ELECTRIC POWER--AN ESSENTIAL COMPONENT OF NATIONAL SECURITY

4 March 1953

1541

CONTENTS

	Page
INTRODUCTION--Rear Admiral W. McL. Hague, USN, Commandant, ICAF	1
SPEAKER--Mr. Philip Sporn, President, American Gas and Electric Company	1
GENERAL DISCUSSION	35

Publication No. L53-108

INDUSTRIAL COLLEGE OF THE ARMED FORCES

Washington, D. C.

Mr. Philip Sporn, President of the American Gas and Electric Company and its subsidiaries, was born in Austria in 1896. He was graduated from Columbia University, School of Engineering in 1917, and received the M.S. degree from Columbia in 1918. Stevens Institute awarded him an honorary degree of Doctor of Engineering in 1947 and he received the degree of Doctor Honoris Causa at the University of Grenoble (France) in 1950. Mr. Sporn is a scientist, engineer, and administrator, who has devoted his entire life to the advancement of the electric power industry and is noted for pioneering work in this field. He is responsible for the design, construction, and operation of the Twin Branch Power Station which operates at a boiler pressure of 2,300 pounds per square inch, the highest pressure regularly used in an operating station in the United States. He had many responsibilities in developing the techniques of operating all the power systems of the eastern United States as one unit during World War II. This vast network was governed by the Philo station of the Ohio Power Company, which was designed and constructed under Mr. Sporn's direction. He is the moving spirit in the development of the "heat pump," which may completely revolutionize all present concepts of residence and commercial heating. He has been the directing head of many experiments now being conducted in the art of electric transmission. He has written many papers for technical and scientific societies, and has received many citations for his contributions to the industry. Most of his professional life has been spent with the American Gas and Electric Company and its subsidiaries, where he has risen from an engineer through all grades to his present position of President.

ELECTRIC POWER--AN ESSENTIAL COMPONENT OF NATIONAL SECURITY

4 March 1953

ADMIRAL HAGUE: Gentlemen, this morning our speaker is Mr. Philip Sporn--scientist, engineer, public-spirited public utilities executive. The subject of his lecture is "Electric Power--an Essential Component of National Security."

You have already read the brief biography of Mr. Sporn; so I will waste none of the precious minutes in going over that material. I will simply tell you that a few months ago I went to New York to attend a conference on atomic energy in industry. The conference had a very heavy schedule--morning sessions, luncheon sessions, afternoon sessions.

There were one or two rather good papers read. Our friend, Dr. Hafstad, put on his usual superb job of discussing the physics of atomic fission. What he said, of course, was necessarily somewhat under wrap. On many of the faces was a sort of starry-eyed wishful thinking that made me wonder before the day was over just why in the world I had gone over to New York.

Then came the dinner session and the dinner speaker. He gave us an "up to the minute, down to earth" look into the future, with such clear vision, based on a realistic and objective analysis of the fundamental facts of life--an analysis that would have delighted you gentlemen as being a most excellent estimate of the situation--that I felt my trip to New York was supremely worth while. The dinner speaker was our speaker this morning, Mr. Philip Sporn.

And so it is with certain knowledge of the treat that is in store for you that I present to you Mr. Sporn.

MR. SPORN: Admiral Hague, General Greeley, and other gentlemen: I first want to thank you, Admiral Hague, for your very gracious and kind introduction. I always enjoy coming down here and talking to this group of mature people, who are trying to do so much and in so short a time in preparation for the task ahead.

The subject that is assigned to me this morning, as announced by Admiral Hague, is on a par with your own major task. It is a very ambitious subject and the scope proposed is very ambitious: "Electric Power--an Essential Component of National Security." I will, however, do my best to comply and cover the scope requested.

I have to apologize to you gentlemen for having had to labor under the same slight handicap that I had to in a number of previous years,

in not having had as much time as I should have liked in the preparation for this task. But I have been able to put together the essence of my talk in a series of charts, tables, graphs, and photographs. They are going to be really the bone, so to speak, or framework of the structure. My comments on them, to give some continuity and put some flesh, so to speak, on the skeleton, will be quite extemporaneous.

Electric power, I would like to point out to you, is indispensible to the functioning of our social and economic system. Ours is an industrialized, mechanized, powered economy.

Now, power is not a major part of the cost of production, but it is very important to recognize that power is critical when it is absent. I don't care how fine or how ambitious an industrial project you put together, without power it will not run, it will not produce. And the more elaborate it is, the more precise or important the operation, the more is it dependent on power; without power it cannot run.

It is well to remember that the cost of power in the average industrial operation represents only seven-tenths of one percent of the total production cost. The annual electric power bill of the United States in 1951 was about 5.65 billion dollars. The bill for alcoholic beverages was 9.2 billion dollars. So that the power bill, with all that it means to this great industrial Nation of ours, was little more than 60 percent of the liquor bill.

I want you to take a look at chart 1, page 3. That will show what power means in terms of the gross national product. The chart almost speaks for itself. I would like to point out to you, though, that the chart shows very clearly how closely utility electric power production is tied in to the gross national product. The two curves seem to have been first put together, and then only slightly pulled apart.

Please note that, following the 1929 crash and the depression, when power production and gross national production fell below the index of 100 in terms of 1929 production, power recovered the 1929 figure by 1934, while the gross national product didn't reach that point until 1940.

The second item I would like you to note is that toward the end of the graph power is again pulling ahead. That is, the parallelism is becoming divergent within the last two years, 1951 and 1952. But it is quite clear from this chart, it seems to me, that an increase in gross national product without an increase in power is almost unthinkable, and I think it is actually impossible.

In table 1, page 4, I have tried to bring together for you the best figures that are available on the production of electric energy per capita in the various countries of the world in 1951. You will

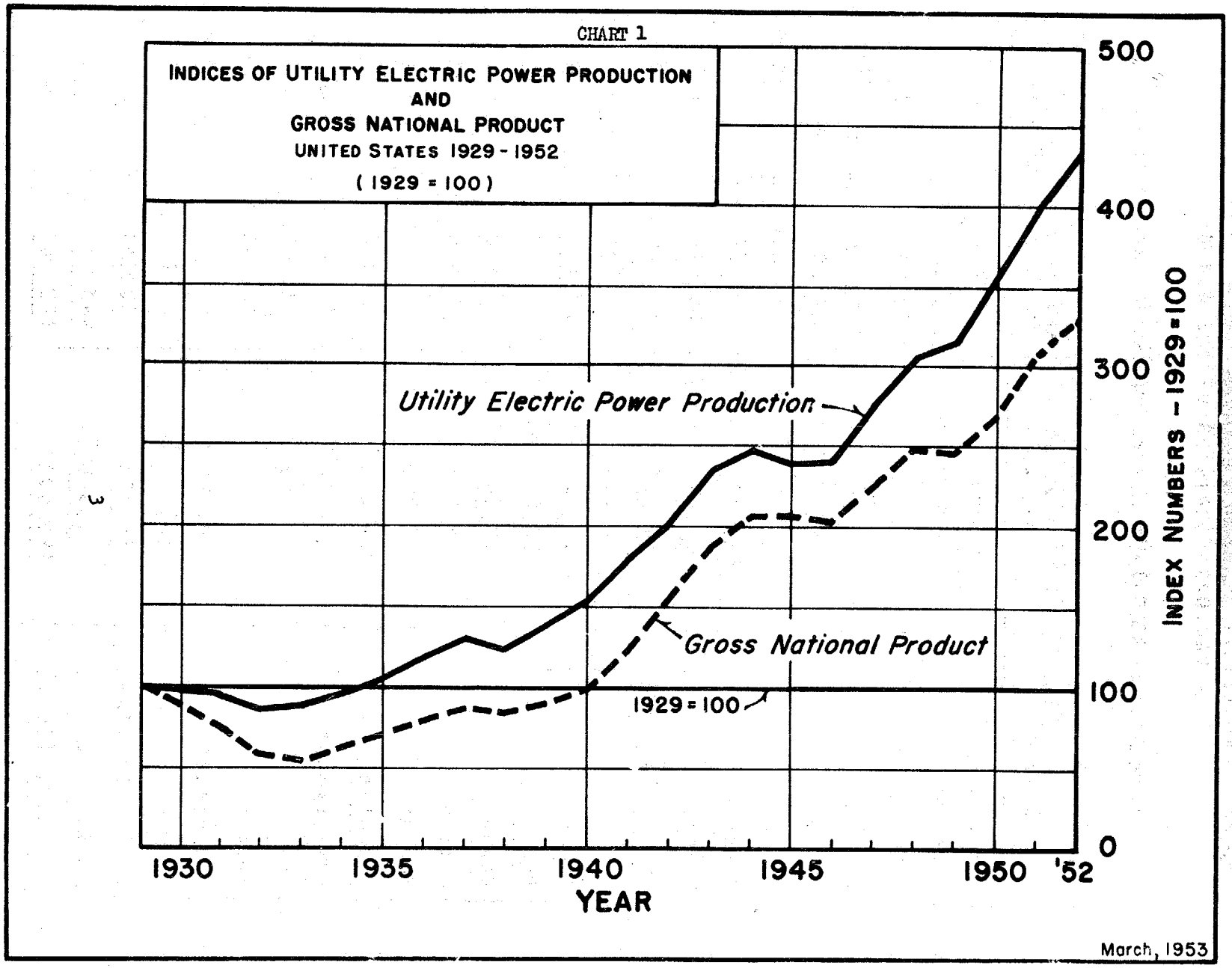


CHART 1
INDICES OF UTILITY ELECTRIC POWER PRODUCTION
AND
GROSS NATIONAL PRODUCT
UNITED STATES 1929 - 1952
(1929 = 100)
Utility Electric Power Production
Gross National Product
1929 = 100
500
400
300
200
100
0
INDEX NUMBERS - 1929 = 100
1930
1935
1940
1945
1950
'52
YEAR
March, 1953

1545

TABLE I

1546

PRODUCTION OF ELECTRIC ENERGY PER CAPITA IN VARIOUS COUNTRIES OF THE WORLD 1951

(Countries of 40,000,000 or more population underscored)

Country	Population (000's)	Kwh Produced (000,000's)	Kwh/Capita
Argentina	17,644	4,236	240
Austria	6,916	5,652	817
Belgium	8,678	9,492	1,094
Brazil	53,377	4,597	86
Canada	14,009	64,300	4,590
Chile	5,912	1,680	284
China	465,000 (Est.)	1,879 [1]	4
France	42,239	36,048	853
Western Germany	48,117	51,360	1,067
Israel	1,346	558	415
Italy	46,598	28,338	608
India	356,829	5,868	16
Japan	84,300	41,112	488
Mexico	26,332	4,896	186
Norway	3,294	17,316	5,257
Pakistan	75,842	212	3
Philippines	20,246	496	24
Spain	28,086	7,200	256
Sweden	7,073	19,440	2,748
Switzerland	4,749	10,248	2,158
Turkey	20,935 [2]	811	39
United Kingdom	50,558	59,964	1,186
United States	154,360	432,319	2,801
U.S.S.R. (Est.)	193,000	103,000	534

Note: [1] 1948
[2] 1950

Sources: EEI

note first that the productive nations of the world, those that you and everyone well informed would consider in that category are the very high kilowatt-hour consumption countries also. They are: Belgium, Canada, France, Western Germany, Italy--although Italy is not too high--Norway, Sweden, Switzerland, the United Kingdom, and the United States. All have very high kilowatt-hour figures per capita--some as high as 5,000. When you contrast these for example, with the figure of Pakistan of 3--a fine country and a fine nation of 70 million or so--you can see what their productivity must be on the basis of what we have here on power.

There are some use figures here that are special. The Canadian and Norwegian figures, I think, are special. I don't believe that they quite mean that their productivity is in direct ratio to their energy consumption. I think the United States figure, considering the large population, is a tremendously interesting one. You will see certain additional data on this as we go along. I think you might also want to make a note and compare the United States figure of 2,801 with that of Russia. The best figure we have for Russia shows an energy consumption of 534 kilowatt-hours per capita.

The same basic information is brought together in a different form in table 2, page 6, which I think is an interesting table from this standpoint: You will note that in 1920 the world production of electric energy was 126 billion kilowatt-hours. The percentage represented by the United States--the most highly industrialized and electrified country--was 44.9, almost 45 percent. Notice that although we dropped in percentage in 1930 and 1940, at the end of 1951 we were practically where we were 30 years earlier. We still account for 42.5 percent of the world's energy production, while the energy production increased eightfold--from 120 billion to over a trillion kilowatt-hours.

Also very interesting and very significant is the practically negligible percentage in terms of the world's total that Russia produced in 1920--only four-tenths of one percent. That figure had risen to 10 percent by the end of 1951. But you will notice that the Russian figure while displaying a rate of growth well ahead of that of the rest of the world, including the United States, is still not one to be alarmed about.

