

The H-Bomb and the Scientists

The public discussion of the issue of the H-bomb ^{(at the time of}
 this writing) ~~is not in a very satisfactory state.~~ The information
 available to the public consists in some cryptic remarks made by Senators
~~whose names are omitted~~ ^{to be} whom we may assume ~~are informed,~~ ^{from the news} and the writings of
 columnists and science writers whose information comes partly from leaks
 and partly from guesses. ^{and is mostly right and well} And finally, we have the statement of the
 President, instructing the Atomic Energy Commission to pursue the
 development of H-bombs ^{in addition} along with all other atomic weapons.

Of all the misleading information with which the public has to
 cope, the President's statement is not the least misleading one. For
 it implies that H-bombs are just another atomic weapon. ^{In a sense,}
~~this might very well be true for the first H-bombs to be built need not~~ ^{In}
~~be any more formidable than were the last plutonium bombs that we~~
~~detonated.~~ But if we want to understand what the decision to develop

H-bombs means, we have to focus our attention not on the first H-bomb that
 will be developed, but on the last one ^{to be} ~~developed~~, ^{and that one can}
~~be called~~ ^{be called} ~~the last H-bomb~~ ^{the last one}.

Among the naturally occurring light elements, the obvious candidate
 for a ~~thermal~~ nuclear reaction is heavy hydrogen. This substance is
 contained in ordinary water, and it is ^{comparatively} ~~relatively~~ easy to procure ^{in quantity}
~~in large quantities~~ ^{in quantities} of a few hundred tons of ~~the substance.~~ ^P The possibility of detonating
 heavy hydrogen in a quantity that is limited only by the size of the
 tank in which it is contained has been pursuing the physicist as a
 nightmare for many years in the past. ~~Until~~ ^{Until} such a bomb has been detonated,
 it is difficult to be certain that the detonation of unlimited quantities
 of heavy hydrogen can be accomplished. But the decision to go ahead with
 developing H-bombs must be interpreted to mean that we are going to
 try, and that those who have been ~~pressing~~ pushing for this development
 believe that it can be done. Naturally, in the course of such a development,
 one will start out with detonating smaller quantities of heavy hydrogen.

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In a sense, this might ~~be~~ ^{to be} very well be true for the first H-bombs built
which might be used to burn up cities or blow up ports, or even be used
as a ~~technical~~ ^{technical} weapon ~~in battle~~ against major troop concentrations.

P

For many years in the past, scientists have been pursued by the nightmare that it might be possible to detonate heavy hydrogen in theoretically unlimited quantities, that is, in quantities limited only by the size of the container which is used for its storage. Bombs of this type, if they are very large, can not be delivered deep inside enemy territory and if we are engaged in a war which we do not know how to win otherwise, we shall be strongly tempted to use such bombs in a different manner. *P* If ~~any~~ H-bomb is detonated, its explosion is accompanied by the emission of neutrons. These neutrons will be absorbed by the nitrogen of the surrounding air and produce radio active carbon. The neutrons which move downward will also be locally absorbed and make the area destroyed by blast and fire *also* radio-active. *for some time to come. radio-carbon* These naturally ~~greatly~~ effects of the H-bomb, we shall disregard in the following as comparatively unimportant. *P* What is important is that an H-bomb can be so rigged as to produce a large amount of *short lived* intense radio-active elements which *will be dispersed* in the air and which will be carried by the trade winds westward and *which might be* deposited as radio-active dust over a vast area of "enemy" territory. A large number of natural elements among ~~which we can choose~~, become radio-active elements if they absorb a neutron. *Each* has a characteristic half-life within which the activity falls to half of its original value and in this respects, we can take our choice. The one which we choose *can be short lived* in the construction that will permit this element to absorb a large fraction of the neutrons liberated in the explosion of the H-bomb. *Assuming that* in a war with Russia, we *detonate such bombs,* west of the Iron Curtain, *we would have to rig up* H-bombs with an element that will supply sufficient coarse dust so that we can be sure that the dust will settle over Russia before the western winds circling the globe reach our west coast. If we can be sure of this, we could rig the bomb with an element that may have a lifetime of a few months of even years. If we were to rig our H-bombs with a radio-active element

