PHYSICS

Probe Fusion Elements

Predict many more H-bomb blasts will be detonated to test the fusion of different combinations of light elements, with the conversion of mass into energy.

By WATSON DAVIS

➤ MANY MORE H-bomb explosions will occur in the Pacific in coming months.

Aside from any military or political reasons, we must know about the phenomenon of fusion, the transmutation of light elements, with release of atomic energy, the conversion of mass into energy. This requires scientific experimentation.

What is being done on a grand scale is comparable historically to the exploration of radioactivity that took place about the turn of the century, or the development of uranium fission and the whole A-bomb program at the beginning of World War II.

There is not just one kind of superbomb — whether you call it hydrogen bomb, thermonuclear weapon, or fusion bomb. There probably are a dozen or so, each materially different. Then there is always the question as to how small and how large each of them may be made. And how they can be made to explode most efficiently.

The essential ingredients in a fusion bomb are: 1. Light chemical elements, part of whose mass is converted into energy. 2. A detonating or igniting charge, which is presumably a plutonium fission A-bomb, which is no small explosion in itself.

The igniting A-bomb would provide the high temperatures of a million degrees or more that are needed to fuse the hydrogen or other elements so that they transform into other elements with conversion of a small amount of their mass into energy.

Probably an A-bomb is the only practical way now known of setting off an H-bomb. But some of the tests now under way may include an attempt to ignite an H-bomb with another source of very high temperature, a fine metallic wire exploded by a jolt of high voltage electricity.

The material in a fusion superbomb is basically some sort of hydrogen, either the double-weight deuterium or the triple-weight tritium. This is the chemical stuff, the lightest element. Theoretically it could be converted into the next heaviest element, helium, with a large yield of energy from the mass or matter lost in the process. This is the kind of reaction that is believed to keep the stars stoked. It happens in the H-bomb in very short fractions of a second, and it has to happen before the atoms involved are flung far apart by the energy that such atomic interactions create.

The first of the U. S. H-bombs, whose explosion in November, 1952, is now being witnessed by the world in officially released motion pictures (see SNL, April 10, p. 227), was presumably primarily a rather simple hydrogen bomb. It probably utilized a D-D reaction, a combination of two atoms of deuterium or heavy hydrogen. It may have been a D-T reaction, in which a deuterium atom coalesced with an atom of tritium or triple-weight hydrogen. Both of these reactions, theoretically, should work.

Certainly one of them did in the now famous first H-bomb shot of 1952 Operation Ivy, which has become psychologically "poison ivy" to many.

The first H-bomb of 1954 (March 1) was about twice as large as the calculated estimate. It has aroused people by its tremendous size and the meteorological accident of "fall-out" of its radioactive material upon Japanese fishermen inside the danger area.

Too little is reported about the March 26 and April 6 bombs to do much speculating, but the March 1 bomb probably contained light element ingredients other than the hydrogens of the earlier H-bomb. That is what probably gave the March 1 bomb its extra "umph." It was an experiment. This test should have been made for scientific reasons, simply to know about the facts of matter and energy, even if it served no military or political purpose.

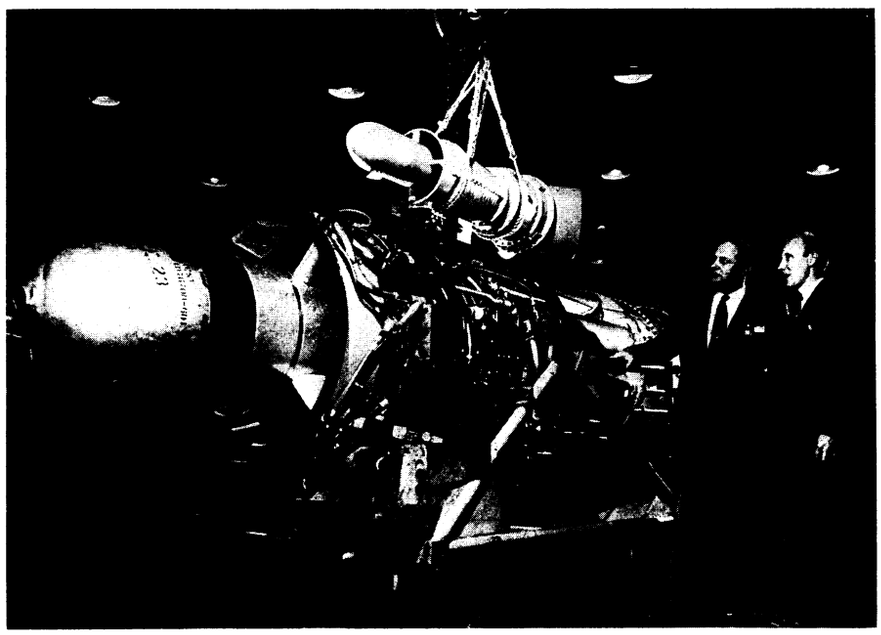
The best guess at an added light element is lithium. This is a light metal, atomic number 3 in the list of chemical elements. Lithium is relatively plentiful in the earth's crust, and it was used in its metallic form during the war to produce hydrogen for inflating weather and radio balloons.