What I want to show from this is something like this: Here are the figures on what is going on energywise in the United States and the world. Without production it is just impossible to conceive that we can have security. Without power we will never have any production. If production is destroyed, it will be impossible to restore the productive capacity without restoring the power first. That isn't fully demonstrated by tables like this, but that is the experience of World War II. I think if you speak with people--and there are quite a few of them in this room--who have had World War II experience, they will be able to give you a great deal more detail on this point.

1548

TABLE 2

ESTIMATED WORLD PRODUCTION OF ELECTRIC ENERGY PERCENT OF USE BY THE UNITED STATES AND VARIOUS OTHER COUNTRIES

(IN MILLIONS OF KWH)

YEAR	1920	1930	1940	1950	1951
World Production	126,000	310,000	505,000	919,000	1,019,000
U. S. Production	56,559	114,637	179,907	388,674	432,319
Percent Use:					
United States	44.9	37.0	35.6	42.3	42.4
Canada	4.7	5.8	6.7	6.2	6.3
United Kingdom	5.1	5.3	6.7	6.0	5.9
France	4 3	5.0	3.4	3.8	3.5
U.S.S.R.	.4	2.7	-	9.8	10.1
Japan	5.5	4.5	6.1	4.2	4.1
Germany	6.8	9.35	12.5	4.8 *	5.1 *

SOURCE: E.E.I.
*West Germany Only

Now, the next question is: How well have we done in expanding power? How well have we done in providing that indispensable tool to expanding production and productivity?

I would like you to take a look at table 3, page 8, where we have shown the power production and growth in population in the United States over the 32-year period 1920 to 1952. Note the fact that the population in the 32-year period has increased roughly 50 percent, that is, from 106 million to 156 million while energy production in the same period has increased over eightfold. It is the kilowatt-hour consumption per capita which really is the index of productivity. It is the growth in kilowatt-hours per capita that were made available to every man and woman who was in the productive field that made possible this increase in productivity. That in itself went up sixfold. It went from 531 to practically 3,000 and you will note that the latter figure is still climbing.

In chart 2, page 9, we have shown a picture of the expansion of power in that same 32-year period and of two other basic commodities--steel and fuel. There are two other items--population and gross national product. The population figure shows an approximate increase of 50 percent. The gross national product went up almost fourfold. You will notice again on this plotted index basis that, while electric power increased over eightfold, steel approximately doubled. The conclusion from that is quite clear, that no other basic commodity--and I am assuming that you are going to grant that power is a basic commodity--has done anywhere near the same kind of job in availability.

Table 4, page 10, which follows the chart, is nothing more than a backup table for chart 2, in case you find it desirable afterward to use it in some form or want to check some figures. The sources of the data are indicated there also.

One more item on this question of how well we have done in expanding power: look at chart 3, page 11. Here we have plotted--again from the best information we have available, but we have taken a great deal of pains to check the data--the expansion in production of electric energy by the utilities in the various countries, in what I would call the principal industrialized countries, particularly Canada, France, Germany, Japan, the United Kingdom, Russia, and the United States. Actually this is really an expansion of table 2. Several very significant things are shown on this chart. First, you will see that power is expanding right now about as fast in the United States as it is in any other country; and that doesn't exclude Russia. And you can see that the average slope of all the other power production curves, which is a quite steep one, is considerably well below that of either the Russian or the United States curve.

I don't mean to indicate that there is presented here any particular basis for smugness. But there is no question about the fact that

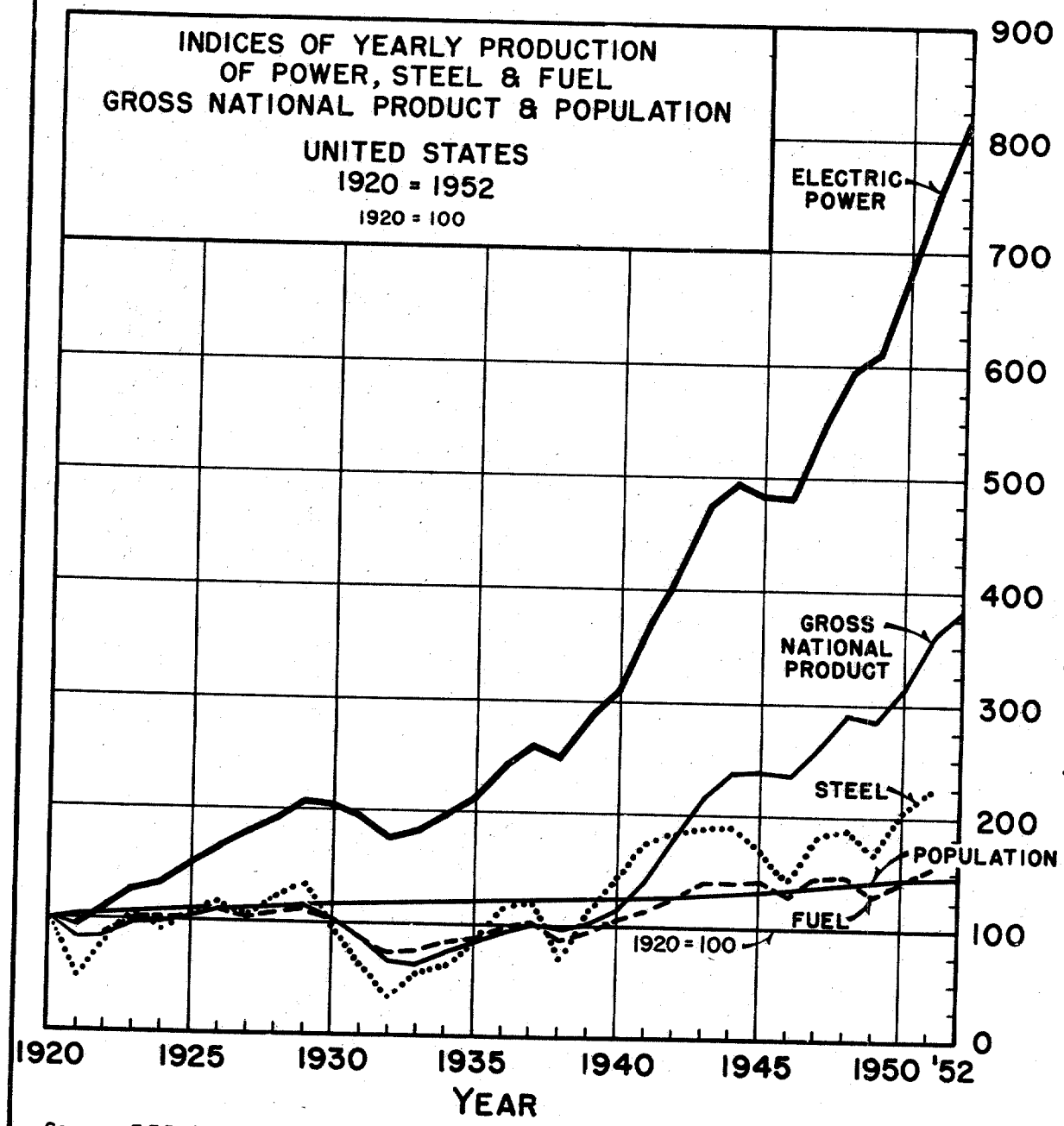
1550

TABLE 3

POWER PRODUCTION AND GROWTH IN POPULATION IN THE UNITED STATES 1920-1952

Year	Population (000's)	KWH Produced (000,000's)	KWH/Capita
1920	106,466	56,559	531
1925	115,832	84,666	731
1930	123,077	114,637	931
1935	127,250	118,935	935
1940	131,070	179,937	1,373
1941	133,203	208,307	1,564
1942	134,665	233,179	1,732
1943	136,497	267,540	1,960
1944	138,083	279,525	2,024
1945	139,586	271,255	1,943
1946	141,235	269,609	1,909
1947	144,024	307,400	2,134
1948	146,571	336,808	2,298
1949	149,215	345,066	2,312
1950	151,689	388,674	2,562
1951	154,353	432,319	2,801
1952	156,981	462,589	2,947

CHART 2



Sources: E.E.I., U.S. Dept. of Commerce, Bituminous Coal Institute

March, 1953

1552

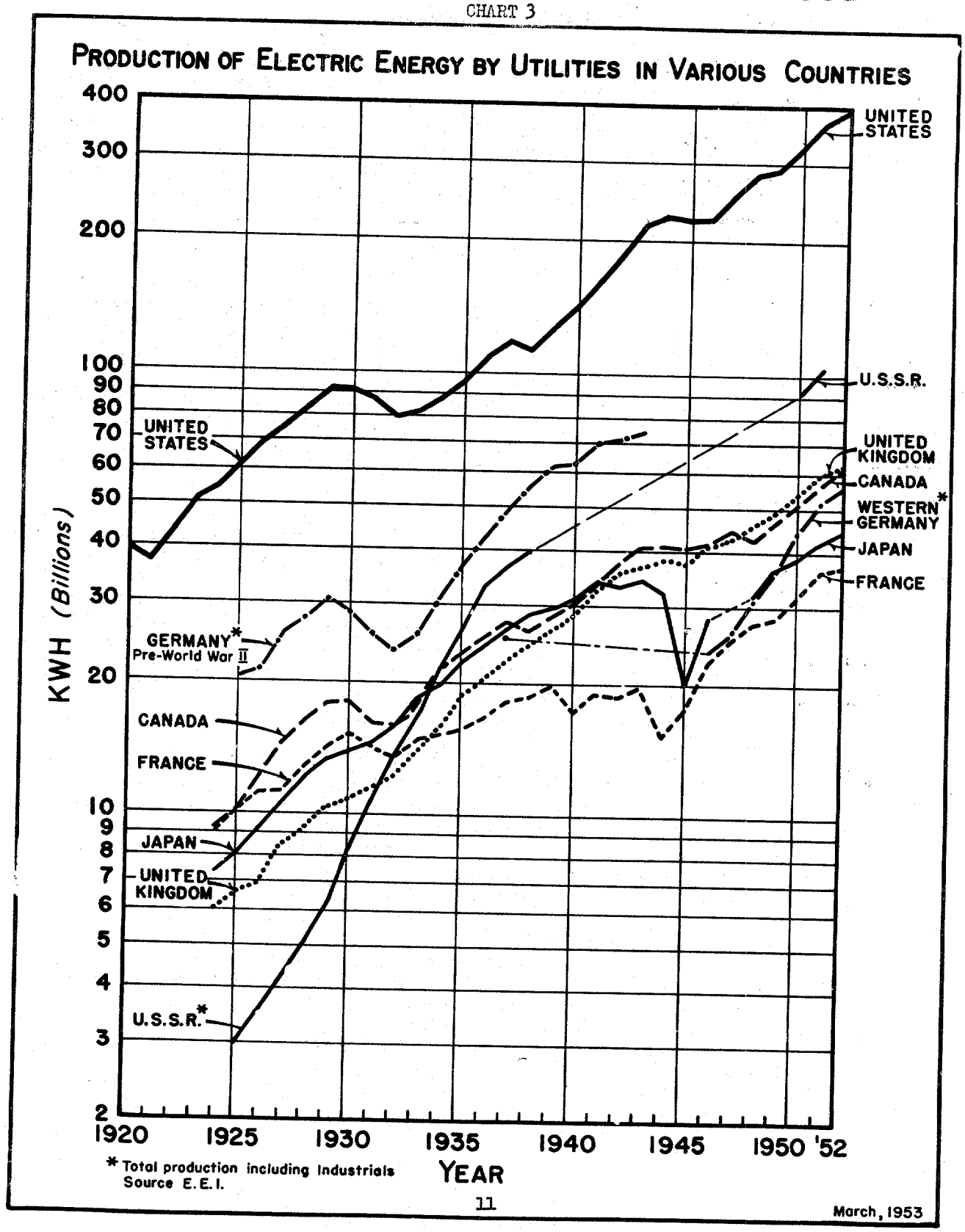
TABLE 4

PRODUCTION OF POWER, FUEL AND STEEL
GROSS NATIONAL PRODUCT AND POPULATION
UNITED STATES
1920 - 1952

Year	Power Production[1] (Millions of KWH)	Gross National Product[2] (Billions of Dollars)	Population[2] (Millions)	Fuel Production[3] (Trillions of Btu)	Steel Production[2] Ingots & Castings (Thousands of Tons)
1920	56,559	90.5	106,466	17,589	47,189
1921	53,125	73.8	108,541	14,304	22,158
1922	61,204	75.9	110,055	15,033	39,875
1923	71,399	88.3	111,950	18,530	50,337
1924	75,892	87.4	114,113	17,743	42,484
1925	84,666	94.4	115,832	17,849	50,841
1926	94,222	99.9	117,399	19,343	54,089
1927	101,390	98.4	119,038	18,543	50,327
1928	108,069	100.2	120,501	18,724	57,729
1929	116,747	103.8	121,769	19,559	63,205
1930	114,637	90.9	123,077	17,749	45,583
1931	109,373	75.9	124,040	14,998	29,059
1932	99,359	58.3	124,840	12,831	15,323
1933	102,655	55.8	125,579	13,163	26,020
1934	110,404	64.9	126,374	14,298	29,182
1935	118,935	72.2	127,250	14,957	38,184
1936	136,006	82.5	128,053	17,091	53.500
1937	146,476	90.2	128,825	17,608	56,637
1938	141,955	84.7	129,825	14,951	31,752
1939	161,308	91.3	130,880	16,507	52,779
1940	179,937	101.4	131,070	18,504	66,983
1941	208,307	126.4	133,203	20,206	82,839
1942	233,179	161.6	134,665	22,300	86,032
1943	267,540	194.3	136,497	24,760	88,837
1944	279,525	213.7	138,083	24,574	89,642
1945	271,255	215.2	139,586	24,799	79,702
1946	269,609	212.6	141,235	22,764	66,603
1947	307,400	235.7	144,024	25,460	84,894
1948	336,808	262.4	146,571	25,751	88,640
1949	345,066	257.4	149,215	23,094	77,978
1950	388,674	282.6	151,689	25,340	96,836
1951	432,319	327.8	154,353	27,241	105,135
1952	462,589	346.3	156,981		

SOURCES: [1] E.E.I.
[2] U.S. Dept. of Commerce
[3] Bituminous Coal Institute.