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detonate such bombs

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Wavy line

which does not settle out as a dust within the first few thousand miles of its flight, then we would have to choose a radio active element which would decay so fast that by the time it reaches our west coast, the effects of its radiation will become comparatively harmless. Any graduate student can figure out that the radio-active dust that will be produced in h-bombs in which a total of 20 tons of heavy hydrogen was burned if it were to settle uniformly over an area 1500 miles wide and 1000 miles deep, stretching from the North Sea to the Adriatic and from the Elba to the Ural Mountains, would upon decaying give individuals living in the territory a radiation dose which they could not survive.

from
I ~~no~~ of no one ~~if~~ who in these critical months preceding the President's decision to give the go-ahead decision on h-bombs suggested that h-bombs should be used in this manner. I have little doubt that if this type of use were at all mentioned it was rejected on moral grounds. But does this offer us any guarantee against the possibility that we shall use the ~~H~~ h-bombs in precisely the manner described above?

P It is well to remember that if there was any moral issue on which all Americans were united before the last war, it was the issue of the ~~erial~~ ~~bombing~~ ~~of~~ ~~cities~~, ~~bring~~ ~~the~~ ~~warfare~~ ~~to~~ ~~civilians~~, the killing of women and children. Before the war, public opinion on this issue was clearly and firm with no voice dissenting and President Roosevelt ~~no~~ more than voiced this public opinion when he warned the belligerents in Europe in 1939 to refrain from this ~~kind~~ ~~of~~ ~~warfare~~. *P* Yet once we ourselves were in the war, we began to use jellied gas bombs against the cities of Japan, burning and maiming millions of Japanese. The decision to do this, if an explicit decision was ever made, was an administrative decision. The Americans ~~were~~ *people* not consulted. The policy of waging this kind of warfare against Japan was not publicly announced. Only very gradually did the American people become aware of what was going on and there was no vigorous protest voiced at any time. The atomic bombs were dropped on

Hiroshima and Nagasaki at a time when the outcome of war hung no longer in balance. The fear of losing the war played no part in the decision to use these bombs and again there was no vigorous protest. [Soon after the Potsdam declaration, a warning was issued of ~~ruthless bombing of~~ ^{that} twelve Japanese cities which were listed by name, ~~Hiroshima and Nagasaki~~ ^{would be destroyed by bombing} were not among them. This was not due to any malice on our part; it was due to lack of coordination. But ~~it~~ ^{there} is no reason to believe that lack of coordination will play any lesser role in any future war than it did in the last war.] ^{use} The use of the atomic bombs against Japanese civilians was ~~supported~~ ^{we} supported by arguments that ~~the use~~ ^{it} in the end saved lives for ~~the~~ ^{us} so the argument ~~goes~~ ^{would}, it ~~might~~ ^{would} have been necessary to invade Japan if we hadn't ended the war by means of atomic bombs ~~which might have been necessary~~ and one million soldiers, ~~both American and Japanese~~ might have perished in such an invasion. ^{it} The atomic bombs killed only a few hundred thousand civilians, so using them saved lives both Japanese and America. ^{we} This is not the place to examine whether the premise upon which this argument is based is correct ~~and~~ ^{we} whether it is true that an invasion would have been necessary to end the war against Japan. It is not a premise, it is the nature of the argument ^{we must} upon which we ~~have to~~ ^{must} focus our attention at this juncture. No one can deny that America is a peace-loving country. Only after long hesitation and ~~much~~ ^{due} delay, would ^{once} America enter the two wars in which we engaged in this century. But that does not mean that America has entered a war she is capable of any restraint, ~~in war time.~~ ^{she is capable of any restraint, in war time.} ~~The only consequence of being peace-loving manifests itself in an impatience to get back to the conditions of peace by ending the war as fast as possible.~~ ^{we may rather} ~~The people have~~ ^{no} no difficulty in adjusting themselves to a double standard of morality, ~~for before the war what they would term~~ ^{a course of action}

The shifting from moral considerations to question of expediency is accompanied smoothly, merely by shifting the attention

as immoral even though expedient

A course of action which they condemned before the war they are likely to ~~approve~~ ^{approve} during the war as an expedient ~~course of action~~ even though difficult to reconcile with ~~pre-war moral standards~~ ^{immoral}.