Even before 1939 when the discovery of the fission of uranium made obvious the eventual building of an atomic bomb, the reactions between the light elements were known both by calculation and observation. In 1950 this reporter detailed such possibilities. (See SNL, Feb. 11, 1950, p. 83.)

For instance, there was a decrease in mass when an atom of lithium isotope 6 and an atom of deuterium or heavy hydrogen reacted. This is translatable into energy by Einstein's famous mass-energy equivalence, $E = mc^2$, or energy equals mass times the velocity of light squared. Similarly, it was known that there was energy in the lost mass of the coming together of the various hydrogens with the other sort of lithium (weight 7), beryllium, boron, and even carbon and nitrogen.

The lack was a means of getting them together so that they would react. That was not available until the A-bomb was achieved. The fission of the A-bomb brought the needed temperature that slammed the light elements together. That is the reason that the H-bomb has to have an A-bomb at its heart.

There are so many possible combinations of the light elements to try that we can expect many more H-bomb tests.



JET FOR HELICOPTERS—A mock-up model of the new gas turbine engine, XT-58, being developed for helicopters by General Electric is shown here, compared for size with a jet engine that powers the Sabre Jet interceptor.

Tritium, hydrogen of mass three, has been assumed to be a necessary ingredient of the H-bomb. In 1950, President Truman ordered full speed ahead on the H-bomb. At a cost of over a billion dollars, the Savannah River plant was built primarily for tritium manufacture. (Tritium is made by bombarding lithium with neutrons from uranium or plutonium fission in an atomic reactor.)

Tritium is a gas in its elemental form, and a radioactive gas at that, half of it disintegrating in about 11 years. A most inconvenient material to put in a bomb, it is highly unlikely that it is used as a gas.

A chemical combination of lithium and ordinary hydrogen, lithium hydride, is a relatively common and solid chemical. Anyone can buy it. Lithium tritide should be a very similar solid and would combine in easily handled form two of the most fusionable elements.

Lithium deuteride would be similar and very much cheaper. No uranium would be consumed if this compound were used because the one part of deuterium in about 5,000 of water is extractable. It might do just about as well in the H-bomb. Thus there may be H-bombs without tritium. If that is true, H-bombs are little more costly than plutonium bombs and all the bombs can be rebuilt to be in the megaton range.

These are the questions being answered by the tests in the Marshall Islands. We can only guess at their answers.

It is unfortunate that the chapters in scientific history being written in secret reports can not be known, for they would be fascinating reading. The price that is paid for military security is the foregoing of the fruits of the great international interplay of scientific facts broadcast freely throughout the scientific world. Out of such freedom of science the atomic age was born.

Science News Letter, April 17, 1954

GENERAL SCIENCE

Explosion of World?

➤ CAN THE world be exploded like a gigantic atomic bomb and turned into a flaming star-like object with all life extinguished? This question has worried the world ever since discussion of atomic energy began.

Despite the tremendous size of the hydrogen bomb already achieved and the possibilities of even larger explosions, there is no danger of setting off a chain reaction which would destroy life on the earth. The answer to this problem of the annihilation of the earth is "no," just as it has been in the past.

Perhaps we can do no better than to repeat what has been said before. On Jan. 30, 1939, at the time when the fission of uranium first became known, it was not only possible to predict definitely that there would be an atomic bomb, but to report at that time (see SNL, Feb. 11, 1939, p. 86):

"The physicists are anxious that there be no public alarm over the possibility of the world being blown to bits by their experiments. Writers and dramatists (H. G. Wells' scientific fantasies, the play "Wings Over Europe,' and J. B. Priestley's novel, Doomsday Men') have over-emphasized this idea. While they are proceeding with their experiments with proper caution, they feel that there is no real danger except perhaps in their own laboratories."

More recently, in 1950, just after President Truman authorized the construction of the hydrogen bomb, this problem was discussed in more detail (see SNL, March 4, 1950, p. 133):

"Not even a monster super-H-bomb, the most gigantic that can be visualized, would explode the atmosphere of the earth or the waters of the oceans, ending life on the earth as we know it.

"That is the best judgment of scientists, despite the alarming statements of a few physicists. The damage that a dozen or so H-bombs could do to big cities is quite alarming enough without calling upon a chain reaction in the atmosphere or the seas.