CHART 3


PRODUCTION OF ELECTRIC ENERGY BY UTILITIES IN VARIOUS COUNTRIES
KWH (Billions)
400
300
200
100
90
80
70
60
50
40
30
20
10
9
8
7
6
5
4
3
2
1920
1925
1930
1935
1940
1945
1950
'52
YEAR
UNITED STATES
U.S.S.R.
UNITED KINGDOM
CANADA
WESTERN* GERMANY
JAPAN
FRANCE
GERMANY* Pre-World War II
CANADA
FRANCE
JAPAN
UNITED KINGDOM
U.S.S.R.*
* Total production including Industrials
Source E.E.I.
March, 1953

we do not have to be concerned as long as we continue to do the kind of job we are doing on the power situation in the United States. There is no question in my mind that a fine job--you might even say an excellent job--is being done on power; but of course, the minute we start sitting back and patting ourselves on the back on our collective superior national characteristics, and feeling that we have the job done and don't have to do anything more--that certainly will mark a point of transition in the history of the country.

Table 5, page 13, is a backup for chart 4, page 14.

The next item I want to cover is the job that has been done in the United States in the period 1941 to 1955. That therefore covers the period of World War II, the period of apparent peace that followed it, and the defense period that followed Korea in 1950. There is little doubt, as I see it, that this interval or at least half of that represents a very critical period. On the one hand we fought the greatest war in the history of civilized man from 1941 to 1945. And we won the war. Whether we won the peace or not is a totally different question. We won the war.

At the present time we are going through a very important--and it may prove to be critical in the history of this country and of the entire world--period of again building up our defenses. It has also been called the cold war. But we have just gone through a series of factual analyses that indicate that power is critically important in production, and therefore in defense production in waging a war, because modern war is a production war. And it is a question of national importance therefore as to how well have we done, how well did we do in the last war, how well are we doing right now, in the period of defense?

In chart 5, page 15, I have shown the load and capability situation of the United States throughout the war period. If you take the space between the two curves, that is the capability in kilowatts of all the generating capacity in the United States, and peak load, also in kilowatts, which is the arithmetical sum of the peak loads in the various areas or regions--that space between the two curves represents our reserve in kilowatts. It is simple enough to get a percentage.

You will notice that in 1945, for example, we had almost 10 million kilowatts in reserve. We had done a good job throughout the war in maintaining a proper reserve margin to protect the power supply of the United States. Some of you I am sure will recall the large amount of discussion that was going on during the war as to whether enough new power was being projected. People both in and out of the Government were very skeptical about the adequacy of the program and some thought that the Nation's safety was being jeopardized by insufficient new capacity being undertaken.

TABLE 5

PRODUCTION OF ELECTRIC ENERGY BY UTILITIES IN VARIOUS COUNTRIES IN MILLIONS OF KILOWATT-HOURS

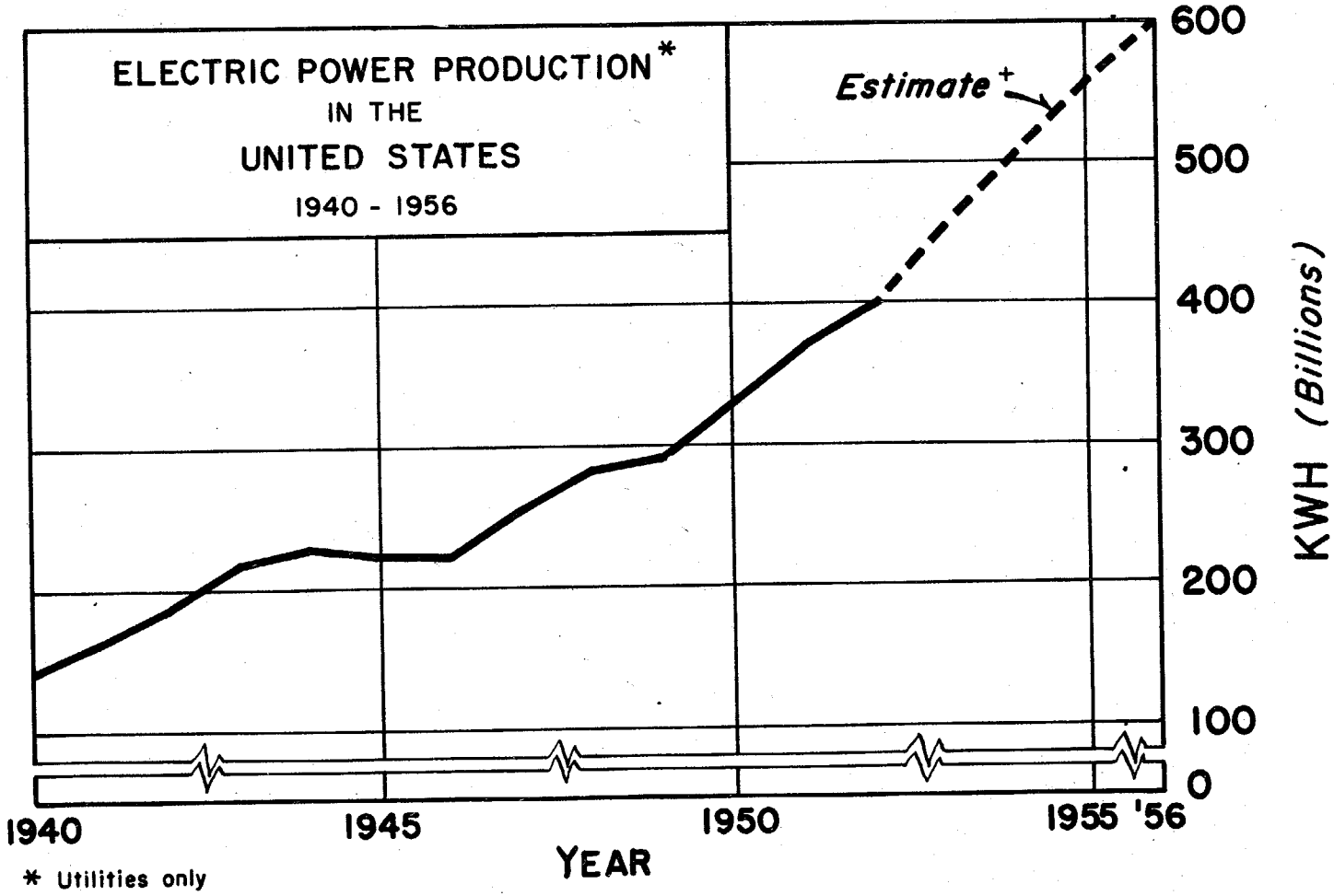
YEAR	UNITED STATES	CANADA	UNITED KINGDOM	FRANCE	U.S.S.R.[1]	GERMANY[1]		JAPAN
						Pre-World War II	West Germany	
1920	39,405							
1921	37,180							
1922	43,632							
1923	51,229							
1924	54,662	9,315	6,022	9,066				7,331
1925	61,451	10,110	6,619	10,222	2,925	20,328	-	8,172
1926	69,353	12,093	6,992	11,268	3,507	21,218	-	9,313
1927	75,418	14,549	8,452	11,388	4,173	25,135	-	10,559
1928	82,794	16,338	9,324	12,976	5,007	27,870	-	12,036
1929	92,180	17,963	10,401	14,352	6,224	30,661	-	13,312
1930	91,112	18,094	10,947	15,339	8,368	28,914	-	13,910
1931	87,350	16,331	11,533	14,232	10,687	25,788	-	14,402
1932	79,393	16,052	12,347	13,602	13,540	23,460	-	15,950
1933	81,740	17,339	13,915	14,906	16,357	25,654	-	18,160
1934	87,258	21,197	15,587	15,172	21,016	30,662	-	19,900
1935	95,287	23,283	17,971	15,818	25,900	36,697	-	22,348
1936	109,316	25,402	20,524	16,659	32,700	42,487	-	24,312
1937	118,913	27,684	22,908	18,162	36,400	48,969	25,200	26,714
1938	113,812	26,160	24,372	18,576	39,600	55,238	-	28,896
1939	127,642	28,344	26,412	19,716	-	61,380	-	29,484
1940	141,837	30,108	28,776	17,376	-	62,964	-	30,972
1941	164,788	33,312	32,364	19,044	-	69,999	-	33,444
1942	185,979	37,356	35,652	18,924	-	71,500	-	33,072
1943	217,759	40,476	36,948	19,956	-	73,943	-	34,284
1944	228,189	40,596	38,364	15,384	-	-	-	32,580
1945	222,486	40,104	37,284	17,568	-	-	-	20,064
1946	223,178	41,604	41,256	22,164	-	-	23,820	28,152
1947	255,739	44,988	42,576	25,128	-	-	25,660	-
1948	282,698	42,384	46,488	27,564	-	-	30,910	31,728
1949	291,100	46,668	49,056	28,560	-	-	35,700	36,072
1950	329,141	50,904	54,960	31,476	90,000	-	44,028	38,832
1951	370,234	57,420	59,964	36,048	103,000	-	51,360	41,112
1952	398,924	61,900*	62,120*	37,150*		-	55,840*	44,610*

SOURCE: E.E.I.