The shifting of moral considerations to considerations of expediency is

accomplished during the war smoothly and almost unnoticed. In war time

the American people are in the happy position not to have to take any responsibility for ~~what they will choose~~ ^{for which they will be held responsible} to call military

decisions. The responsibility for military decision lies with the Commander-in-chief, ^{and} The President of the United States ^{whom he} might be from

a moral point of view no better or worse than the rest of us, ~~but because~~

he has been elected by the American people in war time he is likely to

resolve ~~crucial~~ ^{any} conflicts on the basis of expediency in the narrow sense

of the term. His human instincts might tell him to do otherwise, but the

was he interprets his mandate, he will feel that "as President of the

United States" he cannot follow those instincts. *du absterwe.*

In peace time, American is a democracy ~~and so are~~ ^{as} ~~some~~ the

Western European countries, England for instance. But experience has

shown that in war time, ~~the administration~~ ^{America} is to a much greater extent

under the influence of the military than ~~in other democracies~~ ^{are there}, England

for instance. Those who had an opportunity to compare conditions in

England and America during the last war were much impressed by this

difference between the two countries. In the conduct of the last war the

British cabinet ~~took frequently long-range point of view~~ ^{had to take the} ~~view~~ ^{when one looks the} ~~view~~ ^{point} Having the

post-war situation in mind, the English ~~pleaded for~~ ^{planned} invading the European

continent through the Balkans. ~~In contrast to this, the American policy~~ ^{planned}

was guided by the military point of view of ending the war in the

shortest possible time, which meant invading Europe across the channel.

Nothing has changed in the American political system to ~~encourage them to~~ ^{us}

~~believe~~ ^{indicate} that in the next war, if there is one, the the military influence

on the Government will be any weaker in America; on the contrary, there

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reason to believe that it will be stronger. Crucial decision will be made from the short-range military point of view rather than from the long range political point of view, and this ^{will} ~~seems to~~ be all the more so the more difficult our military and strategic position will be in the war. Surely the job of fighting a victorious war against Russia will be a much more difficult one than ^{was} fighting a victorious war against Japan.

If we ^{cut} entangled into a war with Russia, we get entangled into a war which we do not know how to win by methods of conventional warfare ~~using~~ limiting ourselves to morally acceptable methods of warfare, we might be faced with a 30-years war, ^{for a long time} the outcome of the war might be ^{in balance.} uncertain, ^{and} or we might be in danger of losing the war. The arguments that permitted us to use atomic bombs against Hiroshima and Nagasaki will permit us to exterminate all Russians by detonating H-bombs ^{cut} west of the Iron Curtain. Because we might lose the war and because the Russians might do to us what we might do to them, we ^{will} probably have a ^{much} better case for using radioactive dust against Russia than we ^{ever} had for using strategic bombing against Japan. Moreover, the step of waging war against inhabitants of the cities, men, women, and children, to waging war against all inhabitants ^{er} of a country, is a small step than the step we had already made during the last war when, for the first time in history, we found it acceptable to kill the inhabitants of whole cities. → ^{insert on page 5}

It is necessary to keep all this in mind if we wish to understand what goes on in the minds of our scientists today who try to decide, if each one for himself, whether or not to collaborate in the attempt to develop h-bombs which has been decreed by the President.

