Tanks and Tungsten - Germany's little big problem

Now hear this!

During World War II Germany faced a problem that was difficult to resolve – that of geography. While blessed with picturesque mountains, deep-water ports, and fertile plains, one significant issue was a lack of certain metals, ores and other natural resources – particularly tungsten. That meant Germany was utterly reliant on imports of those materials found in the Iberian Peninsula, mostly from Portugal and Spain.

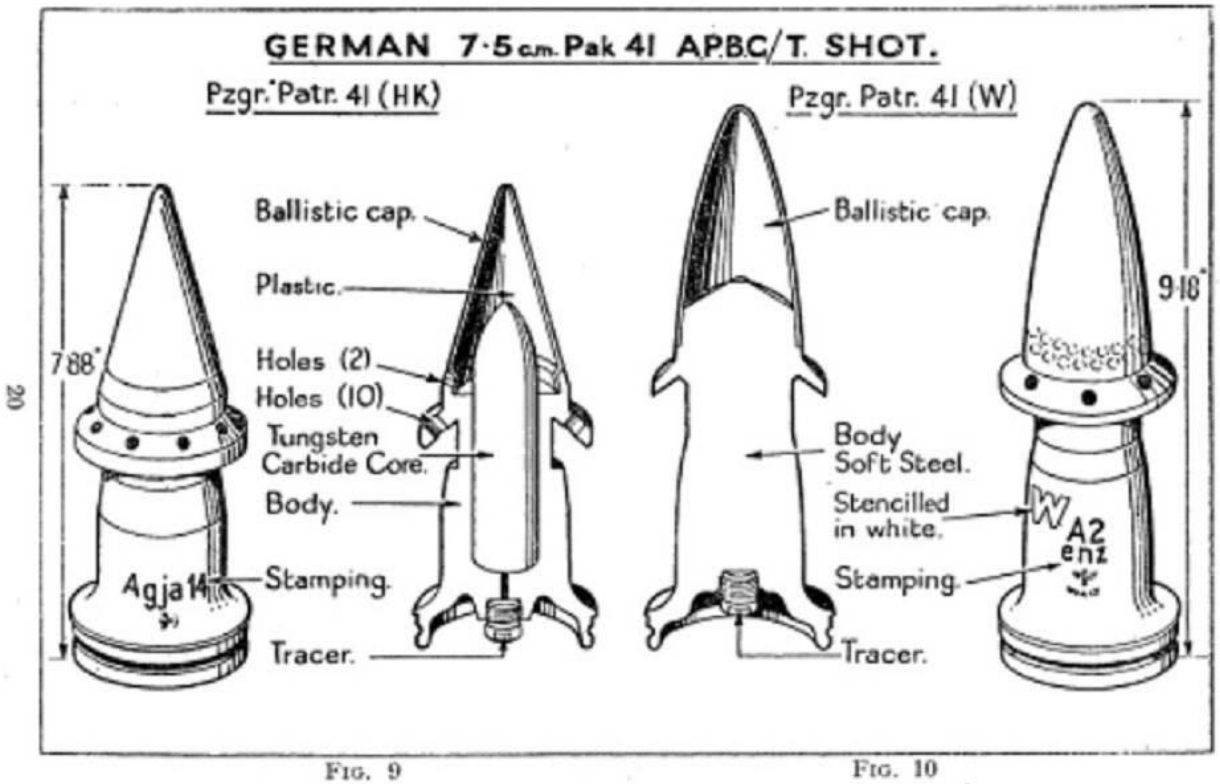


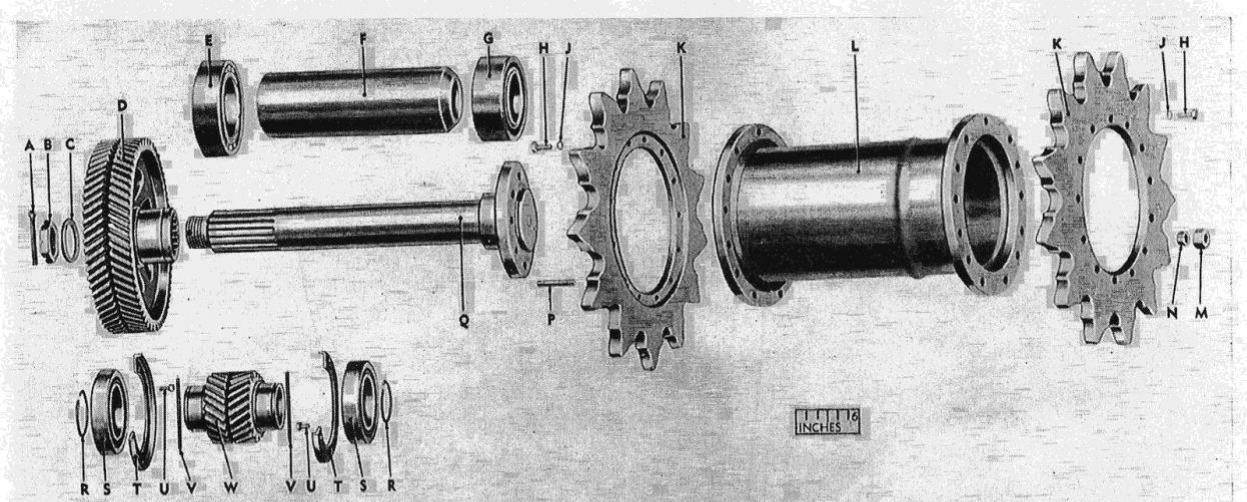
FIG. 9 FIG. 10

Tungsten Carbide core armor piercing shot on left. Mild steel on right

Tungsten is a crucial element needed for tungsten carbide, a vital component of anti-armor ammunition, forming the core of the round that punches through armor plating. The lack of tungsten in ammunition production had many immediate effects, such as limited availability of anti-armor rounds for German forces. But tungsten carbide was also used in manufacturing for precision milling and metal work, which had other, perhaps, less immediately obvious effects.