[1] Total Production including Industrials

* Estimated

CHART 4



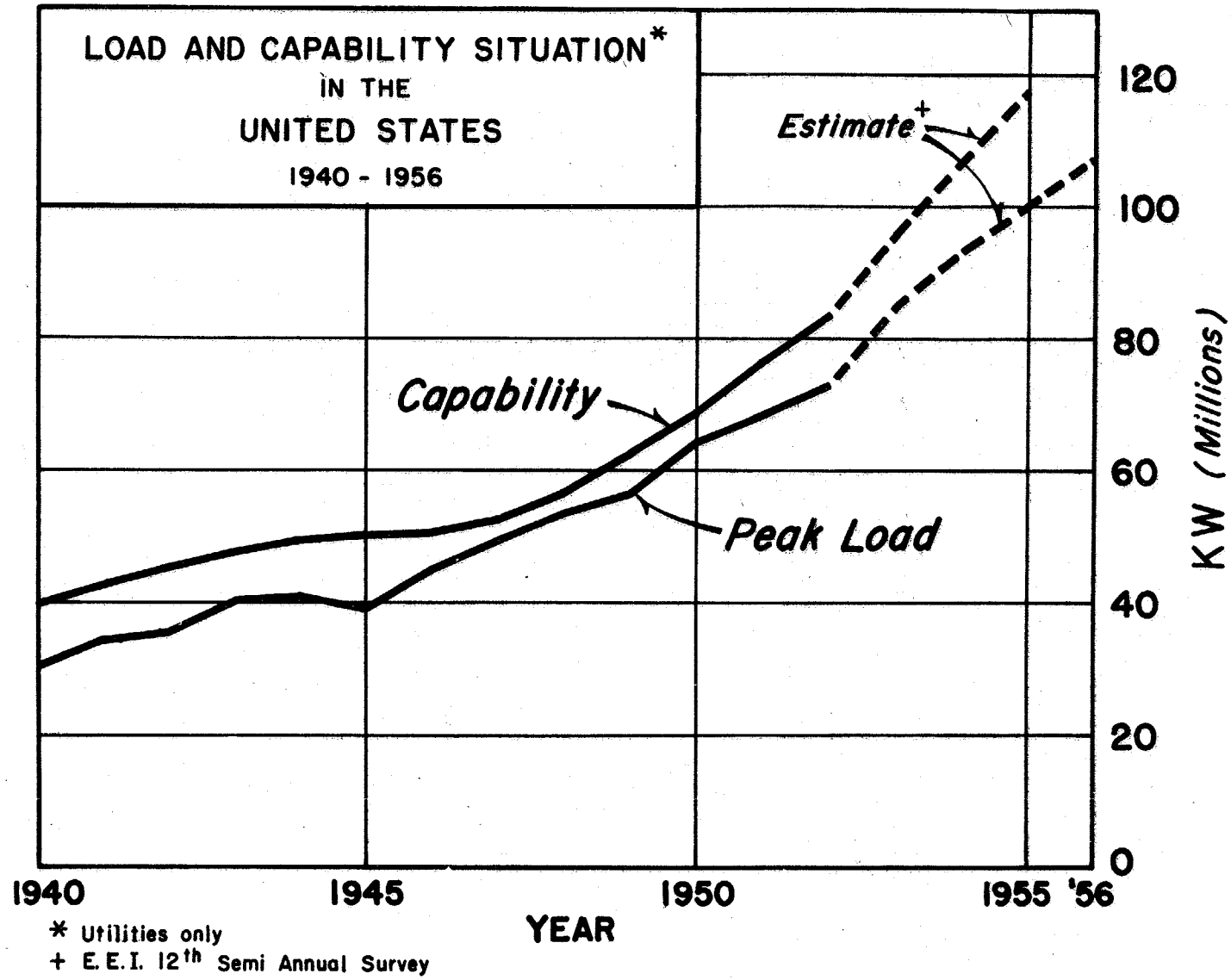
* Utilities only

\+ E.E.I. 12th Semi Annual Survey

March, 1953

1556

CHART 5



* Utilities only
\+ E.E.I. 12th Semi Annual Survey

March, 1953

1557

But I think the record is quite clear that among the jobs that had to be done by the various government agencies in World War II, the outstanding job was done in power, in maintaining with a very close degree of precision, and with an absolute minimum call upon the national treasury of materials and manpower, the proper balance, but no more, between all the power we needed to be able to produce the materials of war and to supply the civilian requirements.

It is true that following the definitely unexpected--and it was unexpected to most of the people of the United States--postwar boom, that the margin of reserve came down to a very small amount, particularly small in the light of the expansion in demand. You can see that clearly from chart 5. At the present time that margin is still not where it should be. But you will notice that we have projected here both demand and capability through 1955. That is possible to do fairly accurately because most of the program is pretty well along, not only on the drafting board, but a good deal of it is under actual construction.

So that we will end up by 1955 with a margin of the order of about 17 percent. That is a good margin. It will be a considerably larger quantity of kilowatts, although the percentage of margin is materially less, than what we had in 1939 and 1940. It will act as what I have called in some of the talks I have given here before as the WR^2 effect, the flywheel effect; that is, the capacity from which we can supply the immediate demands for power when and if the economy should have thrown on it some special war loads, or when and if we should even have some disaster occur, either natural or as a result of sabotage.

I believe that the power supply of the country will be amply protected by that margin. It may mean that we will get down to as narrow a margin as we had in 1947 and 1948. But in the meantime plans can be developed and construction started to bring the margin back to normal again. But it does show that with the expansion in demand, from 30 million kilowatts in 1940 up to 100 million kilowatts in 1955, the capability is moving along to keep up with demand, but with less than a desirable margin, even though the margin is a considerable one. Also we are coming into a period where there is going to be all the margin that the economy can afford.

Chart 4, shows the figures of energy production and the projected production in 1955. Here you can see that we had a production of something like 142 billion kilowatt-hours in 1940. In 1952, the production was close to 400 billion. We are moving into a figure of annual production in 1955 of very close to 560 billion kilowatt-hours. Thus a 4:1 increase will have been taken care of in the interval 1940-1955.

We probably are--if you take a look at chart 4 and just project it a little bit in your imagination--no more than 13 or 14 years away from the time--unless we run into some either economic or international snags

that we don't anticipate--when our total annual energy production will be a trillion, that is, a thousand billion, Kilowatt-hours. Ten raised to the twelfth power in kilowatt-hours is a tremendous amount of energy.

Admiral Hague asked me to touch upon power technology and where we in the United States stand with respect to the rest of the world.

One of the reasons for the increase in power development and in the development and utilization of electric power is the job that has been done, in this country particularly, in keeping electric power costs down. And one of the principal reasons behind the ability to keep costs down has been the fact of the extremely dynamic technology.

You may be interested to know that in 1932--maybe that is a year we don't want to remember, but I recall we had a very extensive discussion with the Bureau of Internal Revenue--I carried on the discussion for my company on the question of depreciation and whether the depreciation that we were taking on our books taxwise was the right amount. The Bureau was convinced that the depreciation was probably excessive, because the Bureau had come to the conclusion that we had reached a period in power of stabilized technology.

I want you to think of that. In 1932 we produced less than 80 billion kilowatt-hours of energy. The domestic utilization, which is now almost up to 2,500 kilowatt-hours per year per consumer was less than 600 kilowatt-hours per year in 1932. The highest pressure steam plant that we had in the United States, or in the world, was 1,200 pounds per square inch. The highest temperature was 725° Fahrenheit. The largest 3,600 rpm turbine generator that could be built, so the designers said, was approximately 39,000 kilowatts. The exact figure was 38,900. We had an extensive discussion on that point with the designers. They assured us that they couldn't build a 39,000-kilowatt alternator. They could build a 38,900-kilowatt alternator--period. The average fuel consumption in pounds of coal per kilowatt-hour in the United States, as you will see from the charts, was a pound and a half. The highest voltage that we thought we could transmit at was 230,000 volts.

Now, there you have a viewpoint which is the kind of thing that goes through cycles. Over and over again you find people who get tired of progress, who see the end of it. The revenue people thought we had reached the end of it in 1932--they thought that we had reached a stabilized technology.

Since then we have, however, made enormous progress. In the United States we have not merely held our own; I believe we have pulled ahead. That is my considered judgment as regards the position we have reached vis-a-vis the rest of the world in power technology. Now, I realize that this can be attacked as being too chauvinistic. I don't

think it is. I think it is a sober appraisal. I do think there is great danger that we may now be tempted to be lulled into a false security, into thinking that we have the world by the tail, and that we don't have to work any more to keep our end up. That would certainly be very bad for our security.

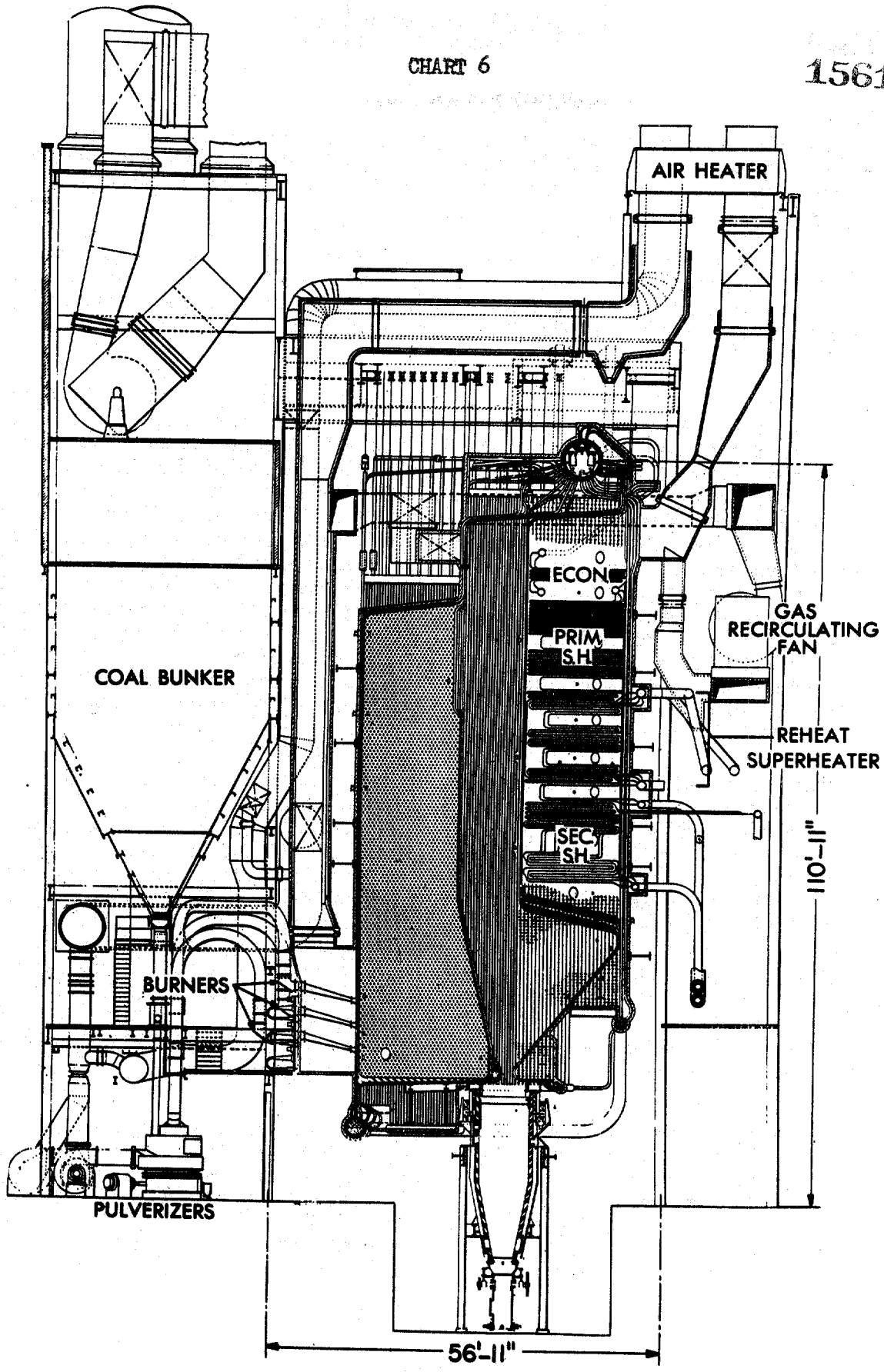
I would like to show you by a few highlights--because that is all we have time for--what we are doing today, where we stand in the United States, keeping in mind what I told you about our world position.

In the United States we are building today 250,000-kilowatt turbo-generators some tandem compound, which means on a single shaft; and some cross compound, meaning on two separate shafts. We are building into a single boiler enough capacity to operate turbines of this size, so that we can build our plants on a unit basis--one boiler driving one turbine. Each unit is more or less self-contained. It doesn't tie in except electrically with the other units. Each such unit has in it a great many elements of technical advance. It could not have been done before we reached the present state of technological development. Such a unit has a great many economic advantages. I would like you to remember that when we talk of economics we generally mean dollars. But, when we are in times of crisis such as periods of defense like the present, or in periods of war, dollars and very critically short materials, like titanium, columbium, nickel, chromium, or even lead must be considered together, and economical dollarwise means the maximum utilization of materials and manpower. This is very important to remember when you are fighting a war.

Chart 6, page 19, shows a cross section of the 200,000-kilowatt boilers, of which 11 are being built for the Ohio Valley Electric Corporation. These will be installed in two plants--five in one plant and six in the other--which will furnish the entire power supply to the Atomic Energy Commission's new diffusion plant at Pike County, Ohio. Now, I think this is a very interesting exhibit. Even from the few dimensions given, you can get a very good idea of its physical size. The lines of this boiler look amazingly simple--they are the result of many decades of development work. You will notice that the burners are at the bottom of the boiler. This is a "wet bottom boiler"; with the burners at the bottom it is easier to keep the ash molten--wet--and allow it to run out through the slag opening at the bottom of the boiler.

These boilers are supplying steam at a pressure of 2,000 pounds per square inch and a temperature at the initial superheat of 1050° Fahrenheit to the cross compound turbine units of 200,000 kilowatts continuous output. The over-all thermal efficiency of this unit, the boiler and turbine combination taken together, will be slightly over 38 percent.

That too is an amazing performance when you consider--and even today practicing engineers can remember--the time when most people


AIR HEATER
ECON
PRIM. S.H.
SEC. S.H.
GAS RECIRCULATING FAN
REHEAT SUPERHEATER
COAL BUNKER
BURNERS
PULVERIZERS
110'-11"
56'-11"

thought that the best thermal efficiency that you could look forward to in a thermal engine was of the order of 10 to 12 percent. Certainly that was true of steam engines, in any form, whether reciprocating engines or turbines.

Please remember that in terms of the utilization of materials, at 12 percent thermal efficiency only 12 percent of the heat content of the fuel is effectively utilized, the balance being wasted, while at 38 percent efficiency, 38 percent is effectively used. This makes a terrific difference. The ratio of the amounts utilized is over three to one.

