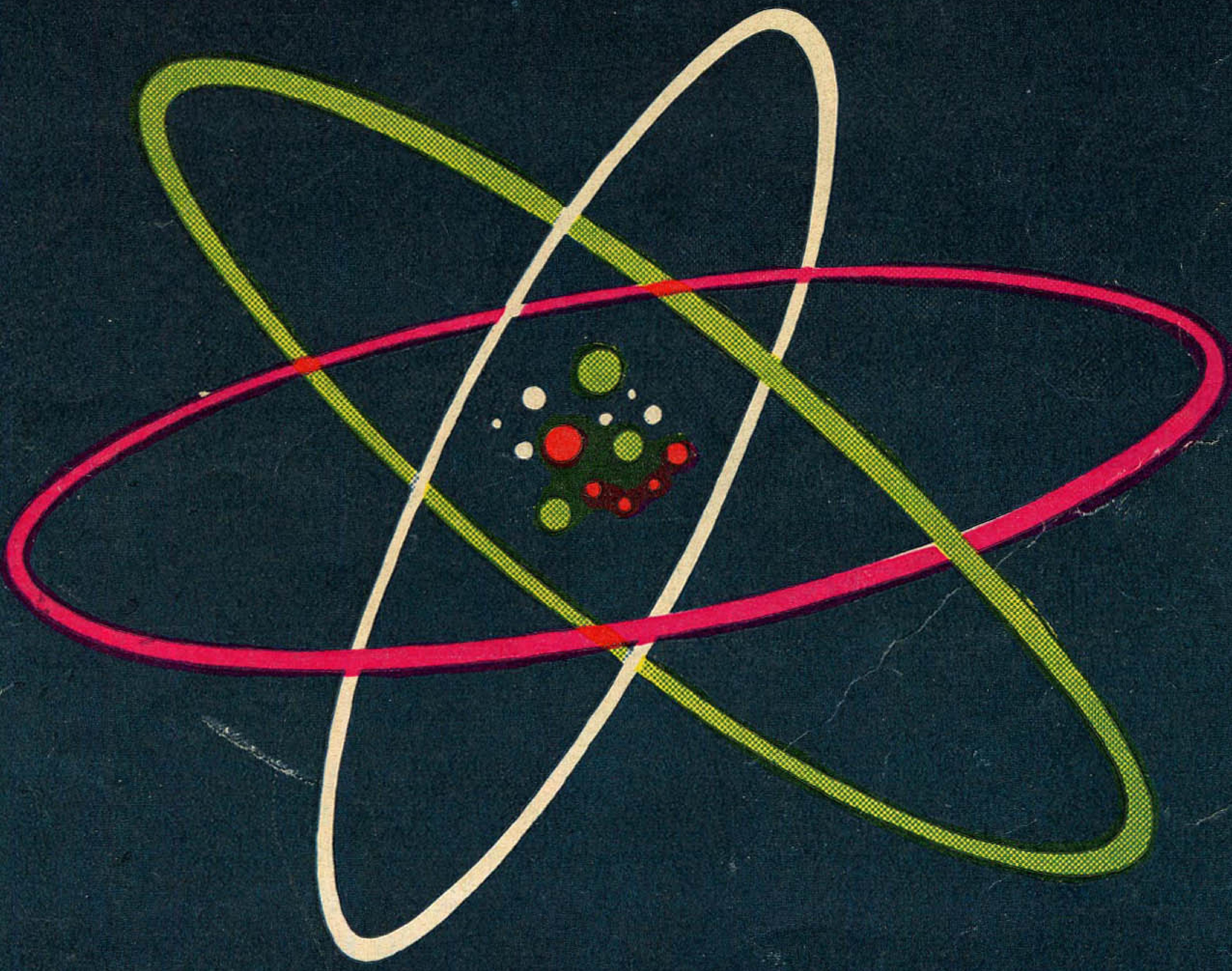
LEARN HOW

# DAGWOOD SPLITS the ATOM!



by JOE MUSIAL

*Prepared with the Scientific Advice of*

Lt. Gen. Leslie R. Groves (Ret.) • Dr. John R. Dunning • Dr. Louis M. Heil

CHIC YOUNG . .
*Creator of "BLONDIE"*

GEN. GROVES *(Left)* AND JOE MUSIAL
*at work on the pages you're about to read.*

## ORIGINAL STATEMENT BY GEN. GROVES

*who headed the great organization which developed the atomic bomb*

TRUTH comes from the understanding of facts. Truth comes from knowledge.

By now the whole world accepts the fact of atomic energy. But it has been made fearful by the results of man's ability to turn loose the power within the atom. In the grimmest sort of paradox our nation was forced to dash headlong into the search for the secret of atomic energy, in order to create a weapon which would save civilization—but which at the same time might even threaten man's future existence.

We found the answer, but we found also that we had created vast new problems. The door opened on a new and uncharted era of man's existence—the Atomic Age.

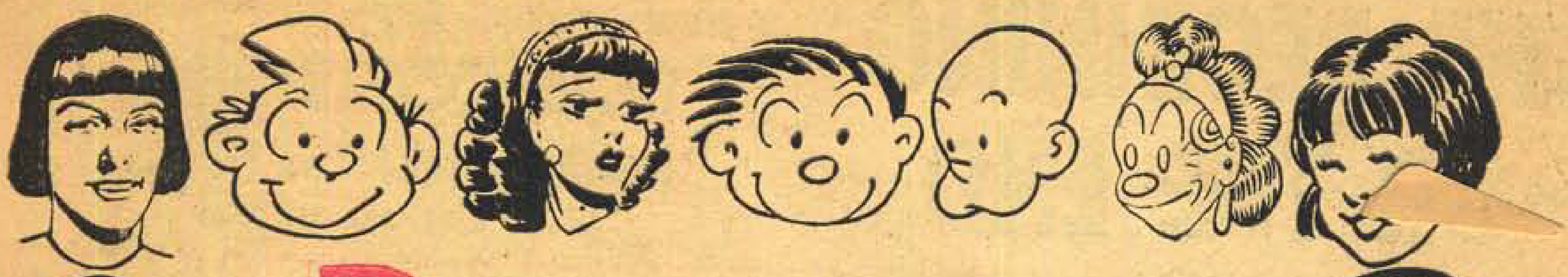
We have hardly stepped beyond the threshold. We now stand in the dim light, peering into darkness. What lies beyond, in this new era, are two paths—one to a benevolent future, the other to a ghastly end. We must choose the path to the benevolent future, we must have light in order to see the way, we must have the light of Knowledge.

No effort is too great for us to make in imparting the facts about atomic energy to the greatest number of our people. Our citizens and our future citizens cannot share properly in shaping the future unless we understand the present, for the raw material of events to come is the knowledge of the present and what we make it.

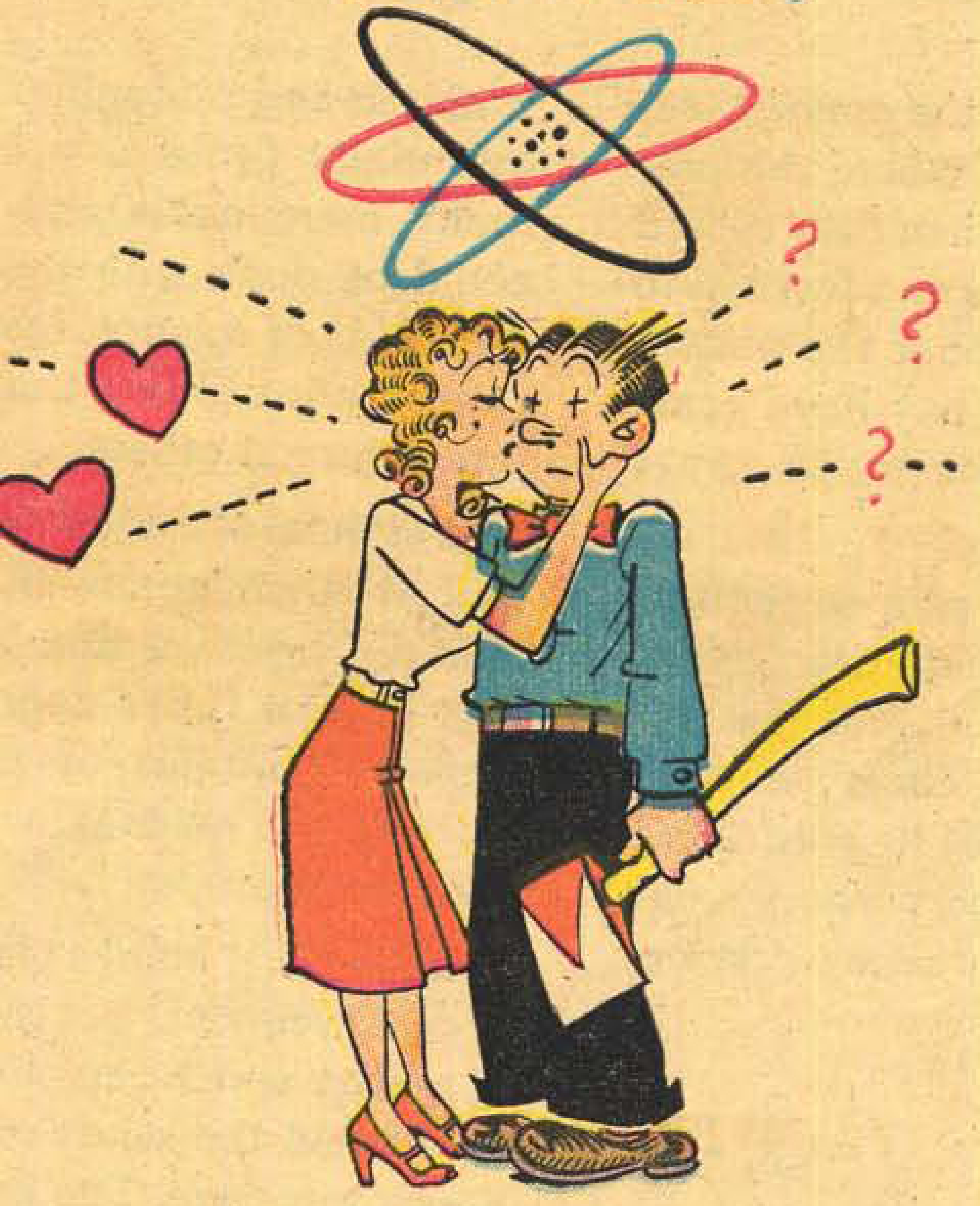
To those who will read it carefully, this pamphlet will bring a clearer understanding of atomic energy. Many will understand what has formerly confused them. Mere words need not frighten them in the future—words such as fission, isotope, proton, chain reaction and atom bomb. This book will reassure the fearful that the future can be made bright.

It will, I sincerely hope, touch off the spark that will send many on a quest for more knowledge and will help us to guide our leaders in creating an endless peace for all the world.

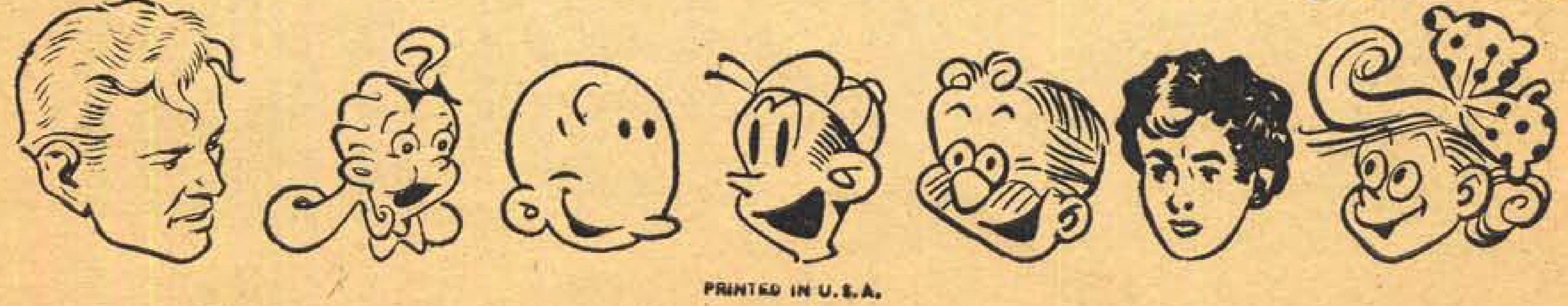
Leslie R. Groves



# DAGWOOD SPLITS the ATOM!



Prepared by King Features Syndicate and Puck, The Comic Weekly, to assist you in understanding the atom.



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# THE BEGINNING —OR THE END

by
BOB CONSIDINE
International News Service
Staff Correspondent

It is difficult for anyone who has not seen an A-bomb explode, or noted the effect of that cataclysm, to understand the power and sense the meaning of atomic energy.

This pamphlet, it seems to me, comes as close to explaining atomic energy, our fantastic new source of power, as anything I have seen in print. It will provide that which all Americans need in this dawn of the Atomic Age: a knowledge of the basic ABC's of atomic energy. It will further provide, I think, a stimulation for the youth of America to learn more about a power which will play such an important role in the future.

Today we, who hold the amazing secret of the atom, stand where the prehistoric savages stood when they ceased running away from Fire and learned to utilize that flame. Without the utilization of Fire we could not have come from caves to build the world as we know it today.

Fire was thought of as a weapon, at the start. Hairy schemers dreamed of lighting sticks and crude torches and applying them to the enemy and his effects. We laugh now at such crudity—just as one day, perhaps, we may laugh at the very notion of wasting precious

uranium and plutonium in anything as essentially futile as a bomb, when so many more noble and helpful things could be done with those elements in the fields of science, medicine, agriculture, public utilities, transportation and ten thousand others.

