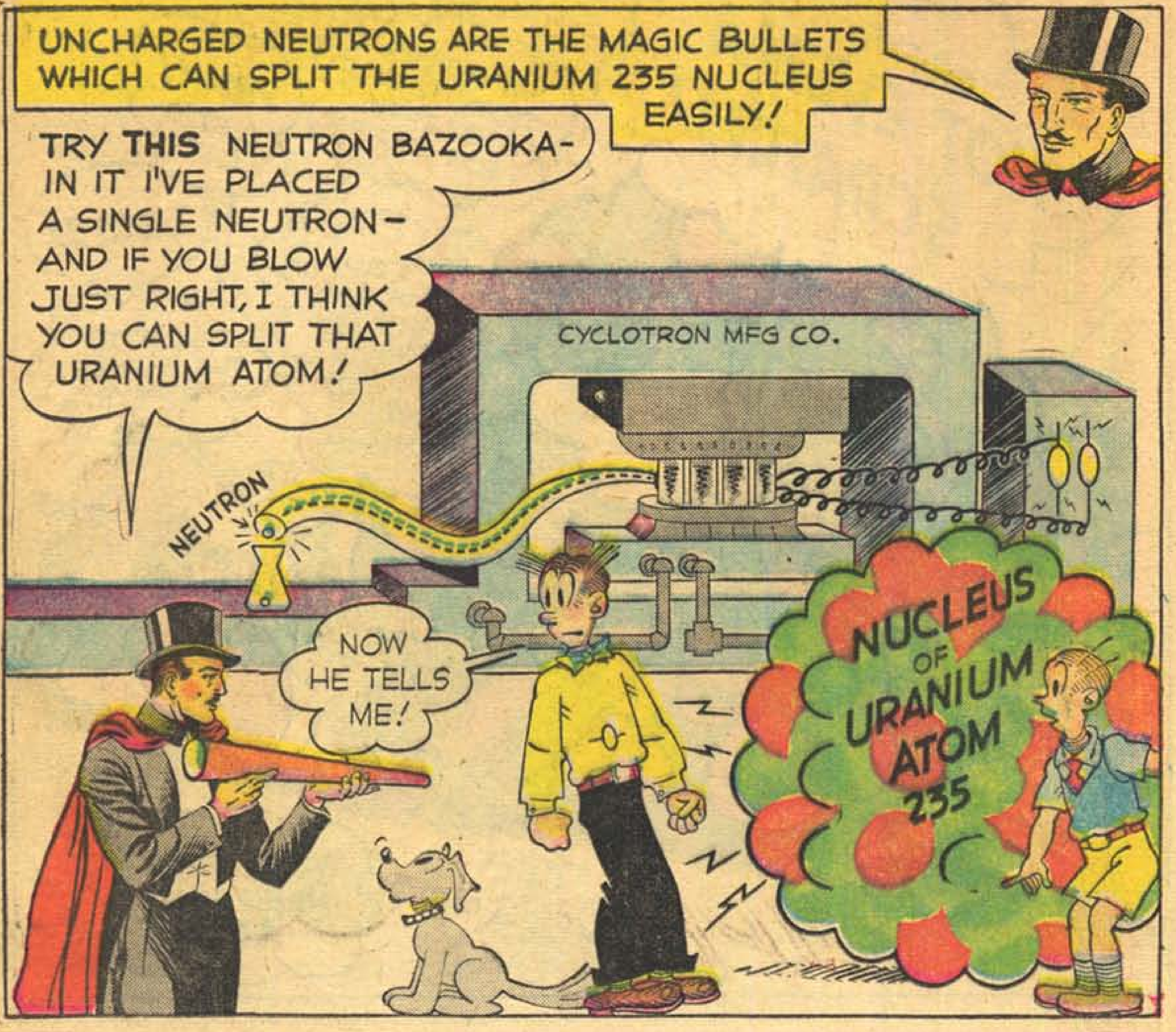
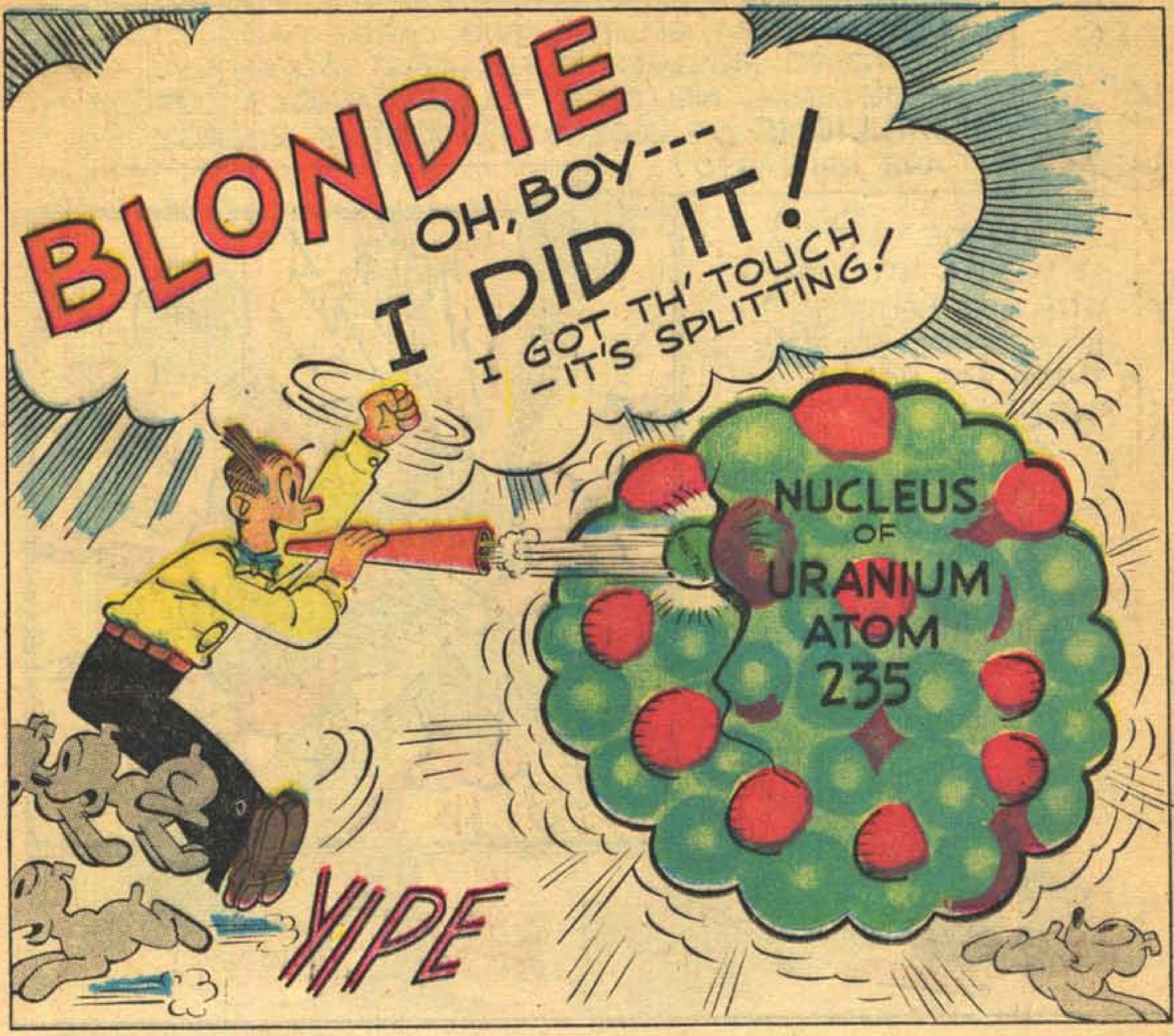