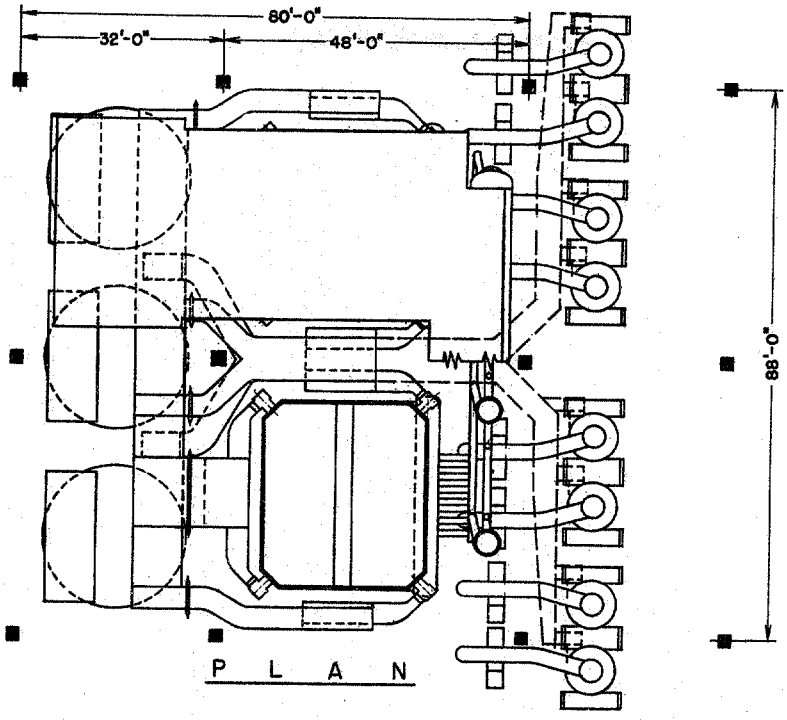
Chart 7, page 21, is a cross section of the so-called controlled circulation boiler. In the lower part of the drawing you will notice a circulation pump which creates the positive head or pressure in lieu of the thermal head in a normal circulation boiler and which enables the circulation through the various sections of tubes of the boiler to be controlled by means of orifices in the tubes. If you look at the plan view, you will find that, although this is referred to as a single boiler--this is a 250,000 kilowatt boiler--it is actually two boilers. It has, for example, two separate firing chambers. In this case the boiler is fired tangentially from the corners as is shown in the plan view. This pumped boiler furnishes steam at a pressure of 2,000 pounds per square inch and 1050° Fahrenheit. Although there is some question as to the real economy of a pumped boiler at this pressure, it is interesting that we have a boiler that can be operated from a single set of instruments so as to deliver 250,000 kilowatts to a single turbine.

That we are going to go to much higher pressures and thus to pumped boilers one of these days, months, or years, I haven't any doubt. I am inclined to think there are some real opportunities for increased thermal efficiencies. As you know at pressures above 3,200 pounds per square inch the formation of steam is not accompanied by bubbling. In other words at that pressure the specific gravity of steam becomes equal to the specific gravity of water so that there is no natural circulation; a pump must be used to maintain circulation. So that we will have, I am sure, boilers operating some day at perhaps 5,000 and, looking far into the future, it is quite possible that we will have operating pressures of 10,000 pounds per square inch. That is looking far into the future.

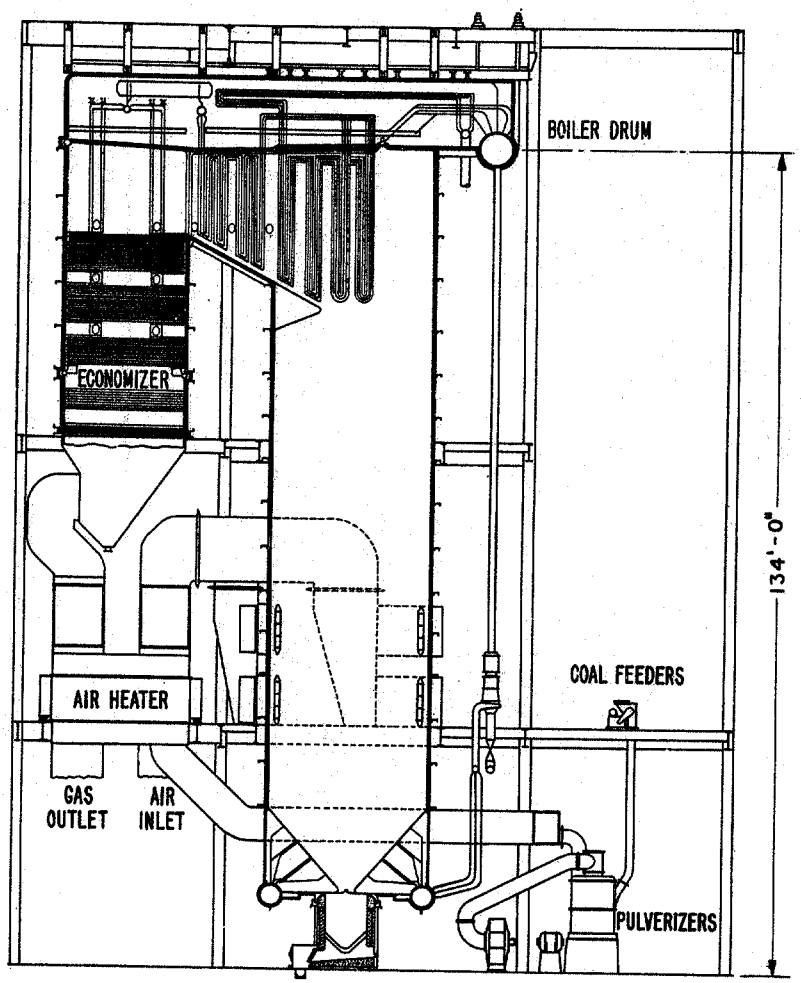
Chart 8, page 22, is designed to merely give you a view of a typical modern turbine room. The units shown are 200,000-kilowatt cross compound turbines. This is a quite accurate view of the turbine room. The only thing that is not properly representative here is the fact, as you will observe, that in this 400,000-kilowatt turbine room there are two men on the floor. There never should be more than one and frequently there are none. But, except for that, I think the view is quite correct.

CHART 7

1563

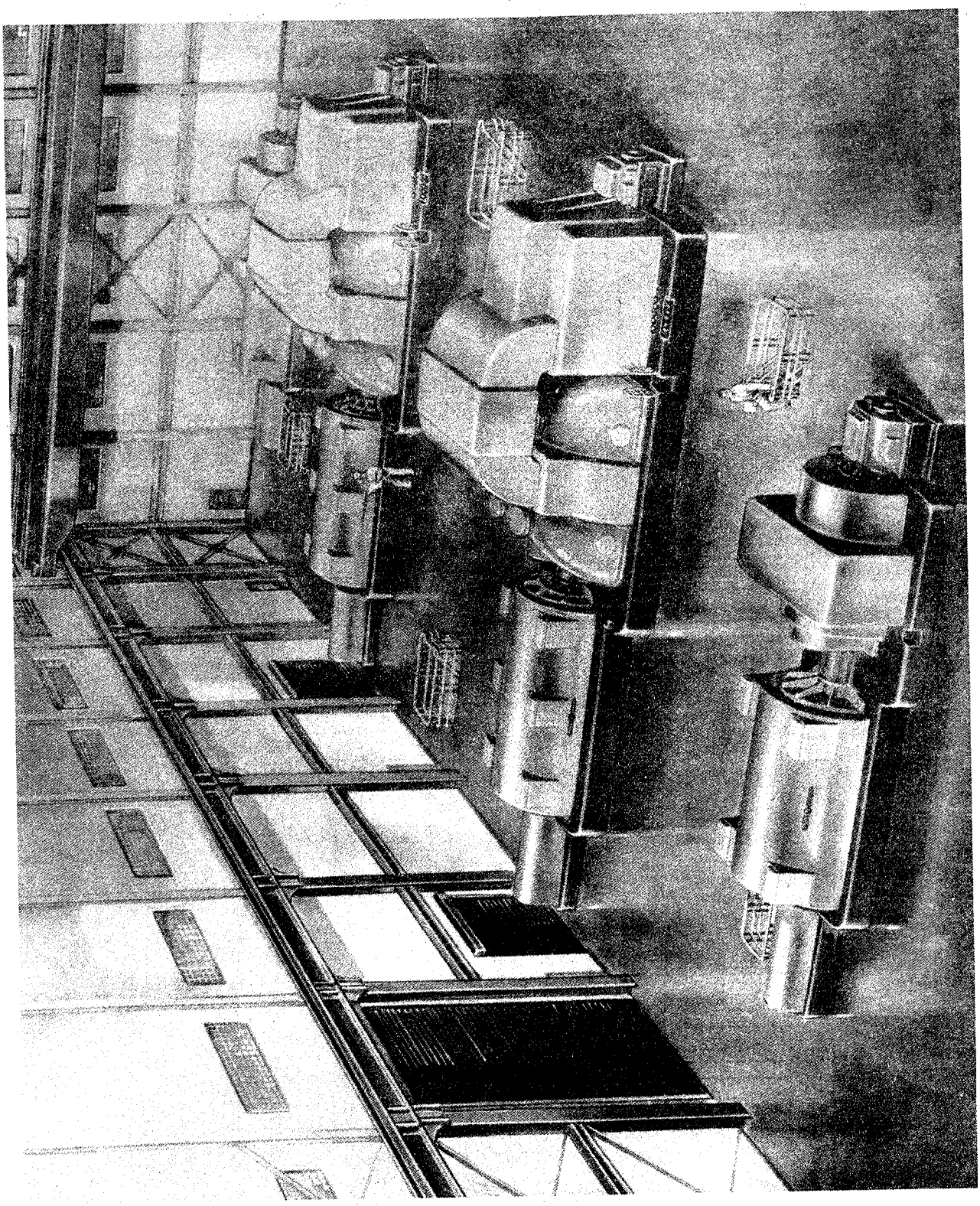


P L A N



C R O S S S E C T I O N

CHART 8



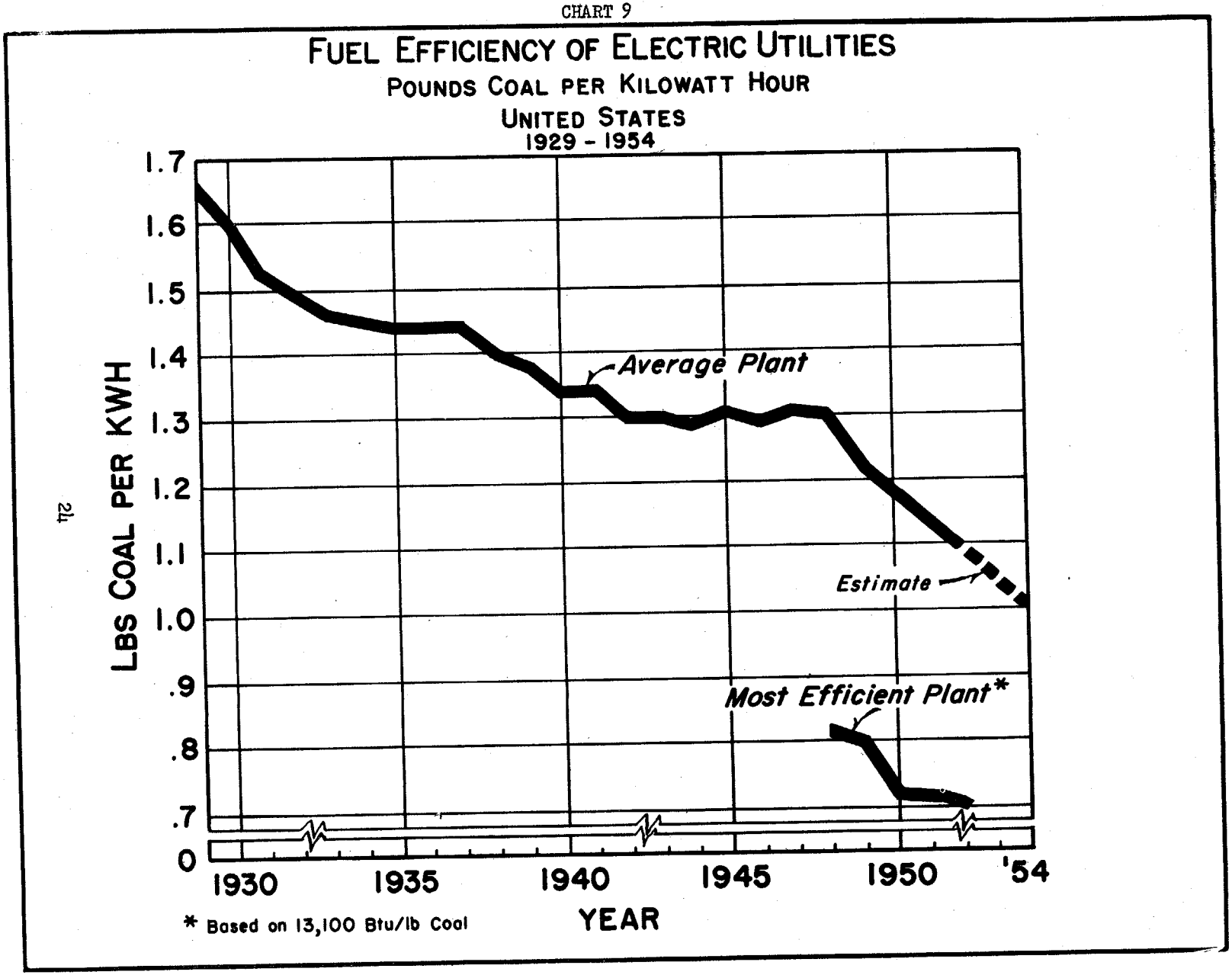
There is a great deal of involved and very beautiful technology that has gone into the development of units such as this, both on the steam end and on the electrical end. Certainly when the designers were saying in 1931, 1932, and 1933 that they couldn't build anything bigger than a 38,900 kilowatt, 3,600 rpm unit, they weren't dumb and they weren't unrealistic. They just hadn't developed some of the technology and the tools that we have developed since. Notable among these tools is hydrogen cooling, which has made an enormous contribution to the extension of size and the improvement of efficiency of turbo-alternators.