We took a big step ~~in the~~ "homeward"

Who will ~~at~~ the crucial moment remind the President of the United States that the Poles will be killed together with the Russians and that the Poles were our allies who, through no fault of theirs, were captured in the Russian orbit. Will it not be regarded as tactless to mention this fact in public and those who happen to have the President's ear at the crucial time, will they not feel that they must not increase his burden by speaking of the Poles when he has so many more important things on his mind? *and unless there is nothing the Pres could do to save the poles anyway?*

And if Russia invaded France, Belgium, and Holland at the beginning of the war and established Communist Governments in those countries ~~as they~~ ^{she} undoubtedly would, ~~will~~ and if we have no other choice but to detonate our H-bombs east of the European coast line in the Atlantic, how long would it take us until we would forget that France, Belgium, and Holland had been our allies and ~~were~~ ^{are} our friends? Would we not argue that it is better to use our H-bombs ^{at an early date} ~~although~~ many of our friends will perish, than to procrastinate and wait until the atomic war reaches a fury that will endanger the life of everyone on the Northern Hemisphere? Just as we can detonate our H-bomb in the Atlantic off the west coast of Europe, so can the Russians detonate their H-bomb in the Pacific off our coast. Is it not better, so people will argue, that the people ^{rather than her} in Europe and Russia perish ~~but~~ the rest of the world survive and face the danger of a radio-active attack on our own country that will force us to counter attack Europe anyway and leave us little time to wait for favorable weather conditions so that we might ^{even} be forced to kill the Chinese along with the Russians by detonating our H-bomb ^{at the wrong place} when part of the ^{radio active} emitted dust will be carried across Russia and settle down over China? ^{not difficult} It is ~~easy~~ to write down in advance what the arguments will be.

They will be very good arguments. And in wartime, they will be ~~impossible~~ ^{resistible} arguments. ~~It is impossible to discuss the is~~
~~past history, and the attitude of the sci~~

Insert 1

As a result of the various utterances, some of them by men who are in the know, others by men who write on the basis of plans, leaks, or hearsay, the picture that has been developed before the eyes of the American public is as follows:

We may expect within one year to have an h-bomb in which unlimited quantities of some naturally occurring light element can be detonated. A practical size for such a bomb may be one which has an explosive power of about a thousand times larger than the Nagasaki bomb and may therefore destroy by blast about 300 square miles. We ought to be able to produce such bombs at no great expense and in case of war with Russia, we should be in a position to retaliate by dropping such bombs over Russian cities. An area destroyed by the blast by such a bomb will remain radio-active for a long time to come and cannot be inhabited. The picture conveyed by the above lines appears to be that which exists in the minds of the best informed people who read the newspapers dilligently, who have neither access to secret information nor go through the process of simple computation to which an elementary knowledge of nuclear physics would enable any graduate student of physics in any of our leading Universities. This picture is dangerously misleading; on the one hand it represents as an actual reality something that is at best a very likely possibility at a few year distance, and on the other hand, it doesn't do at all justice to the real issue of which the h-bomb has become the symbol of the scientific community.

Among the naturally occurring light elements, heavy hydrogen is the obvious choice for a thermal nuclear reaction. There are two questions which immediately pose themselves to the student of physics. First, is it possible under suitable conditions

to utilize heavy hydrogen in a thermal nuclear reaction in an atomic bomb in which the amount of heavy hydrogen that is detonated is limited; and second, would a thermal nuclear reaction started in heavy hydrogen propagate in heavy hydrogen so that the magnitude of the explosion would be limited only by the amount of heavy hydrogen that is assembled. In the following I shall disregard the first two of these questions and focus the attention on the second ones, which must have pursued many physicists in their nightmares. Whether or not such an unlimited explosion in heavy hydrogen can be set up is not an easy question to decide and by making first measurements and computations, it is probably impossible to arrive at the correct prediction with certainty. One might perhaps arrive at some subjective prediction on the basis of which one might be pressed to say that it is as likely as not, or that it is more likely than not that an unlimited ~~hydrogen~~-bomb can be produced. This would be known as certainty only when such a bomb has been detonated, and I am very much inclined to doubt that the columnists that said we shall test such a bomb within a year knew what they were talking about. The peril which exists in bombs such as this represents for mankind can be easily computed by anyone who is capable of maintaining his mental balance when he knows the outcome of his computation may spread the doom of mankind. If a heavy hydrogen atom reacts with another heavy hydrogen atom, either a neutron or a proton are emitted, and in roughly half of the cases, the emitted particle is a neutron. Both a plutonium bomb and in an unlimited heavy hydrogen explosion, neutron emission accompanies the liberation of energy. But an h-bomb which is a thousand times more powerful than a plutonium bomb emits much more than a thousand times larger number of neutrons. Because of this neutron emission, it

is possible to ~~regulate~~^{regulate} a plutonium bomb or an h-bomb in such a manner to catch the emitted neutrons by some suitably selected natural elements and to produce from that natural radio-active element that will then be transported by the wind westward.