NEUTRONS ARE LIKE ARTILLERY SHELLS!

Neutrons are said to split the nucleus of an atom easily because they do not have to have high speeds. Because the neutron is not charged electrically, it can approach the nucleus without encountering any great repulsive force. When neutrons are used to split the nucleus, the scientist says that they are "captured," and calls the process "neutron capture." Actually, as soon as the neutron enters the nucleus, the nucleus is excited and made unstable, and right away it breaks apart, usually into two or more pieces.

Many substances were bombarded with neutrons and changed to new substances by the neutron-capture process before uranium 235 was used. In almost all these cases, however, the bombardment resulted in only one neutron being hurled out of the nucleus as a result of its breakup.

Dagwood says he has "the touch." What this means is that he is hitting the nucleus with neutrons of just the right speed. If a neutron approaches the nucleus with too little or too much speed, its capture by the nucleus is not very likely. The right speed for capture depends upon the nature of the parent nucleus.



AN ATOM IS SPLIT!

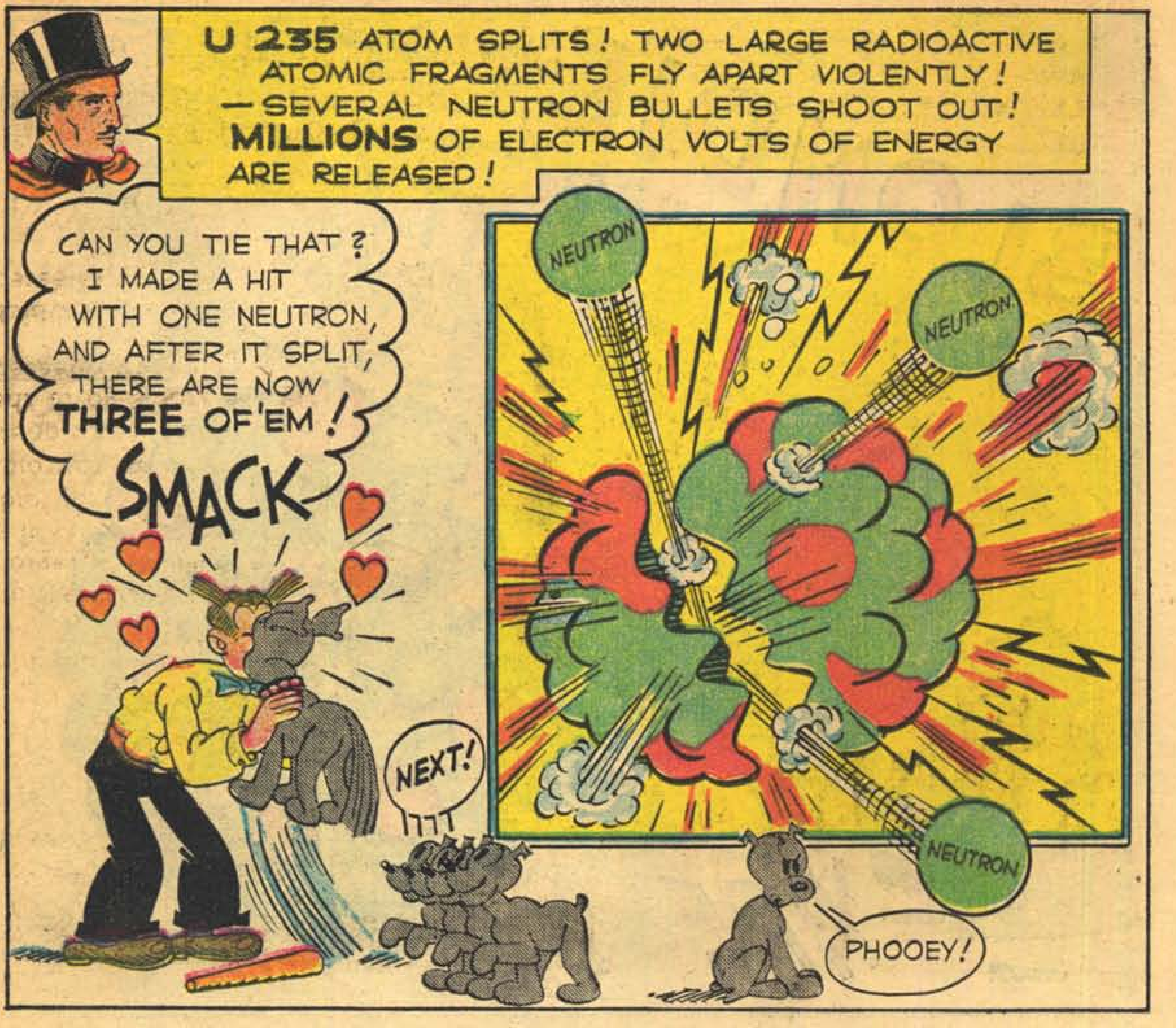
A report came from Nils Bohr to scientists in this country in January, 1939, that two scientists, Hahn and Strassman, had succeeded in splitting the uranium nucleus. Immediately upon hearing this report, Dr. John Dunning, professor of physics at Columbia University, and other scientists set about seeing if it could really be true.

