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SPECIAL SUPPLEMENT

# TUNGSTEN!

*The Paris peace talks promise to be endless. Both Harriman and Vance have moved out of their quarters in the posh Crillon Hotel and found more permanent residences. As the talks proceed slowly, it is important that we fully understand what the war is all about, how we got mixed up in it, and why. One haunting thesis is Tungsten. Here is the story:*

In the Fall of 1953 the French began their last great battle of the Indochina war at Dien Bien Phu. In the years before that battle, French officers called it a "dirty war" because it was physically dirty and because it was impossible to identify the enemy. He looked just like the pro-French peasants, wore no distinctive uniform, carried no flag, and held no definable military position. French generals yearned for an old-fashioned battle, out in the open, over fixed positions. They got it, at Dien Bien Phu.

President Eisenhower, inspired by his inimitable Secretary of State John Foster Dulles, decided the French must not lose their effort to hold on to their Southeast Asian empire, and contributed some $400 million in military aid to the French forces.

On August 4, 1953, President Eisenhower appeared before a conference of Governors where he faced the concern of many that his Administration's foreign aid programs were "giveaways." The President explained why:

"If Indochina goes, several things happen right away. The Malayan Peninsula, that last bit of land hanging on down there, would be scarcely defensible — and tin and tungsten that we so greatly value from that area would cease coming. So, when the United States votes $400,000,000 to help that war, we are not voting for a giveaway program. We are voting for the cheapest way that we can to prevent the occurrence of something that would be of the *most terrible significance for the United States of America* — our security, our power, and *ability to get certain things we need from the riches of that Indochinese territory and from Southeast Asia.*" (Italics added)

## IMPORTANCE OF INDOCHINA

At a news conference on April 7, 1954, President Eisenhower commented further on the importance of Indochina to the United States. The record says this:

"Question — Robert Richards, Copley Press: 'Mr. President, would you mind commenting on the strategic importance of Indochina to the free world?'

"The President: 'You have, of course, both the specific and the general when you talk about such things. First of all, you have the specific value of a locality in its production of materials that the world needs. Then you have the possibility that many human beings pass under a dictatorship that is inimical to the free world. Finally, you have broader consideration that might follow what you would call the "falling domino" principle. You have a row of dominos set up, you knock over the first one, and what will quickly happen to the last one is the certainty that it will go over very quickly. So you could have a beginning of disintegration that would have the most profound influences. Now, with respect to the first one, *two of the items from this particular area that the world uses are tin and tungsten. They are very important.*'" (Italics added).

Interestingly, in the years since these public statements were made by President Eisenhower, there has been much reference to the "domino" theory, but hardly any to tin and tungsten which he listed as the first item of importance and returned to in his conclusion ("Now, with respect to the first one . . ."). Surely one might assume that if tin and tungsten were so important as a reason for U.S. involvement in Eisenhower's time, they would be important in Johnson's time — unless tin and tungsten had lost their value in the intervening years. Upon examination we find that these minerals are vastly more important today than they were in 1954.

Tungsten (Wolfram) is found on the flanks of the Pia-Quac mountains of *North Vietnam*, north of Haiphong, in the N'Guyen Bim District, province of Cao Bang. There are an estimated 300,000 units of $WO_3$ in the 49 known mines of Pia-Quac mountains of North Vietnam. *There are no deposits of tungsten in South Vietnam.*

### Circulate the Story about Tungsten

Order extra copies of this Special Tungsten issue for friends, acquaintances, anyone who should be enlightened about the vital importance of tungsten to our Vietnam adventure in particular and our whole Far East policy in general. Bundle rates: 25 copies for $2.00; 50 copies for $3.50; 100 for $5.00; special rates for larger quantities. Or send stamped, self-addressed envelopes and we'll send single copies.

## THE USES OF TUNGSTEN

Modern war cannot be fought without tungsten, which is one of the hardest substances known. Combined with carbon, it becomes so hard, so durable and strong, that it can sustain immense heat and even maintain its hardness and its sharp cutting edge under extremely high temperatures, when other substances will soften.

Tungsten has many uses, so that modern industry would find it hard to function competitively without it.

Tungsten is used as the filament in electric lights (remember "tungsten lamps"); it is used in making cutting tools and permanent magnets; it is essential in surgical instruments because it is not affected by organic acids; it is needed in X-ray targets, galvanometer suspensions, thermionic devices, electrical contacts, refractory crucibles. Almost all industrial alloys contain tungsten.

Tungsten is indispensible in modern war. So much so that it has become a truism that a nation loses modern warmaking power without it. And the world military power balance might be tilted if adversaries had a plentiful supply of tungsten and we did not.