Yet those of us who watched at Bikini, and at Alamogordo, N. M., and Hiroshima, Nagasaki and—lately—Eniwetok, have a fuller appreciation of the topless fountains of power now unleashed and an urgent yearning to see it handled properly.

Those first bombs were the Model T of such weapons. Yet the tiny little chip of matter which exploded in New Mexico turned the sands of the immediate desert into jade. The bombs over Hiroshima and Nagasaki took such hideous toll that a fanatical enemy, prepared to fight the bloodiest campaign in history —defense of the Japanese homeland—

surrendered in dismay. At Bikini great warships went to the bottom, their thick armor crushed as one might crush tin.

We learned at Bikini and elsewhere that the core of an exploding A-bomb develops a heat somewhere between 25,000,000 and 50,000,000 degrees Fahrenheit, produces immediate gales of more than 1,000 mph., brings to life a light like that of a thousand midday suns, sprays huge territories with killing rays.

But we were advised (and it was excellent advice) not to lose sight of the peaceful pursuits of atomic energy. The mushroom clouds over the Pacific each held radium-like particles amounting to perhaps 100,000 pounds, while only about two pounds of this great and beneficial matter had been produced since the Curies discovered it more than 50 years ago. We learned that a single bomb, if exploded slowly, so to speak, could provide as much electric power as the combined electric output of U. S. powerhouses for many months . . . or propel great ships effortlessly around the peaceful seas . . . or combat cancer . . . or enable man to push aside the thick black curtains of the unknown and learn more about his life and the lives of the things that grow around him.

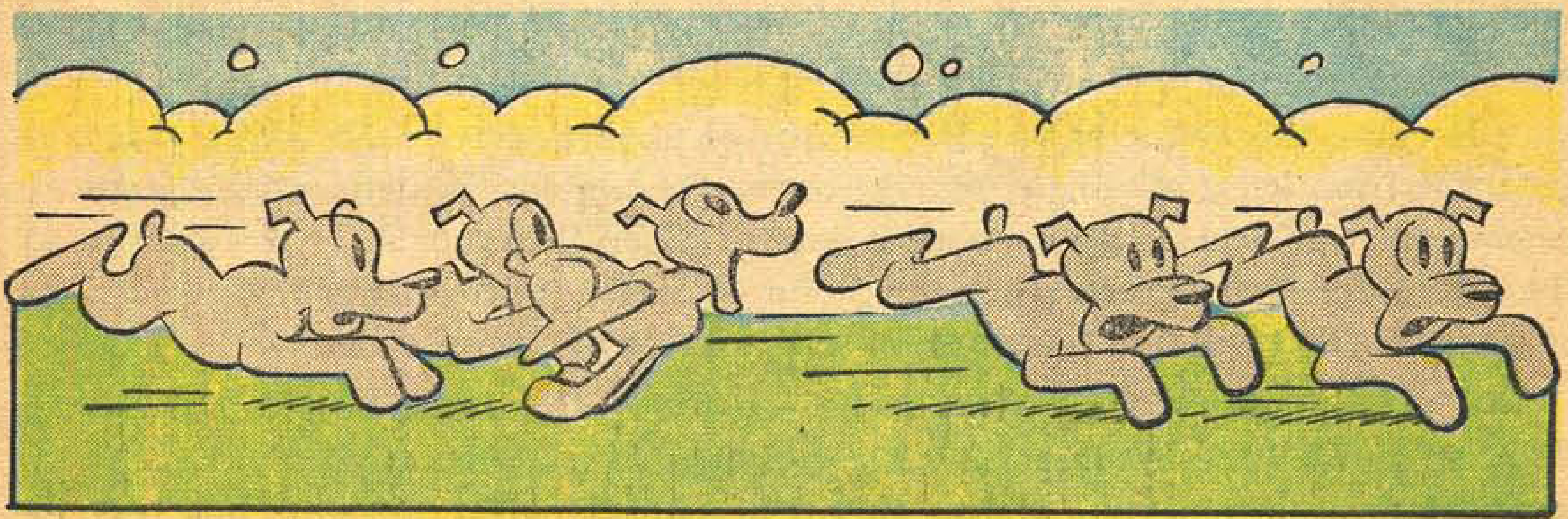
We may not all live to see the day when a miscroscopic portion of the thunderous power which flattened Hiroshima and ended a great war is used to toast our bread, drive our trains and automobiles, give new and safer flight to our planes.

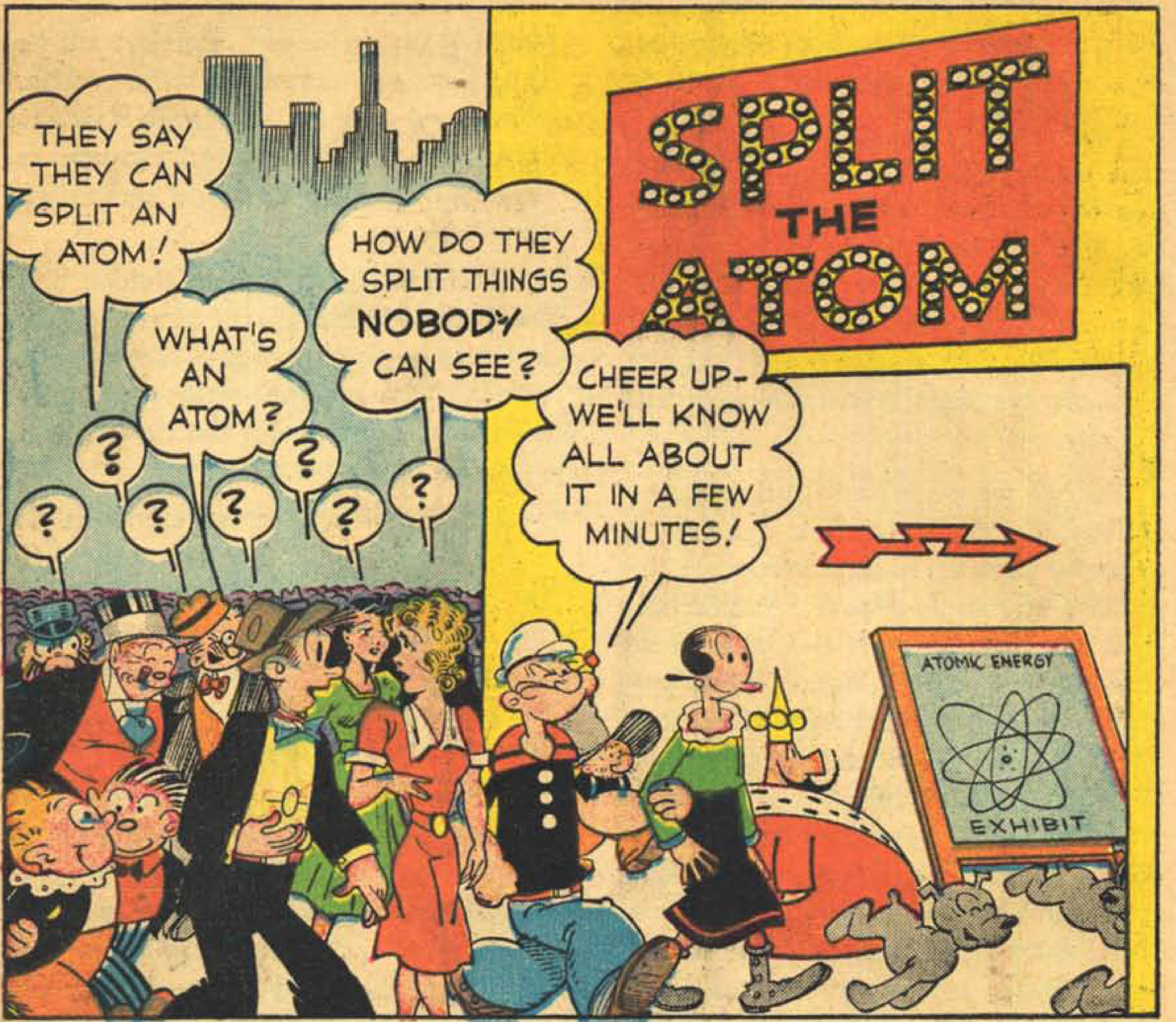
But already enormous strides have been made in the use of atomic energy in these fields and countless others, including remarkable strides made in medical research with the ray-emitting particles of matter.

All of us living today stand on the threshold of a life that can be bountiful. Historians of the distant future may say of this era that it marked the end of the Dark Ages, dismissing most of the earlier achievements of civilization through the past five centuries.

If I were young, and possessed of such experience as I hold, there would not be the slightest question in my mind as to the choice of my study and career. I would look to atomic energy as a many-faceted field with a future so vast and full of imagery that not even Einstein, in all his glory, can see the horizon.

*(NOTE: Bob Considine covered the A-bomb tests at Bikini in 1946 and is the author of the motion picture "The Beginning or the End" and other works on atomic energy.)*



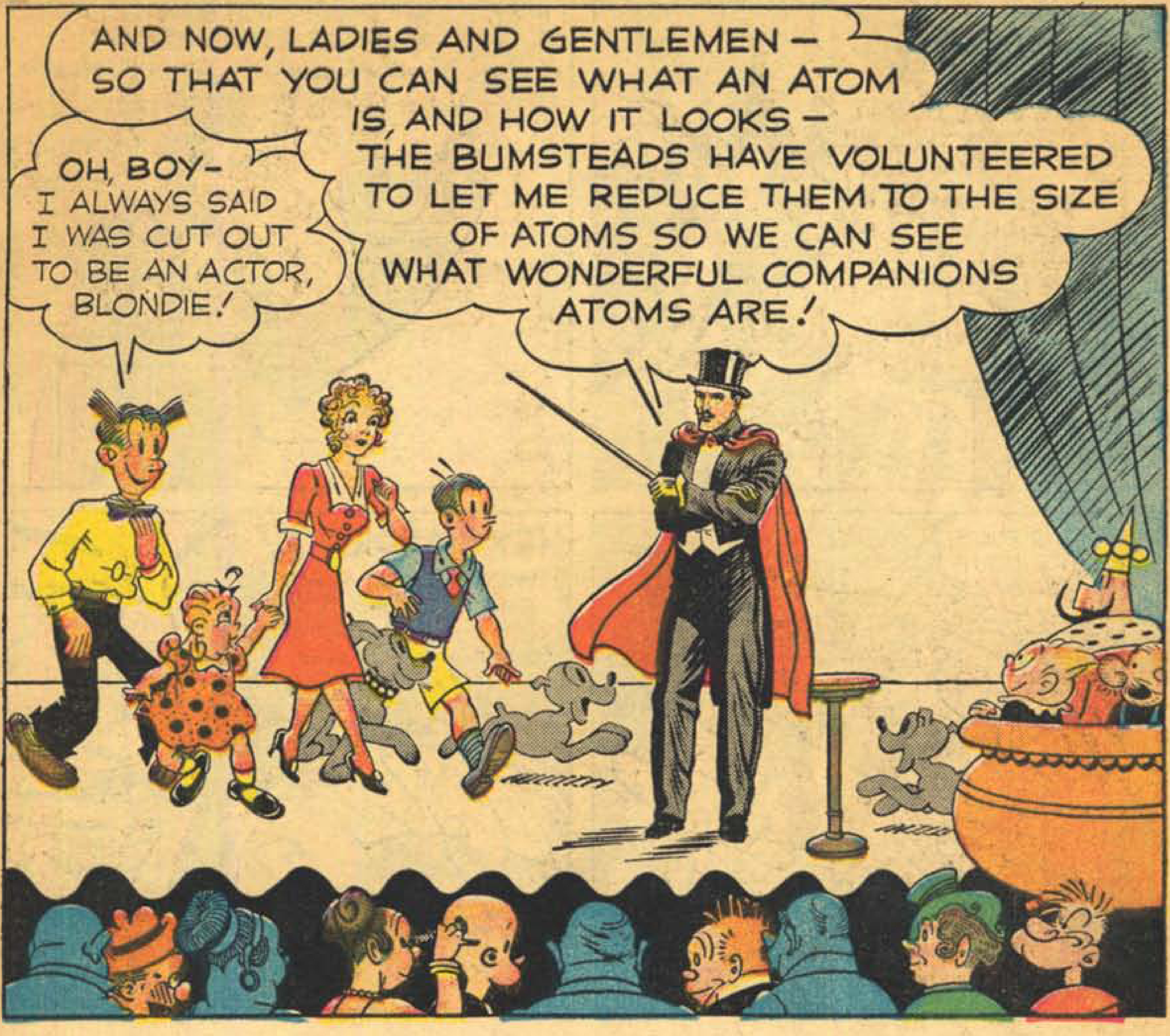



THIS BOOK TELLS what an atom is, how it can be split and what happens when it is split.

Here, therefore, is a comic book that is different from any you have ever seen. On these pages Blondie and Dagwood get inside an atom and witness amazing things. An explanation of certain interesting facts which Dagwood discovers in each picture can be found in the text below the picture. Then, at the end, questions are asked, and on another page the answers are supplied, so that you can answer, first, and then test yourself on how well you have answered.

Because this comic book is different from any you have read before, you will get most from it by reading it several times. First, glance rapidly at the pictures, getting an over-all idea about atomic energy. Then begin again at the start, read the text under each picture, study the picture. Finally, try to answer those questions on page 28. You will find the answers on the inside of the back cover.