I want to show you a summary of what has been done to improve generation equipment in the past quarter century or so. In chart 9, page 24, you will find that we have plotted two things. We have plotted the average performance of the power plants in the United States in terms of fuel consumption per kilowatt-hour over the period 1929-1952 and the performance projected to 1954. You will notice, going back to 1929, that in the 25-year period 1929-1954, we will have reduced the average coal consumption in coal burning plants from 1.65 pounds per kilowatt-hour to one pound. Think what that has meant and what that means today in terms of the national economy when you consider that last year we burned roughly 120 million tons of coal for electric power generation alone. Had we, for example, operated on the 1929 efficiency level, we would have burned 200 million tons of coal, an additional 80 million tons. That means probably not less than an additional 60,000 miners and men above ground would have been engaged in the business of mining this coal. That is quite an army.

But it is also important for you to take a look at the lower curve, where we have shown the most efficient plants in the last five years. From this it is obvious that there still is much work to be done to bring the average plant up to the best. In the last five years the most efficient steam electric plants in the United States were: in 1948 the Port Washington plant in Milwaukee; in 1949 the Sewaren Plant near Newark, New Jersey; in 1950 it was the plant that bears my name in Graham Station, West Virginia; and in 1951 and 1952 it was the Tanners Creek plant near Lawrenceburg, Indiana. You will notice that we are down now, in terms of coal of 13,100 Btu per pound to .7 pounds of coal per kilowatt-hour. That is amazing progress, I think, in so short a time. It is particularly interesting, in the light of the opinion quite generally held only a few years ago that we had reached so-called technical stability in power generation.

I want you to examine chart 10, page 25, which is a photograph of a 330,000-volt double circuit transmission tower from the standpoint of relative size. A man is shown climbing the tower which has three double arms at different heights. It is capable, when there are two wires on each arm, of supporting conductors transmitting as much as a million kilowatts--that is, in the six wires you can have a transmission capacity of a million kilowatts.

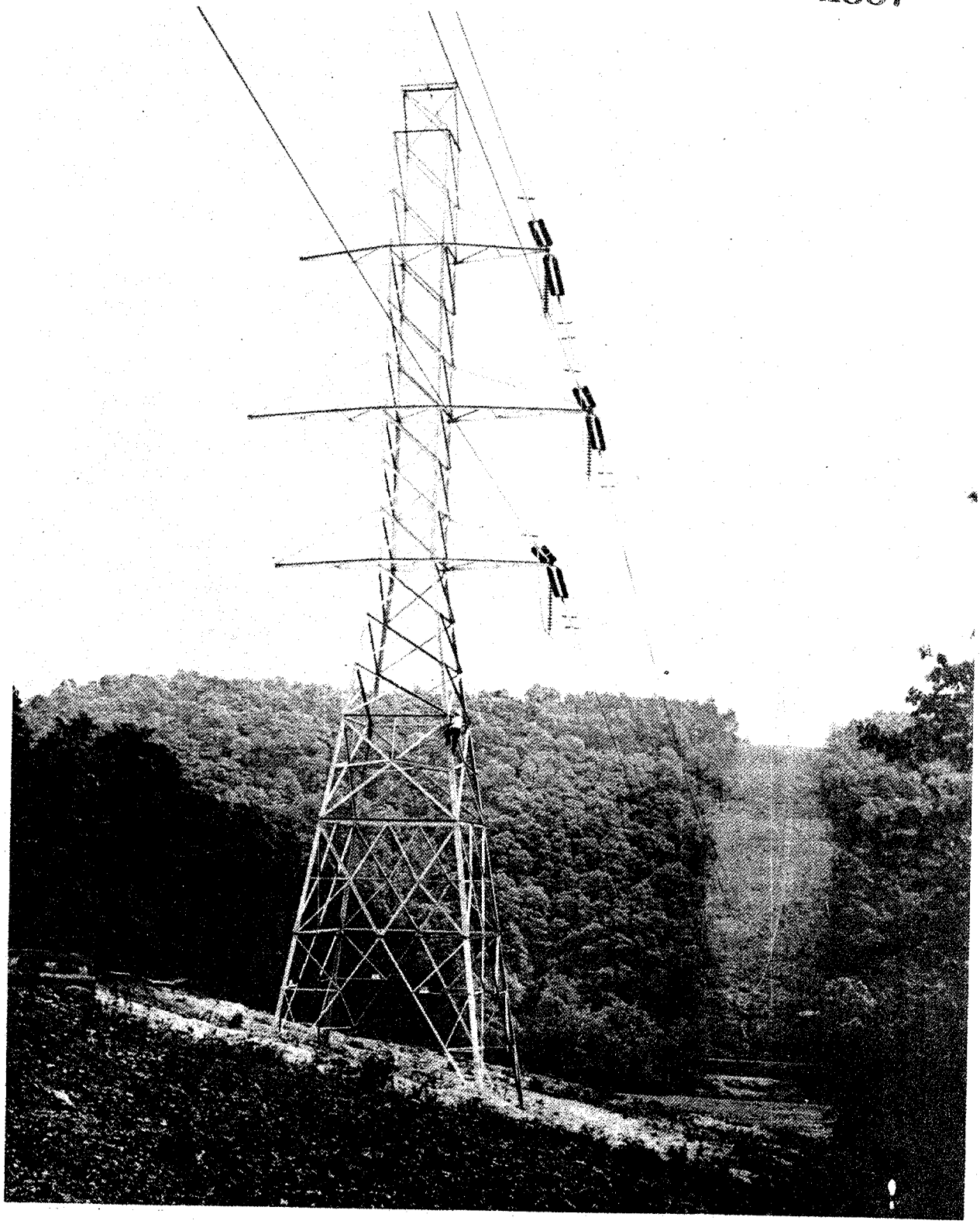
CHART 9


FUEL EFFICIENCY OF ELECTRIC UTILITIES
POUNDS COAL PER KILOWATT HOUR
UNITED STATES
1929 - 1954
LBS COAL PER KWH
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
.9
.8
.7
0
Average Plant
Estimate
Most Efficient Plant*
1930
1935
1940
1945
1950
'54
YEAR
* Based on 13,100 Btu/lb Coal

1566

CHART 10

1567



1568

I would like to make this observation too: If you will take a look at this and visualize thousands of these million kilowatt structures which with time will surely appear on the landscape of this country, you will see what that will mean from the standpoint of safety from bombing attack. I think it is sound judgment to say that, while a number of these towers may be vaporized by an atomic bomb if it comes close enough, it should not take very long to repair the damage. Such towers can be repaired or replaced very quickly if we have the material and the parts. The towers, in short, can be repaired before you can repair the other effects of the bombing operation.

Again, to show you the advance in power technology please take a look at chart 11, page 27. This is a very accurate representation from the working drawings of some of the circuit breakers that are going to be used on a 330,000-volt line. The interesting thing is the fact that these circuit breakers, which fundamentally are nothing but switches on a larger scale like the wall switches that control the lights of this room, will be capable of switching 400,000 kilowatts and interrupting what is the equivalent of about 25 million kilowatts in a fraction of a second, in about a tenth of a second. That is quite a brake. In no other phase of the technology does there exist the know-how of arresting successfully so much power in so short a time. I must admit there is a catch to it. The catch is that alternating current is ideally located or set up to make that possible. There are 120 times in the course of its cyclic life--where we have 60-cycle current--when it goes through a period of zero value. It is at that time that we interrupt the current and try to stop it from building up again.

To show progress in utilization, I have put together chart 12, page 28. All this is designed to show is some examples of the diversity and scope in the development of electric power utilization devices, such as motors, transformers, lamps, and so on. There is no question but that we can build 100,000-horsepower motors any time we need to; we have built some up to 82,000 horsepower already; if the need exists we may build a 200,000 or 250,000 horsepower motor some day.

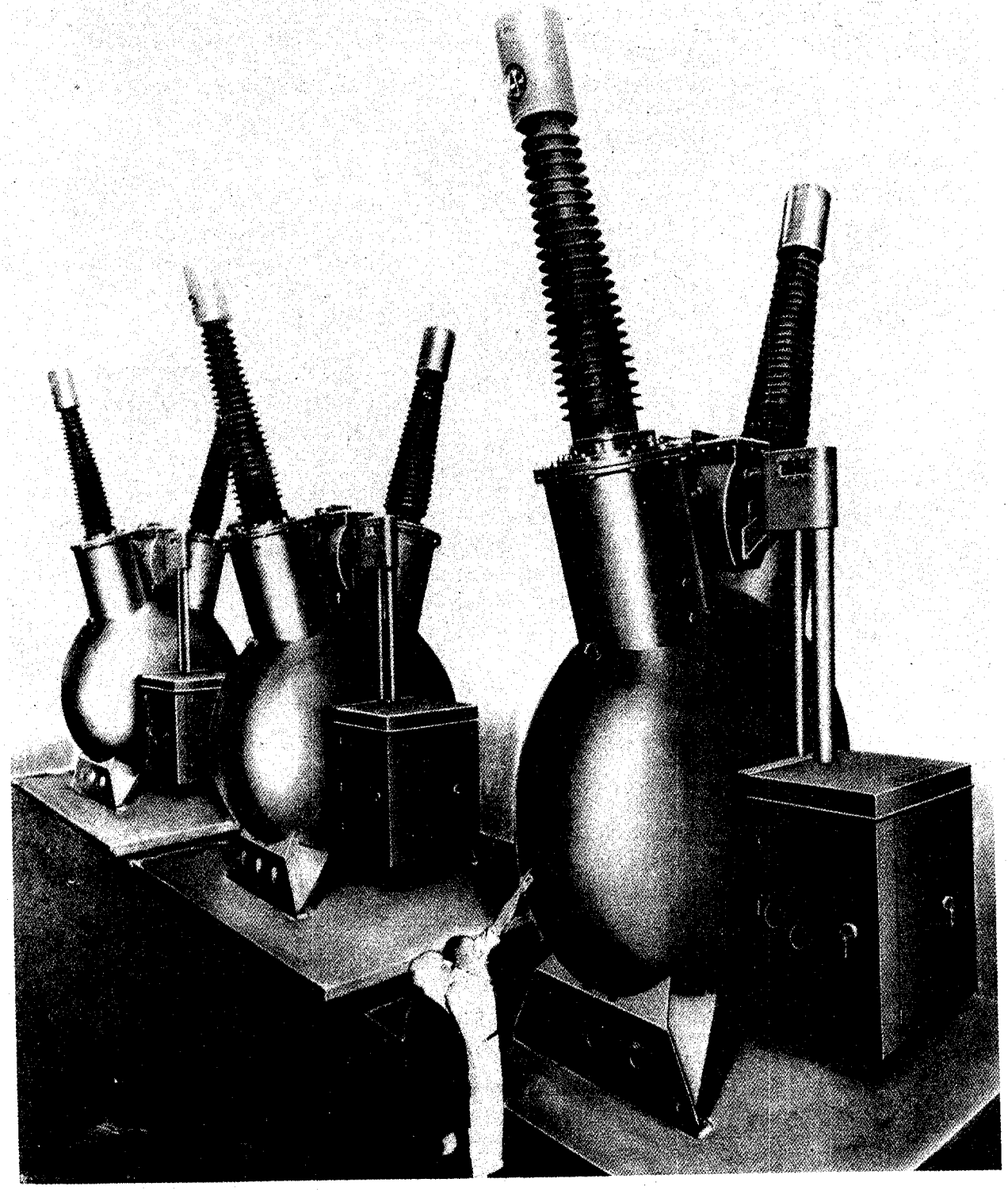
Transformers are being built in sizes up to 200,000 kilovolt-ampere, but they are also being built at one milliampere. That certainly covers a fine range.

