PETROLEUM IN MODERN WAR

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THE INDUSTRIAL COLLEGE OF THE ARMED FORCES

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CAPTAIN WORTHINGTON: Gentlemen, it is a pleasure this morning to have as our visiting speaker Mr. Max W. Ball.

Mr. Ball received his engineering degree from the Colorado School of Mines; his bachelor and master of laws degrees from National University. He is a past president of the American Association of Petroleum Geologists, a Fellow of the Geological Society of America, a member of the American Institute of Mining and Metallurgical Engineers and the Canadian Institute of Mining and Metallurgy and the Bar of the District of Columbia. He is the author of numerous papers and reports on technical and scientific subjects and of "This Fascinating Oil Business," a popularly-written description of the operations of the petroleum industry.

Mr. Ball has served as Chairman of the Oil Board of the Geological Survey; engineer and law officer of the Bureau of Mines; manager of exploration in the Rocky Mountain region for the Shell Oil Companies; and during the war was with the Petroleum Administration for War as Special Assistant to the Deputy Administrator.

Since 1928 he has been engaged in a consulting practice, specializingin estimates of oil and gas reserves, problems of underground storage of natural gas, development of the "tar sands" of Canada, company organization, and oil and gas economics. He is now the Director of the Oil and Gas Division of the Department of the Interior.

MR. MAX W. BALL:

Gentlemen, I am going to do one of the things I do not like to have done to me, and that is read a talk. This is only the third or fourth time in my life that I have done it. I do not like to do it. As I say, I wouldn't particularly like to have it done to me. But the exigencies of a new job, on which I haven't yet gotten my seat warm or my desk cleared, just kept me from getting this thing in shape so that I could do otherwise.

Although the subject assigned to me is "Petroleum in Modern War," I intend to talk primarily about petroleum between wars. This seeming anomaly is due in part to the diffidence that a civilian always feels in addressing a group of officers of the Armed Services about anything that smacks of wartime operations, but mainly to a notable fact highlighted by experience, namely that ability to supply the oil needs of a war depends on what took place before the war.

Oil is not a commodity that can be found today and used tomorrow. Between the discovery of an oil field and the use of fuel or explosives therefrom lies a mountain of wells, roads, camps, pipe lines, pump stations, power houses, refineries, loading racks, tank cars or tank ships, and a host of other things -- a mountain that takes months to climb at best and usually takes years to get over. Most of the oil used in a war, even so long a war as World War II, is oil found before the war started.

My remarks today, therefore, will relate chiefly to the period between the First and Second World Wars and to the present postwar period, with only enough consideration of the periods of actual combat to make the inter-war periods significant.

I have a further reason for not reviewing the oil activities of World War II. They were extensively reviewed before The Industrial College a year and a half ago by five executives of the Petroleum Administration for War, and the record then made is available to you. The date was June 11, 1945. Mr. Ralph K. Davies, Deputy Petroleum Administrator, spoke on the authorization, objectives, and accomplishments of the Petroleum Administration for War. Mr. William H. Newman, spoke on organization aspects of the Government-Industry job. Dr. John W. Frey spoke on historical records, Mr. Walter Hochuli spoke on the domestic divisions of the petroleum administration; and Mr. C. Stribling Snodgrass spoke on the foreign divisions.

These talks were made shortly after the German surrender in Europe and shortly before the Japanese surrender in the Pacific. They were made at the peak of operations in producing and distributing the oil needed for victory. The difficulties of organization had been ironed out, the Government-Industry team was functioning smoothly and most of the men in P.A.W. were looking eagerly ahead to the day when they could roll up their barbed-wire and catch their trains for home.

The men who spoke that day before the College were veterans in P.A.W., the men who had faced and solved the problems. They spoke from first-hand knowledge and a transcript was made of their statements. That transcript is available in your files, so that you may read and study it.

For those of you who are interested--and I think all of us should be--to that transcript, you might add the testimony offered by the P.A.W. personnel before the O'Mahoney Committee of the Senate and the Lea Committee of the House. The basic papers of that presentation were put together in the volume entitled "Petroleum in War and Peace", which was issued by the Petroleum Administration. Finally, there is the report of the Lea Committee, (House Report No. 2736, of the 79th Congress, 2nd Session) issued on December 30, 1946.

These documents give such a complete picture of the petroleum problems of World War II, of the operation of the Petroleum Administration for War, and of wartime cooperation between the Government and the oil industry that I should be plowing ground already better cultivated if I talked to you about the Petroleum Administration for War and the Government-Industry combination that made possible the fueling of the last war.

In order to emphasize the importance of oil in modern war, however, I should like to read a few paragraphs from Mr. Davies' opening statement to the O'Mahoney Committee, as given on pages 5 to 7 of "Petroleum in War and Peace."

"Modern warfare depends on armament and armament depends on oil.

"Military gasoline consumption at the peak of World War II was 100 times that of our overseas forces at the peak of World War I. The American Army and Navy had 600 times as many automotive vehicles as the AEF had in Europe in 1918. The Navy and Merchant Marine have more ships and more tonnage than the combined merchant fleets of the World after the last war. The Army and Navy operated 1,250 percent more planes before V-E day than they did before Pearl Harbor. This was American armament alone; the planes, vehicles, and ships of the other United Nations likewise multiplied in number and consumed proportionately huge quantities of oil products.

"Time was when the major item of supply to a fighting force was food; in this war the volume of liquid fuel shipped overseas was nearly sixteen times that of food. An Army no longer marches on its stomach; an army marches, a navy sails, and an airforce flies on oil.

"The tonnage of oil products shipped overseas during the last few months of the war was almost double all other tonnage combined. Our overseas forces required nearly twice as many tons of oil as of arms and armament, ammunitions, transportation and construction equipment, food, clothing, shelter, medical supplies, and all other materials together. In both essentiality and quantity, oil has become the greatest of all munitions.

"Great as the overseas requirements were, two and one half times as much was required for the war-supporting economy at home.

"Without rationing, conversion to coal, and other oil conservation measures, civilian demands would have consumed so much of the available supply that military needs could not have been met. Even with these measures, civilian consumption was not much below pre-Pearl Harbor volume; the savings were largely offset by the needs of a vastly expanded war industry. In an industrialized nation, the home front requires even more oil than the fighting fronts.

"Essential civilian consumption of allied and neutral nations was not so great, but it was no negligible item. The oil and oil

products supplied from allied sources to allied and neutral civilian economics, not including Russia or consumption in the countries where the oil was produced, reached about 555,000 barrels a day, equal to 15 per cent of the civilian consumption of the United States.

"The job of fueling and lubricating the war was world-wide. Crude oil came from 20 allied, neutral, and liberated countries on five continents. Some of it was refined near its point of production, some had to be processed in distant refineries in other countries. The crude had to be moved to the refineries and the refined products to the points of need. The transportation facilities of the five continents and the seven seas had to be utilized. A global war demands global production, global refining, and global distribution.

"The task of supplying oil products is no simple matter of producing a certain amount of crude oil and processing it in whatever refineries are available. Crude oils from different fields differ widely in their characteristics. Refineries are composed of many units, each specially designed to make certain products from crudes of a certain character. Each type of equipment, military or civilian, requires its own type of fuel and lubricants. Many of them require lubricants of several types. The armed forces use more than 500 different oil products; a B-29 alone uses 20."

That is the end of the quotation from Mr. Davies' opening statement, which you will find in "Petroleum in War and Peace."

