Add-on Armor

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During the Second World War, there was a constant race between armor and anti-tank guns. Because factories could not keep up with the advancements in tank design, obsolete designs had to remain in service. To extend the life span of these designs, the armor was often increased or improved, either at the factory, or in the field. While this increased the weight, and thus decreased mobility, it did improve survivability.

Increasing Armor Thickness

Modifying the plate thickness of an existing tank design can be problematic. Increasing the thickness of one armor plate may require other parts of the tank to be re-designed as well. A large number of armor plates may also already have been made, the re-forging of which would be costly. Even if the base armor of future tanks of an obsolete design was increased, the existing tanks would have to have a second plate added to the existing one.

The second armor plate can be welded or bolted on. While most countries continued to well on additional armor plates throughout the war, in January 1941, German field workshops were forbidden from welding on additional armor. This ban was due to concerns that a poorly-done weld would damage the original armor plate, negating the advantage of the added armor. Instead, bolted-on armor plates, as seen on mid-war Pz Kpfw IV's and Sturmgeschütz III's. Additional armor plates were, however, still welded on at the factories.

It is important to note that, assuming the same armor quality, the resistance to penetration of one armor plate of a given thickness will be greater than the resistance of two armor plates of the same combined thickness. This was demonstrated in an experiment performed in the US, in which a 90 mm M82 projectile was fired against one three-inch armor plate, and an assembly of two one and a half-inch armor plates with no space between them. The single armor plate could be penetrated at up to about 1550 meters, compared to 2900 meters for the two-plate assembly. The reason for this difference is that the penetrating projectile has to displace the steel of the armor plate. At the edge of the plate, the steel can easily displace outwards, whereas the steel in the center will displace sideways, offering greater resistance to penetration. Because the two steel plates have a greater amount of armor plate near an edge, it offers less combined resistance than the single plate.

Spaced Armor

Pz Kpfw IV Ausf. D with add-on armor plates.

Unlike the increased armor thickness, which is intended to increase the resistance to penetration, spaced armor plates serve a different purpose. By adding a relatively thin armor plate in front of the main armor plate, the armor-piercing cap of APC and APCBC ammunition can be stripped from the projectile. This greatly decreases the effectiveness of capped ammunition against face-hardened armor, but has much less influence on uncapped ammunition.

Schürzen

Pz Kpfw IV Ausf. G or H with Schürzen.


This Pz Kpfw Panther Ausf. A has lost all but one Schützen armor plate.

At the time of the German invasion of Russia in 1941, the Russian 14.5 mm PTRD and PTRS anti-tank rifles could penetrate the side armor of all of Germany's tanks. Even the side armor of the Panther could be penetrated at very short ranges.

To increase protection against anti-tank rifles, 8 mm steel sheets, Schürzen (skirts) were hung on rails along the side of the tanks. These steel sheets caused the shots to tumble, preventing them from penetrating the tank's armor. The Schürzen were divided into sections, allowing a single section to be easily replaced if damaged or lost.

Initial experiences

In May 1943, Panzer-Abteilung 21 of 20. Panzer-Division received five tanks with Schürzen for trial purposes. On 27 May 1943, they submitted their experiences to the Panzeroffizier beim Chef Generalstab des Heeres

(Armored Officer of the Army General Staff). While the report reconized the protection against “shells with highly sensitive fuzes, anti-tank rifles, and magnetic anti-tank mines”, it listed a number of draw-backs:

- The frames on which the skirts were hung was too fragile, causing them to bend when hitting obstacles.
- In muddy conditions, the skirts pushed mud into the drive train, thereby straining the tank.
- In dry conditions, the skirts caused an increase in dust and sand in the engine air intakes, thereby making them clog up more quickly.
- The skirts made it more difficult to perform repairs on the running geag, such as changing road wheels and track links.
- The left-side skirts had to be removed to refuel the tank.
- The skirts covered the vision and submachine gun ports. This allowed close-combat anti-tank units to approach the tank from the sides and rear, and to climb on and off the tank, without the crew being able to see or shoot at them.
- The skirts helped close-combat anti-tank units, as the skirts would act as a basket for explosive changes that would otherwise roll off the tank. After catching the explosive charges, the skirts would furthermore act as a containment wall for the explosion, increasing the effect of the blast. In one trial, a single Eihandgranate 39 (egg hand grenade) was caught in the space between the turret and the armored skirt, with the explosion punching a hole larger than a hand through the superstructure roof.
- The weight of the skirts further strained the chassis and engine, which they already considered to be strained beyond its intended capacity due to the up-armoring and additions.

The report concluded that the disadvantages out-weighed the advantages, and that work and material were not justified.

Later improvements

Later in the war wire mesh Thoma Schürzen were manufactured. These were lighter and still offered protection against anti-tank rifles as the rifle shots would tumble after striking one of the wires.