The fundamental ideas of atomic energy are really not difficult to understand. You can grasp these fundamentals by studying each picture carefully. Bit by bit, as the pictures unfold, your understanding of man's greatest discovery will become




clear and you will glimpse the stupendous possibilities, the almost incredible opportunities that are offered by atomic power as a force and as a field of study and work.

As you read and study these pages, remember how important it is that young people like yourself should understand atomic energy. There are two reasons for this. First, the use of atomic energy for GOOD purposes depends upon the future citizens of our country. Young people should learn NOW about atomic energy, so they will be prepared to meet one of their most important responsibilities as citizens. Second, the opportunities for young people to make some phase of atomic energy their life work seem to be almost without limit and are steadily growing. The atomic energy problems which are now being studied—problems that affect every human interest—are already many times greater than those which followed any discovery ever known before; and their number and importance are increasing every day.

Atomic energy is truly a subject which *young* people must master.

To them—our youth—this book is dedicated.

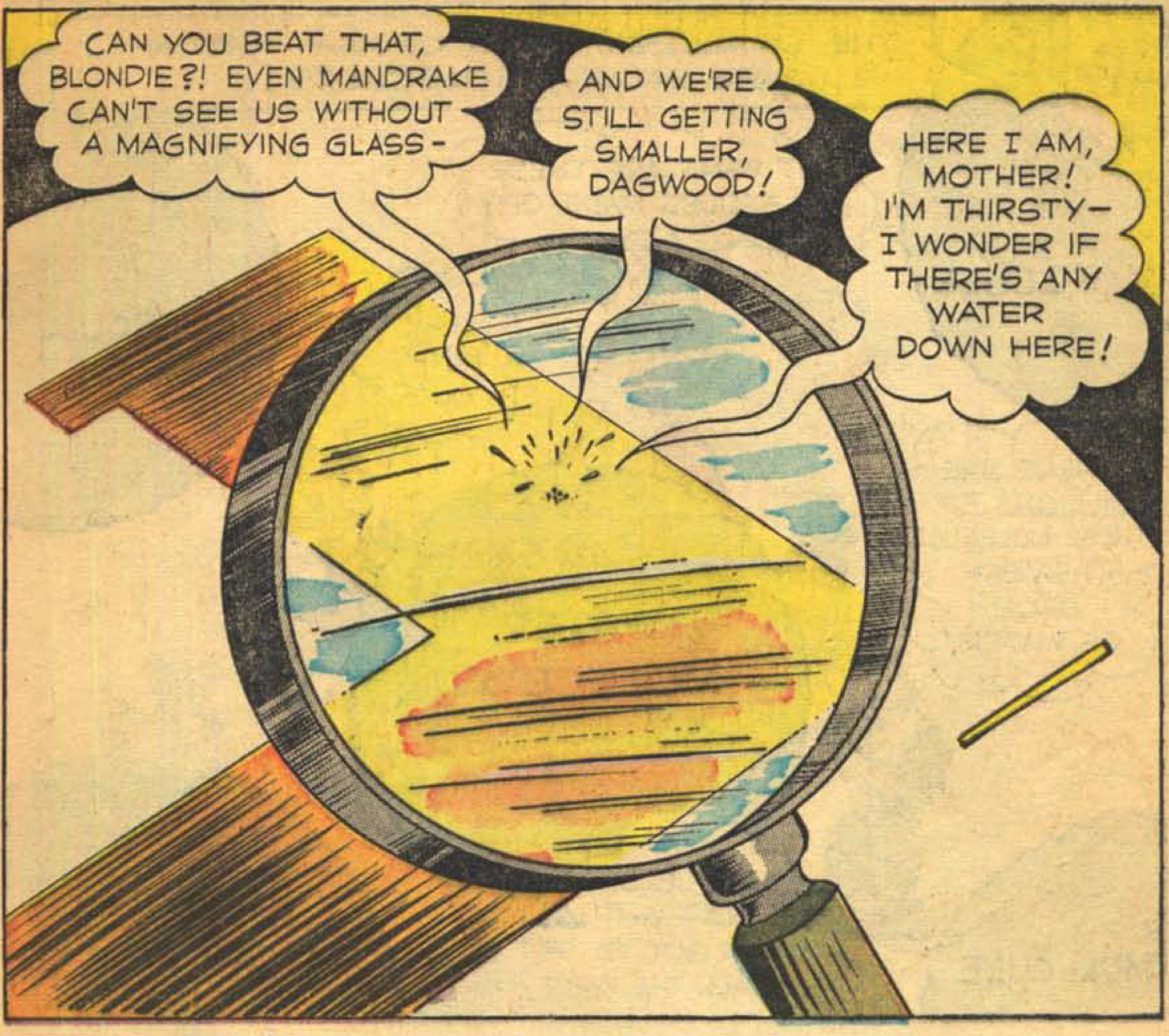
Joe Musial


## WHAT IS A MOLECULE AND HOW SMALL IS IT?

A city is made up of buildings. Each building has rooms, some alike, some different. A drop of water is like a city in which the buildings are all alike. The molecules in the drop of water are like the buildings in the city. The atoms which make up the molecules are like the rooms which make up the buildings.

Molecules, like buildings, are of different sizes and shapes. The smallest molecule consists of two atoms of hydrogen. It is like a two-room building in which the rooms are alike. No one really knows how big the largest molecule could be, because scientists are learning more every day about how to build molecules from atoms. Scientists do know that the molecule of ordinary laundry starch consists of several thousand atoms. But even this molecule is so small that it cannot be seen with our most powerful microscopes.

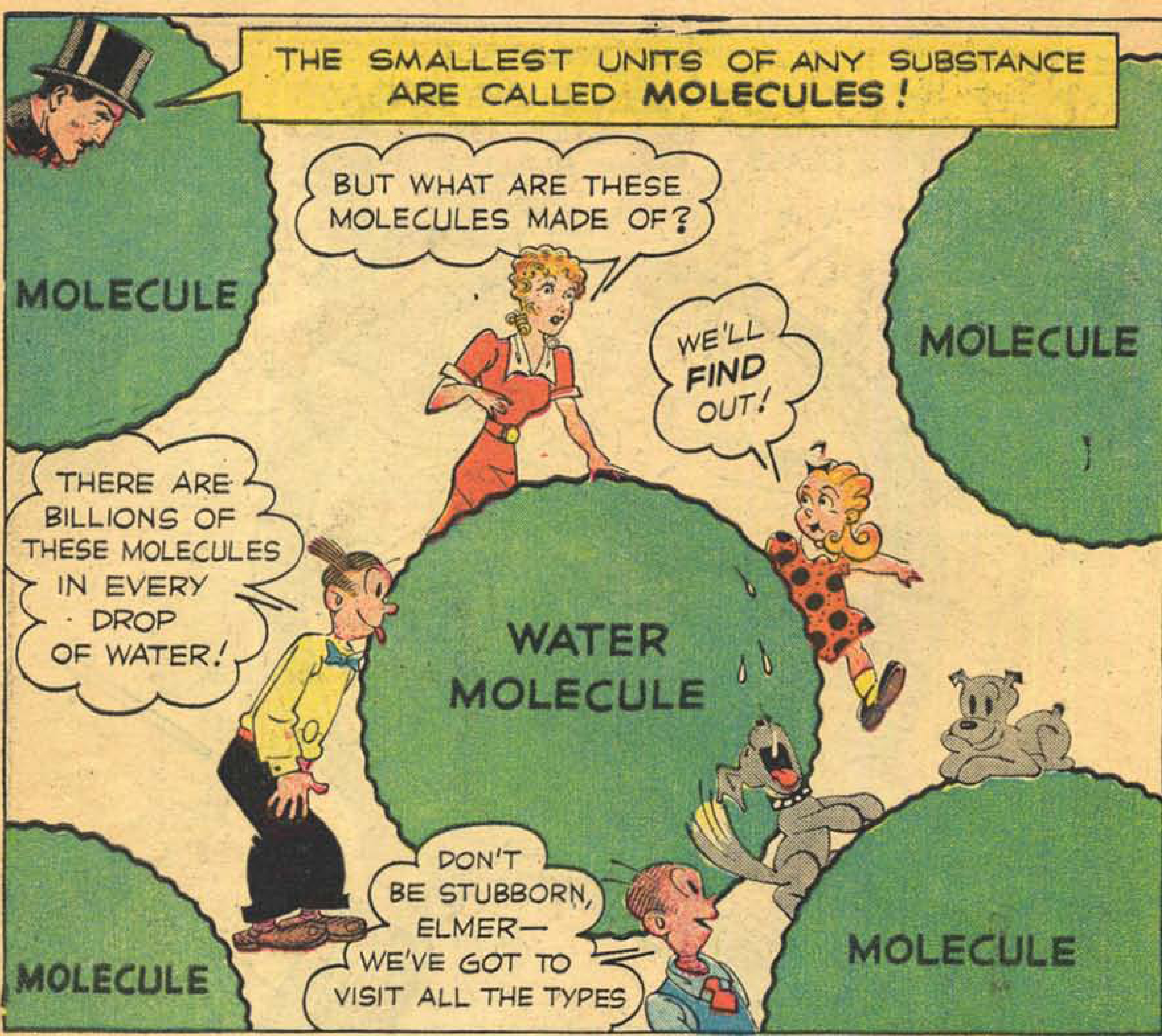
Mandrake would have to shrink Dagwood many millions of times to make Dagwood as small as a water molecule, which is about one hundred-millionth of an inch in diameter. Or, if Mandrake were to make Dagwood and the water molecule larger at the same rate, Dagwod would be so big he could touch the sun 93,000,000 miles away when the molecule became as large as Dagwood was at first.




## HOW MOLECULES ARE MEASURED

About twenty-five years ago Dr. Irving Langmuir, a Nobel Prize winner, performed an experiment to measure the diameter and length of the molecules of certain oils, which scientists at that time thought to be long and slender. His experiment, known as the oil film experiment, has become famous among scientists. Dr. Langmuir and other scientists knew that the molecules of these oils were of such nature that one end of the molecule was strongly attracted to water. He proved that if a small amount of this oil were poured on the surface of water, the molecules of the oil would stand on end with their "feet" in the water, so to speak. Then, knowing how much oil he had poured on the water and how many oil molecules were present, he was able not only to compute the distance across each molecule but also to compute its length. His experiments confirmed the scientists' idea that the oil molecules were long and slender.

Since Dr. Langmuir performed his experiment, scientists have devised many other ways of measuring the size of molecules and determining their shape.



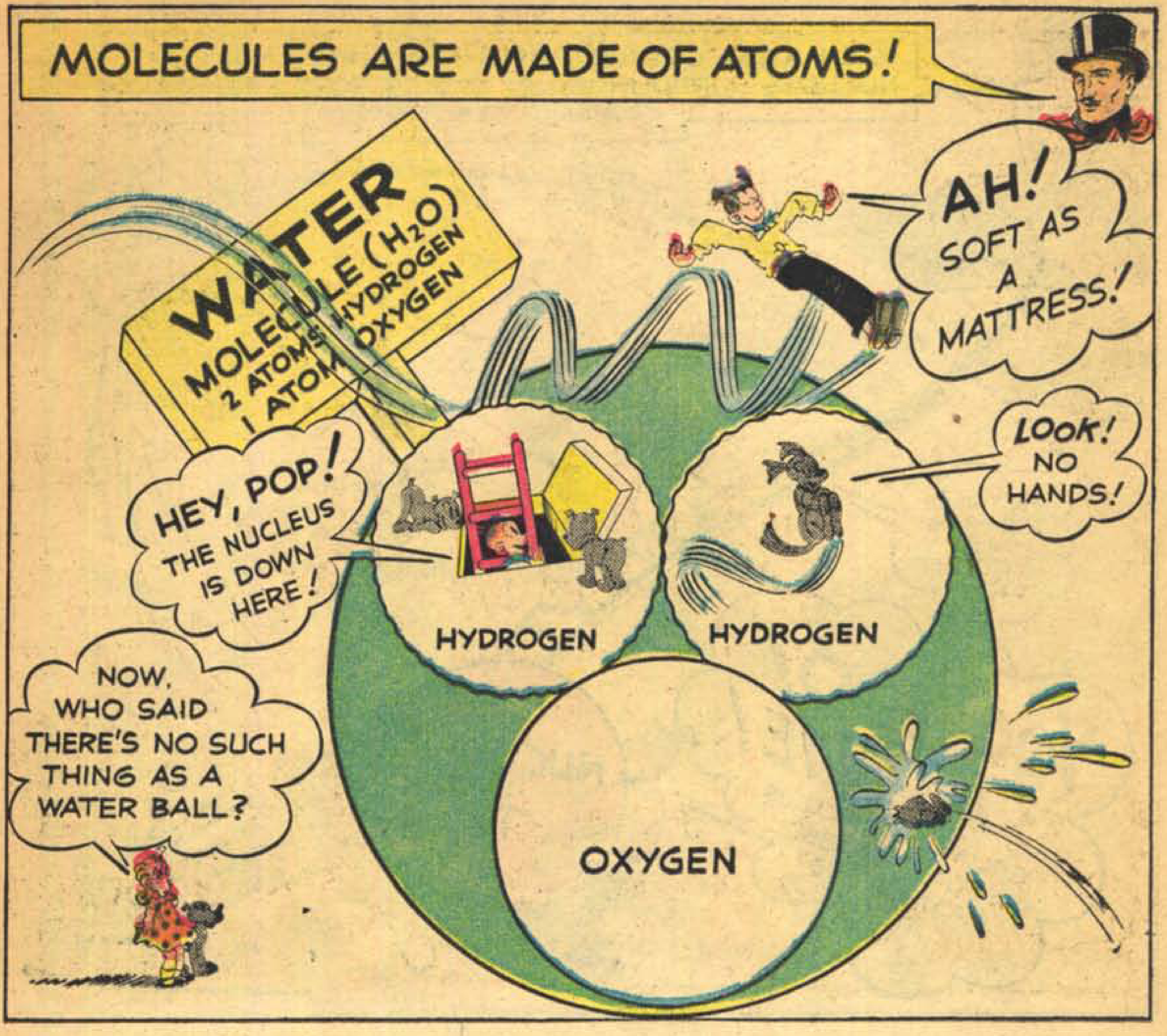

## MOLECULES ARE ALWAYS IN MOTION

If Dagwood and Blondie were really exploring the water molecule, they would be riding along with it just as people are carried along by the earth on its surface as it moves through space. The molecules of any substance are in constant motion. The rate of motion depends on the temperature of the substance. For instance, the molecules of very hot steam move faster than those of cool steam.