The military possibilities of petroleum were little recognized until World War I. Their first public dramatization came when the taxicabs of Paris moved a fresh army to the front during the first battle of the Marne in 1914.

Thereafter recognition came quickly. It was crystallized in the often-quoted statement by Lord Curzon, made to the Inter-Allied Petroleum Council in London ten days after the 1918 Armistice, and treasured ever since by the oil industry as an award of honor, that "the Allies floated to victory on a sea of oil."

Captain Paul Foley, U.S.N., put it more concretely when he wrote in November, 1924:

"Reviewed in the perspective of six years it is clear that next to the physical number of bayonets on the western front, the factors contributing most to victory were the impetus conferred upon those bayonets, and the flexibility given them, by gasoline. Tank, tractor and aviation activities all were measured in terms of gasoline. It evacuated the wounded and effected replacement of combatant troops.

Gasoline saved Paris in 1914 and, by enabling the French to concentrate hundreds of thousands of troops at the weakest points of the enemy's line without his knowledge, it definitely saved Verdun. It stabilized the line at the Marne in 1918, and was absolutely essential for the Argonne advance. With this agency the Allies won; without it on a quantity basis, the enemy lost. Not in exaggeration was it said that a drop of petrol had been the equivalent of a drop of blood. The torch borne high on Flanders Fields was a gasoline torch."

The quantities of oil products involved, less than 200,000 barrels daily to the Allied forces, now seem insignificant in comparison with the vast quantities moved during the recent war, but measured in terms of the facilities and capacities then available, the job was impossible, except for the demonstrated ability of oil men to do the impossible. It was the accomplishment of this impossible job, and its importance, that were emphasized by Lord Curzon and Captain Foley and that were so widely noted at the time and thereafter.

Less note was taken, however, of the sources from which the oil for victory in World War I had come. Domestic crude oil production in the United States did not equal domestic demand during that war, let alone provide for overseas military shipments. There was a deficit of production in the United States. This deficit was met by imports from Mexico and by oil which had been stored in tanks in the Mid-Continent since the period of overproduction which followed the discovery of the Cushing field in 1912. By the time of the 1918 Armistice, the bottoms of many oil tanks in the Mid-Continent were being scraped. Some who were associated closely with the supply situation at the time have expressed the opinion that a scarcity of supply would have developed had the war extended through 1919. Captain Foley stated that "had not the Armistice intervened, restrictions on the use of gasoline, especially in the Eastern States, would inevitably have become very rigid indeed."

A period of oil scarcity did follow shortly after the Armistice. It continued until the discovery of new supplies in California in 1922 and 1923. The rapidity with which these prolific new supplies reversed the situation is shown by one of those striking facts that characterize the oil business: Tankers which when ordered were intended to carry Mexican crude oil to California were used when completed to carry California crude oil to the East Coast. Such reversals in supply situations illustrate the truth of the statement that I heard made by a veteran oil-man many years ago. He said, "The only thing certain about the oil business is that it won't be tomorrow what today you think it will be."

The reversal did not come, however, until nearly four years after the Armistice. One wonders what might have happened had Germany waited

five or six years before starting the First world War. If she had, the war would have come when we were short of oil at home and would have included the time when the oil fields of the Golden Lane in Mexico went to salt water. On the other hand, Germany in the intervening years might have acquired additional oil, through the one-fourth interest which, prior to the First world War, she had in the concessions of the Turkish Petroleum Company in Mesopotamia, now Iraq, and elswhere.

The Second World War, as we shall see, came at a time when we were peculiarly well prepared in terms of oil. We have been fortunate that the enemy has chosen the wrong times for him to engage us.

In the two decades which followed the First World War, there were several important developments in the United States which had a direct bearing on the duration and final outcome of the Second World War.

First, great new supplies of oil were found, largely through the development of geophysical prospecting, but with old-fashioned geology and the independent "wild-catter" playing a very important part. The "Golden Decade" began with the fields of the Los Angeles Basin in 1922 and 1923 and continued with Seminole and Oklahoma City in Oklahoma, with Yates, Hendricks, and the other big fields of the Permian Basin in West Texas and New Mexico, and reached a climax in 1930 with the mammoth East Texas oil field. Along with these giants were found many fields of moderate size, and a host of smaller ones. By the time of Pearl Harbor, our proved reserves and daily productive capacity had increased beyond the dreams of Armistice Day.

Second, we learned how to produce oil more efficiently. Instruments were developed for the measurement of bottom-hole pressures and the sampling of formation fluids, which figuratively and almost actually enabled petroleum engineers to "look" into the producing horizons underground. The function of natural gas in the production of oil received full recognition, and the utilization of the energy of the gas that occurred with the oil, to bring the oil out of the producing formation to the well and up the well to the surface, was controlled through the adoption of gas-oil ratios in oil production. Many other advances could be listed, but the crucial point is that engineering control was applied more and more widely and wisely in oil and gas production. The additional oil thus made available by improved engineering practices is often referred to as "engineering oil."

Third, the principal oil-producing states, with some important exceptions, adopted oil and gas conservation laws whereby the principles of engineering control were applied uniformly in the oil and gas fields. With this application of engineering control, the method of oil production was changed from an "open flow" to a regulated basis. In other words, we got in the oil-and gas-producing states (most of them under State control) compulsory, proper

engineering practices. Under such control, the pressure in the reservoirs was conserved, the flow-period of the fields was extended, and reserve productive capacity was established and maintained. The oil thus made available that would otherwise not have been producible, or that would have been prematurely produced and wasted or wastefully used, we may call "conservation oil."

Reserve Productive Capacity

The reserve productive capacity, built up through the finding of new fields and the availibility of engineering oil and conservation oil, proved to be the main source from which the added demands of World War II were met. This reserve capacity, by the time of the Pearl Harbor attack, totalled about one million barrels daily on a sustained basis. You should stop and think just what this meant to our ability to supply oil for the war needs. In 1941, we produced a little more than 3,800,000 barrels of crude oil daily in the United States. With a reserve productive capacity of a million barrels daily, we could produce efficiently and did, from those same oil fields a total of 4,800,000 barrels daily. It was like having a mammoth underground storage tank from which we could draw an extra million barrels of oil daily. As I plan to point out later, that reserve capacity supplied about six-tenths, 60%, of the extra oil needed to win the war.

Development in Foreign Fields

Fourth, large reserve supplies were developed in friendly areas outside our boundaries.

The deserved emphasis placed upon the reserve productive capacity of our oil fields must not be taken to mean that domestic oil alone contributed to victory, or that we did or could have depended upon our domestic oil supply for our war needs, or that we could hope to do so in the event of another war.

In the period between the two wars, oil fields in foreign countries were being developed, new producting areas were being found, pipelines were being laid and refineries built. The foreign fields, too, had an available productivity in excess of then-current needs so that there was a substantial reserve productive capacity in foreign oil fields which were under allied or friendly control. The oil supplied by these foreign fields, particularly those of Venezuela and the Middle East, was a vital addition to our oil supply. It was good that we had friends in these foreign countries. When oil historians review the war period, they will find that oil from foreign sources provided much of the fuel for the final punch.

In May, June, and July, 1945, when tanker shipments to the Army and Navy overseas averaged nearly 1,200,000 barrels daily, loadings at foreign ports provided 41 per cent of the total in May, 45 per cent in June, and 51 per cent in July.