To make an unlimited h-bomb is one problem to solve. To make it so as to deliver it deep over enemy territory is another problem and one which may ~~perhaps~~ not be capable of solution if adequate measures of defence are adopted. In case of war with Russia, a situation might easily arise when the only way we can win the war will be to send an h-bomb regulated by activity westward of the iron curtain and allow the prevailing winds to transport the radio active material across Russian territory. The lifetime of the radio active element would have to be chosen so that radio activity be largely gone by time the winds reach our Pacific coast. And in that case, the radio activity may be appreciably formed by the radio mass sweeps over China so no casualties in China need to result. I think that we can be certain ~~whether~~ that no American who advocated the making of h-bombs or who approved the President's statement after ~~the issue was made public~~ the issue was made public, had in mind this type of warfare. But is it at all certain that we will not be forced to this type of warfare by the events which are out of our control?

I think no one will contest that the United States is a peace-loving nation. Twice in this century, the United States was forced into a war which it entered with the utmost reluctance and only after long hesitation. But once the United States is at war, it undergoes a transformation which we have all witnessed during the last war. Before the war, public opinion in the United States ~~was~~ had unanimously condemned the areal bombing of cities with the inevitable result of killing thousands of women and children.

Churne
Roberts
Judy

President Roosevelt gave expression to this universal opinion when in 1939 he solemnly reminded the belligerents in Europe of their duty to refrain from waging warfare against the civilian population. Yet during the war, without any announcement of explanation, we engaged in large scale attacks of jellied gasoline bombs, burning and maiming millions of Japanese civilians. This went on for a number of weeks and months before the American public even learned about it, and when very slowly the fact penetrated the public consscious, ~~it~~ ^{there} was no large outcry of protest on the part of the public. At a time when the outcome of the war hung no longer in balance, we dropped the atomic bombs over Nagasaki and Hiroshima and again there was no appreciable public protest. To make matters worse, after the Potsdam declaration and prior to the dropping of the bombs, we issued a warning of destruction ^{Destruction} by bombing ^{of} the Japanese cities, ^{and} naming ^{all} twelve of their cities, ^{and} then dropped the atomic bomb on Hiroshima that was not included in that list. There was no malice involved in this action which was a result of lack of cooperation ^{human various subdivisions of the armed services} rather than anything else. But ^{of course} lack of cooperation can be counted upon to play a larger role in ^{the} our character ^{against} our actions in any future war. The arguments which have been advanced to justify our bombing of Hiroshima at a time when the war was essentially won, were based on considerations of expediency. It was pointed out that dropping the atomic bombs shortened the war ^{would} and thereby in the end it saved ^{would} lives. Perhaps we are more susceptible to such arguments than are certain other nations because once we are in war, we are so anxious to get back to peace time as fast as possible. Perhaps being ~~peace~~ ^{a neutral} loving makes us more ruthless in war than we otherwise would be. ^S The thought that we might kill the population of ~~the~~ ^{a neutral} the continent for the sake of winning

the war will be rejected by American public opinion today just as the bombing of civilians was rejected by public opinion before the Second World War. Compared to before the Second World War, the measures which we adopted towards the civilians of Japan were however no greater departure of human behavior than would be the departure of killing the inhabitants of the continent compared to the accepted standards of all human behavior of the present day. In peace time, America is a democracy ~~would~~ which has been time tested. But if we compare the American democracy and ^{an} other one, say the British in war time, we see