"There is energy (excess mass that turns into energy) when hydrogen, oxygen and nitrogen of the air and water are transmuted to other elements. That is clear and no scientist disputes this fact. But in the explosion of an H-bomb there is even less than in an A-bomb of the sort of radiation and other debris that would propagate a chain reaction, particularly in the light elements.

"In the H-bomb the process is more of a combination of the light-weight elements involved to make other elements with an incidental loss of mass or matter, which turns into energy. This is what is called fusion. In the uranium-plutonium atomic bomb it is a matter of these two very heavy elements splitting into other middle-weight elements, with a slight loss of mass that turns into energy. This is called fission.

"In fission of the A-bomb, neutrons in excess are let loose and this makes possible the extremely rapid chain reaction. Probably neutrons do not have such a key role in the so-called hydrogen bomb, which seems to be a matter of smacking together the atoms of the hydrogen isotypes, deuterium and tritium (double and triple weight hydrogen), one or the other or both.

"To set off a chain reaction in the atmosphere or in water, something to react with the oxygen and hydrogen of the water and the nitrogen and oxygen of the air would have to be produced in profusion. This does not seem to be provided by the H-bomb if guesses as to its nature are correct.

"Not only that, but if the triggers or inciting radiations were present, the atoms of the air and water are too far apart to be easily acted upon and transmuted in bulk as would be necessary for an 'end-of-the world' disaster.

"If there was believed to be any considerable risk to an atmospheric or oceanic chain explosion, it is very likely that even the Russians would think a long time before risking a test. We must assume that since they seem to want to have a communistic world, they will not risk anything that they believed would envelop the earth in flame."

Science News Letter, April 17, 1954

Theoretically, the longest possible time that a total *eclipse* of the sun can last is seven minutes and 40 seconds.

SCIENCE NEWS LETTER

VOL. 65 APRIL 17, 1954 NO. 16

The Weekly Summary of Current Science, published every Saturday by SCIENCE SERVICE, Inc., 1719 N St., N. W., Washington 6, D. C., NOrth 7-2255. Edited by WATSON DAVIS.

Subscription rates: 1 yr., $5.50; 2 yrs., $10.00; 3 yrs., $14.50; single copy, 15 cents, more than six months old, 25 cents. No charge for foreign postage.

Change of address: Three weeks notice is required. When ordering a change please state exactly how magazine is now addressed. Your new address should include postal zone number if you have one.

Printed in U. S. A. Entered as second class matter at the post office at Washington, D. C., under the act of March 3, 1879. Acceptance for mailing at the special rate of postage provided for by Sec. 34.40, P. L. and R., 1948 Edition, paragraph (d) (act of February 28, 1925; 39 U. S. Code 283), authorized February 28, 1950. Established in mimeographed form March 18, 1922. Title registered as trademark, U. S. and Canadian Patent Offices. Indexed in Readers' Guide to Periodical Literature, Abridged Guide, and the Engineering Index.

Member Audit Bureau of Circulation. Advertising Representatives: Howland and Howland, Inc., 1 E. 54th St., New York 22, ELdorado 5-5666, and 435 N. Michigan Ave., Chicago 11, SUperior 7-6048.

SCIENCE SERVICE

The Institution for the Popularization of Science organized 1921 as a non-profit corporation.

Board of Trustees—Nominated by the American Association for the Advancement of Science: Fernandus Payne, National Science Foundation; Karl Lark-Horovitz, Purdue University; Kirtley F. Mather, Harvard University. Nominated by the National Academy of Sciences; Harlow Shapley, Harvard College Observatory; Homer W. Smith, New York University. Nominated by the National Research Council: Leonard Carmichael, Smithsonian Institution; Ross G. Harrison, Yale University; Duane Roller, American Association for the Advancement of Science. Nominated by the Journalistic Profession: A. H. Kirchhofer, Buffalo Evening News; Neil H. Swanson, Baltimore Sun Papers; O. W. Riegel, Lee Memorial Journalism Foundation. Nominated by the E. W. Scripps Estate: John T. O'Rourke, Washington Daily News; Charles E. Scripps, E. W. Scripps Trust; Edward J. Meeman, Memphis Press-Scimitar.

Officers—President: Harlow Shapley; Vice President and Chairman of Executive Committee: Leonard Carmichael; Treasurer: O. W. Riegel; Secretary: Watson Davis.

Staff—Director: Watson Davis. Writers: Jane Stafford, Marjorie Van de Water, Ann Ewing, Allen Long, C. Marden Cotton. Science Clubs of America: Joseph H. Kraus, Margaret E. Patterson. Photography: Fremont Davis. Sales and Advertising: Hallie Jenkins. Production: Priscilla Howe. Interlingua Division in New York: Alexander Gode, Hugh E. Blair, 80 E. 11th St., GRamercy 3-5410.