These scientists knew that they could produce plenty of neutrons by bombarding certain substances with particles speeded up in a cyclotron. They placed some uranium near the spot where the neutrons were being produced. Then with a detecting device like a Geiger counter, they watched for results. They found that the uranium atom would really split with a release of a huge quantity of energy and, most important, with the release of several neutrons.

This experiment was conducted in several laboratories, and the cooperation shown by scientists in this and other wartime work was nothing short of vital.

Scientists immediately knew that the splitting of the uranium atom could be the basis for a new kind of bomb, and the race then started between scientists of several countries to produce enough uranium 235 and to get other scientific information to make the atomic bomb.

Scientists have learned that atoms of a few other elements found in nature—for example, Thorium—can be converted into synthetic atoms which split easily under the action of slow neutrons. Such a conversion offers the possibility of making more abundant fuels for atomic energy—for example, Plutonium 239 and Uranium 233.



THE BASIS FOR CHAIN REACTION!

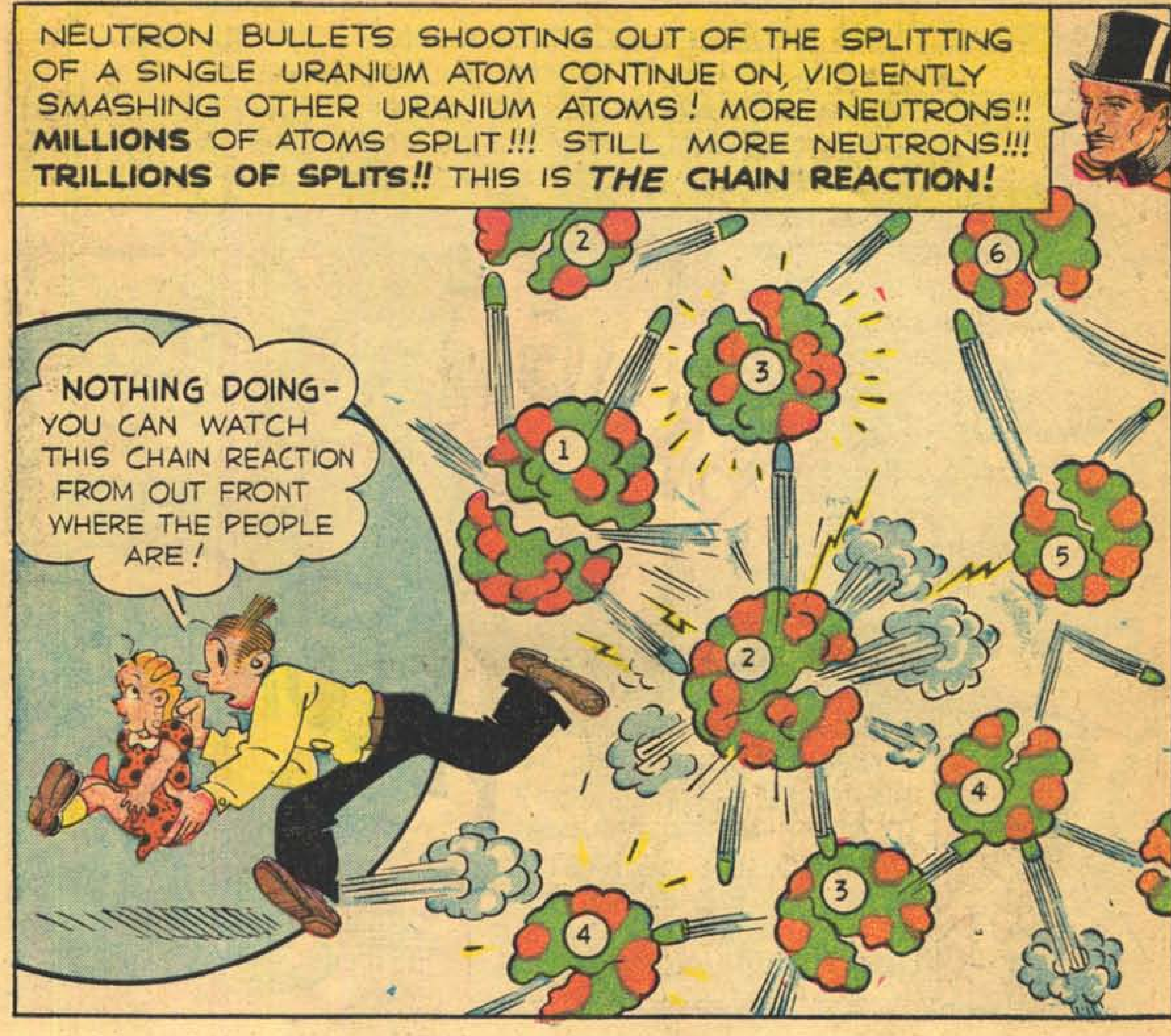
No wonder Dagwood is happy about getting more than one neutron from the splitting of the uranium 235 nucleus. The neutrons given off can split other uranium nuclei, and in this way the splitting process can continue on its own. This splitting process is sometimes called atomic fission.