Germany first demonstrated the value of tungsten in the manufacture of war equipment during World War I. The need in modern war is for high speed munitions production to keep up with exhausting of supplies. Ordinary metals cannot operate in machines at high speeds; tungsten can.

Before World War I munitions were turned out at a predictably limited rate and were usually consumed faster than they could be replaced. Because modern war required advanced weapons which took so much longer to produce. military strategists in allied countries predicted the war would end quickly because Germany would use up its stockpiles in six months and could not then replenish them because it would take so long to turn out new equipment.

After six months the allies found the Germans were not running out of munitions at all. Instead of decreasing the fury of their attacks, the Germans intensified them, and had an apparently limitless supply of war materiel. By the end of the first year the Kaiser's armies had bigger munitions stocks than when the war began. British intelligence discovered the Germans were using a high-speed steel made with tungsten, and were manufacturing munitions with tungsten cutting tools which never seemed to wear out. Speed generates heat and heat destroys metal so speed normally had to be retarded — until the Germans found that tungsten could withstand even the most intense heat. They could bring up their production without concern about machinery wearing down or tools losing their cutting edge.

**SCRAMBLE FOR TUNGSTEN**

The Great Powers began a world-wide scramble for tungsten. Within a very short time, by 1916, American manufacturers were also producing munitions at a faster rate than ever before, and began shipping it to allied forces in Europe. Germany announced that all armed merchant ships of the allied nations, or others carrying supplies to the allied nations, would be sunk without warning.

President Woodrow Wilson rejected the Kaiser's ultimatum. He asked Congress to authorize the arming of all American merchant ships, but Congress refused. President Wilson was not to be deterred; after all, the Germans were turning out fresh armament at a high rate because they had tungsten, and now that the United States had tungsten (from China), it was turning out munitions at an even faster rate (because of superior American production methods and capacities), and it had to be delivered to the war zones. So the President issued an Executive Order, directing that all American merchant ships be armed – simply ignoring the Congressional refusal to approve. When American merchant vessels were armed, the Germans began their unrestricted submarine attacks on U.S. shipping. In April, 1917, President Wilson asked Congress to declare war on Germany, "to make the world safe for democracy." World War I ended with more than 37 million casualties. 8,538,315 were military dead. Civilian dead unknown.

When the war ended the price of tungsten dropped to prewar levels. Then the world's leading industrial powers turned their attention to China, which was (and is today) the world's largest known producer of tungsten. Moreover, Chinese tungsten is the purest to be found anywhere. There were five leading industrial nations in those days: The United States, Germany, Great Britain, France, and Japan. Germany was not invited to Great Power machinations because Germany had lost the war and it was to the victors the spoils belonged.

**THE RICHES OF CHINA**

In 1921 the United States, Britain, France and Japan signed a solemn treaty in Washington pledging respect for the territorial integrity of China. Although the four major industrial powers were pledging to keep out of China, China was not even included in their conference.

Half a dozen years later there was an uprising in China. The ruling Kuomintang split into factions and some of the dissidents were attacking British Consulates. Fearing that U.S. property might be endangered, the United States sent 1,000 U.S. Marines to Nanking. Much of the U.S.-owned property the Marines were to protect was tin and tungsten. The uprising died down, the Marines were recalled, but a larger invasion of China was to follow.

Japan had been roused from three centuries of complete isolation by the American, Commodore Perry, who arrived with four warships in 1853 to open trade. Japan dared not refuse and her doors were opened. Japan decided to catch up with the industrial revolution. Within an amazingly few years Japan built industries and became a highly advanced technological society. With industrialization, Japan began to feel the same urge which had motivated the Europeans to search for empire – need for market and sources of raw materials to feed the hungry factories.

China was the big prize. China, land of untapped riches: coal, iron, oil, aluminum, gold, silver, sulphur, jade – and, tin and tungsten (they are usually found together). Chinese coal was next only in quantity to the deposits in the U.S. and Canada; virtually every Chinese province had coal deposits. Seventy percent of the world's supply of antimony was to be found in Hunan province, which is where the tungsten is. And manganese—an average yearly output before the Japanese invasion of about 100,000 tons. About half the world's supply of alumina is produced in China's Cheking province alone. There are raw materials for making porcelain, the famous Koaling clay, in Kiangsi and Anhwei provinces. addition, extensive water resources: more than 1500 rive with a potential of over 450,000,000 kilowatts of hydroelectr power.