Developments in Technology

A fifth important factor that developed between the wars was in the field of processing instead of production. Feasible methods of cracking crude oil in great volume catalytically were devised and the alkylation process was developed. Catalytic cracking makes it possible to obtain a larger percentage yield of gasoline of greatly improved quality from crude oil than any other commercially feasible method. The patent for the alkylation process was issued on August 15, 1939. just two weeks before Hitler invaded Poland. One can wonder if the German intelligence officers recognized the significance of the process or warned Hitler and Goering of what it was destined to mean to Germany.

It was catalytic cracking and the alkylate, a high-octane blending agent, which made possible our truly enormous production of 100-octane aviation gasoline during the recent war: There was another known chemical route, that of making codimer and hydrogenating it, which could have provided an equally-satisfactory blending agent for the manufacture of 100-octane gasoline. That method, however, would have called for more butylene production, and that in turn would have knocked the props from under the synthetic rubber program. By the codimer method, with the expenditure of three or four times as much critical material and money (which would have been three or four times a billion dollars) we might have achieved the same final result as we did with the alkylation process, but we can not even now look back and say for certain that, with the money and materials, we would have had the fortitude and ingenuity needed for the job.

Thus we must count the development of catalytic cracking and the alkylation process as a major element for our victory. If we had not had as much aviation fuel as we did, our air attacks would have been on a smaller scale, the victory would have been longer in achievement, the outcome might have been doubtful and many, many more lives would have been lost. We were extremely fortunate that, in the laboratories of free enterprise, there were scientists working on the hydrocarbons who succeeded in developing the processes so vital to victory. Note, again that that was done between, not during, the wars.

A sixth, and still less widely recognized, contribution was in the field of utilization. This was the production of toluene and other derivatives of oil and gas essential in the manufacture of explosives. Two companies started plants to make toluene before

the war and both were ready for operation about the time of the Pearl Harbor attack. Other companies followed. I think it is a safe guess to say that three-fourths or more of the high explosives used during the war were dependent upon derivatives from crude oil or natural gas. If we had had to rely on by-product coke-ovens for toluene, as we did in the First World War, and assuming operations could have reached the volume required the least that can be said is that we would have been swamped with coke. One oil man, familiar with the work done during the war, was asked what would have happened if we had had to depend upon coke ovens for toluene during World War II and his answer left no doubt. He answered, "We would have lost the war."

These happenings are, I think, the outstanding accomplishments in the petroleum field which made victory possible in the manner and time in which it was won. The finding of large deposits of oil, the development of engineering control, and the application of conservation rules and regulations gave us the million barrels a day of reserve productive capacity; the development of foreign fields, pipe lines, and refineries made available a larger additional productive capacity; catalytic cracking and the alkylation process, at home and in allied countries, made possible our tremendous production of 100-octane aviation gasoline; and oil and gas provided the raw materials for the larger part of our high explosives.

We find a sharp contrast however, in another field in which the available data indicate that no one seemingly did very well. That was in estimating our military requirements for petroleum in the event of war. I will cite some of the known estimates:

The Army and Navy Munitions Board had appointed a Mineral Advisory Committee with a petroleum sub-committee. The oilmen serving on the sub-committee were exceptionally capable; no better choices could have been made. They did an outstanding job in estimating the productive capacity of the American oil industry. In their report of May, 1939, they did pioneering work in measuring our crude oil productive capacity, and did it with extreme accuracy, but their estimates of military requirements were far short of the mark. They estimated that if the British Empire and France were engaged in war with an enemy and the United States gave them military support, the total petroleum consumption of the three nations for military purposes would total 116 million barrels a year, or about 319,000 barrels daily. You see, that is only 50% above World War I.

A representative of the Navy Department, testifying before a Congressional Committee in November, 1939, stated that the Navy's needs for petroleum in time of war "might increase to as much as 50 million barrels of fuel oil" per year. A representative of the

War Department, testifying next, stated that, according to the estimates for wartime of the planning branch, the maximum consumption of the Army "might be in the neighborhood of ten to twelve million barrels annually." Adding the two gives a figure of 60 to 62 million barrels annually, or about 170,000 barrels daily, which is less than the consumption at the height of World War I.

An estimate of the National Resources Planning Board --this is just to show you all the mistakes were not made by the military-- estimated that during a national emergency the demand for petroleum, including both civilian and military, would increase by one-fourth or, at that time, by about 800,000 barrels daily.

These estimates are not cited now, with the wisdom which comes from hindsight, in any critical manner. They are cited to show how qualified people were not thinking of a two-ocean war, or of the magnitude of operations and degree of mechanization which actually resulted when the war came. They were still thinking of war as a revised version of World War I. They must have been because the military oil shipments from domestic and foreign sources at the peak of operations were fully ten times as large as the average of the industry and military estimates. It was again a matter of extremely good fortune that we had developed a crude oil productive capacity in the United States several times larger than the estimated military needs, and that we had the "know-how" and ability to do what had to be done.

Advance estimates of aviation gasoline requirements were similarly low. In 1939, the American oil industry was capable of producing 28,000 barrels daily of 100-octane aviation gasoline, but was producing only 6,700 barrels daily. The petroleum subcommittee which reported to the Army and Navy Munitions Board estimated that, if a major construction program could be undertaken, the United States would have a potential production of 150,000 barrels daily. That must have appeared to be an over-generous supply from the 1939 viewpoint and even later than that. In June, 1940, official military estimates placed the probable maximum war demand for 100-octane aviation gasoline at 71,000 barrels daily. In November, 1941, the Army-Navy Aeronautical Board estimated that the ultimate requirements, to be reached in July, 1943, would total 121,000 barrels daily. In other words, they did not quite double their estimates in the time between June, 1940 and Nov. 1941. When war came, it was a "stern chase" for supply to catch up with demand. New plant capacities were added and added. Production in the United States finally reached 500,000 barrels daily early in 1945, with an additional 100,000 barrels daily in allied foreign plants, or a total daily supply of 600,000 barrels, eight and one-half times the maximum demand as estimated by the military in 1940--and all of it was needed!

I have already referred to the vital importance of oil during the recent war. I think it worth stating again, however, that except for special distribution difficulties in local forward areas, no military operation suffered or was delayed for lack of oil, or oil products.

I have brought with me a few charts selected from among those which were presented to the Committees of The Congress and which are reproduced in the P.A.W. volume "Petroleum in War and Peace." I regret that the large master charts, from which these were prepared, were not retained and that the Oil and Gas Division has only a few sets of these smaller copies left. However, if you will be good enough to share these among yourselves or even be so impolite as to look over your neighbor's shoulder, I will comment briefly on some of them which are related to what I have said.

Chart No. 21 will show you graphically how much 100-octane aviation gasoline was produced during the war and the sources from which it was derived. By "sources" I don't mean the oil fields from which is came but the types of plants and processes. One of the interesting points is that "ingenuity and resourcefulness" contributed as much as did the pre-war plants.

One fact, not shown on the chart, is very important. To make 500,000 barrels daily of 100-octane gasoline, it was necessary to draw constituent parts thereof from about 85 per cent of all of the crude oil processed in the United States, or from more than 4 million barrels of crude oil daily. This should be kept in mind, because it would not be possible to add up the individual items of military demand, such as aviation gasoline, 80-octane all-purpose motor fuel, 7-0-2 diesel oil, Navy special fuel oil, and other products, and expect to supply them from a quantity of crude oil equal to the sum of the products.