Actually, then, Dagwood and Blondie would be riding while they were exploring. And what a ride! The molecule would be moving at a speed of more than one thousand miles per hour—faster than the fastest jet airplane.

But Dagwood and Blondie would not have smooth sailing through space. Many billions of other molecules, like the one they were on, would also be moving with equal speed and in all directions. Their molecule would have many collisions with other molecules. The scene would be like that in a speeded-up movie of the turmoil and confusion in a crowd leaving a big football game.

The scientist knows that molecules are in motion when he studies a substance like smoke. Smoke really consists of tiny pieces of carbon. Seen through a microscope, these tiny pieces of carbon are found to be moving slightly back and forth and to and fro. The scientist tells us that this zigzag motion is caused by speeding air molecules bombarding the tiny pieces of carbon. The scientist cannot see the air molecules but he sees the particles of carbon being jostled by them.

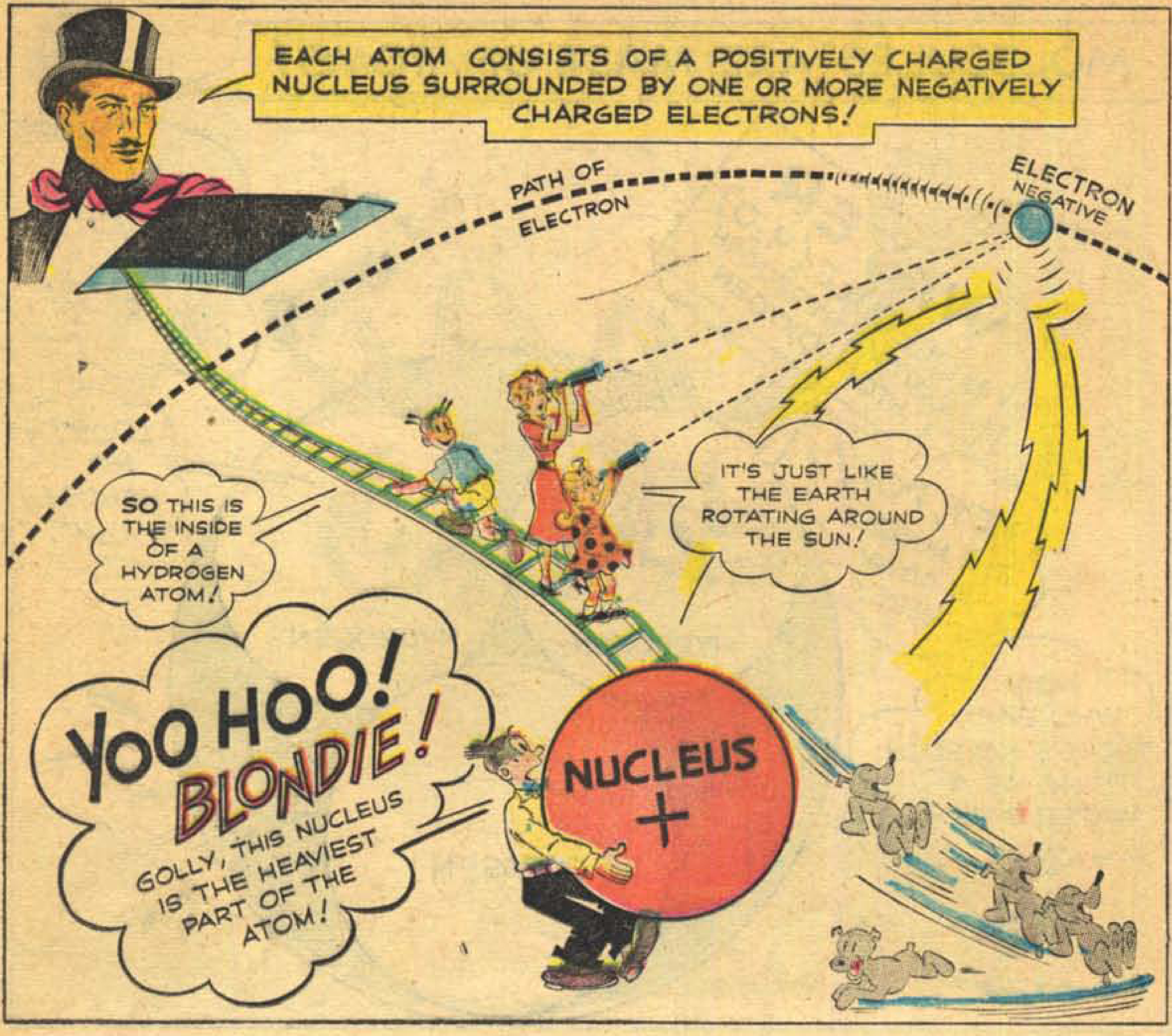



## WHY DOES DAGWOOD SAY THE ATOM IS SOFT?

When a person combs his hair in cool, dry weather, it becomes light and fluffy and won't stay down. Each one of the hairs is electrified by the combing. The electrified hairs repel one another because all are charged alike, and thus they stand apart.

The outer parts of all molecules are electrically negative. Therefore, when one molecule comes close to another, the outer parts repel each other just as the individual hairs are repelled.

How does the scientist know that water is two parts of hydrogen and one of oxygen? The scientist puts two wires from a battery into water in which a small amount of acid has been added. Bubbles of hydrogen then gather around one wire in the water and bubbles of oxygen around the other wire. The scientist measures the exact amount of hydrogen and oxygen which has gathered around the wires, and finds that there is just half as much oxygen as there is hydrogen. This experiment is called the electrolysis of water—the splitting of water by electricity.




## THE ATOM AS A SOLAR SYSTEM

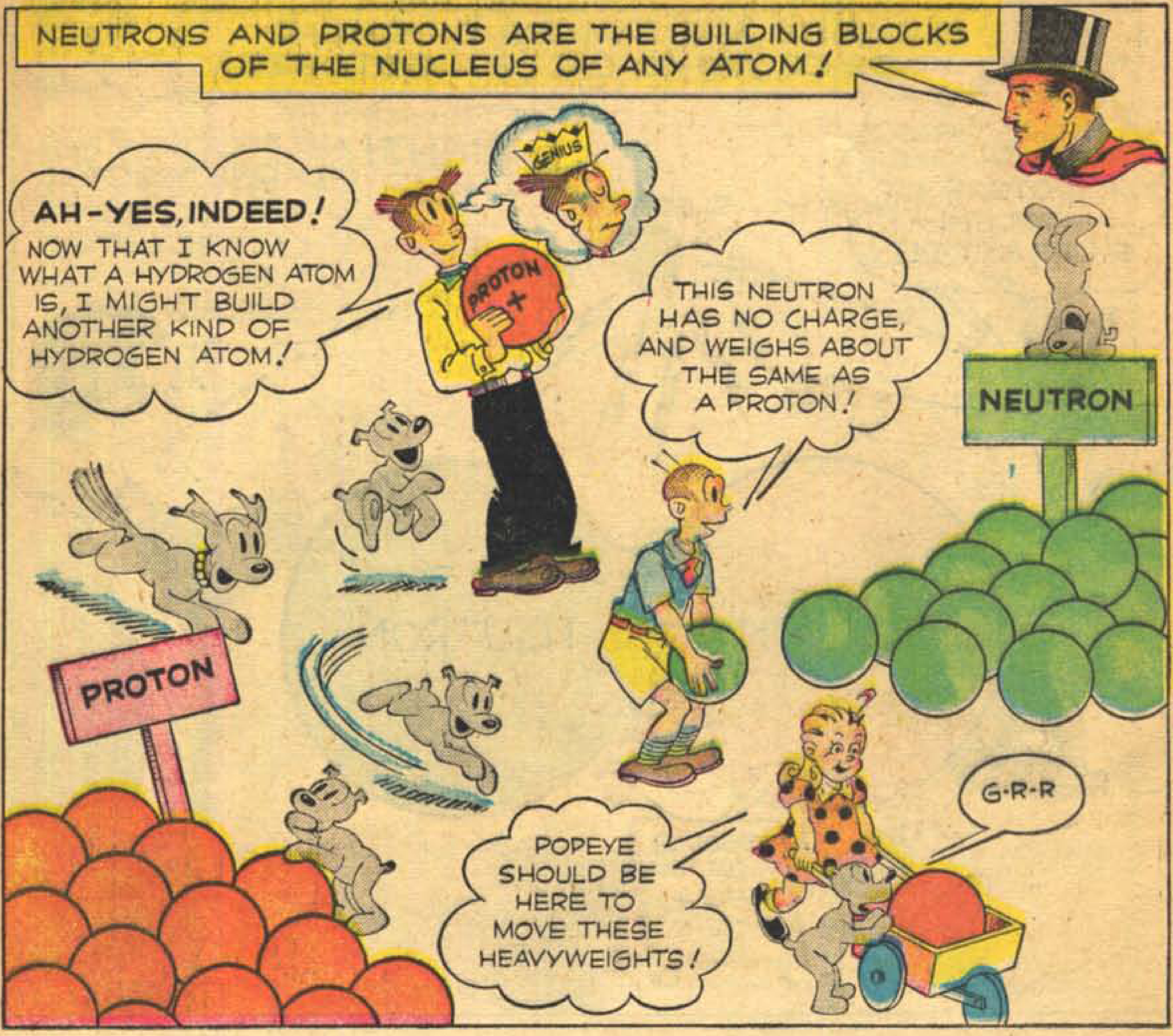
Just about forty years ago many scientists were trying to find out just what an atom is made of and how it is put together. One of these scientists was Professor Nils Bohr of Denmark, another Nobel Prize winner.

Professor Bohr had the idea that an atom is like a tiny solar system in which one or more negatively charged particles called electrons revolve around a positively charged, heavier central nucleus in much the same way that the earth, Venus, Mars and other planets move around the sun. According to this idea, an atom of hydrogen is a nucleus with just one negatively charged particle, an electron, moving around the nucleus just as the earth moves around the sun. Building on this idea, Professor Bohr imagined that atoms of heavier substances were simply made up of a larger number of electrons moving around a central nucleus in which most of the weight of the atoms was located.

Although Professor Bohr's theory has been changed slightly by other scientists during the past twenty years, his main ideas are still respected.

One of the important details of the Bohr theory is that an atom is almost all empty space.

Actually, if an atom were made much larger in all ways until it became as large as the solar system, there would be as much empty space in it as there is in the solar system.



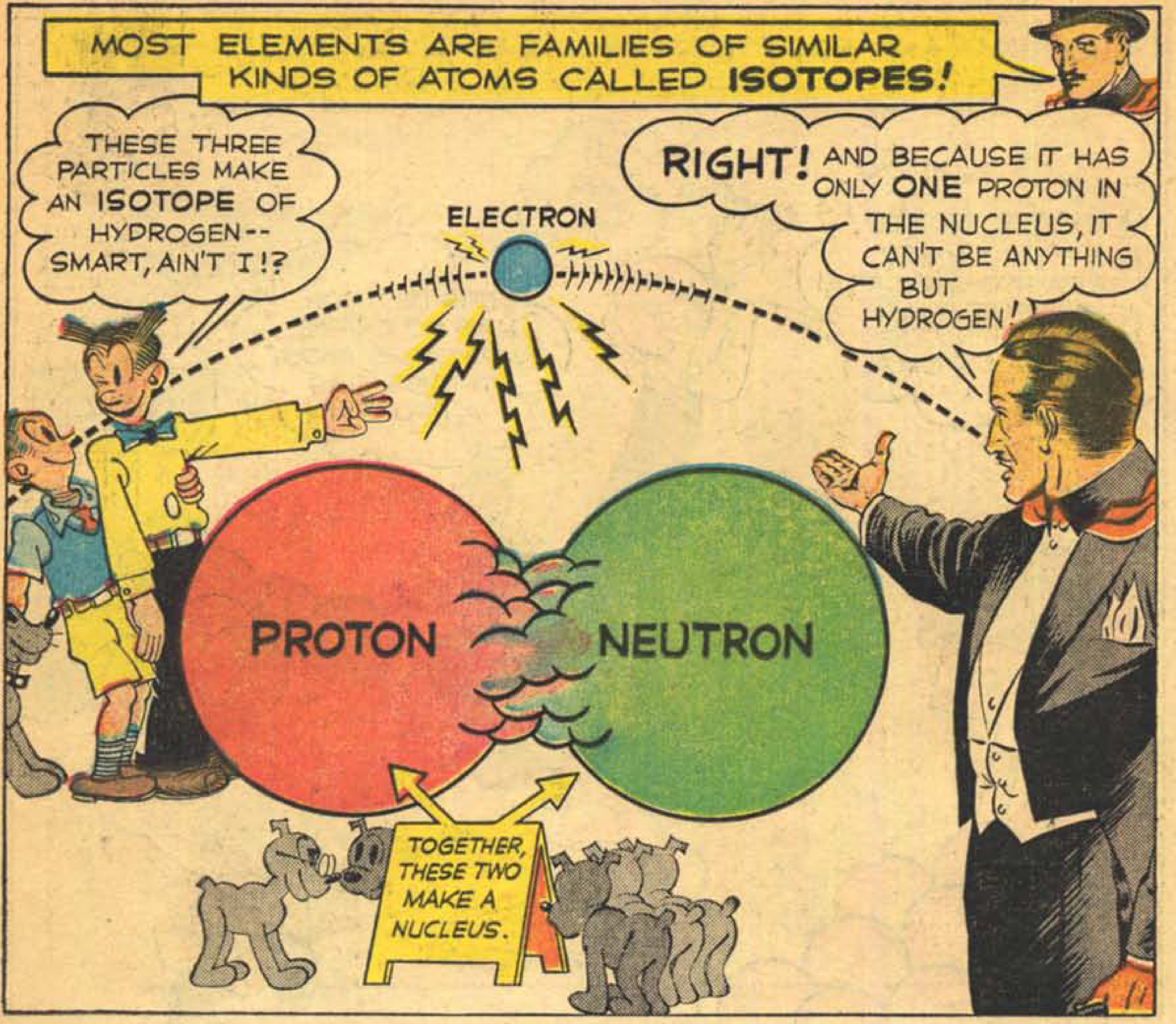

## THE WORD "NEUTRON" MEANS NEUTRAL PARTICLE

This tiny particle, which weighs about as much as a hydrogen atom, has no electrical charge. It can be thought of as the nucleus of a hydrogen atom, which has been neutralized.