There was far more than these earthly riches in China lure the Japanese empire-builders – there were the Chine people. Not only were they numerous, but particularly de terous, resourceful and ingenious. It was the Chinese wh produced the world's three great inventions: printing, gu powder, and the compass. China was first to produce silk, far back as the 13th century *B.C.* From the silk they invente a by-product, a silk-paper on which one could write.

The pattern of conquest was faithfully followed: First ga a mainland foothold in Korea, then invade Manchuria, the the rest of China through Shanghai.

**PREPARING FOR WAR**

Meanwhile, the Germans under Hitl were preparing for World War II. Ge man *Nazional-Sozialismus* (Nazism) fo lowed the then familiar Fascist pattern of Italy: industr allied with the military-backed political dictatorship whic catered to the interests of the military-industrial comple Other interests were subordinated, only those of big busine and the military were the prime concern of Hitler's goverr ment; all were determined to build an empire to last thousand years. German industries yearned for raw materia and captive markets, the military yearned for war and infl ence, the politicians dreamed of power.

And all needed tungsten – the chief ingredient of moder war and modern industry.

Hitler sent General von Seeckt to China to serve as chie German military adviser to Chiang Kai-shek. In July, 193( he sent his Defense Minister, Colonel General Werner Frit Von Blomberg, General Von Reichnau, and Herr Ober Thomas to join with Von Seeckt in negotiating for tungste with the Generalissimo. They worked out a 100 million mar revolving barter agreement on July 25th.

By that time China had become world renowned as a rar metal producer with the world's largest supply of fine qualit tungsten ore. In fact, Chiang had put up tungsten as securit for loans from the United States. Now China was selling tung sten to the Germans, but without the slightest suspicion tha Germany was preparing for World War II. American an British economists did not associate German tungsten pur chases with war plans; they were concerned only that Ger many might dump tungsten on the world market and pull th price down. They expressed this fear to the Chinese wh became concerned about what would happen to their tungste business. Chiang called Von Blomberg aside and voiced hi fears about Germany selling tungsten in order to get foreig exchange. Chiang demanded a formal agreement that Hitle would keep the tungsten in Germany and not re-sell it. Th German Defense Minister chuckled with relief and told th Generalissimo to write the letter of agreement and that he Von Blomberg, would sign it. Chiang must have concluded that Hitler was a man of his word and that you can do busi ness with him, since not a pound of German tungsten reached the world's markets.

Germany kept buying up tungsten wherever it was avail able, from China, Mexico, Peru, Argentina and Bolivia.

**"INCIDENT" IN ASIA**

Although Japan was at war with China, the conflict was called an "incident" so that the United States Neutrality Act would not apply. The Neutrality Act forbade American commerce with belligerent nations. Since Japan thus called herself a "neutral," she was officially treated as a neutral by the United States, Canada and Latin America — even though Japan was allied with Hitler and Mussolini in the Axis pact. Latin American nations sold tungsten to Japan prior to Pearl Harbor. The Japanese had not been informed by their German allies of the value of tungsten in production. When Japan acquired tungsten it promptly sold it to the Germans. After Pearl Harbor, it happened that a Japanese freighter "Wilimoto" left South America with a cargo of tungsten destined for Germany. In mid-voyage the freighter was renamed "Odenwald" but it did not escape identification by the United States, which had broken the Japanese navy code by that time. The steamer was captured by U.S. warships, with its tungsten cargo intact.

The Germans continued buying tungsten after war with America began, and paid whatever was necessary. Franco was a Hitler ally, contributing at least one "Blue Division" to fight alongside the Reichswehr, but the Spanish dictator was not above making money out of his friend, supporter and military ally. Spain joined Portugal in making Germany pay record prices for tungsten, prices that ran as high as $50,000 per ton of ore. The United States and Great Britain by this time became aware of the value of the material, and agreed to pay Franco and Portugal's Salazar even more than the $50,000 per ton in order to keep more tungsten out of German hands. Before World War II the tungsten countries had few customers besides Germany. In Berlin there was a purchasing center headed by the German tungsten expert, Hermann C. Starck, who managed to concentrate in his stockpile just about all the available off-grade ore from all over the world.

Not all of it was available. Latin America produced tungsten, not as pure as that from China, which the United States in the summer of 1940 began buying up simply to keep it out of German hands. Also war with Japan was expected at any time so that shipments across the Pacific would be interrupted. The United States entered the race for tungsten somewhat tardily; Germany had long been the world's major importer.