As soon as scientists knew that the uranium 235 nucleus could be split into atoms like krypton and barium and several neutrons, the United States Government, cooperating with England, set about producing uranium 235 on a large scale.

About this same time scientists undertook to determine whether, as they expected, uranium nuclei would really continue to split, one after another.

This question was soon answered, and the scientists were so sure of the answer that they did a very interesting thing. They made a pile consisting of a large amount of uranium and neutron-slowing-down materials—graphite, which almost everybody identifies, and cadmium in the form of rods, which is a neutron-absorbing material. They found that if they gradually removed some of the neutron-absorbing control rods, the whole mass became very hot and seething with radiation and a continuous chain reaction had been achieved!

This arrangement of uranium and neutron-slowing-down material or "moderator" is called an "atomic pile."

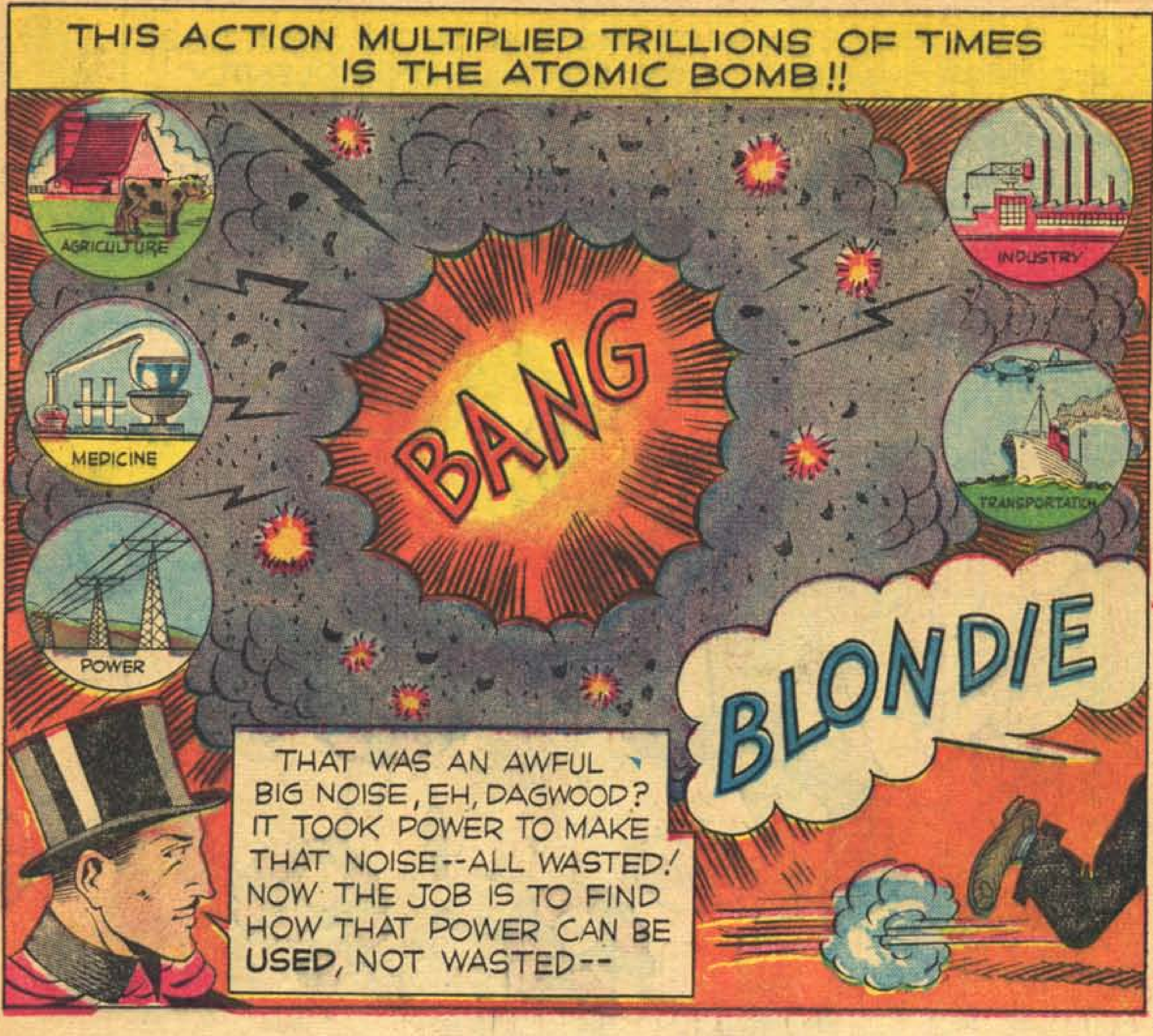


A CHAIN REACTION IS NOT REALLY NEW

Actually, every time you strike a match you start a chain reaction. The friction of striking the match produces enough heat to raise the temperature of some of the substance of the match head to the point where it reacts chemically and releases more heat. This heat causes more chemical reaction, more heat, and very quickly the head of the match is ablaze.

In many kinds of chemical reactions the only control of the chain reaction is in the amount of substance supplied. When dynamite is set off, the chain reaction builds up quickly with a tremendous and sudden release of energy. Coal burning in a furnace is another chain reaction, though this reaction is usually controlled by regulating the amount of air supplied to the fire.

In an atomic pile, the chain reaction is controlled by the amount of neutron-absorbing material present. In the atomic bomb explosions there was uncontrolled chain reaction, releasing tremendous energy.



HOW CAN ATOMIC POWER BE USED?

In an atomic pile both energy, in the form of heat, and tremendous quantities of radioactive materials are produced. The radioactive materials send out billions of high-speed particles and high-energy light. These particles and waves, called radiation, are both good and bad.