The following section is from the August 1944 edition of the Nachrichtenblatt der Panzertruppen, the official newsletter of the German armored forces.

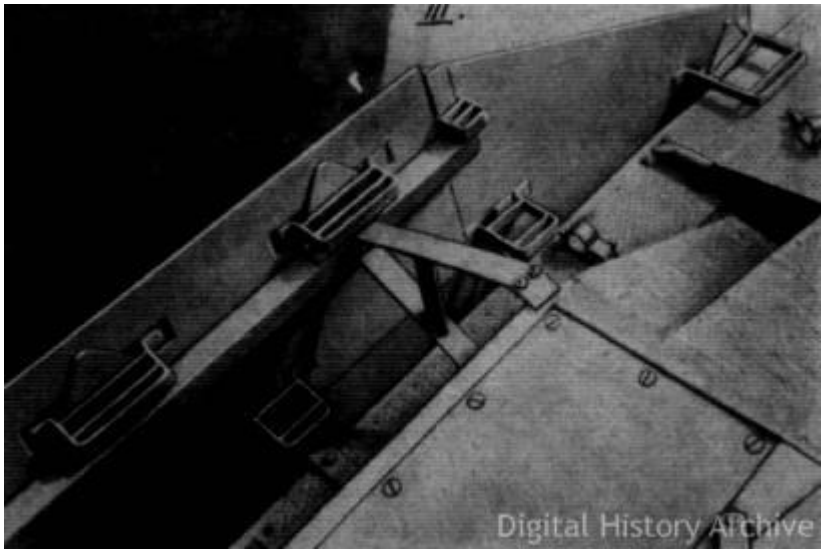
Protective covers for tanks (armored skirts)

The protective covers (Schürzen) were implemented on the orders of the Führer, in order to offer sufficient protection against Russian anti-tank rifles. As could be expected, following the use of the first version of Schürzen at the front, a number of deficiencies were revealed, necessitating improvements.

Experience reports on the armored skirts are still sent to the Inspector General of the Armored Forces. It is not clear from the reports, however, the type of skirts to which the reports refer, and thus whether the tanks were equipped with the latest version.

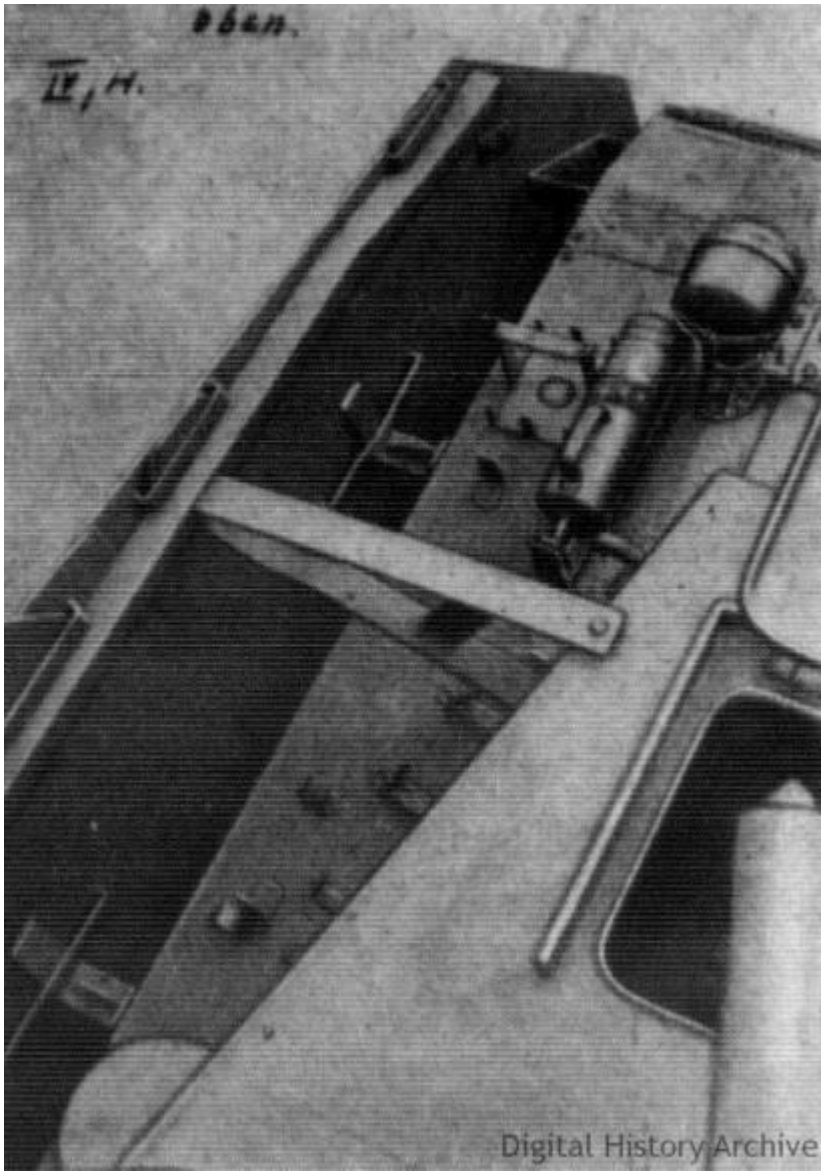
For the sake for clarity, the following designs are the versions currently shipped:

Assault gun on Panzer III chassis



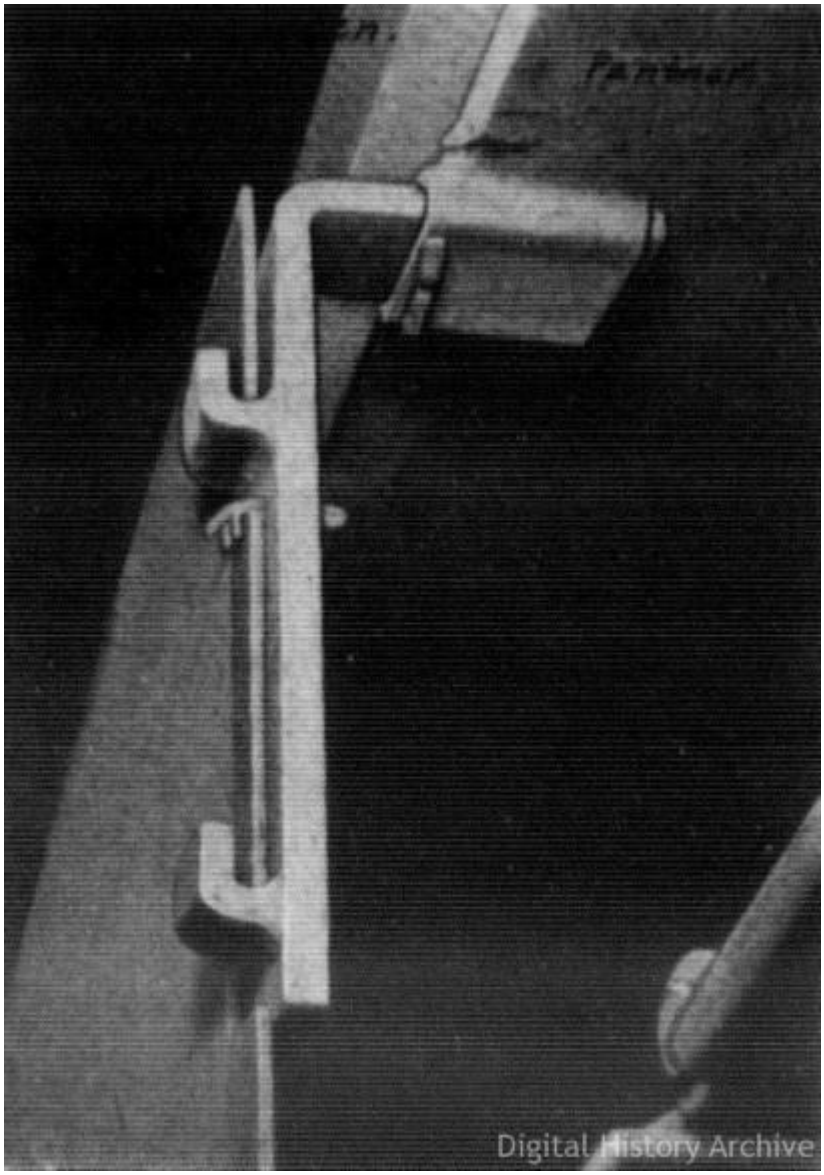
A downwards and oblique view of a part of the armor skirt. The brackets and hangers are clearly visible. The brackets allow the skirts to be hung at difference distances from the tank, to accomodate for the different widths of the summer and winter tracks.

Panzerkampfwagen IV Ausführung H



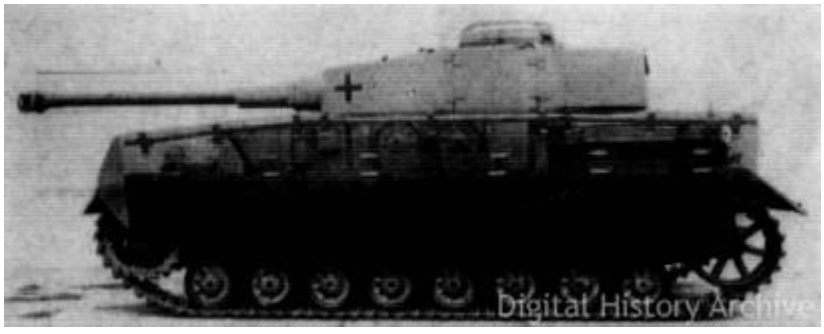
A downwards and oblique view of a part of the armor skirt. The brackets and hangers are clearly visible.