In the U.S., tungsten was comparatively easy to obtain – due to supplies located on continental soil. As such, the American automotive industry was well-tooled with sufficient machinery to pump out nearly 50,000 M4 Sherman tanks alone, as well as thousands of tank destroyers and other armored vehicles. These vehicles benefited from a transmission and final drive assembly that used double-herringbone gears, which spread out the forces on individual teeth and helps

prevent shearing of gear teeth. But this comes at a cost – double-herringbone gears are harder to produce and require complex milling.



KEY ITEM	PART NO	GROUP	KEY ITEM	PART NO	GROUP	KEY ITEM	PART NO	GROUP
A—PIN	179095	1008.2	H—BOLT	7069577	1304.1	Q—SHAFT	7012301	1008.2
B—NUT	A196368	1008.2	J—WASHER	180447	1304.1	R—RING	A196363	1008.2
C—WASHER	A196360	1008.2	K—SPROCKET	D47366	1304.1	S—BEARING	707645	1008.2
D—GEAR	7067282	1008.2	L—HUB, ASSY	C135867	1304.1	T—RETAINER	A196369	1008.2
E—BEARING	709807	1008.2	M—NUT	503367	1304.1	U—BOLT	571153	1008.2
F—SPACER	7012302	1008.2	N—PIN	A196382	1304.1	V—WIRE	22-W-1642-100	1008.2
G—BEARING	707689	1008.2	P—STUD	A196384	1304.1	W—PINION	7067281	1008.2

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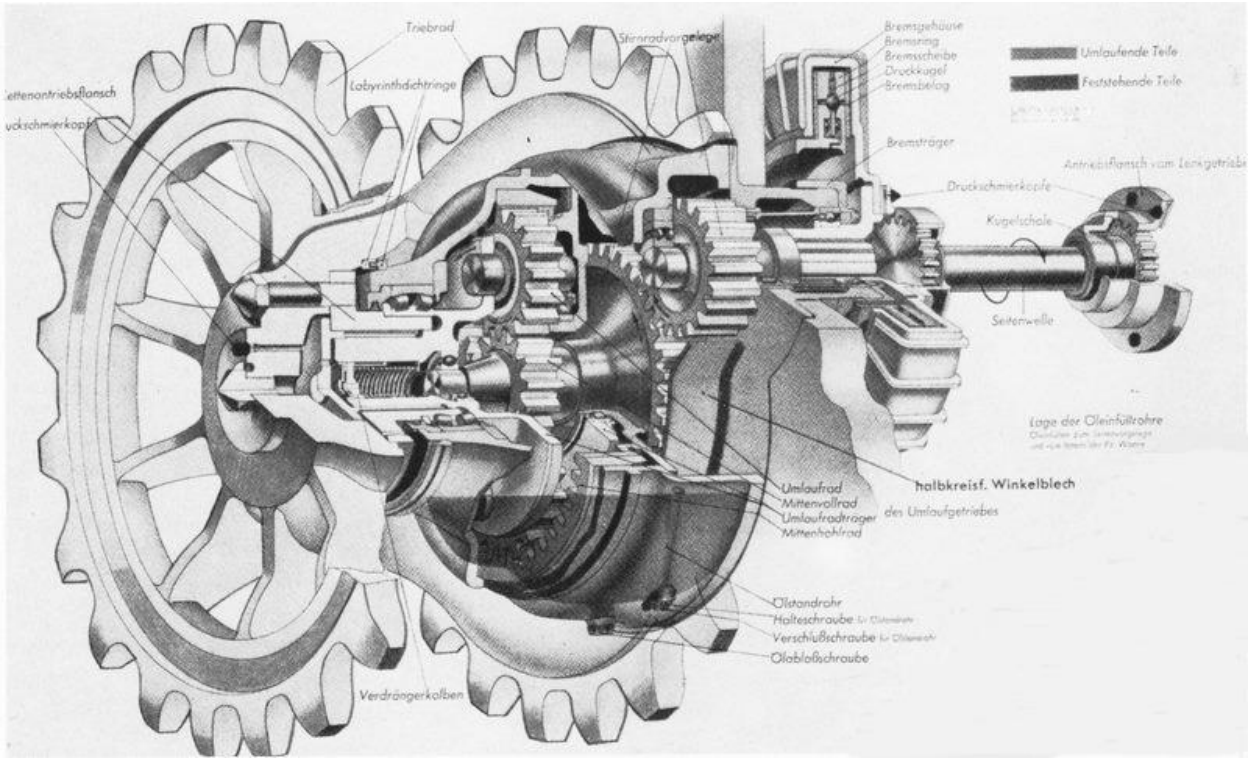
Figure 10–22. Final drive gears and sprockets (wide track), exploded view.