The radiation is good because the radioactive atoms, called radioactive isotopes, can be used in many kinds of scientific investigation. They have been used in agriculture to study how chemicals move through plants and how and where they are deposited. They are used in medicine to find out whether people have certain diseases and to treat people who have certain diseases. They are used in industry to trace metals, to measure delicate amounts of materials, and in other ways.

The radiation is bad because it must be guarded against when an atomic pile is used to produce energy. Atomic power for an automobile is, therefore, not very probable, because the shield for absorbing the harmful radiation would weigh many times more than the automobile itself.

At the present time the most probable use of atomic power is where large amounts of power are required—such as in electric power plants or large boats. But even these uses may not be economical for many years.

"The release of atomic energy that has brought man within sight of world devastation has just as truly brought him the promise of a brighter future. The potentialities of atomic power are as great for human betterment as for human annihilation. Man can choose which he will have....

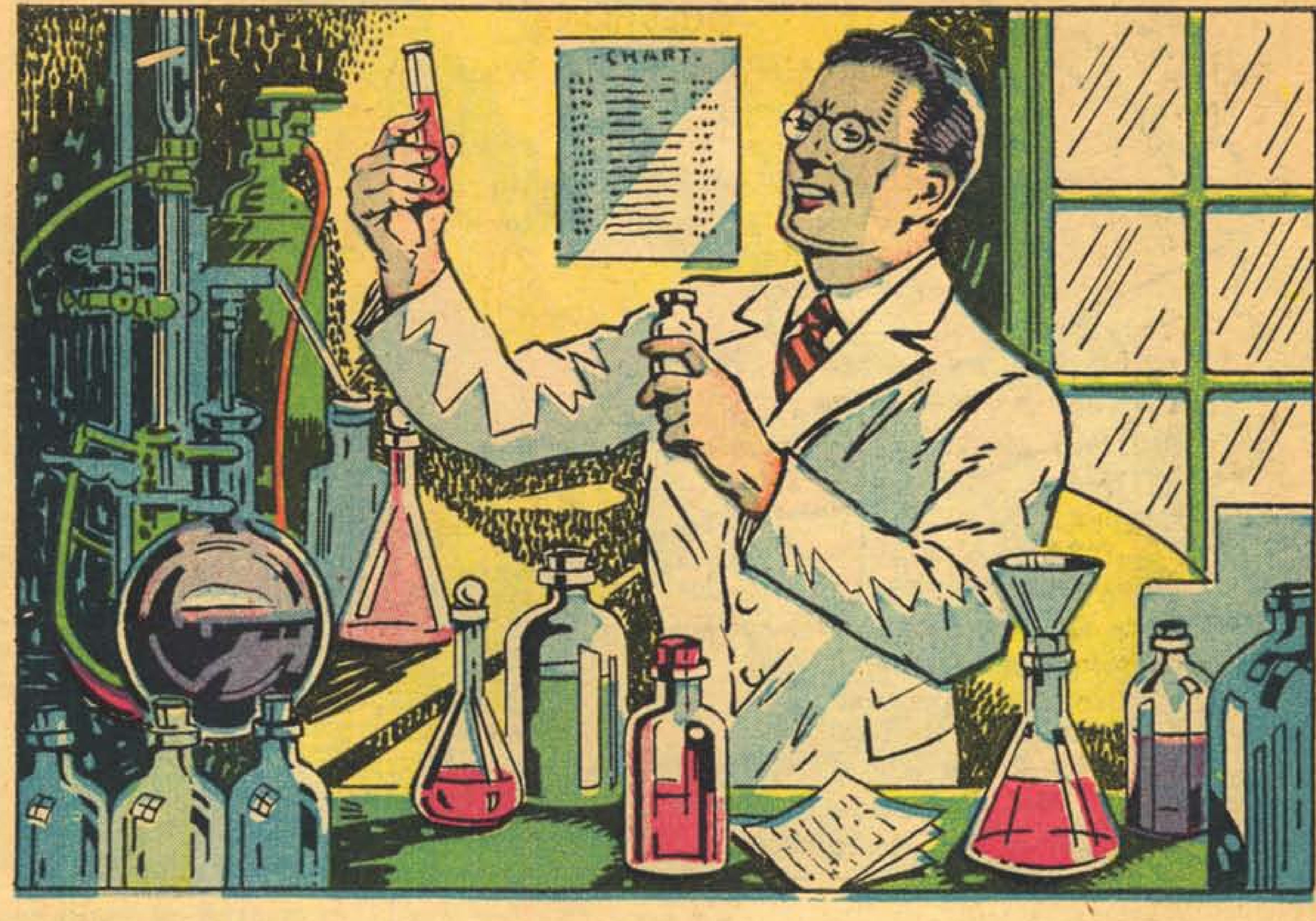
"In a real sense the future of our civilization depends on the direction education takes, not just in the distant future, but in the days immediately ahead."

—Report of the President's Commission on Higher Education, Volume 1, December, 1947.