Electric furnaces are operating to supply the high-quality steel that we need for our armament, jets, and turbines. We have actually furnaces of 100 plus tons capacity, running up to 25,000 kilowatts of demand for a single furnace. Then there are small furnaces with only 50 pounds capacity which take only a few kilowatts.

We have lamps up to 50,000 watts in size and down to only .17 watt for instrument lamps.

CHART 11

1569



1570

CHART 12

SOME EXAMPLES OF DIVERSITY AND SCOPE
IN DEVELOPMENT OF
ELECTRIC POWER UTILIZATION DEVICES

Device	Largest	Smallest
Electric Motor	83,000 H.P. - 600 r.p.m. Westinghouse Driving Wind Tunnel Fan Tullahoma, Tenn.	.002 H.P. - 6500 r.p.m. General Electric for Aircraft Use
Transformer	190,000 KVA - 3 Ø - 60 cycle Water Cooled Westinghouse Detroit Edison Co. Detroit, Michigan	M M T-3 transistor coupling transformer 1 milliampere at 100-20,000 c.p.s. .725" x .625" x .625" Crest Labs. Inc. also Iron Cored Pulse Transformer for use in Guided Missiles Weighs .03 oz. P. C. A. Electronics
Electric Furnace	Electric Arc Furnaces 115 Ton Capacity - 15,000 KVA 20' x 29' Eliptical Shell Timken Roller Bearing Co. Canton, Ohio also 80-100 Ton Capacity-25,000 KVA Sheffield Steel Co. Kansas City, Missouri	Smallest Electric Arc Furnace 50 Lbs. Capacity Smallest Otherwise Dental Lab. - Brazing Teeth 3" x 3" x 6" - 1 KW
Lamp	50,000 Watt Filament Type for movie studios and searchlights General Electric	.17 Watt - "Grain of Wheat" lamp for instrument lamp in child surgery General Electric
Heat Pump	3 - 5 H.P. Package Unit for House Heating - See Bulletin 1/2 H.P. Hot Water Heater See Figs. 13 - 14 Window Air Conditioners - N.Y.Times See Fig. 15	

There seems to be no limit on either the upper part or the lower part of the scale of either size or power demand of electrical utilization devices.

I have included in this tabulation the heat pump because I think it is one of the most interesting and useful devices that is coming into use. In chart 13, page 30, is shown a photograph of a water heater which operates on the heat pump or reverse refrigeration principle. Remember that this device takes all its heat from the surrounding air. You could run such a heat pump on the air in this room. Chart 14, page 31, shows a cross section of this water heater. It really is amazingly simple once you examine it. All it consists of is a condenser, which is inside the tank, and which heats the water, a compressor which operates exactly the same way as the compressor in any other refrigeration cycle, and an evaporator which picks up the heat in the room in which the heater sits. We have used such a heater in one of our field offices for more than two years.

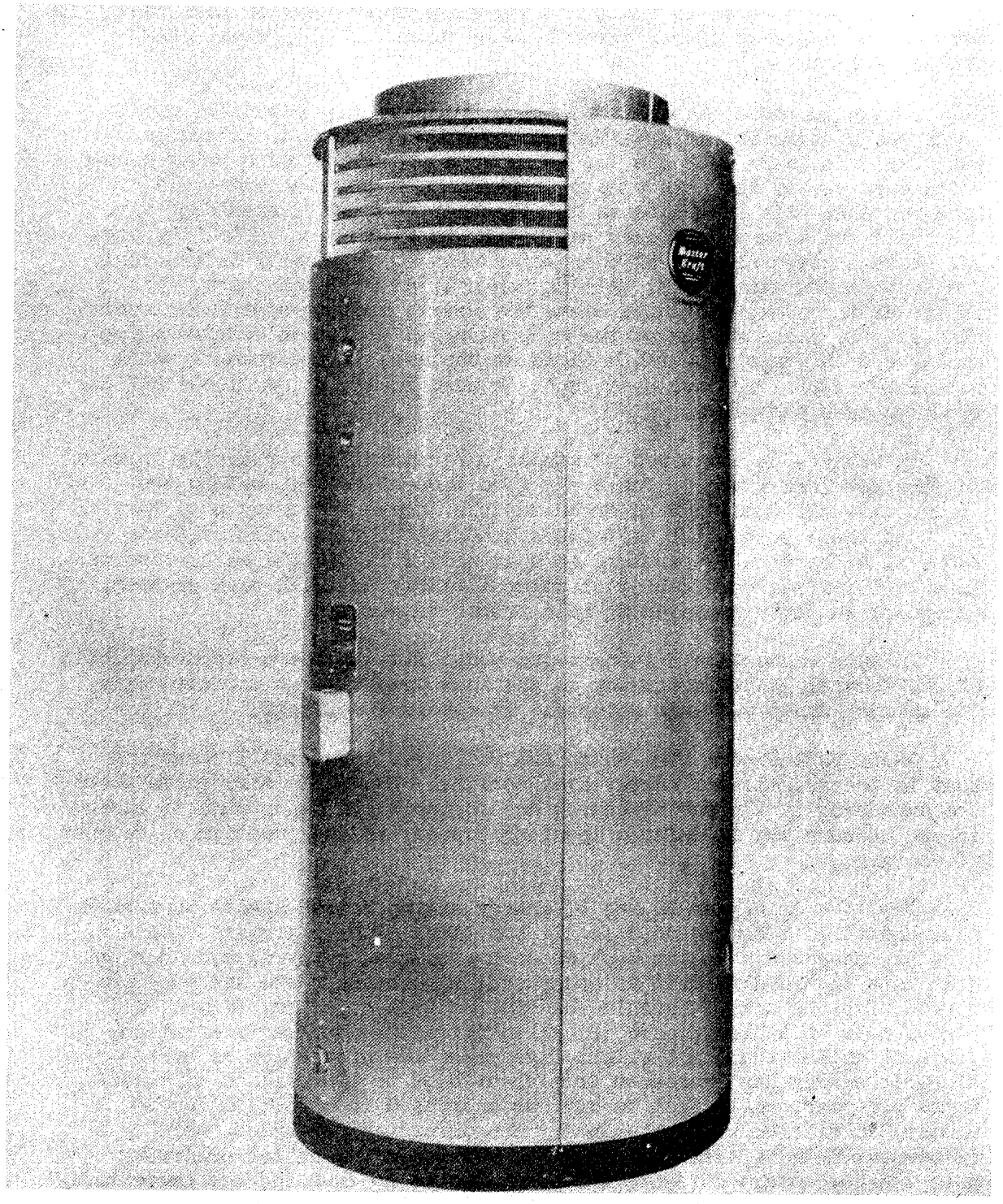
An article on new types of window air conditioners recently appeared in "The New York Times." These air conditioners are put out by two of our fine air-conditioning organizations. What they mean when they say that these units will heat rooms automatically and will hold the rooms at a constant temperature is that they will operate as heat pumps. They will operate continually or intermittently and will cool or heat, depending on what is needed to hold proper temperature.

In this connection I thought you would like to see a recent bulletin of the General Electric Company on the heat pump; it was included with the charts handed you this morning. It speaks for itself.

There is one more item which Admiral Hague suggested I cover and that is the question of energy availability. The whole discussion about the expansion in the use of energy and the critical importance of energy in our economy and in defense lead, of course, to the question of sources of energy.

Now, the principal source of energy in the United States is fossil fuel and it is becoming more so all the time. I have prepared table 6, page 32, based on a recent book on energy sources by Ayres and Scarlott. This is a little difficult to grasp easily, because there are many conversion factors that I haven't had time to work out. But if you will take a look at table 7, page 32, which gives more direct information, you will notice that in the last five years the production of hydroelectric energy has increased from about 82.5 to 105 billion kilowatt-hours per year, while fuel energy has increased from 200 billion to almost 300 billion kilowatt-hours. The percentage of hydro, which was 29 percent in 1948, was 26.4 in 1952. There is reason for believing that the percentage of hydro will continue to go down and the percentage of fuel will go up.

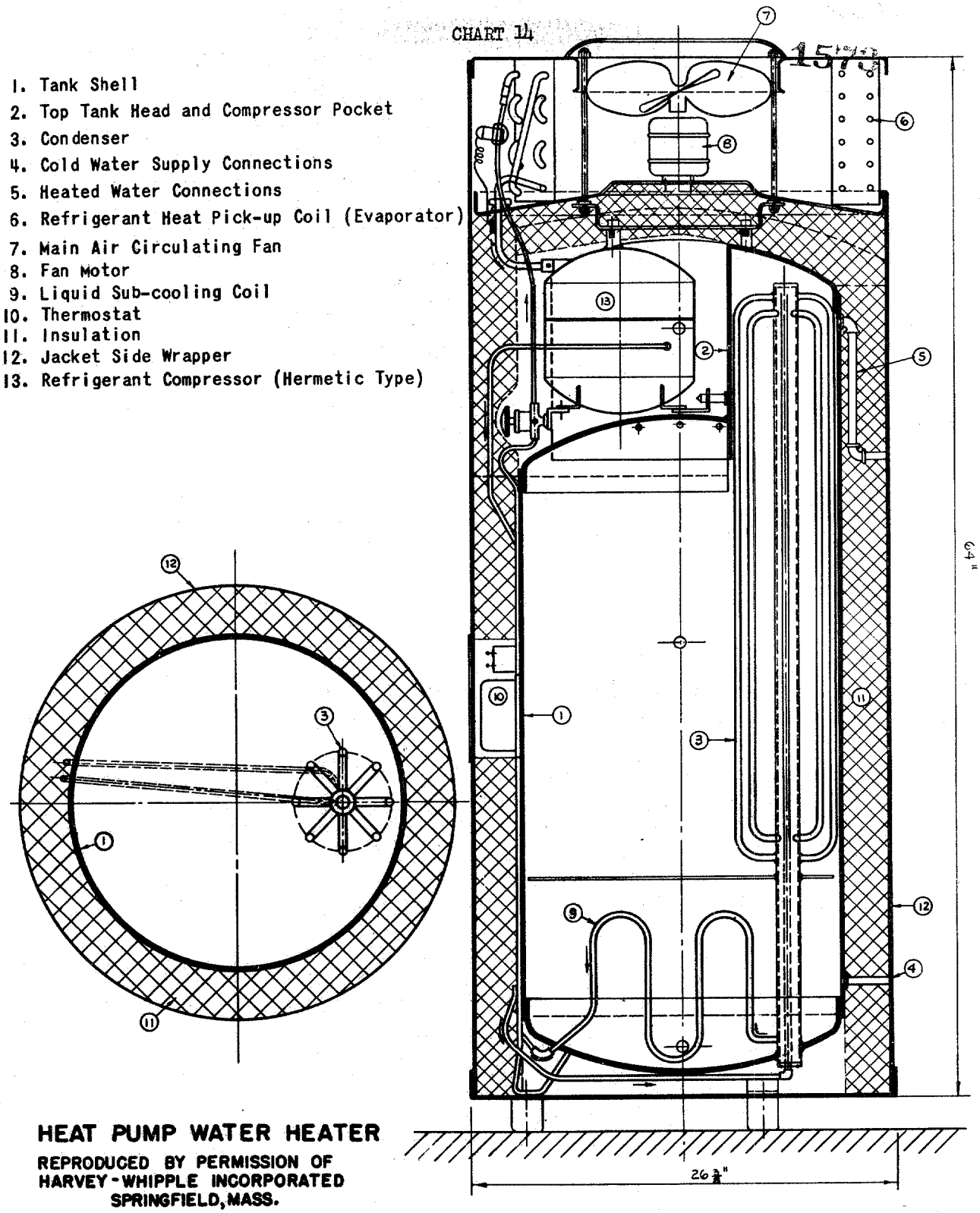
CHART 13



HARVEY WHIPPLE WATER HEATER - OPERATES ON REFRIGERATION OR HEAT PUMP PRINCIPLE.

CHART 14

1. Tank Shell
2. Top Tank Head and Compressor Pocket
3. Condenser
4. Cold Water Supply Connections
5. Heated Water Connections
6. Refrigerant Heat Pick-up Coil (Evaporator)
7. Main Air Circulating Fan
8. Fan Motor
9. Liquid Sub-cooling Coil
10. Thermostat
11. Insulation
12. Jacket Side Wrapper
13. Refrigerant Compressor (Hermetic Type)



HEAT PUMP WATER HEATER

REPRODUCED BY PERMISSION OF HARVEY-WHIPPLE INCORPORATED SPRINGFIELD, MASS.