To supply the aviation gasoline, it required nearly all of the refinable crude oil of the country and nearly all of the refining plants. That does not mean that those plants were devoted exclusively to the manufacture of hundred-octane gasoline but that from all of those plants constituents had to be supplied. The significance of the fact is that adequate defense and attack in a total war must depend upon the total facilities of the Nation. In terms of oil, this means that if we are to be secure there must at all times be a strong oil industry within the area that we can count on controlling, an industry capable of meeting the total security responsibility. The military demands can not be set apart and met separately. They can be met only if the petroleum industry is strong enough to meet both military and essential civilian needs.

Chart No. 7, entitled "Crude Oil Production and Productive Capacity, United States", is one of the more interesting charts. The red line at the top shows the maximum efficient productive capacity; that is the maximum quantity of oil that could be produced from the oil fields of the United States without creating conditions of waste. Maybe I should interject something at this point. An oil well--let's take a single well--may have a total capacity of, let us say, 10,000 barrels a day; that is, that is the amount that it would produce if you floated it wide open. Now if you floated that well wide open at 10,000 barrels a day, it would continue to produce 10,000 barrels a day for a very, very short time. At the end of six months it would be down to 5,000--I'm speaking in rough terms. At the end of the year it might be down to 2,500. Each year thereafter it would produce some 25 per cent less than it did the year before.

But that is not the worst thing. The worst is that if you produced that well wide open you would get out of it by the time the well was exhausted and quit, some 30 years from now perhaps, perhaps only 25 per cent of the oil that that well would have produced if the gas energy which drives the oil to the well had been conserved. In other words, by producing a well wide open you waste your reservoir in it.

Now there is a rate for each well at which it can be produced, which we call the maximum efficient rate; that is the maximum efficient rate at which the well can be produced and still get the largest ultimate recovery of oil from it. If you produce beyond that maximum efficient rate, that maximum efficient productive capacity, then you are merely leaving in the ground oil that otherwise could have been recovered. The solid black shows how much was produced. The space between the red and black lines, that is, the space marked "Reserve Productive Capacity" in the vertical black cross-hatching was our backlog of productive capacity. It represents the additional oil efficiently producible from existing fields.

You will note it totalled about a million barrels daily before the war. As the war progressed and demands kept increasing, however, the reserve capacity decreased, until during the last half of 1944 and all of 1945 we were forced to produce in excess of our efficient capacity, although such production rates were harmful and tended to lower the ultimate production of oil.

Even with such high production rates, our domestic supply, at the close of the war period, was not sufficient to meet fully the oil needs of our military forces and the essential civilian demand at home, without counting the oil we shipped under Lend-Lease. The balance came from foreign fields, and if the war had continued the foreign sources in United States control, as distinguished from that of our Allies, would not have supplied the deficit. In a very short time we should have had to draw on Allied sources for part of our own domestic and overseas needs; that is to say, reverse Lend-Lease would have exceeded Lend-Lease, so far as oil was concerned.

I said earlier that our domestic reserve productive capacity provided about six-tenths of the extra oil provided for the war from the United States. Rationing of civilian demand, particularly passenger-automobile fuel and domestic heating oil, and the curtailment of civilian exports, saved oil equal to about three-tenths of our military needs from the United States. It is interesting to note that the amount saved per day by rationing was roughly equal to the daily output of 100-octane aviation gasoline during the latter part of the war. Extra imports and oil taken from storage provided the remaining one-tenth.

The sources of the extra oil you will notice differed in World War II from those of World War I. In the First World War, imports and withdrawals from storage met all of the extra needs; in the Second World War, only one-tenth of the extra supply came from imports and stocks.

I have stressed the importance of our reserve productive capacity in providing oil for the recent war. The fact that we no longer have that reserve productive capacity is a fact of outstanding importance.

Crude oil production in the United States did not revert to pre-war levels at the close of the war. Except for a very brief period, demand and production have continued at high levels. In 1946, crude oil production in the United States averaged 4,745,000 barrels daily, a larger amount than was recorded during any of the war years. To meet 1947 demands, current estimates indicate that an even larger production will be required. These rates of production are higher than the maximum efficient rate, as last estimated. We no longer have the backlog from which the bulk of the military demands of World War II were met. That absence of the backlog presents a critical problem to all who are planning the sources from which petroleum can be had to meet future emergency needs.

Chart No. 8 shows the necessity of continued drilling to support the productive capacity of our oil fields. If you study that chart you will see what would have happened if we hadn't continued drilling during the war. Merely to keep pace with demand and maintain our proved reserves at their present level we need to find each day in the United States a new oil field of the average size of those discovered between 1939 and 1944.

You may be interested in Chart No. 16, which presents a classification of the petroleum possibilities of the world. You will note that the land area of the Eastern Hemisphere is twice as large as that of the Western Hemisphere, and that the most favorable areas for oil-finding in the Eastern Hemisphere, the red and yellow areas, are about twice as large as those of the Western Hemisphere.

One eminent geologist (Mr. Wallace E. Pratt) has estimated that the western hemisphere ultimately will produce one-third of the world's oil and the eastern hemisphere two-thirds. I think that is very sound reasoning, not only because Wallace Pratt is one of our outstanding thinkers in such matters but because it checks with the present knowledge of the geology of the regions. Conversely, the United States has been using about two-thirds of the world's oil production, drawing upon its ultimate oil resources more rapidly than the remainder of the world.

A brief reference to Chart No. 26 may be of interest, as it shows that the proved reserves of natural gas in the United States were increased substantially during the war period, despite the increased use of gas. On the basis of heat values six thousand cubic feet of natural gas are about equal to a barrel of crude oil. Applying this factor to the 135 trillion cubic feet shown, it will be noted that, in terms of oil, our proved gas reserves are equal to or slightly larger than our proved oil reserves.

There are other charts in the sets which have been distributed. I will not attempt to discuss them, but will try to answer any questions which you may have regarding them.

I would like to leave these charts with you, but as I said previously, the Oil and Gas Division has only a few copies left. I would be glad to leave them with you for a few days, so that you may have a better opportunity to study them at your leisure. When you have finished with them, I would appreciate it greatly if they could be returned to me, as there will be future occasions when they will be needed at other meetings similar to this. I suspect that you will find them of maximum interest if you look at them in their context in "Petroleum in War and Peace," of which I am sure you have one or more copies in your library.

Captain Foley concluded his 1924 article on the petroleum problems of the First World War by stating, "By vigilance alone can security be assured." Vigilance implies preparedness. We have been fortunate in our two World Wars in that we had time to get ready and make up, after the wars started, what we had failed to do beforehand.

The state of our oil-preparedness from the side of the Federal Government before the First World War can be judged by the fact that one of the first jobs of the Oil Division of the Fuel Administration that was created was to make a list of the petroleum refineries in the United States, find out where they were located, their capacities and what they were producing.

On the information side, we were much better prepared for the Second World War, but we had other weaknesses. They are fully covered in the material to which I have referred, which will, I think, repay careful study by anyone interested in preparing for another war if one should come.

From the experiences of each war, we can learn lessons for the next. An outstanding lesson from the Second World War is the benefit of close, coordinated, unceasing teamwork between Government and industry and among Government agencies. That was the secret of oil's success in the last war.