QUESTIONS

1. *What are the smallest units of any substance?*
   - ☐ Molecules ☐ Particles
   - ☐ Neutrons ☐ Electrons
2. *What are molecules made of?*
   - ☐ Isotopes ☐ Protons
   - ☐ Atoms ☐ Electrons
3. *What is the heaviest part of an atom?*
   - ☐ Nucleus ☐ Electron
   - ☐ The outside ☐ The inside
4. *What is the nucleus of an atom made of?*
   - ☐ Neutrons and electrons
   - ☐ Electrons and protons
   - ☐ Neutrons and protons
   - ☐ Isotopes
5. *What two particles make up the nucleus of an isotope of hydrogen?*
   - ☐ Proton and neutron
   - ☐ Isotope and electron
   - ☐ Electron and proton
   - ☐ Isotope and proton
6. *How many neutrons in the nucleus of hydrogen isotope 3?*
   - ☐ One ☐ Two
   - ☐ Three ☐ Four
7. *What is the nature of a radioactive substance? It is*
   - ☐ Unstable ☐ Stable
   - ☐ Neutral ☐ Heavy
8. *How many protons are there in a helium nucleus?*
   - ☐ One ☐ Two
   - ☐ Four ☐ Eight
9. *What is it that makes one isotope of an element different from another?*
   - ☐ Weight
   - ☐ Stability
   - ☐ Electrical charge
   - ☐ Instability
10. *What is changing into helium and producing atomic energy in the sun?*
    - ☐ Protons ☐ Neutrons
    - ☐ Hydrogen ☐ Infra-red light
11. *What does a diamond consist of?*
    - ☐ Hydrogen ☐ Helium
    - ☐ Carbon ☐ Electrons
12. *What particles in the nucleus make Uranium 235 different from Uranium 238?*
    - ☐ Three isotopes
    - ☐ Three neutrons
    - ☐ Three protons
    - ☐ Three electrons
13. *Can the nucleus be chipped, dented or broken by Dagwood?*
    - ☐ Chipped
    - ☐ Broken
    - ☐ Dented
    - ☐ Neither chipped nor dented nor broken
14. *Why can't Dagwood split the nucleus? Because of*
    - ☐ Electrical repulsion
    - ☐ Electrical attraction
    - ☐ Heavy weight of nucleus
    - ☐ Light weight of nucleus
15. *How much electrical charge does a neutron have?*
    - ☐ Two units of positive electricity
    - ☐ One unit of positive electricity
    - ☐ One unit of negative electricity
    - ☐ No charge
16. *Why does the neutron split the nucleus easily? Because the neutron has*
    - ☐ No electrical charge
    - ☐ Small weight
    - ☐ High electrical charge
    - ☐ Heavy weight
17. *How many neutrons are necessary to split a uranium nucleus?*
    - ☐ One ☐ Two
    - ☐ Three ☐ Four
18. *What is it that makes the chain reaction possible?*
    - ☐ Electrons ☐ Protons
    - ☐ Neutrons ☐ Isotopes

ANSWERS ON INSIDE BACK COVER



MEDICAL SCIENCE

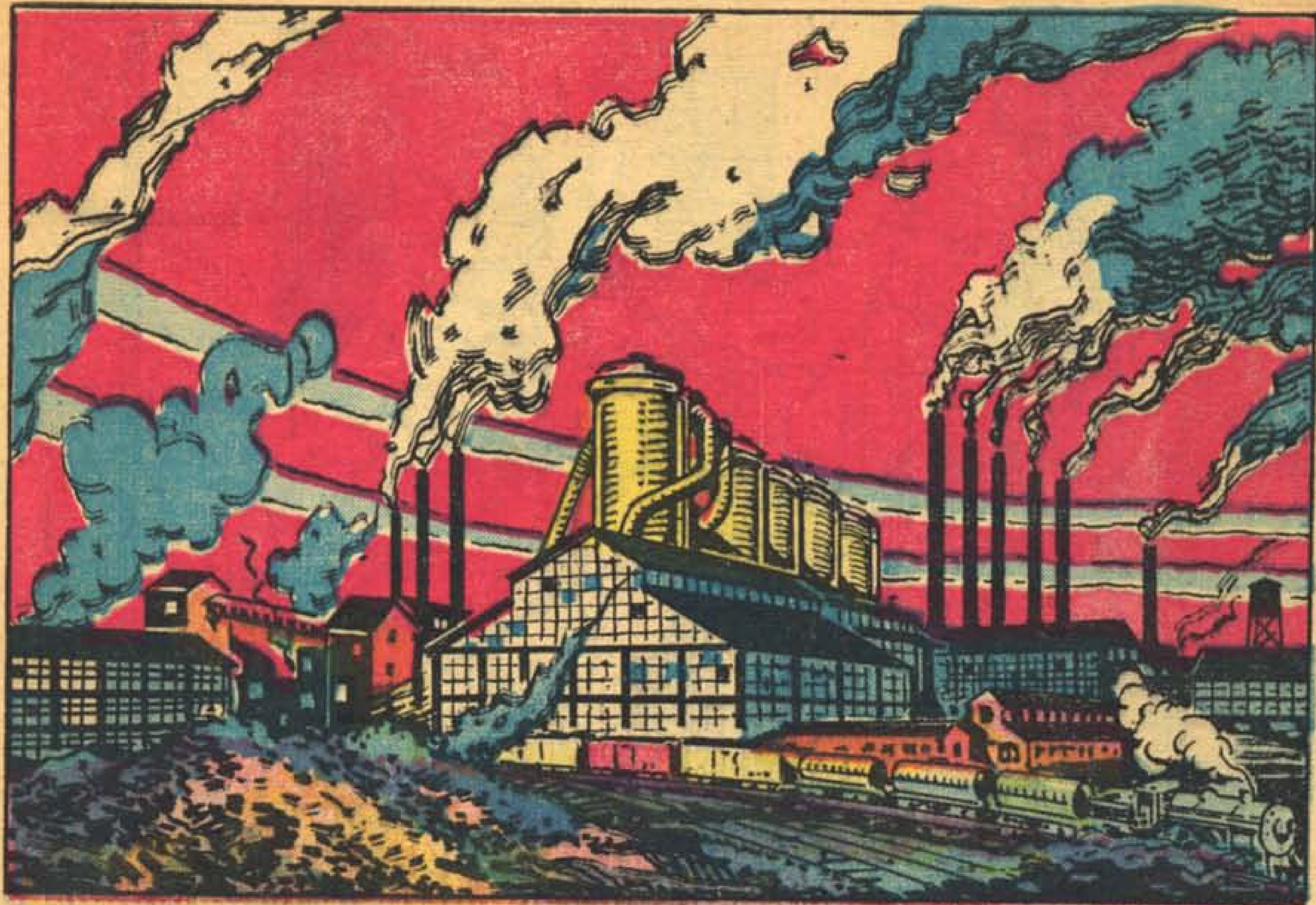
WHEN medical history comes to be written in the year 2000, radioactive isotopes will be recognized as making the most important contributions of this century. Used to trace the intricate process which a chemical undergoes from the time it enters the human body until it leaves, radioactive isotopes also are used to treat the body's ailments.