TABLE 6

PRODUCTION OF ENERGY IN THE UNITED STATES
(Excluding wood and non-fuel uses)
IN TRILLIONS OF HORSEPOWER-HOURS

	1940	1950	1960
Hydro Electric	0.35	0.65	0.90
Natural Gas	1.10	2.30	3.85
Coal	5.00	4.85	5.30
Oil	3.10	4.90	6.80
Total	9.55	12.70	16.85
% Hydro	3.7	5.10	5.35

SOURCE: "Energy Sources" by Ayres and Scarlott

TABLE 7

ELECTRIC ENERGY PRODUCTION IN THE UNITED STATES
IN BILLIONS OF KILOWATT-HOURS

Year	Hydro	Fuel	Total	% Hydro	% Fuel
1948	82.5	200.2	282.7	29.1	70.9
1949	89.7	201.4	291.1	30.8	69.2
1950	95.9	233.2	329.1	29.2	70.8
1951	99.8	270.9	370.7	26.9	73.1
1952	105.0	293.9	398.9	26.4	73.6

SOURCE: E.E.I.

It might be well at this point to look a little further ahead and point out just how the sources of fuel, as shown in charts 6 and 7, fit into the future picture. At the present time we have these fuels: natural gas, coal, and oil, which are all classified as fossil fuels; and we have hydroelectric power. In the future we have ahead of us--we may or may not develop them, because they may or may not prove to be economical--wind power, tidal power, solar energy, and nuclear power. Of the possible sources of future power, neither wind nor tidal power has so far proven practical. The difficulty is technical in the case of tidal power and economic in the case of wind power.

Now, the development of a practical utilization of solar energy labors under great difficulties. The possibility of improving the economics for obtaining solar energy, that is, energy from the sun by photosynthesis, has been studied, but it is only in the laboratory stage. Development of it may come along someday, but it will certainly require many decades.

As to nuclear power, there recently has been new optimism about the prospects of that. There is some justification for it. But I think it is necessary to re-emphasize the elemental point that nuclear energy, when it becomes available, will provide merely another form of fuel. In other words nuclear power is a fuel. The reactor producing it will take the place of boilers in thermal generating stations.

As far as we can see at the present time, the conventional turbine, the steam turbine, will remain unaltered. So that when we talk about nuclear power, what we are hoping is that we are going to reduce one of the components in the production of power, and that is the fuel component.

Now, as to the fuel picture, when you take a good look at that, you find a number of very interesting things. I have put them together in table 8, page 34, which really speaks for itself. What we have shown here is the world reserves of crude oil, shale oil, natural gas, and coal. These, again, are fossil fuels. You will notice that the total resources in conventional fuels is 82.8×10^{18} Btu, which perhaps is an encouraging figure.

However, if you will look at the nuclear fuels at the bottom of the table, you will see that only two of them offer prospects for generating energy. But if you evaluate these two on the basis of what it would be possible to do by atomic fission at a 1:1 breeding ratio, you will see that, if we actually carried out the fission of every bit of uranium, not merely the U-235 component, but the U-238, and in the case of thorium every bit of thorium, through conversion into U-233, then you have this terrifically brilliant prospect of fuel reserves amounting to $1,820 \times 10^{18}$ Btu. In other words we have over 22 times as much ahead of us in nuclear fuel reserves as we have in conventional or fossil fuels.

TABLE 8

ESTIMATED WORLD RESOURCES OF FOSSIL AND NUCLEAR FUELS

FUEL	ESTIMATED WORLD RESOURCES	SOURCE OF DATA	UNIT OF ENERGY	TOTAL ENERGY Btu
CRUDE OIL	610 Billion Bbls.	L.G. Weeks	6.4×10^6 Btu/bbl.	39×10^{17}
SHALE OIL	620 Billion Bbls.	Bureau of Mines	6.4×10^6 Btu/bbl.	40×10^{17}
NATURAL GAS	2,100 Trillion cu ft	M.K. Hubbert	1000/Btu cu ft	21×10^{17}
COAL	3,482 Billion Tons	Bureau of Mines	13,500 Btu/lb 14,000 " " 9,000 " "	722×10^{17}
TOTAL CONVENTIONAL				82.2×10^{18}
URANIUM	25* Million Tons	Raw Materials Division, A.E.C.	3.5×10^{10} Btu/lb	1750×10^{18} 1 to 1 Breeding
THORIUM	1* Million Tons	" "	"	70×10^{18} 1 to 1 Breeding
TOTAL NUCLEAR FUEL				1820×10^{18}

* Recoverable at $100/lb in Billet Form

1576

But please remember this point: We simply must not forget that the prospect of ever having available this radically large amount of new fuel is still only a prospect, still only a hope. There never has been a time during recent years when we have had any doubt that we are going to be able to get power from nuclear fuel. Nuclear power for driving submarines, nuclear power for driving a carrier, is definitely here. Economical nuclear power, competitive with other power, is a prospect, which will take a long time to explore.

It is apparently unrealistic to even think that we can have a plant--whether you call it a prototype, a pilot plant, or whether you call it a developmental plant, but a plant of any consequence for the generation of power by nuclear energy--in much less than five years. Once we get such a plant, it will certainly take not less than five years of work of running it, taking out its bugs, evaluating it, and meanwhile developing all the difficult technological phases and solving the difficult problems. There are difficult metallurgical problems and difficult chemical problems--particularly in chemical treatment. It is unrealistic to think we can do that, say, in less than five years. At the end of that time, which may be 10 years from now, we should be in a position to judge whether we do or do not have open to us at that time economical nuclear power.

Now, I think we are in the habit of indulging in wide swings of mood, between pessimism and optimism. Some of this indulgence is quite a luxury. By it we tend to lose our perspective. I don't think there is room for bouyant optimism about our achievements in nuclear power generation in the last year or so. The achievements that we have made are definitely moderate compared with the ultimate dimensions of the problem. We are, I think, entitled to optimism in the sense of feeling encouraged, because we are working on a very long and difficult job. This feeling of encouragement I don't think can be a mistake; but we must not permit it to be mistaken for the feeling that we will have, when and if some day we certainly succeed in solving these problems successfully. But it will be some time before we can indulge in that feeling. But in the meanwhile we have a great deal of work ahead of us to bring it up to the point where a decision about the prospects for economical atomic power can be made.

QUESTION: We would like to know whether you have any plans for stockpiling the structural materials that would be required for rebuilding transmission lines if they should be bombed out.

MR. SPORN: I think there were such plans in effect in almost every utility system in the last war. I know one very large system where there was a very intensive program of material stores and availability. Whether some of the materials in that stockpile has since been infringed upon I don't know. I would be inclined to think that it has been.

But I would say this: That upon the appearance of any change in the climate, so to speak, of our foreign relations, I am sure it could and would be reactivated rather quickly.

Now, the long lead-time items, such as the things needed to repair turbines, boilers, and such, are always available on every system. For example, we had a turbine failure on the ninth of January. If we had to get delivery even under an accelerated manufacturing program and with every priority of the parts necessary, to put that turbine back on the line, it would normally take on the order of 15, 16 or 18 months. But the particular turbine I am referring to is going to be back on the line around 1 May 1953, only because most of the critical materials were available in stock. That is a 150,000-kilowatt machine, incidentally.

QUESTION: Would you care to comment on the factor of needed reserves in our power systems? I understand that at the beginning of the last war there was what you might call a major reserve in the fact that almost all our industrial plants were working on one shift. The power systems were able to increase very much the amount of energy put out simply by the fact of industry going to two shifts. One of the many advantages in going to two-shift operation was to increase the power available. Are we getting back to a situation now where we have such a needed reserve or not?

MR. SPORN: This is the situation: First, as regards two-shift or three-shift operation, a great deal of that kind of operation has gone back to a normal one-shift setup. So there is no question that a great deal of additional industrial production could be brought in, and would be brought in, in case of a critical condition in regard to production and therefore defense, by stepping up shift operations and going back to operation on a two-shift and three-shift basis.

Now as to the other question as to reserves: On another occasion I pointed out the fact that we went into World War II with a very excellent situation as regards reserves, and because of that were able to carry the increases that came in 1939 and 1940, particularly after Pearl Harbor in 1942, until additional capacity could be built.

Right now the situation as regards capacity reserve in the United States is not good enough. I don't think that any of the people who run the power systems, or in the Government, or in private industry, believe that it is. The defense electric power program, that is this expansion program that is now under way, has been projected to bring that reserve back to where it should be. The program was going great guns when it was given a terrific blow last year by the steel strike, so that we did not bring in anywhere near the capacity that was scheduled to be brought in during 1952. It will take some time before the program recovers from the effect of that.

If the program gets the support and the critical materials in the next year or two, that is, 1953 and 1954, I think we ought to come into good shape as regards reserves, unless between now and then some kind of crisis develops. But I think it is very important that we get the proper support.

So if we go, for example, into the next crisis with 15 or 16 percent reserve in terms of a 100-million-kilowatt peak load, we will have 15 or 16 million kilowatts of reserve capacity that will put us in a very excellent position for taking up new production more quickly than new generating capacity can be brought on the line.

QUESTION: Our committee has a question which can be divided into two parts. First, what proportion of this reserve rests with Federal power developments as compared with private utilities? Second, how has the development of Federal power contributed to this increase in the national capability picture?

MR. SPORN: During the last five years the percentage of the total power contributed by Federal agencies has not increased. At the present time roughly 80 percent of the power resources of the United States are under private control, that is, in the private utilities, about 5 percent rest in municipals, and 15 percent of the resources belong to the Federal Government. That is a very rough breakdown.

There is no question in my mind that, while public power contributed its share to the reserve picture, if the private utilities hadn't picked up and maintained this terrifically aggressive program, as evidenced by their expansion during the past five years, we would not be in as favorable a power supply situation in the United States as we are today.

QUESTION: Going back to the load and capability situation, chart 5, you indicated that in 1945 the reserve was really satisfactory. Going on through to the end of 1952, you show an increase in the load which one would normally assume would extend at a normal slope. I would like to know, what is the reasoning behind the increase in your load at the year 1953 and from there to 1954, because if you carry out your slope, we had a terrific increase. Then you will find that your differential between your capability and load in the year 1956 will be approximately the same in 1945, which was satisfactory then and might possibly be satisfactory later.

MR. SPORN: The answer to what I think is your question is this: The situation with regard to reserve capacity for the year 1952 would not have been as good as it actually was, if we hadn't had the steel strike. While the steel strike has delayed bringing in some of the new capacity for the utilities, it delayed completion of a good many more defense projects and a good many loads that were scheduled to come on in 1952 and that didn't come on. These are still the most important

1580

elements of the defense load--steel mills, aluminum, magnesium, chlorine, and other similar and very heavy users of power. Some of their loads have been in the process of expansion for the past two years or more. Whether, when they come on they are going to change the slope of load curve is anybody's guess. There is a good chance they will.

You will notice that the forecast of power production shows a slightly greater rate of growth after 1952. It is possible that that is too optimistic a projection--that the load growth will not go on at that rate. But it is equally possible that the load growth will continue, primarily due to the failure of the predictions on the part of some of our economists that the present economic cycle just can't keep on.

So that the best you can do is to project very conservatively. That is what we have done here. This is the sum of projections on the part of literally hundreds of different groups that are in contact with the economic situation all over the country. The result is shown in this curve. This is not the projection of, let us say, a staff man in my office; but it was made by hundreds of utility organizations. In many cases that means that hundreds of organizations have contacted perhaps thousands of industrial and economic enterprises and have gotten their opinion of what is ahead. That is what is shown here.

QUESTION: Our group has a question on the same chart. With respect to this reserve, the difference between the bottom and the top lines, of course, are over-all figures in the United States. We would like to know if there are any problems having to do with distribution.

MR. SPORN: There are some problems. You cannot say that the capability and availability in any one section of the United States is available everywhere else in the United States. On the other hand there is a very high degree of interregional integration. We have, for example, in the eastern part of the United States integrated over 30 million kilowatts of capacity by extensive interconnection and are operating that in parallel. That covers really the principal industrial areas in the United States.

Everything from Chicago east, as far as western Pennsylvania and as far south as the Gulf, and running up the Mississippi, is interconnected; and there is a remarkable amount of large-scale interchange. So that today, for example, if we have need for some extra supplies of power at Paducah or any other plant of the Atomic Energy Commission, we have many scores of companies that can be brought in to jointly furnish the additional capacity. And it is brought down from all their power plants to the one plant of the Atomic Energy Commission. But such interconnection isn't universal. Universal interchange by transmission is possible, but it does not exist in many places today.

CAPTAIN CASTELAZO: Mr. Sporn, our time has caught up with us. Once again I thank you on behalf of the Commandant, the faculty, and the students for an excellent lecture. We know that you are a busy man; we certainly appreciate your coming down from New York and giving us your time.

(22 June 1953--350)S/ibc