

SOME ASPECTS OF ATOMIC ENERGY

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(A Wire Recording of an Extemporaneous Talk)

Mr. Chairman, you are very kind:—

Gentlemen, it is a great pleasure to me to be invited to attend this conference. I hope you gentlemen will enjoy the conference and will come again to see the University.

The Committee asked me to talk to you about some aspects of Atomic Energy. I am not deluded with the idea that I can bring to you any new basic ideas relative to atomic energy. I can tell you little of the implications of the release of atomic energy about which you have not already thought, or read or heard discussed. I do not pretend to be an expert.

However, as we look back on the release of atomic energy and forward to the future, there are some aspects of the problem of procurement of available energy which it seems to me might profitably be discussed. I am trying to share some of these ideas with you. Now it is a fact that man, *Homo sapiens*, has been on the earth about one million years. He has a written history of some 4,500 years. There seems to be good reason to believe that if man continues his so called civilization as at present organized, and maintain his present "standard of living", which is made possible by his exploitation of natural resources, the human race could hardly hope to have a life expectancy of another 4,500 years.

During all this 4,500 years of written history and longer, man has been struggling for survival, for food, clothing, shelter, but the most important single element in the developing of his civilization was the use of the energy available to him.

In the early beginnings, man's only available energy was his own muscular effort. The work of his world was done by his own power.

In many parts of the world slavery developed as an institution basically as a means used by some men, fortunately situated, to shift the burden of the world's work to the backs of slaves. In many parts of the world today, man's muscular effort is the chief source of power. Slavery still persists in the world today.

Later man began to enslave animals wherever he found them, to do his work. Our ancestors in Europe enslaved the bullock and horse and in the warmer regions and the desert, man used the elephant and the camel. In the cold regions he used the dog and the reindeer. It

mattered little what animal he used, the purpose was the same. He was trying to get the work of the world done without doing it himself. There was need for energy with which to lift weights, grind grain, saw wood, or pump water.

Then our day and generation came, when men began to invent machines. I shall not define a machine for you, or tell you how they happened to be invented — it is an intriguing story. You know that we are living in a so-called “Machine Age”. The very foundation of that Machine Age is the use of available “natural resources”, or as the geologist says, “fossil fuel”. We mean by that, coal and gas and oil. It is a wonderful idea to get energy that way. We have lived in that age and we have a wonderful civilization, but the fact is, that the basic process is a chemical process which we call burning. When we burn fossil fuel, we rearrange a few electrons in the outer periphery of the atoms as atoms unite to form compounds, and we obtain available energy. Now the energy you get when you do that is of a magnitude of about six-tenths of an electron volt per atom. That is all you can do. Many engineers have spent their life trying to make the process a little more efficient. When you put 100 foot pounds of energy in the form of coal under a boiler, of an ordinary steam engine, you are lucky if yet get out eight foot pounds of energy at the drawbar pull of the engine. You waste the rest of it. Engineers have made their contribution. What if you got it all, you only get six-tenths of an electron volt per atom. Civilization has been pretty well satisfied with that result. On it we have built our present standard of living.

Now in the present “Atomic Age” we have learned how to fire neutrons into the nuclei of certain radioactive atoms, and release energy. In other words, we have discovered “fission”. When you fission an atom and thereby convert matter into energy, instead of getting about six-tenths of an electron volt per atom, you may get 200 million electron volts per atom. It means that in a pound of Uranium 235 which would be about as large as an egg, you have tied up in that small piece of matter eleven million four hundred thousand kilowatt hours! That is almost the entire energy equivalent output of all the hydroelectric plants and steam plants in this whole United States for nearly a month. You have it in one little body of matter.

Now this is a curious thing. A single pound by itself won't do you any good since you cannot use it in that form, but if you get what we call “critical mass”, you can make an atomic bomb. I am not going to tell you in detail how that is done. Part of this detail I do not know, part of it is a government secret, but the fact remains that something

less than thirty pounds of material will actually make a devastating explosion. Now at the very time when man found that he could release atomic energy by converting mass into energy, according to Einstein's equation $(E = MC^2)$ he also learned something else. The first atomic bomb that was ever exploded revealed in the spectrum of the light, the line of helium. This meant to scientists that helium had been made. It was not made by breaking down Uranium. It was made by the fusion of hydrogen atoms, to form an atom of helium of atomic weight of four. This process of fusion also releases atomic energy but the amount released is not dependent on "critical mass". Thus it is theoretically possible to make a bomb many times more powerful than an atomic bomb. So when we talk about a hydrogen bomb, we are talking about something so big that it staggers the imagination.