Radioactive iron is aiding the study of anemia (lack of red corpuscles). Radioactive phosphorus is being used to study blood flow in the heart and what happens (coronary occlusion) when a blood clot blocks a path in the heart. Radioactive sodium in sodium chloride (common table salt) is being used to observe the movement of sodium in blood plasma. These are but a few of the many ways in which radioactive (or "tagged") atoms are being utilized in medical science to determine how the human body works. All were impossible on any large scale until now.

Every radioactive atom gives off energy when it explodes. This energy already has proved useful in the treatment of blood and lymph diseases.

The wonder story of radioactive isotopes in medicine concerns the detection and treatment of thyroid cancer. (The thyroid is a gland in the lower neck region which regulates the energy and activity of the body.) Medical scientists have long known that the element iodine is necessary for the proper action of the thyroid. Also, that most of the iodine taken into the human body goes directly to the thyroid. Radioactive iodine carries cancer-killing energy which it gives off when it explodes. Therefore, if a patient is given radioactive iodine, the radioactive atoms go to the thyroid, where the energy is liberated—exactly the spot where the energy released can kill the cancer.

The problem for medical scientists now is to identify other chemicals which will carry radioactive isotopes to other parts of the body where the energy released can attack disease. Already, progress has been made on this problem.



INDUSTRY

MODERN industry depends upon many scientific instruments and devices—on electric "eyes," for instance, which detect flaws in machine parts, and on thermocouples, by which large baking ovens are delicately controlled—all operating on principles known for years.

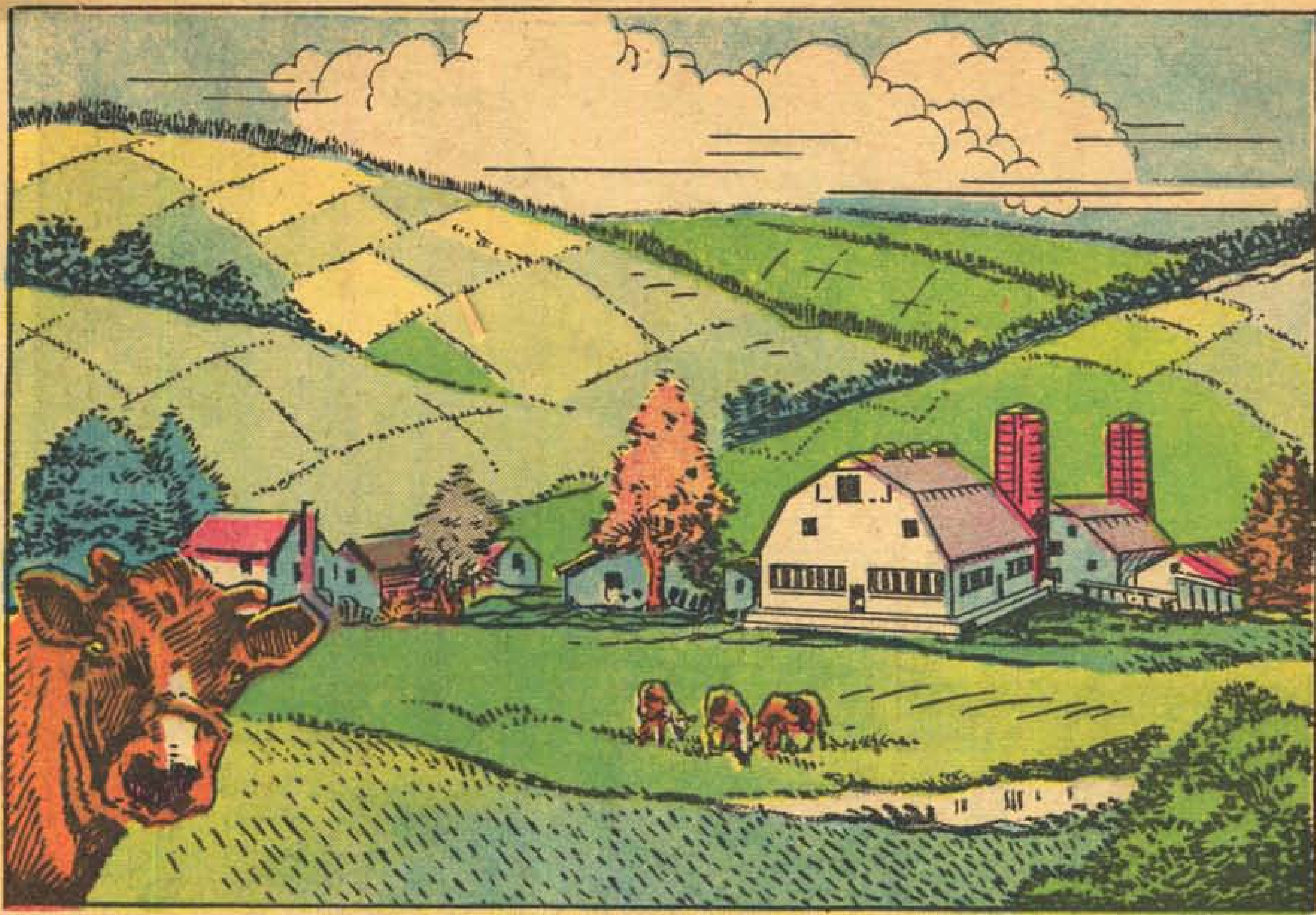
Now industry has a new tool—atomic energy in the form of radioactive isotopes—and is making quick use of it.

The age-old problem of friction is being solved at last by means of radioactive atoms. With these, the scientist is learning what happens when two surfaces are rubbed together.

Water seepage thru crevices in rock strata has spoiled many an oil well. Oil men have sealed such crevices with cement, but they could never be sure that the cement was of the right thickness and in the right places. By adding radioactive isotopes to the cement and using a Geiger counter, oil men now make sure.

