turned after him, staring with the lens in its nose—

This was, after all, a perfectly natural thing, because Felix the Heat-seeker was reacting to the VIP's body temperature, which may have gone up a degree or two because of this performance. The somewhat nerve-racking demonstration was, in part, a device for being remembered in the budget. In addition to that it was a kind of summary of recent developments in military technology, a lecture with the theme that it is no longer true that "a miss of an inch is as good as a mile." The saying should now be that a twenty-foot miss is a clean hit.

That came about in three ways.

The first, simplest and also oldest is the exploding charge. If a solid cannonball missed a soldier by six inches, he could shrug and continue charging. If, later on, a 105mm. howitzer shell exploded at a distance of six feet from the soldier, it was a hit. The biggest application of this principle is, of course, the fission bomb, which, for this very reason, can't even be a front line weapon any more.

The second way of transforming a miss into a hit is essentially an addition to the exploding charge. It is what may be called the "sensing" fuze,* which will perceive the nearness of a target and respond at the precise fractional instant of closest approach.

The third, finally, is to correct the trajectory of whatever you are throwing at your enemy, *prior* to missing the target, so that the throw is turned into a hit. As far as strict chronological sequence goes, the third method was thought of and even tested before the second, but the second, the sensing fuze, was used first.

IT APPEARED in action during the early days of the Second World War, just when the war looked quite leisurely. The manifestation of the new principle in military technology was called a "magnetic mine," which is hardly a good name, for the device happened to be as non-magnetic as possible. Up to that moment all military engineers had known that a fuze (unless it happened to be a time fuze) had to make "contact" to be set off. That was still true, but it had always been taken for granted that any contact would be a physical one. That there could also be a contact of force fields was new.

The fuze of the so-called magnetic mine relied on the simple fact that the earth has a magnetic field. The best known manifestation of that field is that it makes a magnetic needle assume an approximate North-South position, as in a compass. But if there is a large mass of iron nearby—for example, a ship—the earth's magnetic field is disturbed for some distance and the compass needle misbehaves. Any schoolbook says so, but the Germans applied the information lethally.

They built a naval mine of non-magnetic materials, mostly aluminum, gave it the shape of an airplane bomb so that bombers could plant it, and put a fuze inside which would go off when a magnetic needle was disturbed. Such a disturbance meant that there was a large mass of iron nearby—again, for example, a ship. They

*The spelling FUZE is the one authorized by the Dept. of Defense. This is to distinguish it from a FUSE, which is an electric safety device.

also had a safety catch on that fuze, consisting of a so-called hydrostatic switch, a device which prevented the fuze from working unless it was under water which opened the switch by its pressure.

It was the undoing of the scheme that one of these parachuted mines did not fall into water but landed on a mudbank. Commander J. G. D. Ouvry, R. N., approached the monster with a kit of non-magnetic tools, mainly bronze. He opened up the mine, giving a running account of his actions through a microphone so that, in case of accident, the next mine opener would know what had been done wrong. He was both skilful and lucky, since he happened to be protected by the faithful functioning of the hydrostatic switch. The Allies then knew how such a mine worked: it just sat in the bottom mud of shallow water, waiting for a ship to come close.

Once the principle of operation was known, counter-measures were not too difficult. Simultaneously the torpedo experts at Newport, R. I., began to think about disturbed force fields. Torpedoes, if they scored a hit, were very effective weapons. They were also very expensive weapons, which point was usually remembered when a torpedo made a near miss. The result of the thinking about near misses and disturbed force fields was that the torpedo was cross-bred with an advanced magnetic mine.

THE offspring was the Torpedo Mark XIV with magnetic fuze. It would explode when passing under a ship of shallow draft, and it would explode even when crossing the bow or stern. Performance was marred at first by a mistake in calibration of the early production models, and sailors made remarks featuring the word "long-hairs"—which they quickly took back when the device was made to work.

The most famous example of sensing fuzes operated above the water line. I mean what the military call the VT fuze. It means "variable time," though engineers are more likely to call it "proximity fuze." That fuze is something which is a bit hard to believe, not so much because of its action, which makes it go off in the proximity of a target, but because it is really a radio set.

You don't expect a radio set to be still in one piece, or even in working order, after it has been shot from a gun. But the VT fuze, after some 800 million dollars were spent on its development, remains in working order. In fact, it is *not* in working order before firing; it needs the shock of firing and the spinning of the shell to activate its battery.

The working principle may again be called that of a disturbed force field, but it is utilized somewhat differently. When the battery has been activated, the fuze sends out a steady radio signal that forms a kind of aura. As long as nothing enters the aura, nothing will happen. But when the shell comes close to an airplane, radio waves are reflected back to the fuze. A special tube in the fuze senses the reflection and builds up resentment in the form of a charge. When the charge has grown strong enough—all this taking place in fractions of a second—this tube sets off a detonator. The detonator explodes a booster charge and the shock of the exploding booster makes the TNT of the main charge go off. Which is the end of the VT fuze and its radio aura, but usually also the end of the obstacle in the aura.

These VT fuzes accomplished quite incredible feats during the Second World War. At Anzio Beach they downed 691 *Luftwaffe* planes, aided by a gun-directing mechanism known to ordnance personnel as the M-9. But the important point is *not* the large figure. It is that out of these 691 hits, some 680 were in all probability *near misses,* old style!