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America is a democracy in which in peacetime the influence of the military is very small, but in wartime, the influence of the military becomes inordinately large. This is not so in all democracies. In England, for instance, the influence of the military in wartime is kept in check just as much as it is in peacetime. This difference of the roll of the military in the two countries is reflected in the ~~xxxx~~ fact that in the United States in wartime, considerations of military expediency very often win out over long range conditions suggested by political wisdom. We saw an illustration of this in the American-British controversy on the issue whether Europe should be invaded across the channel or whether our expeditionary forces should move into Europe through the Balkans. The position taken by the United States was guided by the considerations of bring the war as fast as possible to a successful conclusion and this consideration of short range military expediency won out over the political considerations which favored an invasion through the Balkans. Who can doubt that in a war with Russia which if it comes will be a life and death struggle, at a time when many will feel that it is a question of us or they, the outcome will hang in balance when we shall suspect the Russians of planning to do to us those plans we consider doing to them. Military expediency will require that we act with dispatch. Who can ask that it will be argued that by killing the inhabitants of Russia, we will save ~~in~~ not only our own lives by possibly save mankind and that the use of our h-bomb rigged by radio-activity will in the end save lives. It will be regretted of course, that the position of our allies in the past war who are subjugated against their will will perish together with the Russians. That is, if we shall at the crucial time think of the policies at all, and if Russia would have invaded

and occupied France, Belgium, and Holland, can we be sure when our whole nation will be threatened with elimination, military expediency will not force us to detonate our h-bombs somewhere in the Atlantic area? we can transport them without much difficulty even though our allies in Western Europe will perish along with the Russians. If you think that all this is exceedingly gruesome and unlikely to happen because we are a peaceloving nation, just ask once whether the steps which we took during the last war were not a greater departure from accepted behavior than would not be the steps stated above. Starting from the principle that it is wrong to wage war against civilians and then waging war with jellied bombs and gasoline bombs against Japanese cities is that not a bigger step than just going over from killing the inhabitants of the cities to killing the whole civilian population of a continent. And even if this were not so, ~~XXXXXXXXXXXXXXXXXXXX~~ ~~XXXXXXXXXXXX~~ will our decision not be taken under a much greater stress than were the decisions that we took in the war against Japan? In that war, there was no danger ever that we shall be defeated and even less that our population might be killed by radio-active fumes sweeping across our continent from h-bombs detonated along the Pacific coast. This, however, is not the only way in which h-bombs can be used. H-bombs, present in sufficient quantity and rigged for radio-activity, would make us invincible if we possessed them and they would make the Russians invincible if they possessed them, provided we or the Russians were determined in no circumstances to lose a war. Whichever government, ours or the Russian, finds herself threatened with immediate defeat could threaten to detonate in its own territory h-bombs which might be too heavy for transportation and the ensuing radio-activity will then within a few weeks sweep across the northern hemisphere, killing the

population of the enemy as well as their own population. If our government were threatened with defeat, she could make such a threat and the Russians, disbelieving us might call our bluff. It then might or might not turn out to be a bluff. The same might happen the other way around if we call the Russians' bluff. The decision to pull the trigger will ~~not be democratically~~ arrived at. It will be the decision of a small group of people or merely of just one man, a man who might be demented. -- The Chief-of-Staff, the Secretary of Defense, or the President of the United States, the head of the Polit-Bureau or the Commissar for the Defense. Once we created a situation in which the fate of mankind hangs on the decision of one single man or a political click that fights for its life, the continued existence of mankind hangs in the balance. Ten h-bombs, each of which would burn 250 ~~kilo~~ tons of heavy hydrogen in its explosion, would produce radio-activity in an amount which would kill every man on the earth if it were universally dispersed throughout the atmosphere. It is perhaps fortunate that the exchanges of air masses between the Northern and the Southern hemispheres is rather slow and that therefore ~~the~~ ^{the} inhabitants of the Southern Hemisphere might escape with their lives while the inhabitants of the Northern Hemisphere might perish if h-bombs rigged for activity are detonated by Russian and America, or if such h-bombs are detonated by one of these two countries by a government which prefers death to defeat.