Oil men use radioactive isotopes in another way too. A source of neutrons lowered into a drilling causes the walls of the drilling to become radioactive. This is detected by the Geiger counter. Because oil-bearing hydrocarbon material absorbs neutrons more readily than heavy solid rock, it is possible with the Geiger counter to determine whether oil is near-by.

Also, industry is using radioactive isotopes to study how iron products age. A change may be coming in the practice of aging iron castings by exposing them to the weather before they are machined, if the scientist can discover what happens to the movement of carbon atoms during this aging process. He is studying this problem now with the aid of radioactive carbon atoms.



AGRICULTURE

A GROWING plant is a chemical factory, of course. Scientists have known this for years—but haven't known exactly what went on in that factory. They didn't know and couldn't find out how chemicals entered the plant, what the chemicals did, how they accomplished their work. So, agriculture has had to depend on trial-and-error in producing vital food.

Now agricultural science has perfected a way for studying and following plant chemicals from the time they leave the soil until they are finally deposited in the various parts of the plant. By mixing small quantities of radioactive isotopes with the soil, the scientist, with his Geiger counter, can now follow the movement of important chemicals through the whole cycle of plant life.

Potash, needed by growing plants, is stored in the soil—but nobody has known how. Now science is learning the answer by following with a Geiger counter the movement of radioactive potassium atoms in the potash.

The growth of plants is known to be regulated by plant hormones. Just how plant hormones stimulate plant growth is a question which, if answered, would mean millions more bushels of food. The action of plant hormones in producing growth is being probed by radioactive atoms and Geiger counters.

A big question that has baffled science is, how does a green leaf change the energy of sunlight into the energy of starches and sugars in the plant? The scientists call this process "photosynthesis", and with the aid of radioactive isotopes they soon may find the answer.

Most of the present study with radioactive isotopes in agriculture is concerned with the nature of plants. Later this knowledge will be applied to the treatment of plants not only for healing their diseases but also for making them more resistant to pests and hardships.

Food production, therefore, is passing from trial-and-error to certainty.

WHAT will atomic energy and radioactive isotopes do for mankind? Nobody can foretell!

When Ben Franklin drew electricity from the clouds he knew as much about it as was known at that time, but even he could not have foreseen the huge electrical generators at Boulder Dam. When Marconi sent his first wireless message, he could not have imagined pictures being sent by television. The Wright Brothers in their flimsy flying machine could not have visualized a DC-6, a B-29 or a jet-propelled plane.

Being fully aware that discoveries can develop beyond one's wildest dreams, scientists believe that the possibilities in atomic energy are too vast for our present understanding. No one among them would dare to predict all that atomic energy will be doing for mankind next year or generations hence.

ATOMIC energy is here for good or for bad—but it *is* here! It can be used for either good or bad purposes. It will be used for one or the other. You and the rest of us can determine which purpose it shall serve.

People who regret that atomic energy was discovered because it can be used as an atomic bomb are like those others who, years ago, might have regretted the discovery of dynamite because it could be used for destruction. But for every destructive use of dynamite there are many constructive uses.

So it is with atomic energy. As scientists and engineers work with it, they will use it to improve agriculture, medicine, transportation and industry. Its development may even create problems and change living conditions. But atomic energy cannot be put back into the realm of the unknown. It is here, and we must vigilantly watch its development and help to influence its use for the good of mankind.

WHAT can *you* do about atomic energy? Well, what can you do about playgrounds, health conditions, books—what can you do about anything? You want to improve something, so you study what is wrong and you suggest solutions; you talk with local officials, you write letters, for you've learned that constructive effort may bring results.

You can do this about atomic energy: first, find out more about it—what it is and what it is not, what it should do and what it shouldn't. Then you can talk with other people about it and gain their interest. The full use of atomic energy for *good* purposes should be your goal.

If you and thousands like you make atomic energy your own possession and useful tool, that goal will be won.

ANSWERS

to questions on Page 28

1. MOLECULES–*See what Mandrake says, Page 8.*
2. ATOMS–*See what Mandrake says, Page 9.*
3. NUCLEUS–*See what Dagwood says, Page 10.*
4. NEUTRONS AND PROTONS–*See what Mandrake says, Page 11.*
5. PROTON AND NEUTRON–*See what puppies are reading, Page 12.*
6. TWO–*See what Cookie says, Page 13.*
7. UNSTABLE–*See what Mandrake says, Page 14.*
8. TWO–*See what Dagwood says, Page 15.*
9. WEIGHT–*See what Cookie says, Page 16.*
10. HYDROGEN–*See what Cookie says, Page 17.*
11. CARBON–*See what Blondie says, Page 18.*
12. THREE NEUTRONS–*See Mandrake, Page 19.*
13. NEITHER CHIPPED NOR DENTED NOR BROKEN–*See what Dagwood says, Page 20.*
14. ELECTRICAL REPULSION–*See text, Page 21.*
15. NO CHARGE–*See what Mandrake says, Page 22.*
16. NO ELECTRICAL CHARGE–*See text, Page 22.*
17. ONE–*See what Dagwood says, Page 24.*
18. NEUTRONS–*See what Mandrake says, Page 25.*

"Let us keep in mind the exhortation of Abraham Lincoln, whose words, uttered at a moment of shattering national peril, form a complete text for our deliberation. I quote, paraphrasing slightly:

" 'We cannot escape history. We of this meeting will be remembered in spite of ourselves. No personal significance or insignificance can spare one or another of us. The fiery trial through which we are passing will light us down in honor to the latest generation.

" 'We say we are for Peace. The world will not forget that we say this. We know how to save Peace. The world knows that we do. We, even we here, hold the power and have the responsibility.

" 'We shall nobly save, or meanly lose, the last, best hope of earth. The way is plain, peaceful, generous, just—a way which, if followed, the world will forever applaud.' "

—**Bernard M. Baruch**

June 14, 1946