HOWEVER, there must have been an additional number of actual misses beyond the range of action of the VT fuze, for once a shell had left the gun muzzle, it was on its own. To influence it even *after* it had been fired was the goal of the third method.

The third method, that of guiding a lethal missile, cropped up for the first time in 1911. It was, of all places, in a circus in Berlin. They had a model of a Zeppelin airship there, about 15 feet long. When the time for the act came, a console was carried into the arena and the inventor closed one switch. The battery-powered electric motors of the airship model began to whir and the ship moved. A second switch was closed and the airship model flew in a curve. A third switch was closed; the airship dropped a small bomb, which exploded with red flames and much smoke in the sawdust.

Some time later, the same inventor demonstrated a motorboat which he ran by wireless signals from the shore of the lake. He pointed out that this would be a fine method for sending explosive-laden ships into enemy harbors or fleet formations. Probably because the range was very short and the signals could easily have been "jammed," these unmanned supertorpedoes failed to materialize during the First World War. After that war, however, the Germans utilized the idea in their famous *Zähringen,* a small warship with full armor but minus guns. Equipped with radio steering gear and all empty spaces stuffed with cork, the *Zähringen* did long service as a mobile target ship.

People who have read Goethe's *Faust* like to quote the lines: "All theory, my friend, is gray; but life a flowering green tree." It may be true in some cases, but when it comes to the guiding of missiles it works the other way round. It all looks fine and lush in theory. In real life performance, things begin to look dark. When Dr. Ralph E. Gibson of the Applied Physics Laboratory in Silver Springs, Md., was interviewed recently, one reporter asked how far one could fire a missile now. Doctor Gibson was willing to concede some 500 miles or a little more. And for what distance, asked another reporter, would you guarantee a hit? Ten feet, snapped Dr. Gibson. This I consider somewhat understated; he could have guaranteed a hit for the length of the missile itself.

FACT is, in the Second World War, the only guided missiles used operationally were those released from aircraft, where conditions are somewhat simpler. There were ground-to-ground missiles, like V-1 and V-2, but they were not guided. In the V-1, a robot pilot maintained the flying bomb on a straight course and at a given altitude. In the V-2, an automatic device saw to it that the power was shut off when the rocket had reached the proper velocity, which is, actually, the equivalent of doling out the right powder charge for a big gun.

Of true guiding there were only beginnings. As an example I might mention a large anti-aircraft rocket that was supposed to form part of the German Rhineland defense. Naturally, the rocket was named *Rheintochter* or Rhine Maiden. The idea was that when an allied bomber would be caught in a radar beam, a Rhine Maiden would be fired immediately and be trailed by a second beam, through which it would receive directional orders. Then the two beams would be brought together.

It did not work too well and most experts now believe that this was not due to wartime hurry, but that the system itself was at fault. Those who think so prefer the "one-beam system," in which the anti-aircraft missile is fed into the same beam that has caught the attacker. The missile receives no orders from the ground, but is equipped with a mechanism that will always shunt it back into its beam.

Doctor Gibson calls that "conscience guiding," the missile being unable to stray from the narrow path leading to the enemy. Using only one beam, this method is not merely simpler, it has another advantage. Since one can feed several missiles in succession into the beam, the enemy would not have won out by default just because a single missile's conscience slipped. All that would be needed for final success would be a radar man on the ground who did not lose his target.

But why not just send the missile aloft in the general direction of the enemy and entrust a device like Felix the Heat-seeker with the actual hunting? Well, during that demonstration the engineers had been careful to leave Felix alone with just one source of heat radiation. In real action there would be so many heat sources that any device would be confused. It would have to be brought pretty close to the intended prey until it could take over. And even then it might be useful only against an attacking unmanned missile. If it tried to chase a manned bomber, sniffing either for the heat of its exhaust or the noise of its engines, the crew could do something about it.

They could, for example, drop an instantaneously igniting incendiary bomb with a parachute that keeps it from falling too fast. The total weight of such a bomb would be around three pounds, small enough to allow any plane to carry a considerable number of them. Result: the heat-seeking interceptor would suddenly get a much hotter scent and strain all control surfaces in diving wildly after the floating magnesium bomb, blowing it successfully into smaller hot splinters. Any competent fireworks chemist can compound a mixture which does no harm but produces a considerable noise while burning. Incorporated into a parachute bomb, that would take care of noise-seeking missiles. One can confuse the radar man on the ground, too, but not that easily.

Going on from here, one could ask: why specific measures? Why not develop a field which will set off all VT-fuzed projectiles and missiles at a distance, where their explosion can't cause any harm?

PERSONALLY, I don't know if this can be done. I am mostly wondering whether a plane could carry the necessary equipment to do it. But even if it can be done and if the plane can carry the necessary equipment, there exists one kind of VT fuze that might spoil everything. It is the *optical* VT fuze which actually *sees* the plane.

The trick is accomplished by having a solid lucite lens which is covered except for a slot running all around the nose. Light enters through the slot and is focused on a photo-cell. An airplane that gets in the way is just something that acts as a partial screen reducing the amount of light received by the photo-cell. The photo-cell answers with a change in voltage that does what the reflected radio waves do in the other type.

If you now feel like the VIP who was left alone with Felix, you find yourself in large company. All these developments took place so fast that nobody has been able to think his way through. And if there should be a good partial answer, it is not likely to be published. But it looks as if attack and defense are better matched than they were in 1940. By hard work and ingenuity, things may be kept that way. —WILLY LEY