Chinese tungsten was the finest obtainable anywhere. A major U.S. import of Chinese tungsten came about in a dramatic, cloak-and-dagger type of intrigue. Chiang Kai-shek had shipped a very large quantity of tungsten to French Indochina for safekeeping, to guard it against the Germans and the Japanese. France was overrun by the Germans in May, 1940, and the Germans set up a puppet government at Vichy under Marshal Petain. Japan's pattern of conquest called for acquisition of Indochina as a stepping stone to Southeast Asia, as Korea had been an entree to northern China. Japan waited for Hitler to conquer France, anticipating that he would then turn Indochina over to his Asian ally. Japan had her eye on that huge stockpile of Chinese tungsten at Haiphong, ready for export.

Late in May, 1940, Japan urged Hitler to dictate that Marshal Petain remove the French Governor-General of Indochina, General George Catroux, because he was "uncooperative." He had refused to turn the Chinese ore over to Japan. Hitler obliged, and Petain dutifully replaced Catroux with Admiral Jean Decoux who would be more amenable to Tokyo's wishes.

**AMERICAN INTRIGUE**

Word of this came to the ears of K. C. Li, the leading American tungsten expert (about whom much more later). Mr. Li was a scientist and industrialist not a statesman; his contacts were not with Secretary of State Cordell Hull but with the Federal Loan Agency Administrator, Jesse H. Jones. He informed Jones of the Chinese tungsten in northern Vietnam and what he had learned about Japanese moves to acquire it. Mr. Jones acted promptly. He contacted Secretary of State Hull who immediately cabled the American Consul-General, Reed, at Hanoi. Although the French Governor-General Catroux had been ordered replaced by Vichy, the replacement had not yet arrived, and Catroux was still in charge. The American Consul-General was able to get Georges Catroux's signature to an immediate release of the entire Chinese tungsten stockpile (which belonged to the Chinese government) and Catroux designated it as "U.S. property." Four U.S. "special vessels" — SS Birmingham City, SS Puerto Rican, SS Oregonian, and SS Chickasaw City — raced to Haiphong and loaded the entire quantity of Chinese tungsten ore and steamed away, all before the new Vichy-French Governor-General arrived. And before Japan was able to get Hitler to turn all of French Indochina over to the Imperial Government of Emperor Hirohito. When the four ships arrived at Staten Island, New York, their captains reported that the Japanese were so furious that four Japanese cruisers followed the American vessels for three days after they left Indochina.

This maneuver, plus the import of Latin American and other ores, provided the United States with enough tungsten to eliminate the possibility of shortages during the forthcoming American war with the Axis powers. It was the tungsten which enabled American industry to gear quickly for war production, to turn out planes, tanks, guns and other munitions swiftly, and to produce the armor-piercing and heat-resisting armaments which finally tilted the scales against the enemies. For the acquisition of the very large and critical Chinese tungsten stockpile in French Indochina, the United States was indebted to Li Ho-ching, the man who had discovered tungsten in China in 1911, who had pioneered the tungsten industry in America (see next week's issue) and who more than any other single factor was responsible for the American war power of 1941-45, and thereafter.

Early in World War II the German General Rommel almost demolished the British tank force in North Africa with a tungsten-carbide high-velocity, armor-piercing projectile. British war reports said that British tanks "melted" when hit by the German missiles.

By the time of D-Day, it was the allies who had put tungsten to use in war production and in munitions themselves. Now it was the allies who turned the penetrating power of tungsten-missiles on their enemies:

### *French General on Vietnam*

"I think that at this moment they (Americans) have lost the initiative and do not have the means to recapture it, because they would have to regroup their reserves, and they can only do this by evacuating somewhere. But they haven't taken a decision to evacuate anywhere because they want to preserve the occupation which they have achieved. Thus, in order to regroup their reserves, they are obliged to wait for reinforcements, and so long as they have no reinforcements they are in a very delicate situation . . .

"The deployment of the Americans consists of an archipelago of strong points on all the northern plateaus, strong points with an air strip in the center and around it a sizeable garrison for protection. This takes up between four and six divisions. They can evacuate everything, but this is a step they haven't taken, and if they don't take it, the troops are pinned down there."

—From an interview with General Andre Beufre, Ramparts, June 29, 1968

After the Normandy invasion the Germans were pushed back to the Rhine. German General Von Runstadt staged a surprise counter-offensive spearheaded by Tiger and Panther tanks, backed by 15 troop divisions. He drove almost to the outskirts of the city of Brussels, in effect producing a "bulge." It was then that the newly-developed American tungsten-carbide projectiles came into action for the first time, destroying Tigers and Panthers as if their walls were cardboard instead of thick armor plate. The missiles crashed through steel with such force and velocity that they came through almost unmarked. Once inside, the shells would explode, shattering shrapnel, setting the tank interior on fire at such heat as not only to turn the human occupants to ashes but to turn the heavy steel into a shapeless mass of molten metal. The victory in the Battle of the Bulge spurred the United States into an all-out tungsten-acquiring program aimed at supplying 30 million tons of the remarkable metal.