To further the continuance of such teamwork in oil, the President on May 3, 1946, requested the Secretary of the Interior to establish within the Interior Department an organization which would "assure co-ordination in peacetime of the Federal Government's many interests in petroleum and petroleum products and associated hydrocarbons." Responding to this request, the Secretary of the Interior established the Oil and Gas Division, whose functions are to assist in the execution of the President's instructions, to serve as a central clearing house for statistics, technical data, and other information relating to oil and gas, to keep currently informed as to the adequacy and availability of petroleum and its products to meet the current and future needs of the Nation, and to make recommendations with respect to these matters and other significant developments in the petroleum field.

The President also suggested the establishment of an industry organization to advise and consult on oil matters. This organization has been established as the National Petroleum Council, consisting of about 85 leaders in the oil and gas industries. This Council, which meets quarterly, will hold its third meeting in Washington next Tuesday.

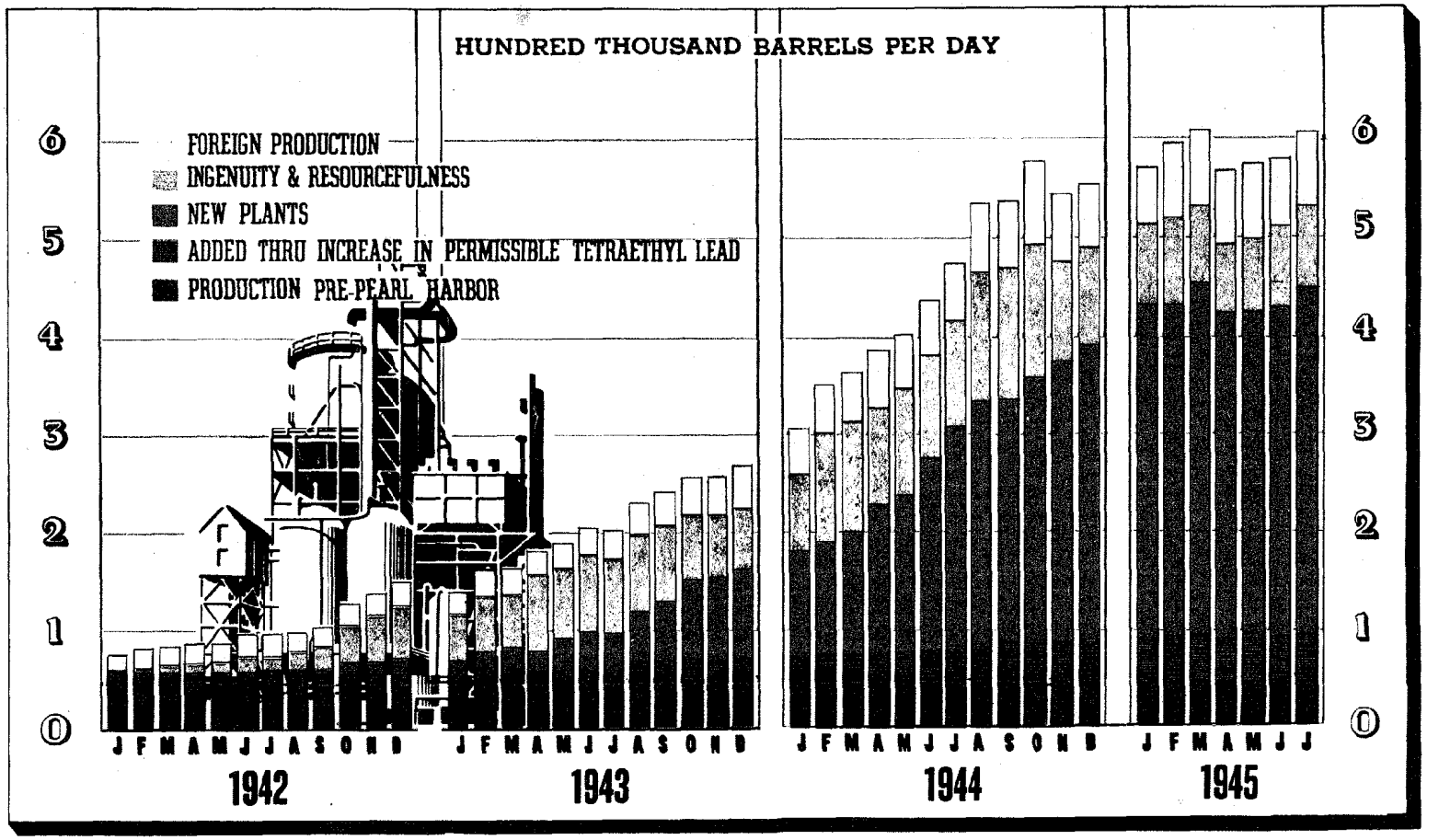
If the Oil and Gas Division works in cooperation and harmony with the Armed Services, the other Government agencies concerned with oil and gas, and the industry through the National Petroleum Council - - if it thus fulfills its intended function - - we shall not again be caught without adequate knowledge of the petroleum resources available at home and abroad or of the means necessary to avail ourselves of them in an emergency.

I have enjoyed this opportunity of talking briefly with you, not as briefly as you could have wished although I feel that I have but touched the surface of the subject. If you have any questions which may clear up any points or fill in the gaps, I shall do my very best to answer them. Thank you very much for your courteous attention.

(21 Jan. 1947 - - - 350)L

100-OCTANE AVIATION FUEL

SOURCES OF PRODUCTION



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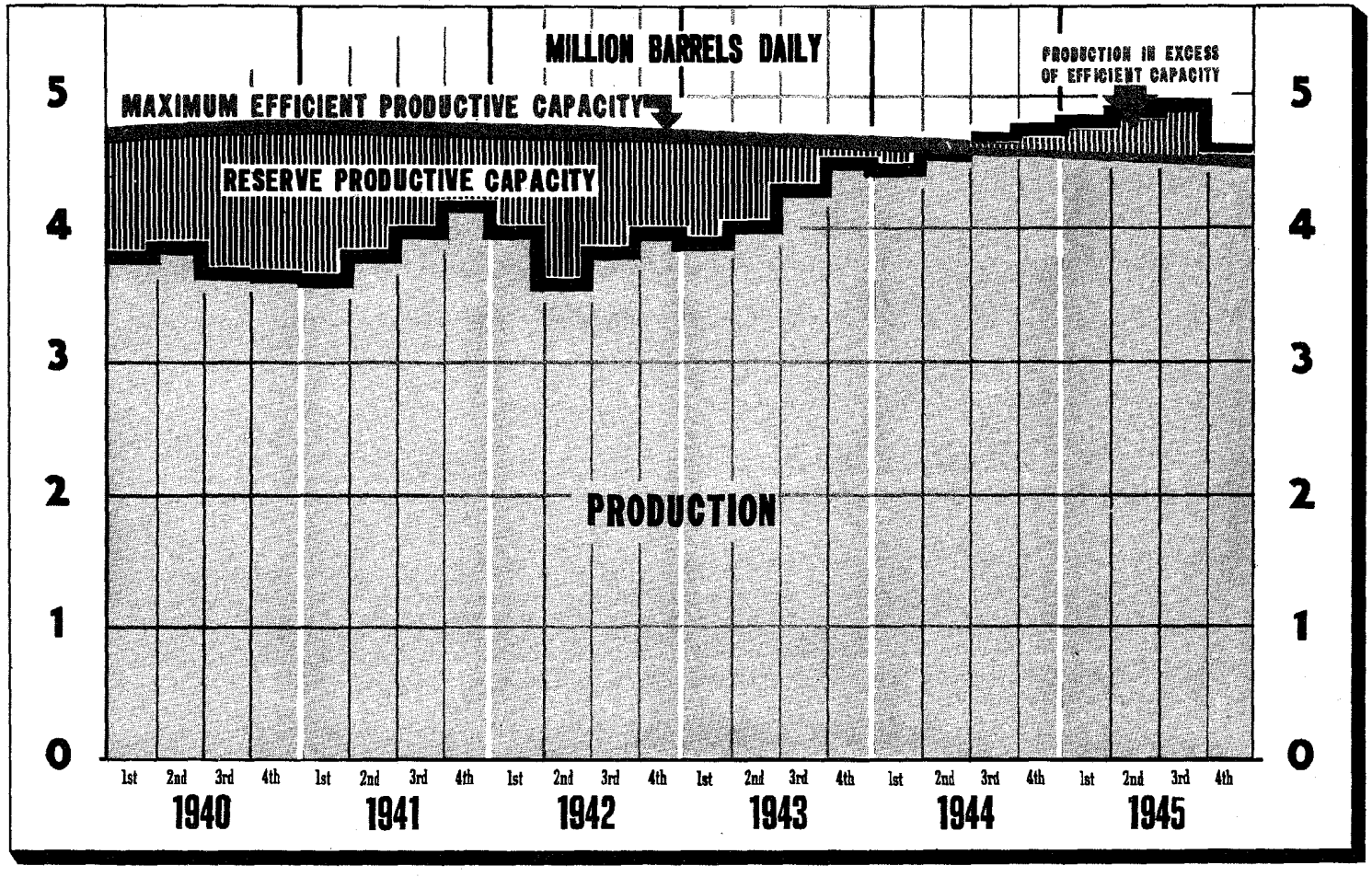
PAW CHART NO. 21