Because the neutron is neutral, it was not discovered as quickly as the charged particles which scientists learned about. It was identified only about fifteen years ago by Chadwick, an Englishman.

When a neutron comes close to another neutron or even close to an electrically charged particle, it is neither repelled nor attracted unless it gets extremely close to the other particle. For this reason the neutron is quite penetrating. It can easily pass through the outer part of most atoms. It can also penetrate the nucleus of an atom quite readily.

The "proton" is just the nucleus of the ordinary hydrogen atom. It takes about one billion-billion-billion protons to weigh one pound. Each proton is charged positively with the same amount of charge that the negative electron has, though the electron weighs only about 1/2000th as much as a proton.

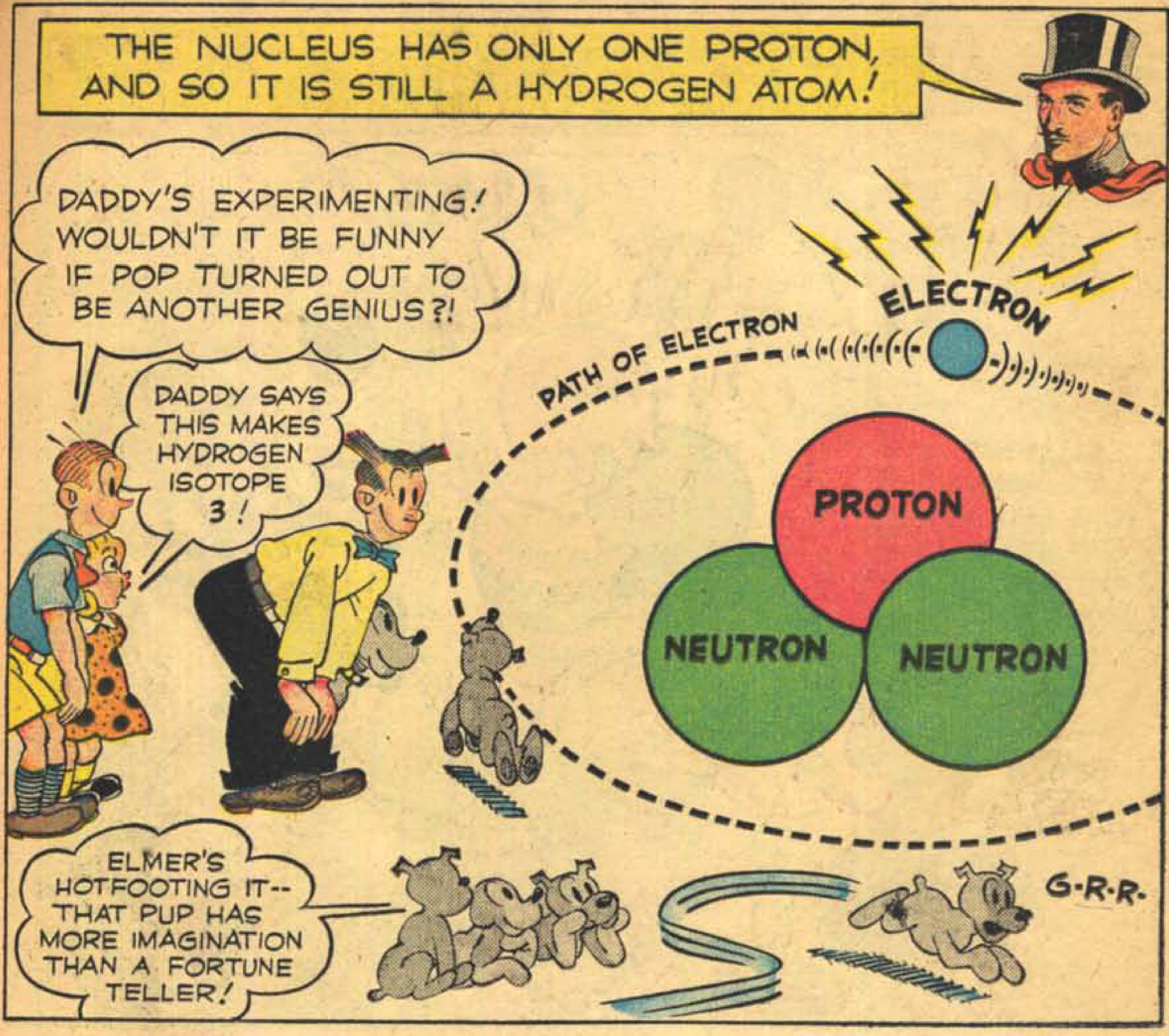



## ARE ATOMS OF THE SAME SUBSTANCE IDENTICAL?

It wasn't until 1907 that J. J. Thomson found that an element like mercury consisted of atoms which were alike in every respect except their mass. Thomson was able to show that this was true by putting an electrical charge on atoms like mercury and then making them pass through a magnetic field. What he did is very much like putting milk through a cream separator. When the separator is turned, the heavier part of the milk is thrown outward while the lighter cream is collected toward the center. Thomson found that when he made the electrically charged mercury atoms, called mercury ions, move into a magnetic field, all the ions moved in circles. But the heavier ones moved in big circles, while the lighter ones moved in paths closer to the center.

This kind of apparatus on a much larger scale was used during the war to separate atoms of uranium 235 from those of uranium 238.

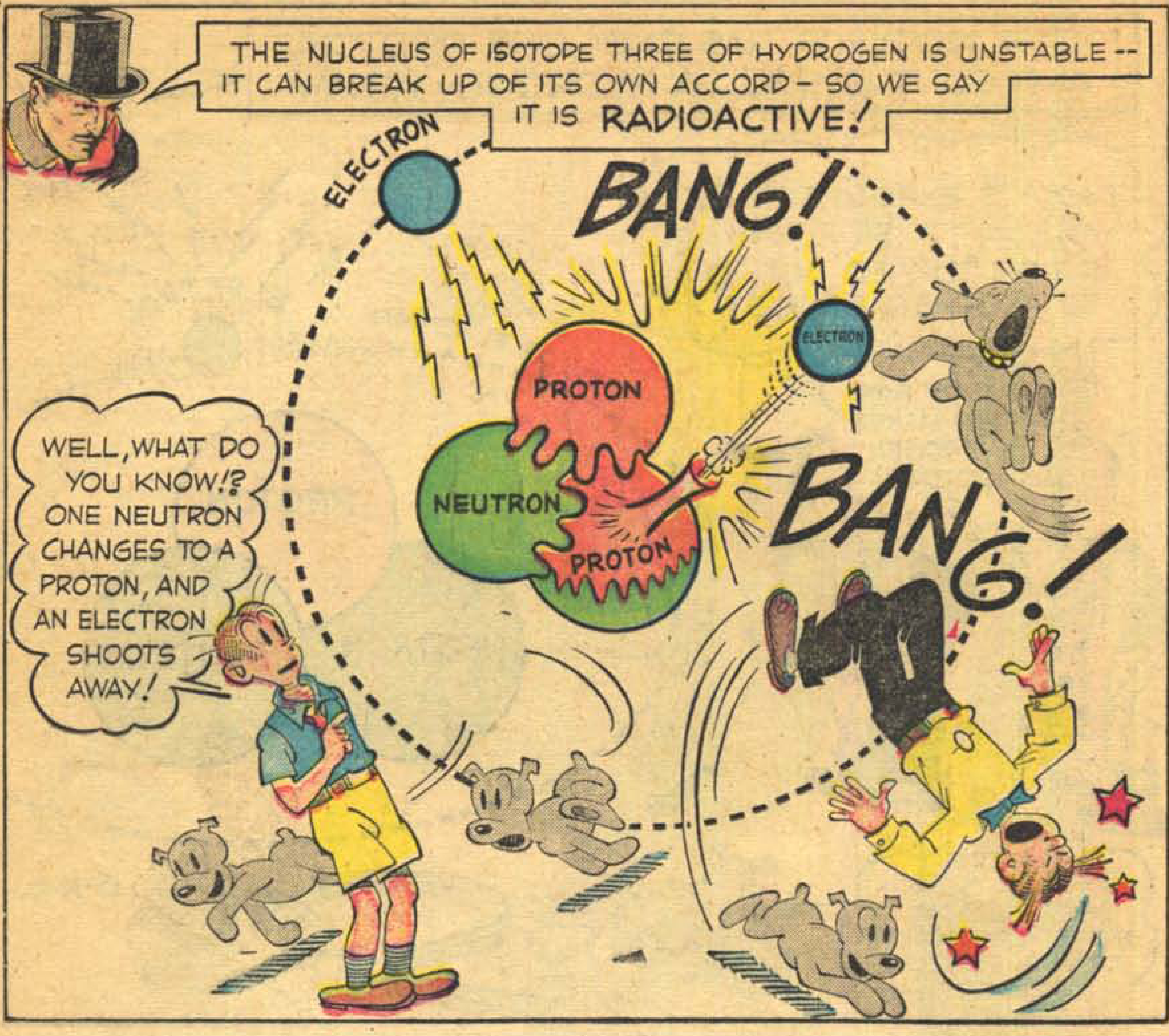
A second method for separating these isotopes, also used during the war, is called the thermal diffusion process. This method is based on the fact that when a substance is heated, the speeds of heavier molecules are less than the speeds of lighter ones. The apparatus used is a container, of which one part can be heated and another kept cold. If unseparated uranium is placed in the hot part, the lighter uranium atoms, are speeded up more than the heavy ones and thus more quickly reach the cold part, where they are removed.




## PRODUCING A NEW ELEMENT!

Actually, the scientist cannot build up elements in exactly the same way as Dagwood. But the scientist is able to do almost the same thing as Dagwood, by means of cyclotrons and Van der Graf generators. What these machines do is to speed up electrified particles until they have very great speeds and to allow these speeding particles to hit a substance. When this is done, a speeding particle frequently enters the nucleus of an atom and changes not only its mass but also its electrical charge. In this way an atom of a new element is produced.

In 1919, Ernest Rutherford, the famous British scientist, first performed an experiment of this kind. He did not have cyclotrons or Van der Graf generators to work with. In his famous experiment he used speeding alpha particles as atomic bullets. An alpha particle is the nucleus of a helium atom, and is shot out from a natural radioactive substance like radium. Rutherford allowed his speeding alpha particles to fall on nitrogen atoms. He deduced that the alpha particles entered the nucleus of the nitrogen atoms and produced a new element, for he found protons.