Sherman final drive, note the double herringbone gears

It seems that when faced with similar engineering issues, German planners and engineers elected to use straight-tooth gear designs, which are easier to manufacture, but more prone to shearing of individual gear teeth. A clear reason why double-herringbone gears weren't used remains shrouded in the past. However, a lack of tungsten carbide needed for the complex milling of those gears may have contributed to that choice.



Panther final drive assembly, note the straight spur gear

“It is interesting that the American Sherman tank used double-herringbone gears in the final drives, which provides more torque capability for a given width of a final drive,” said Jacques Littlefield, founder of the Military Vehicle Technology Foundation, in Michaels Green’s book *Panzers at War*. “The Panther uses straight spur gears, so there must have been some manufacturing limitation, as double-herringbone gears were well known at the time for their ability to carry larger amounts of torque for a given width.”

While in service during the war, the German Panther tank was especially prone to failure in the final drive unit and transmission. German prisoners of war interviewed post-war as part of the 1951 U.S. Army Operations Research Office technical memorandum ORO-T-117 said that "usually more Panthers were disabled [from mechanical issues] by overland moves than in actual battles.". Though capable of neutral steering — turning in place without moving forward or in reverse — French post-war testing of the Panther found that doing so would cause a failure in the final drive.

Mechanical problems, especially in the drivetrains, bedeviled much of the German panzer fleet and not just Panthers. According to the post-war analysis of ORO T-117, a full 40 percent of German tanks recovered by the Allies were lost to crew abandonment or scuttling. Even the Panther’s combat debut had warning notes for the future.

While the Panther didn't require the turret to be removed for transmission and final drive work like the Tiger, this was a common scene in maintenance depots

“Almost at once major defects in design and construction—particularly of the steering and control mechanism — were discovered, with the result that all 326 Panther tanks had to be withdrawn and returned to the [German] zone of interior for complete rebuilding,” notes the U.S. Army’s 1954 publication German Tank Maintenance “To perform the necessary work, a special tank-rebuild plant was established near Berlin.” In looking at the Panther’s overall performance throughout the war, it shared the Tiger’s operational rate of around 36 percent. Though, the Panther’s reliability rose to approximately 50 percent by the end of the war, as issues were identified and resolved in subsequent versions of the tank. The Tiger II, which was larger than the Panther, but shared many design features, also experienced similar issues.

In Repairing the Panzers, author Lukas Friedli observed that “on approach to the front in August 1944 most of 501's [501st Panzer Battalion] new Tiger IIs broke down with final drive problems.”

Because of its use in armaments and manufacturing, tungsten, in a sense, became another battle front. Allied strategists determined that if Germany were deprived of tungsten “its machine-tool industry would virtually shut down within three months, severely diminishing Germany’s capacity to continue the war," according to findings in the U.S. State Department’s 1997 publication *U.S. and Allied Efforts to Recover and Restore Gold and Other Assets Stolen or Hidden by Germany during World War II*. If the tungsten supply could be cut off, Germany's war factories would grind to a halt, unable to replace cutting heads necessary for performing precision mill-work essential for guns, cannons, engine parts and a host of other war materials.

There were several efforts undertaken to deny Germany these key imports. First, the U.S. and U.K. entered trade deals with neutral countries such as Portugal, purposefully buying goods like tungsten far above its market value. While these independent countries profited immensely from this "trade war," the Allies succeeded in diverting large amounts of raw production materials into their own stockpiles versus Germany's. Germany, accordingly, tried to keep these vital minerals flowing by using gold reserves it captured from countries conquered in 1939 – 1941.

Looted gold was used to bankroll tungsten purchases

On Feb. 22, 1944, the Allies issued the "Gold Declaration," which warned neutral countries that the Allies would not buy gold on the international market unless it could be clearly proven it had not come from the Axis powers looted reserves. Coupled with the Gold Declaration, a growing threat of a larger Allied embargo against them led to Spain and then Portugal both cutting off all exports to Germany in late 1944.

Once Germany's stockpiles of tungsten were depleted in early 1945, its ability to keep producing precision-milled components for armored vehicles also plummeted. Through strategic economic pressure and the rejection of looted gold for use in international trade, the Allies' "victory" on this hidden battlefield helped bring an end to the war in Europe.

That is all.