CRUDE OIL PRODUCTION & PRODUCTIVE CAPACITY

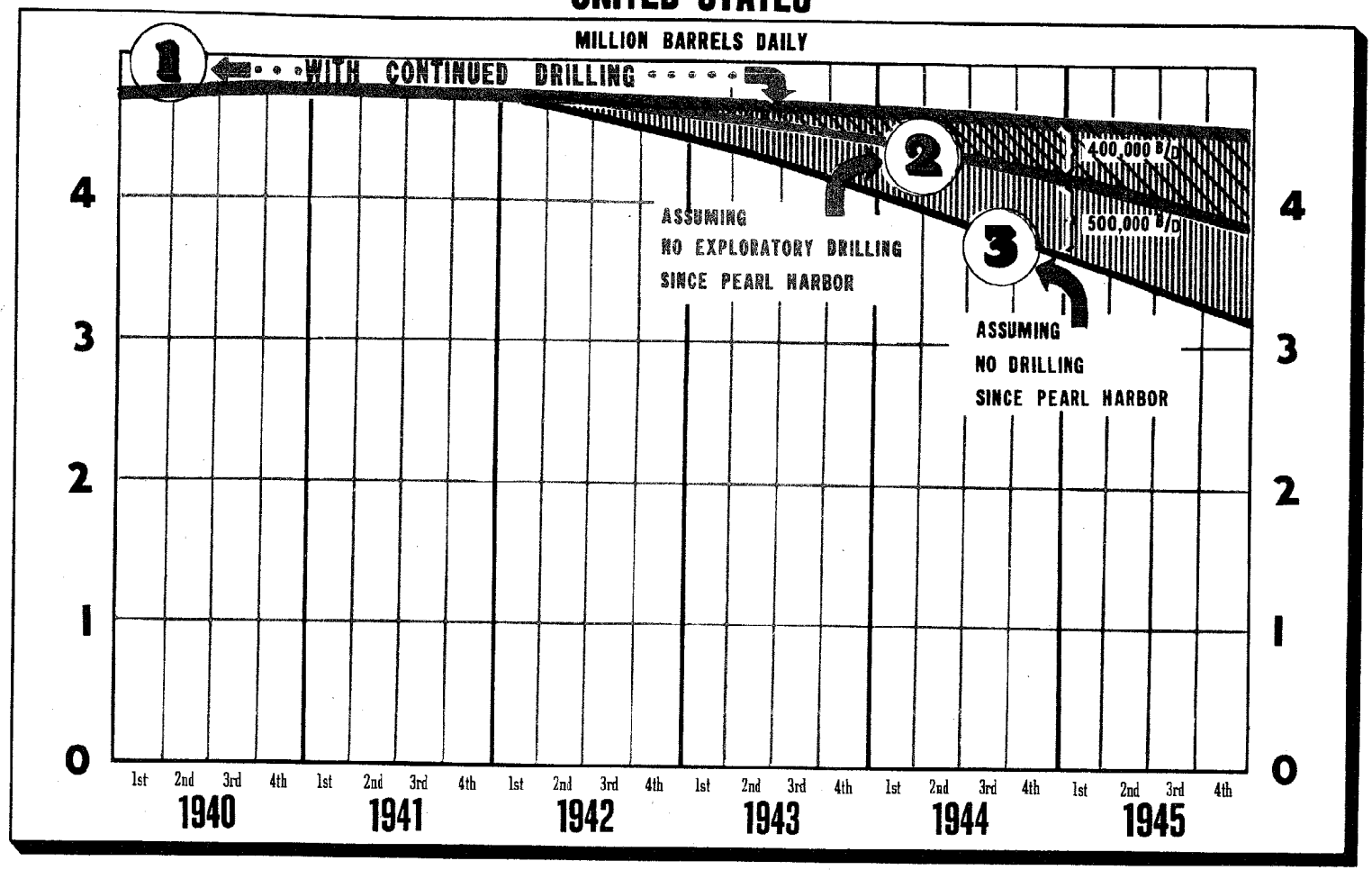
UNITED STATES



PAW CHART NO. 7

EFFECT OF DRILLING ON CRUDE OIL PRODUCTIVE CAPACITY

UNITED STATES



PAW CHART NO. 8

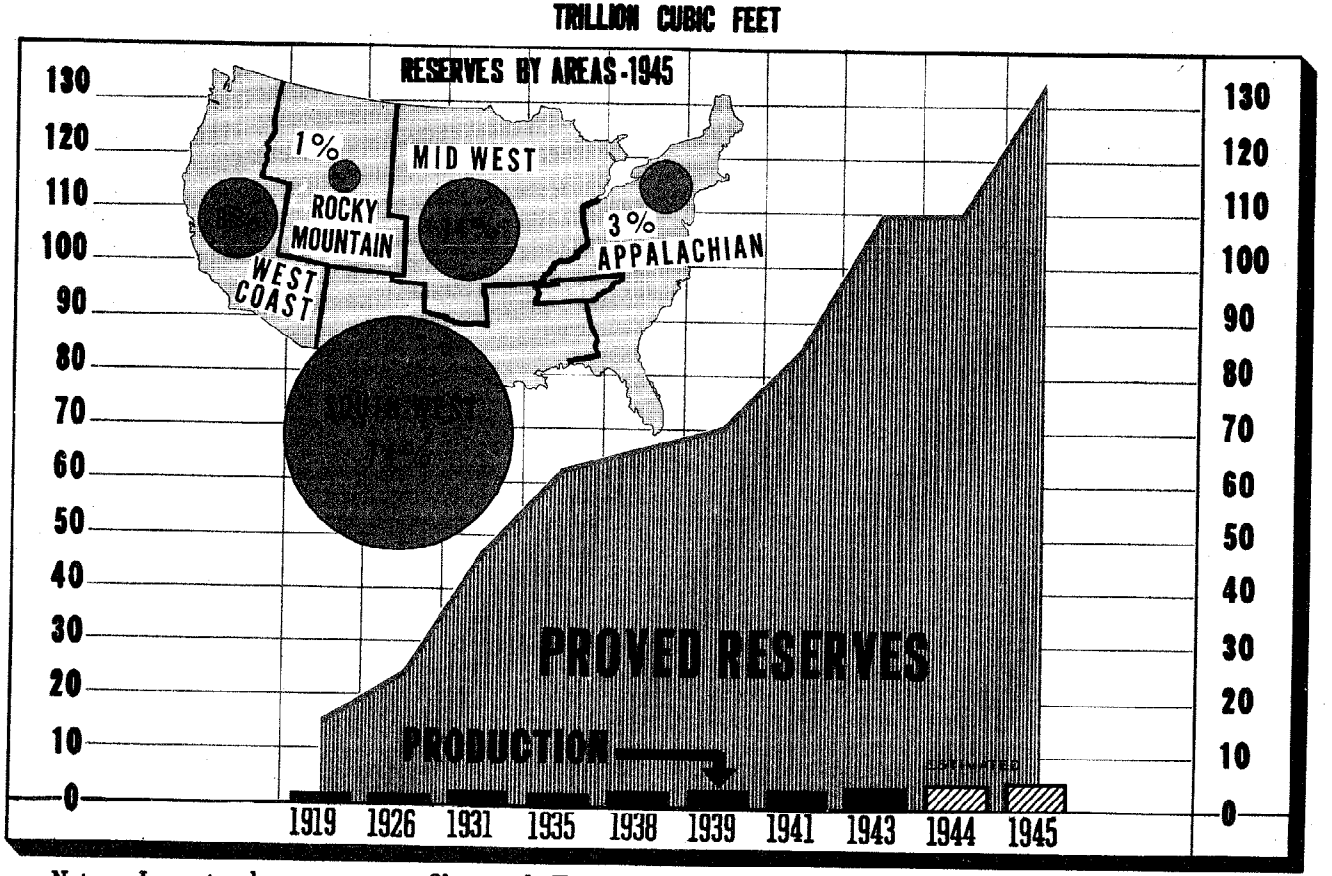
189

CLASSIFICATION OF THE PETROLEUM POSSIBILITIES OF THE WORLD

PAW CHART NO. 16

592

NATURAL GAS RESERVES VS. PRODUCTION



PAW CHART NO. 26

Note: In natural gas matters Ohio and Kentucky are included with the East Coast states in the "Appalachian Region."