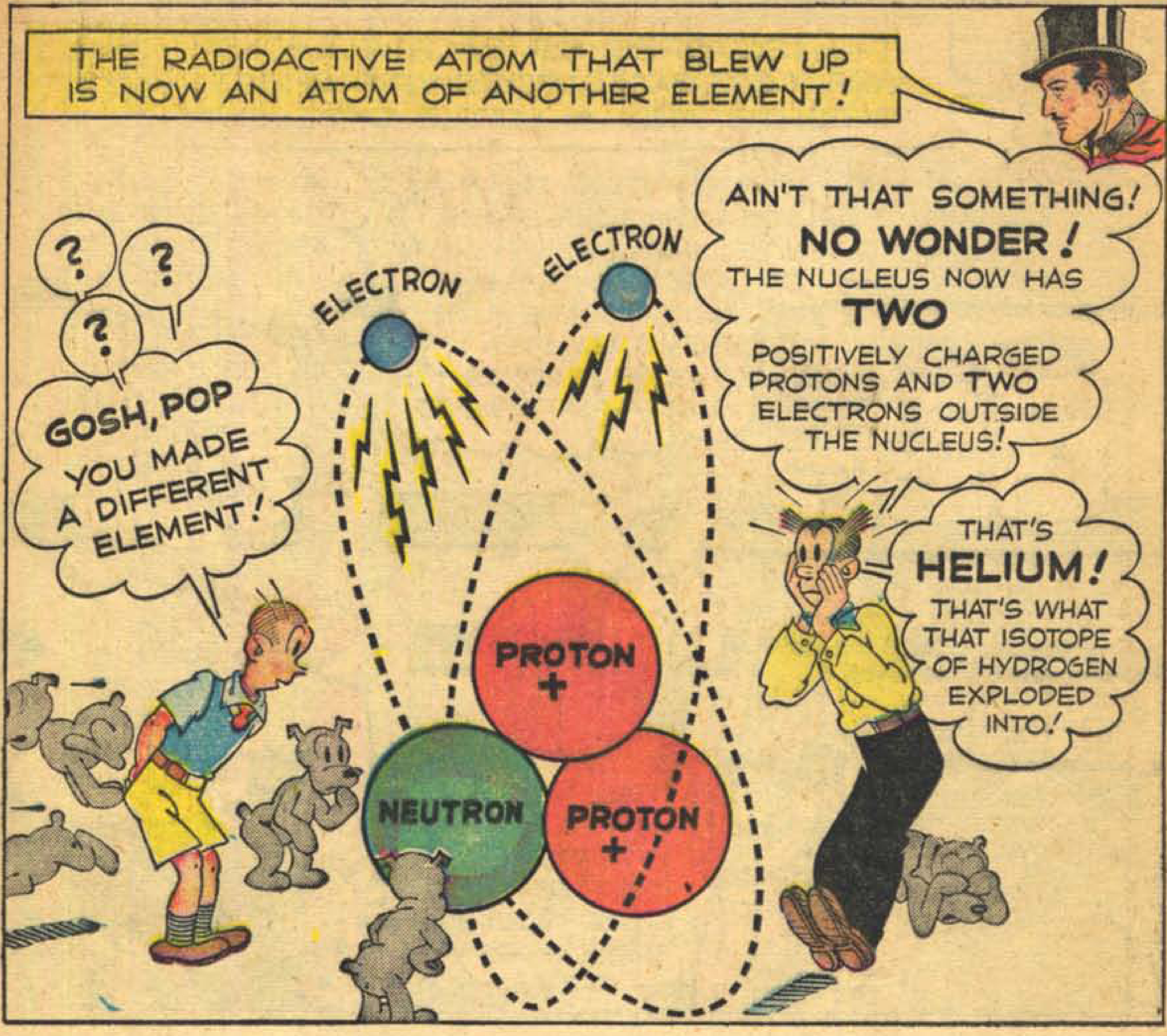



## DETECTING RADIOACTIVE ATOMS!

If you visit the Memorial Hospital in New York City, you find biologists and other scientists working with a strange new gadget called a Geiger counter—a detector of radioactivity. Often this device, about as big as a radio tube, has a thin window on one end. Wires from the counter go to an electrical control box with a loud speaker and a counter like an automobile speedometer. When a single speeding electrical particle, such as a proton or a high-energy light ray, passes through the window of the Geiger counter, a click can be heard in the loud speaker or the counter registers one notch.

The Geiger counter is used to detect single atoms of a radioactive substance. Such radioactive atoms are called tagged atoms because they tell where they are when they explode and send out an electrified particle or a gamma ray.

Doctors, by using the Geiger counter, are finding out many new things about how chemicals go to different parts of the body through the circulatory system, for with the Geiger counter they can actually follow the path of the tagged atoms by trailing their explosions.



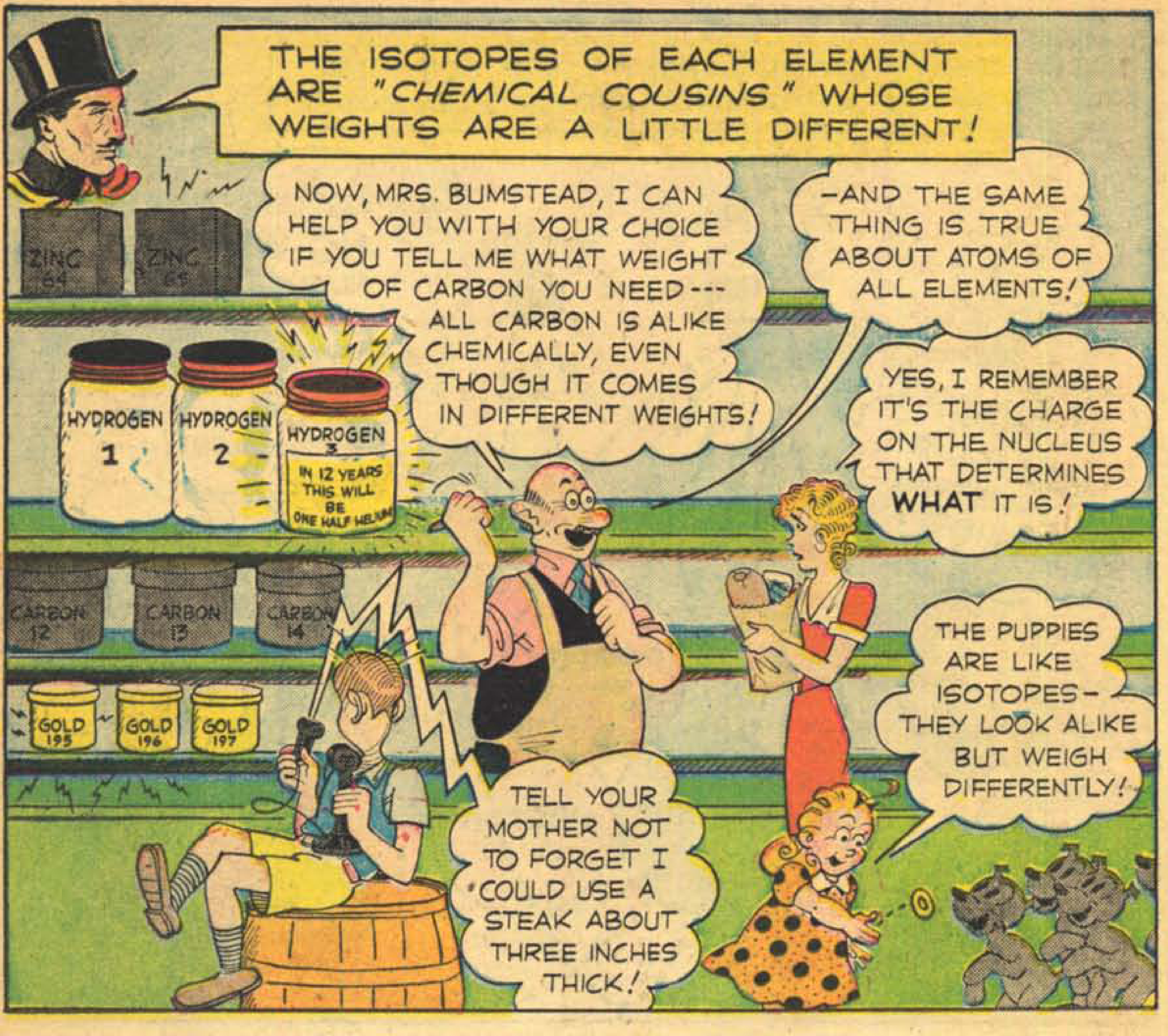

## SOME ATOMS ARE STABLE!

Dagwood probably doesn't know it, but he's pretty safe as long as he stays around helium atoms.

The reason is that when a radioactive substance sends out particles and breaks up into an atom of another element, this new atom tends to be more stable than the original radioactive atom. This is true even though the new atom also is radioactive. The process is quite like that of water running downhill, which in the process may give up its energy to a water wheel. In much the same way, when a radioactive atom explodes, the speeding particles which are hurled out of its nucleus take energy from it, and the new atom has less energy than the original atom.

Although a radioactive atom which explodes may form a new and somewhat more stable radioactive atom, eventually a point is reached in this radioactive process where a really stable atom is produced.

For relatively light radioactive atoms, helium is one of the "stopping points." Dagwood need not fear the helium atom—because it will not blow up in his face.




## MANUFACTURING ISOTOPES!

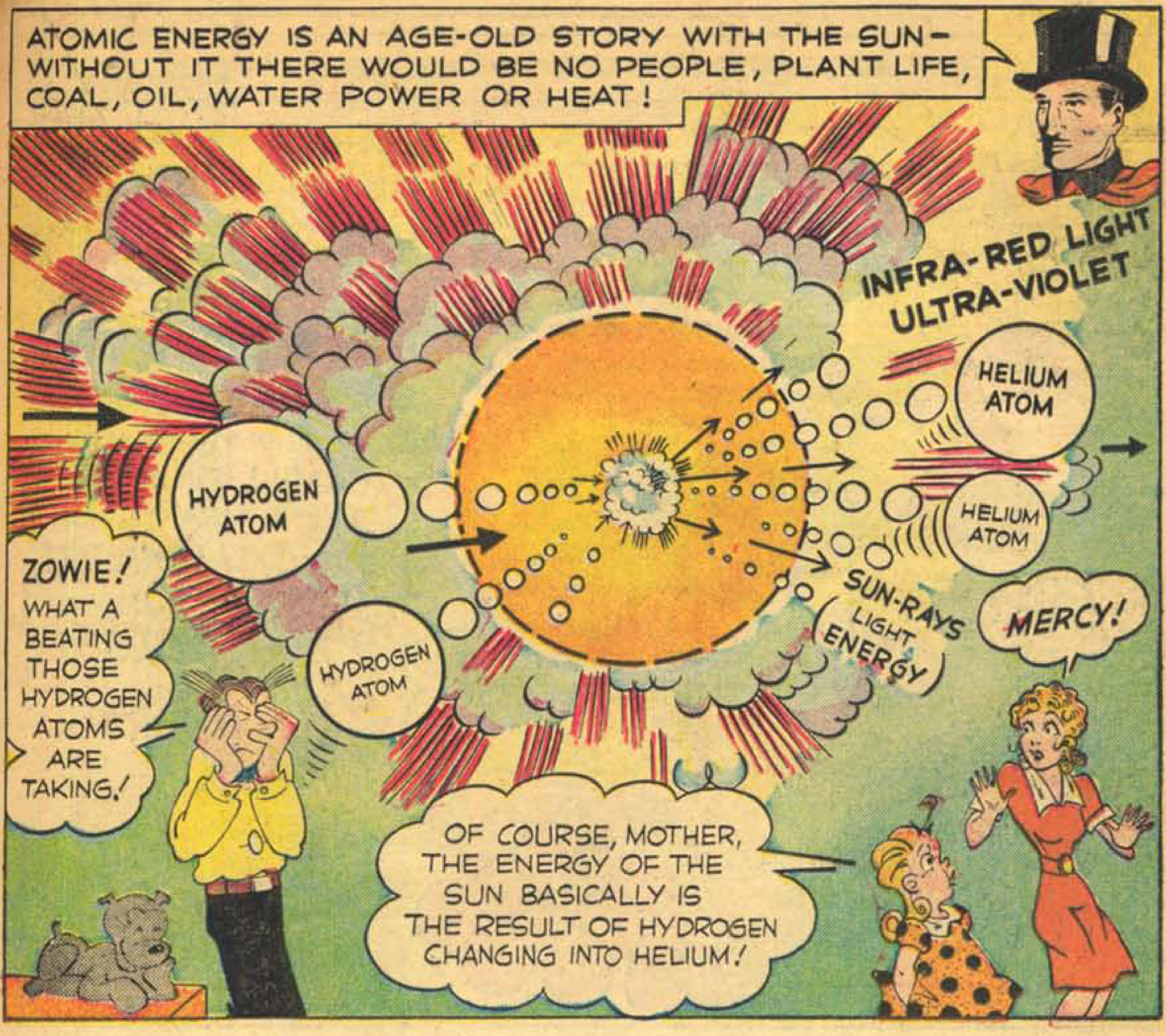
The Oak Ridge plant is literally a radioactive grocery store. An order placed there for a quantity of a radioactive isotope can be filled from stock. Each such order, however, has to be wrapped in a special lead container, so that people handling the radioactive isotopes are protected from the radiation which is given off.

Before the huge atomic energy plants were built at Oak Ridge, Tennessee, and at Hanford, Washington, scientists knew about a number of radioactive isotopes. But even for those that they knew about, the amount of any of these substances they had to work with was pitifully small—so small that a radioactive isotope was just a scientific curiosity.

Now, with these two huge plants, many more radioactive isotopes are known and their production is practically on an assembly-line basis.

The first shipment of radioactive isotopes for peacetime use was made from the Oak Ridge plant of the United States Atomic Energy Commission on August 2, 1946. More than one hundred different radioactive isotopes from the Oak Ridge plant are available to universities, industries and hospitals for use in intensive scientific studies.

Also, the cost of radioactive isotopes has been greatly reduced. A unit of radioactive carbon which cost one million dollars before the Oak Ridge plant was constructed, now costs about fifty dollars.