**MOST SOUGHT-AFTER METAL**

Tungsten helped both sides produce munitions at a greater rate and in greater quantities than ever in history. Tank turrets, torpedoes, aircraft parts, shells and anti-tank high-velocity shells were machined from 10 to 50 times faster with tungsten-carbides than with conventional "high-speed steel" (iron-tungsten). The Germans found that tungsten-carbide bits for rock drilling would drill 50 percent faster and last ten times longer than with high-speed steel.

Tungsten has become the most sought-after metal in today's technology. It has the *highest melting point* of any metal, so that when another metal is used as a substitute it necessarily is at least second best. The temperature at which tungsten begins to melt is so high it is not accurately known – somewhere between 3380° Centigrade and 3410° Centigrade, which corresponds to 6116° Fahrenheit to 6170° Fahrenheit. A standard yarn among engineers was that it is impossible to cast anything out of tungsten because there is no suitable material capable of standing the high temperatures needed as a mold. Today, however, some of the newer ceramic materials will hold tungsten for a limited time, while electron beam-melting methods provide the high temperatures in a vacuum chamber. Obviously the size and accuracy of the casting or ingot is very limited. The reason it has not been possible to determine the precise melting temperature of tungsten is that the thermometer melts before the tungsten does. Scientists have even tried to make the thermometer out of tungsten but there must always be some measuring material included, and these component materials melt before the tungsten reaches its melting point.

Another statistic to illustrate the enormous value of tungsten: It has a *boiling point* (as distinguished from the melting point which is of course lower) of 5900° Centigrade, or 10,652° Fahreinheit. That means that the tungsten boiling point is HOTTER than the surface of the sun! (The sun's solar surface, measured by several indirect methods, shows a temperature of about 10,000° Fahrenheit.)

Not only does tungsten have the highest melting point of any metal, and a boiling point higher than that of the sun's surface, but it is the *strongest* metal in common use. There are stronger metals than tungsten, but their extremely high cost precludes their general use: boron, rhenium, iridium, osmium, and ruthenium all have higher elasticities than tungsten, but they cost about a hundred times as much (all prices are in excess of $318 per pound as compared with tungsten's average cost of $3.50 per pound).

Here are more figures, technical data which must impress even the layman: Young's modulus of elasticity at 20°C. for tungsten is 59,000,000 pounds per square inch. Compare this with the elasticity of aluminum: tungsten is about six times stronger. It is five times as elastic as cast iron, 3.4 times as elastic as copper, twice that of steel. The tensile strength of tungsten ranges from 16,000 pounds per square inch up to 610,000 pounds per square inch – depending on the size, type, and form of the specimen being tested. The higher figure is the highest of any known metal.

Another quality: *vapor pressure*. Tungsten's vapor pressure is the LOWEST of all metals, and its *compressibility* at 20°C. equals 0.28 X $10^{-6}$ per megabar, which is the SMALLEST of any metal.

**VITAL IN NUCLEAR PRODUCTION**

Tungsten finds particular application in the nuclear industry, and in the manufacture of atomic weapons as a shielding material, because of its high density and relatively high "thermal neutron absorption cross sectional value." In fact, in these fields tungsten is irreplaceable.

The very high and very low limits make tungsten invaluable where such extremes are required. But even at ordinary room temperature tungsten has remarkable strength, so much so that it rates *highest of all metals* in strength-weight ratio. At elevated temperatures where steel is useless, tungsten still has a higher tensile strength than steel has at room temperatures.

It is relatively resistant to chemical attack by acids and liquid metals. Water, ammonia and hydrogen have no effect on it at all. While other metals will oxidize at temperatures somewhat above room temperature, tungsten will begin oxidation at about 752° Fahrenheit, which is just a bit above room temperature, we may be sure.

In short tungsten is a unique metal with properties of tremendous strength, resistance to wear and to the extremes of heat, friction, and corrosion. No one disputes its rare qualities, its enormous value, its practical indispensibility in specific industrial and military application. What may be disputed is the lengths to which the United States government will be ready to go to acquire it and at what cost. This leads to our next inquiry: where is tungsten to be found? Along with the dramatic story of K. C. Li. (Next week)

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*–W. W*