Mr. Truman says a hydrogen bomb could be made a thousand times larger than an atomic bomb. The number of times larger is not a fixed value, but is determined by the amount of hydrogen that one wants to use in the explosion! We are told that if a hydrogen bomb was contaminated with small quantities of certain elements, the resulting compounds of which are poisonous, it would be perfectly possible, with a few atomic bombs, to so poison the atmosphere over a continent that all life in a great area would pass away, and quickly. Now, I am not concerned with that problem in this discussion today. Rather, I would invite your attention to a long range energy problem about which men today might do some constructive thinking.

I do not know how much you have thought about our world situation relative to available energy, but from 1900 to 1950, one-twentieth of the total supply of our fossil fuels was consumed in carrying on our civilization. Now our fossil fuels came in the geological age of the carboniferous. It began about 350 million years ago. This old earth of ours is 1,500 million years old and 350 million years ago, plants grew on the surface of the earth in great abundance and their remains were swept up by natural processes and there was started the laying down of the old coal beds. This continued for about fifty million years. Our sun furnished the energy which produced all this great mass of carboniferous debris on the then surface of the earth, and we got our coal beds. We have used in fifty years one-twentieth of the total supply. What does that tell us? It surely means that if we keep on using it at the present rate, and if the population does not increase, and if we do not extend our high standard of living to other peoples, but just keep on consuming as we are now doing, we might hope to maintain our civilization for another thousand years. But does anybody believe the

population in this country is not going to increase? Do you see anybody who wants to have a lower standard of living? We are talking about carrying our standard of living to the uttermost parts of the earth! What do you think is going to happen in a thousand years if we keep on? Well, simple arithmetic seems to say that in a thousand years from now there will be no coal, no gas, and no oil. What are we going to do then for energy to do the work of the world?

Someone may suggest the use of atomic energy. The facts are we do not have enough uranium and other naturally radioactive resources to supply our need very long even if it was all available. The truth is, in every average ton of rock on the face of the earth there is enough uranium and thorium jointly, if its atomic energy could be made available, to equal the energy derived from a ton of coal. That is, if the radioactive elements in the rocks could be freed of all their contamination and the energy made available, every ton of rock on the earth would yield as much energy as a ton of coal does now. But we cannot get this energy out. We do not know how to purify the uranium and thorium that is there. It is not now available to us. So long as the government maintains a monopoly on the ownership and control of radioactive elements very little outside research can be done on the release of atomic energy from this source.

I am suggesting to you that we are drifting along, spending in every fifty years, one-twentieth of the available energy resources we had in 1900 and we are doing very little to recover the atomic energy fuel dissipated in the earth's crust. Where then are we to get available energy after another thousand years? There is but one answer. Instead of worrying about atomic bombs, instead of trying to do all our research in nuclear physics, we ought to seek to tap the only source of energy left to the human race, the greatest atomic pile that was ever made — the sun itself. The sun is an atomic power plant. It creates helium from hydrogen and thus converts matter into energy and gives us energy by radiation. On every square foot of surface on the earth there is delivered about one kilocalorie of energy every minute. If you integrate that in time and area, for every acre of the earth's surface there is at least twenty million kilo-calories per day. That is about 1,000 times as much energy as it necessary to take care of every man, woman, and child in the United States who is likely to be here in the next 5,000 years. If we could catch that energy and hold it and render it useful, our problem would be solved. Now, so far as we know at present, there is only one way to do it. And that is the way of nature. When the sun shines on the chlorophyll of growing plants, by the

process of photosynthesis carbon is stored in the body of the plant, and the energy of the sun is thus stored up.

There is relatively little research being done today on photosynthesis, while millions are being spent on atomic energy studies, much of it directed toward instruments of war, and on national defense. One cannot condemn the expenditures by government for these seemingly necessary ends, but one is tempted to speculate on what might be accomplished in the storage of solar energy for future use, if similar sums were spent for research in photosynthesis and related fields. It might be, that within a generation, research would develop some improved method of utilization of solar radiation so as to guarantee sufficient available energy for the future.

While we put forth such tremendous effort in the study of atomic energy, we should not forget that the sun is itself a huge atomic pile, which has sustained life on the earth from the beginning. Because it is some 93,000,000 miles away, it is safe to share its benefits with even our worst enemies, who, like us, are not able to control it.

When our present supply of energy from fossil fuels is exhausted, as it must be in another thousand years or less, we must look to the energy of the sun, atomic energy, as the sole supply for the earth. Thus continuance of human life on the earth seems to depend on man's ability to store the energy of the sun so that he might have an adequate supply at command.