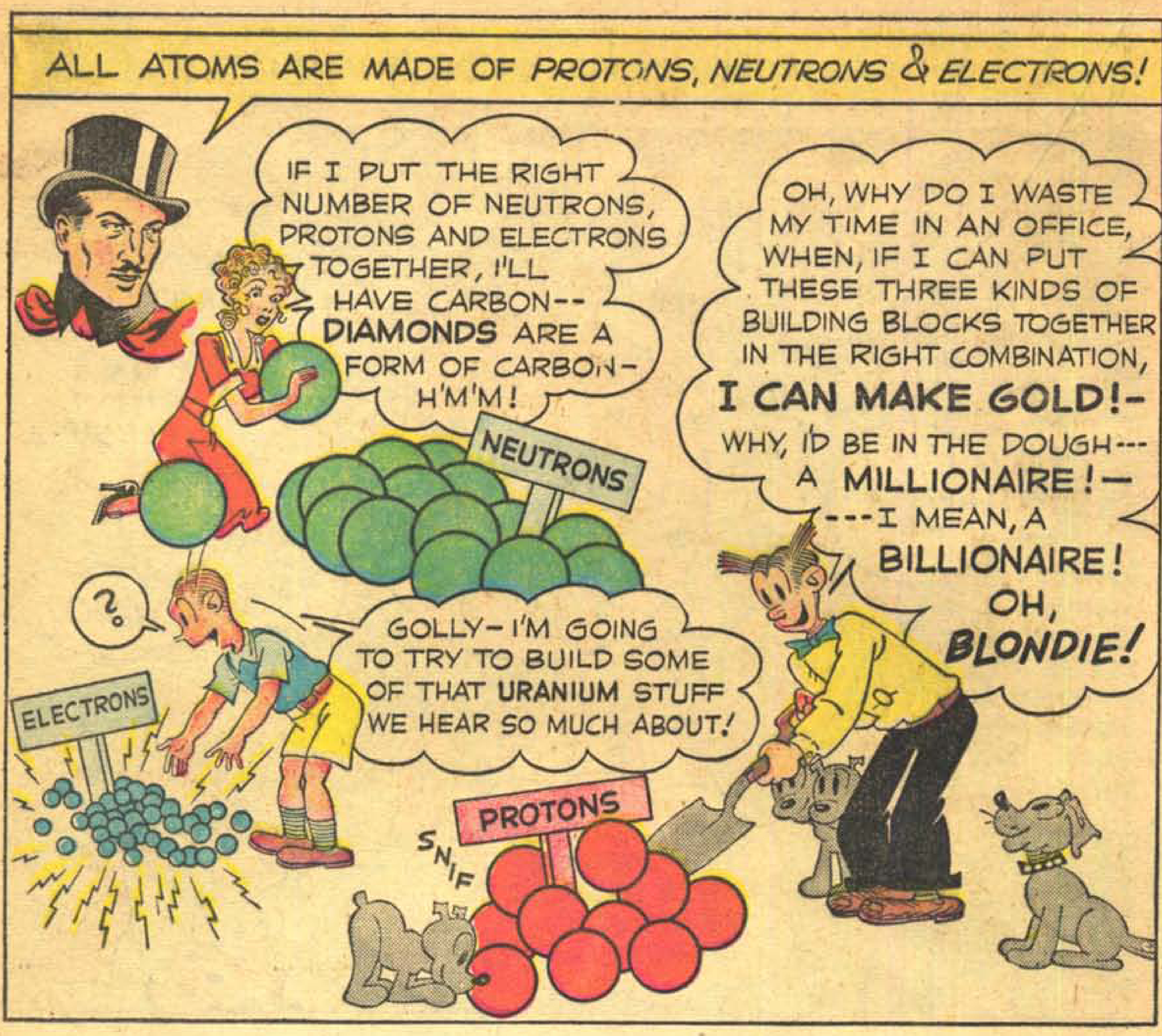



## ATOMIC ENERGY IN THE SUN!

For many, many years scientists have been puzzled by the problem of what keeps the sun hot. Many different theories have been offered, but none has explained the very great length of time that the sun has been radiating energy.

It is only recently that Professor Bethe, of Cornell University, and other scientists have proposed what seems to be a satisfactory explanation. Based on the fact that there is a tremendous quantity of hydrogen in the sun, a theory has been worked out which pictures hydrogen in the form of protons (nuclei of the hydrogen atom) as bombarding carbon atoms deep within the sun. This bombardment is believed to change the carbon into an isotope of carbon, which in turn is again bombarded by protons. This second bombardment produces an isotope of nitrogen. After two more bombardments the final result is the original carbon atom and helium. What this total process adds up to is that hydrogen is converted into helium. The number of carbon and nitrogen atoms present is unchanged. These atoms have only to be there to make the process go on. Hydrogen is the atomic fuel which, when converted to helium, produces energy at all the stages in the process, and this energy is eventually radiated from the surface of the sun in the form of light and heat.

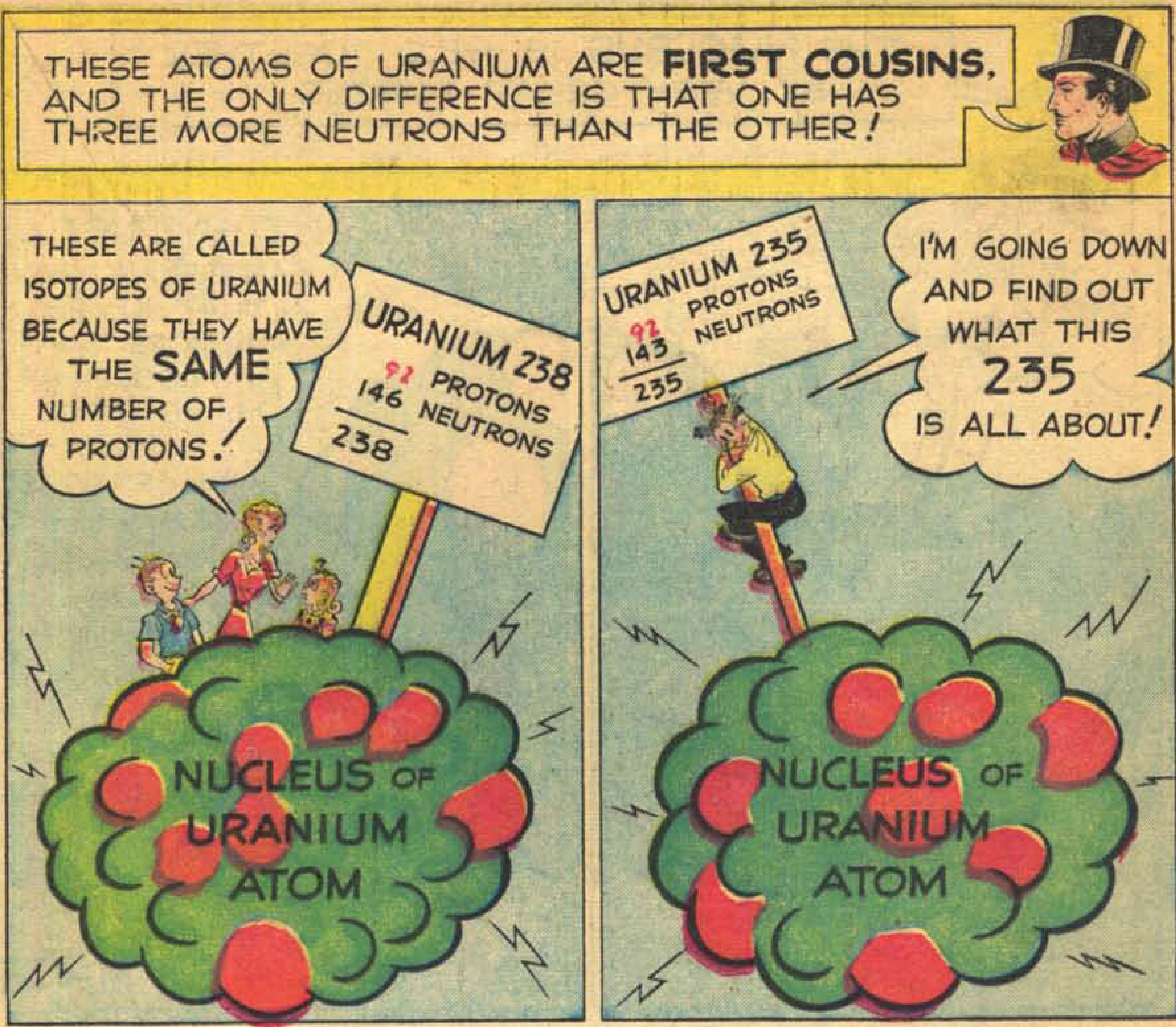
Calculations made by scientists show that the amount of hydrogen in the sun—and indeed in other stars in our universe—is enough to keep stars like our sun shining for several billions of years.




## A NEW KIND OF CHEMISTRY

Ever since man discovered that he could make two substances react chemically, he has had the dream of making precious substances from cheap ones—of making gold, for instance, from a base metal. In one sense the modern scientist has made the old alchemists' dream come true. The scientist of today can make gold from other elements. He calls this process the transmutation of one element into another.

Actually, though, the cost of such a transmutation, at present, even with modern apparatus, is such that it is cheaper to get gold the hard way by prospecting and mining. The reason is that the transmutation of an element by modern methods is a process of hurling an individual particle such as a proton into the nucleus of another atom. Such speeding particles are obtained either by a cyclotron or by a Van der Graf generator. In this process the number of hits by the speeding particles is far less than the number of misses. Therefore, the process is very expensive. Many scientists believe, however, that the use of neutrons will tell a different story. These atomic bullets in an atomic pile (see p. 25) have been found to produce large quantities of synthetic elements.

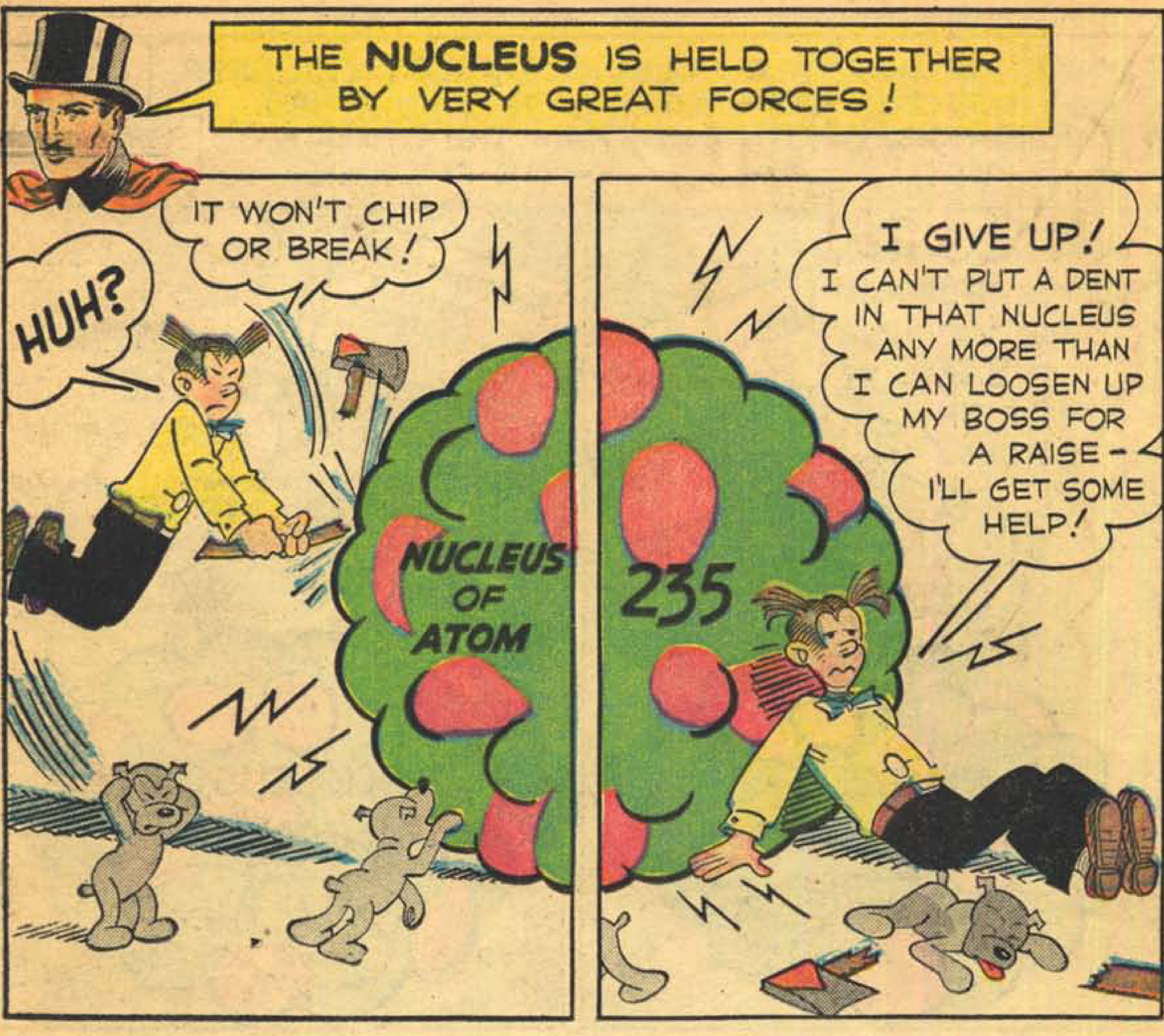



## WHAT IS URANIUM?

The element uranium is known to be present in more than one hundred different minerals. In only two of these minerals, pitchblende and carnotite, is uranium present to any great extent. The mineral pitchblende, a dark-brown, sometimes black, ore is found in Germany, the Belgian Congo in Africa, and the Great Bear region of northern Canada. Carnotite, the other major mineral source of uranium, is found as a bright, yellow streak in sandstone. It has been discovered in Utah, Arizona, and Colorado.

Because of the importance of uranium in atomic energy work, an intensive search for pitchblende and carnotite has been under way during the last ten years and has revealed deposits of these minerals in other parts of the earth. It is difficult, however, to state where rich deposits have been found, because each nation today is guarding such information as it guards a military secret.

Until the discovery of the importance of uranium for atomic energy purposes, the need for this element was very small, mainly as a coloring substance in glass and pottery.