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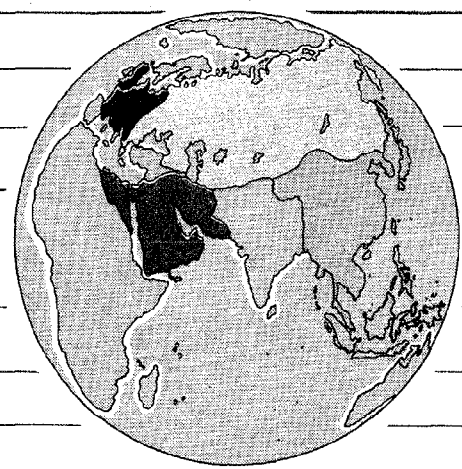
PRODUCTION - EASTERN HEMISPHERE

MILLION BARRELS DAILY



FAR EAST
MIDDLE EAST
OTHER EUROPEAN
U.S.S.R.

1.5
1.4
1.3
1.2
1.1
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1

1900 1905 1910 1915 1920 1925 1930 1935 1940 1944

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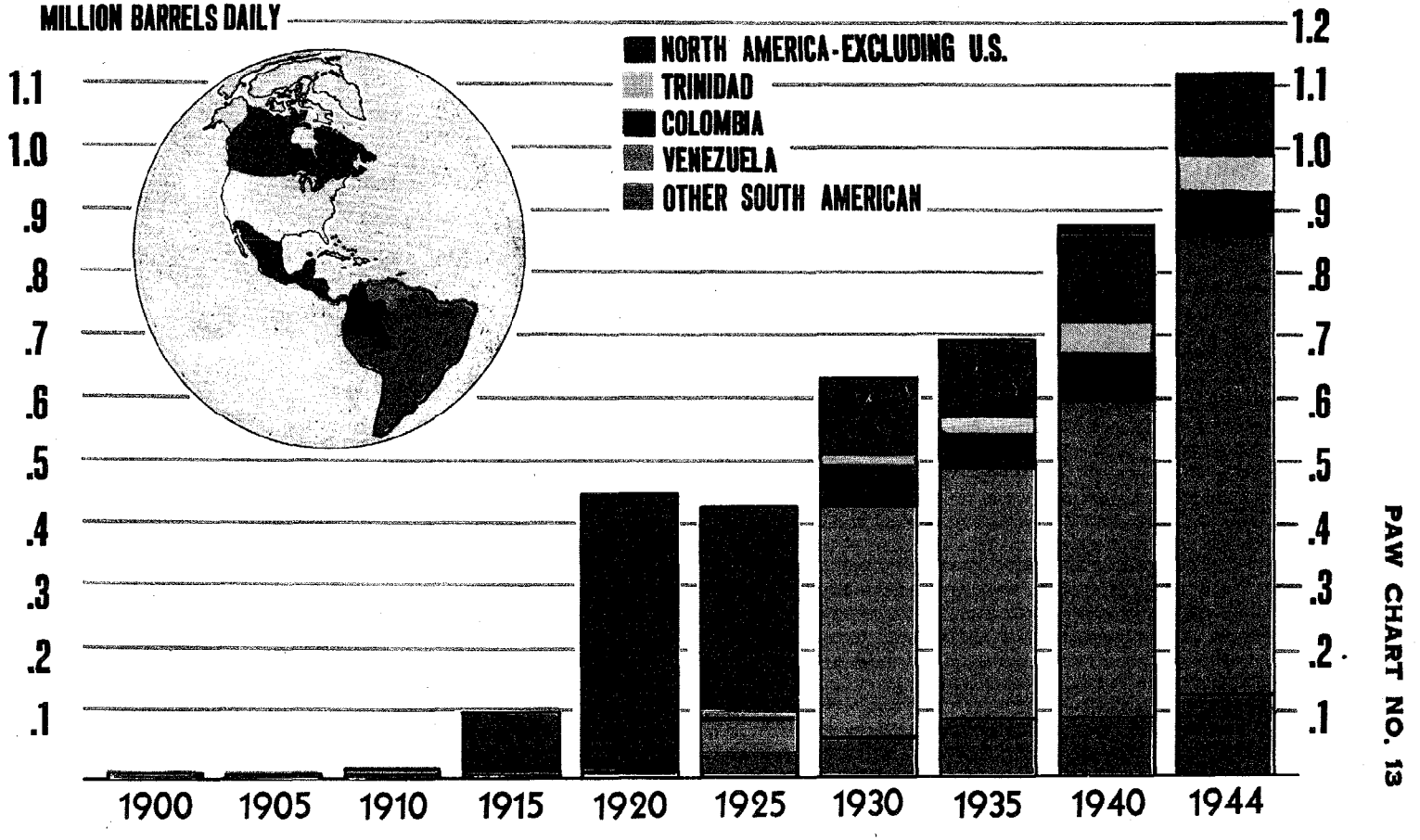
PAW CHART NO. 12