"Panther"



A downwards and oblique view of a cut-away model of the skirt mount.

Panzerkampfwagen IV Serie J [Sic]



Side view of the new wire mesh skirt. This type of skirt is going to be introduced from the J series.

Production Against Hollow Charges

It is a myth that Schürzen were designed against hollow-charge ammunition of the Bazooka or PIAT. As the American army did not use anti-tank rifles, military intelligence assumed that the Schürzen were designed to

protect against the weapons they knew. The theory was that the stand-off distance would prevent the jet from the hollow-charge ammunition to reach the armor. Russian late-war tanks did use specially-designed wire mesh protection welded to the turrets, to protect against German hollow-charge weapons, such as the Panzerfaust. The actual effectiveness of this is still debated, with reports indicating that it would be effective against low-quality hollow-charge ammunition, but not against high-quality ammunition.

The German high command did consider hollow charge ammunition a significant new threat to armored vehicles, as can be seen in this report from the Panzeroffizier beim Chef Generalstab des Heeres on 18 May 1943:

The satisfactory progression in the development of hollow charge ammunition for use against armored vehicles has at several occations caused led to the conclusion that this marks the end of the armored forces.

I consider this position to be false.

It is important to find counter-measures against the hollow charge principle.

Suggestion: Investigate if hollow charge penetration only work through heat or also mechanically.

In the first case, the effect of hollow charge ammunition could be defeated by inserting asbestos or chamotte, that is a thin armor sheet, then a layer of asbestos, and only then the armor plate.

The layer of insulation that is repeatedly reported to be used by the Russians to remove the risk of ignition could serve as a defense against hollow charge ammunition.

It is interesting to note two things: That while Schürzen were being experimented on at the same time, they were not considered as a potential solution, and that the idea to use asbestos or clay was similar to modern, composite armor.

Improvised Armor

In addition to officially approved add-on armor, individual units often attempted to improve the protection of their tanks. Some of these included poured concrete, seen on the Sturmgeschütz III and IV, and sand bags stacked along the side of the tanks, mainly seen on Allied tanks on the Western front. Even tree trunks are known to be placed on vehicles.

Late in the war, it was common to see spare track links stacked on the front of tanks on both sides. Especially the Pz Kpfw IV and Sturmgeschütz III are known for this, as some of their spare track link racks were purposely welded to the front of the vehicle. There are even examples of T-34 track links on German tanks. However, as the track links were not made from armor quality steel, the actual value was limited.

Official Stance on Improvised Armor

In the September 1944 edition of the Nachrichtenblatt der Panzertruppen (Newsletter for the Armored Forces), the following order was given, prohibiting the use of improvised armor.

According to a report from a Waffenamt officer, the following types of add-on armor have been observed in the field:

1. 48 track links were placed on a Panther. 30 of the track links were placed on the turret, while the remaining were placed on the side armor covering the engine compartment. Furthermore, the placing of track links was observed on numerous other tanks.
2. A layer of reinforced concrete, also intended as add-on armor, was observed to partially covering both tanks and assault guns.

The following must be observed:

Track links placed at shallow angles does not offer any significant additional protection. When placed at an angle of 80 to 90 degrees they will even reduce the armor protection compared to that of the armor plate alone. On the other hand, the track links will increase the weight of the vehicle, which will increase the strain on the drive train, engine and gearbox. It is known that the 75 mm anti-tank shell of the Pak 40 will penetrate between 60 and 100 cm of concrete at short distances. Consequently, when the layer is only 20 cm thick the additional protection is very limited, and does not make up for the additional strain on the vehicle. Covering an area of one square meter with a 25 cm thick layer of concrete, which has a weight of 2200 to 2400 kg per cubic meter, the weight will be approximately 600 kg. Since the area covered is probably greater than one square meter, however, the additional weight will likely be in excess of one ton.

Because the vehicles' existing weight is already using almost the entire load capacity, any weight increase must be considered as a threat to the vehicle.

While these measures may improve the troops' morale by increasing the sense of security, the actual protection is never increased.

Attaching add-on armor of any type is therefore prohibited.

The statement in the document above to the ineffectiveness of concrete armor is supported by an experiment referenced in a document from the German head of artillery from 24 January 1944:

[…]

Following a firing trial, the reinforcement of armor by the use of concrete is not found to be advisable. The weight is high and the fragmentation effect is unfavorable, and it has therefore been rejected by the ordnance office.

Sources

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Last updated 2021-02-21 12:25:48.