PRODUCTION - WESTERN HEMISPHERE

EXCLUDING UNITED STATES



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PAW CHART NO. 13

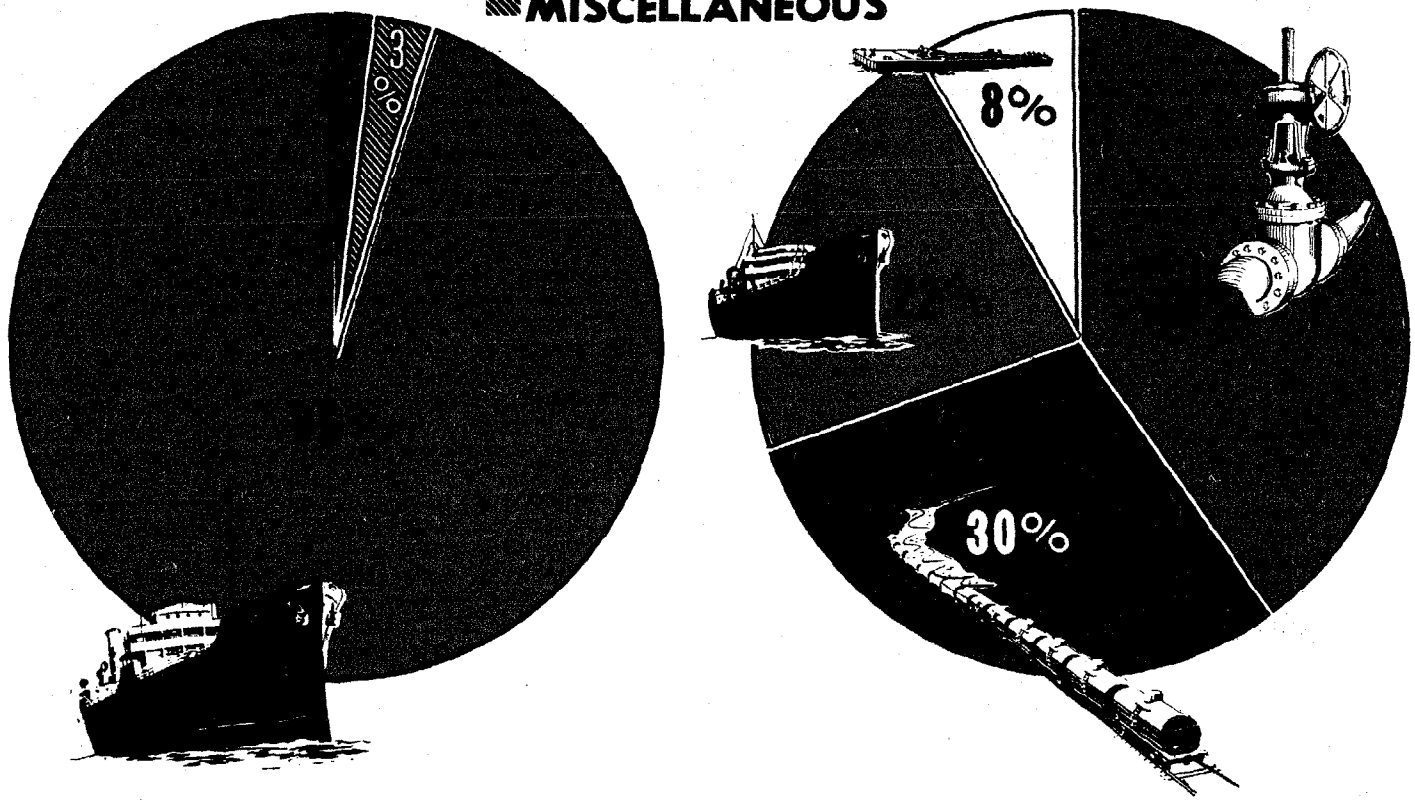
PETROLEUM DELIVERIES TO EAST COAST

PEACETIME - JUNE 1941

WARTIME - APRIL 1945

TANKERS PIPELINES TANK CARS BARGES

MISCELLANEOUS



PAW CHART NO. 29

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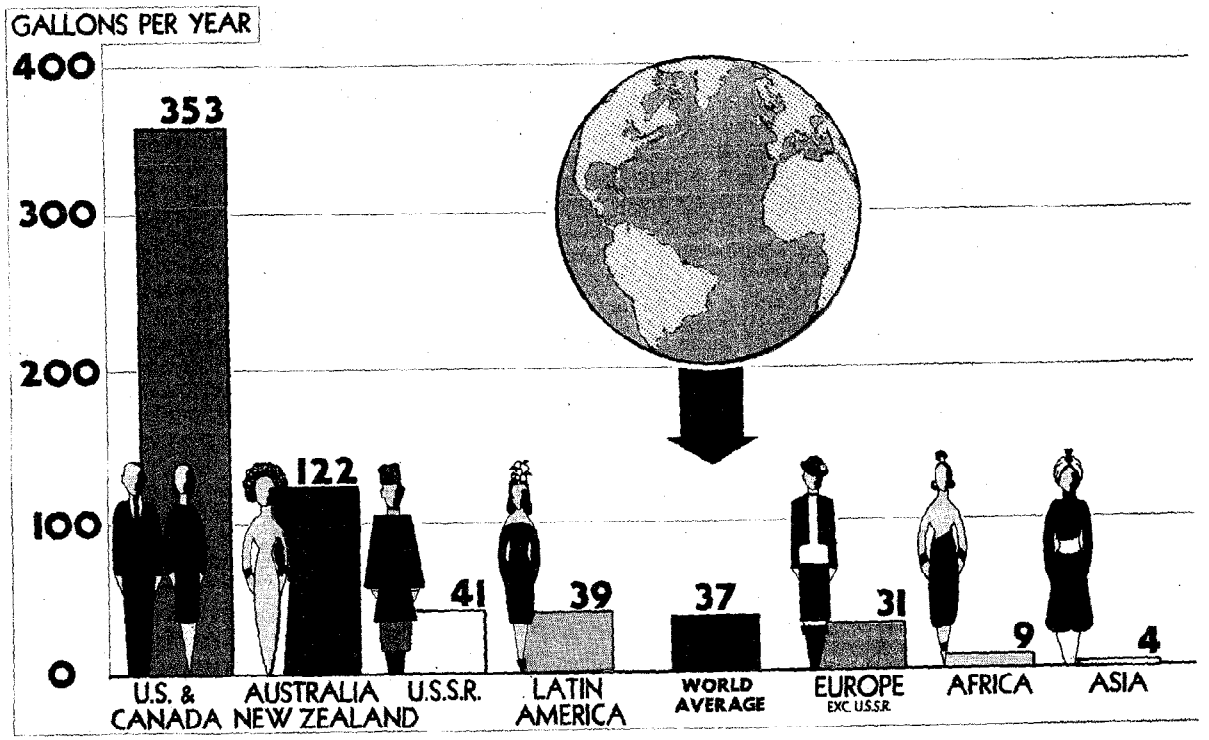
PER CAPITA CONSUMPTION OF PETROLEUM
WORLD-WIDE · 1938



PAW CHART NO. 40

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