## MYSTERIOUS FORCE HOLDS NUCLEUS TOGETHER

The proton and neutron are very much smaller than the atom as a whole. In fact, if the atom were as large as a room, the nucleus in the center would be smaller than a pea.

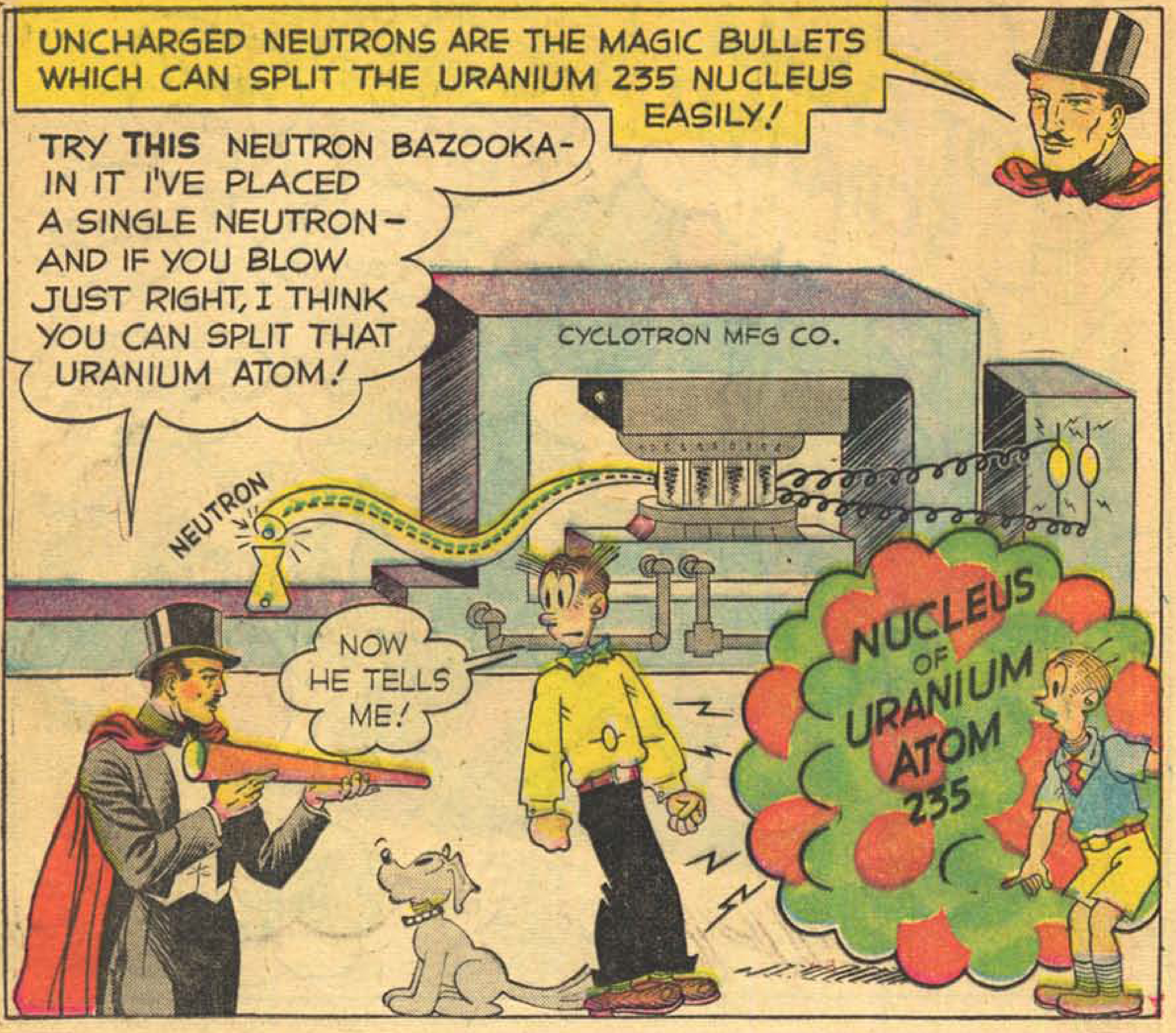
The protons and neutrons making the nucleus of any atom seem to be packed very closely together. This means that there is much less empty space between these particles in the nucleus than there is in the region outside where the electron is located. This fact is important, for it compels scientists to think of new and different kinds of forces as holding the nucleus together. The forces which scientists already know about would tend to make the protons, being charged alike, repel each other with tremendous forces at extremely small distances, and this would cause the nucleus to fly apart. Therefore, a new and more powerful force, different from any that scientists have identified, must be acting on the particles of the nucleus in order to hold them together.


## WHY CAN'T DAGWOOD SPLIT THE NUCLEUS?

Trying to split or penetrate the nucleus of an atom is again like trying to make hair stay in place when it has been combed on a cool, dry day. Dagwood is using a crowbar. But the crowbar consists of atoms, and each atom has a nucleus. When the end of Dagwood's crowbar is brought very near the uranium nucleus, there is a force of repulsion on the bar because the uranium nucleus and the nuclei of the atoms in the end of the bar are close together—and the closer they get, the greater is the force of repulsion.

Scientists have the same trouble that Dagwood has in attempting to penetrate the nucleus. What they have to do, to get anything inside the nucleus, is to use speeding particles. Often they use speeding electrified particles. If they do, each speeding particle must be moving so fast that the repulsion on it, from the nucleus, will not stop the particle before it gets inside the nucleus. The particle must actually be moving thousands of miles per second in order to penetrate the nucleus.

Such speeding particles are often obtained by means of the cyclotron, in which the electrified particle gets its speed by being whirled many times in a spiral path. This action is very much like that which the hammer thrower uses in getting the hammer up to speed.

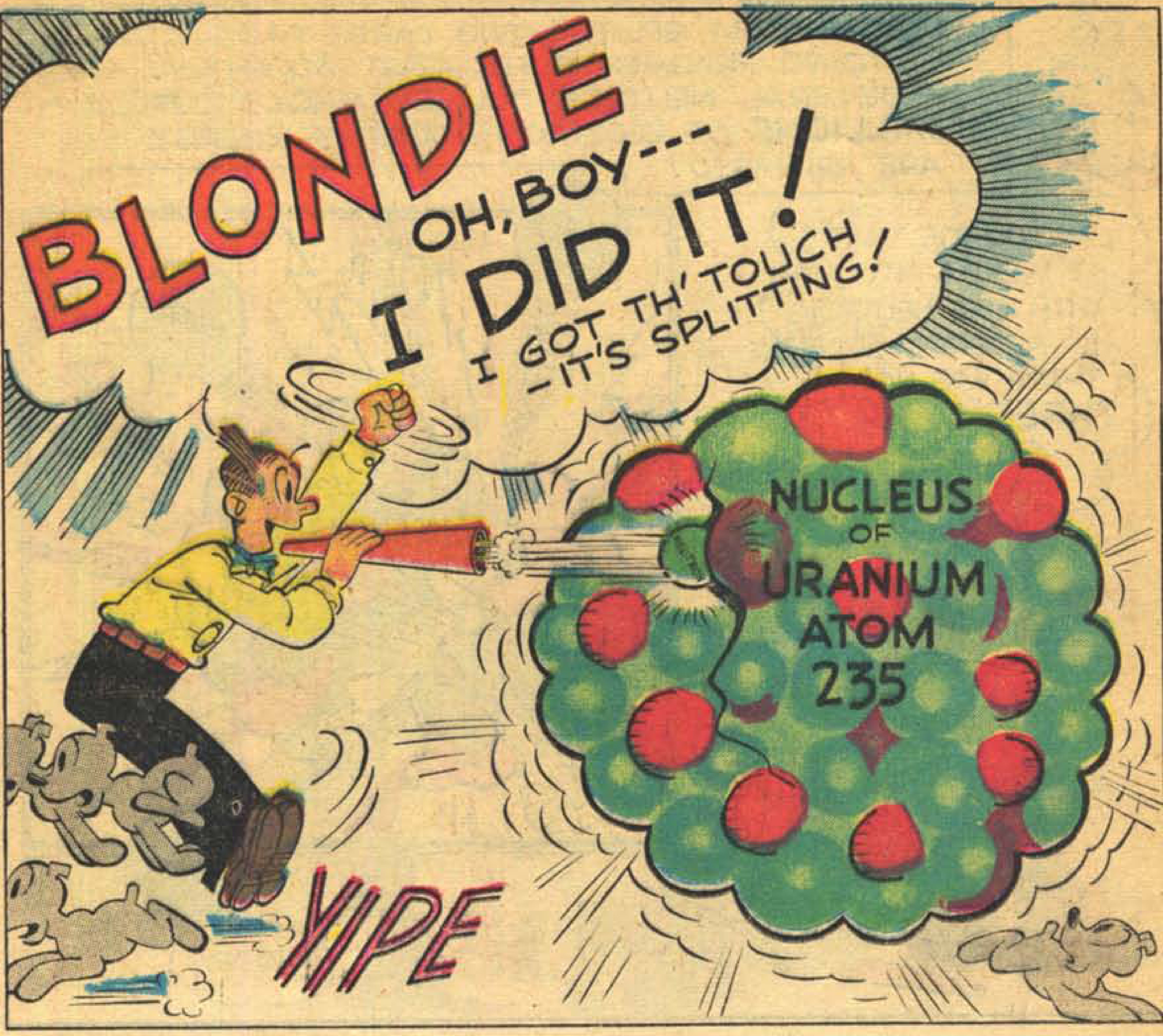



## NEUTRONS ARE LIKE ARTILLERY SHELLS!

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!

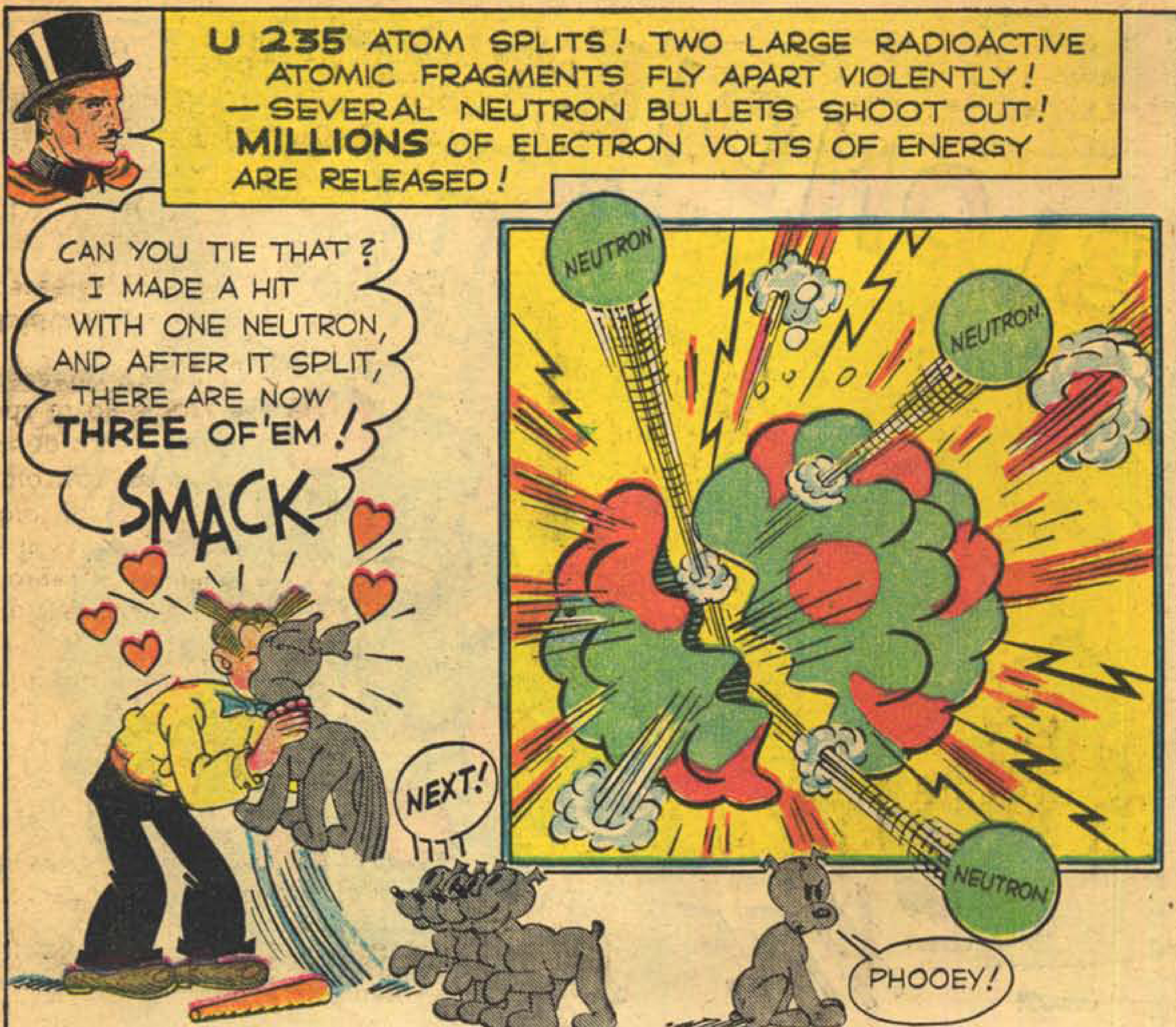
A report came from Nils Bohr to scientists in this country in January, 1939, that two scientists, Hahn and Strassman, had succeeded in splitting the uranium nucleus. Immediately upon hearing this report, Dr. John Dunning, professor of physics at Columbia University, and other scientists set about seeing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

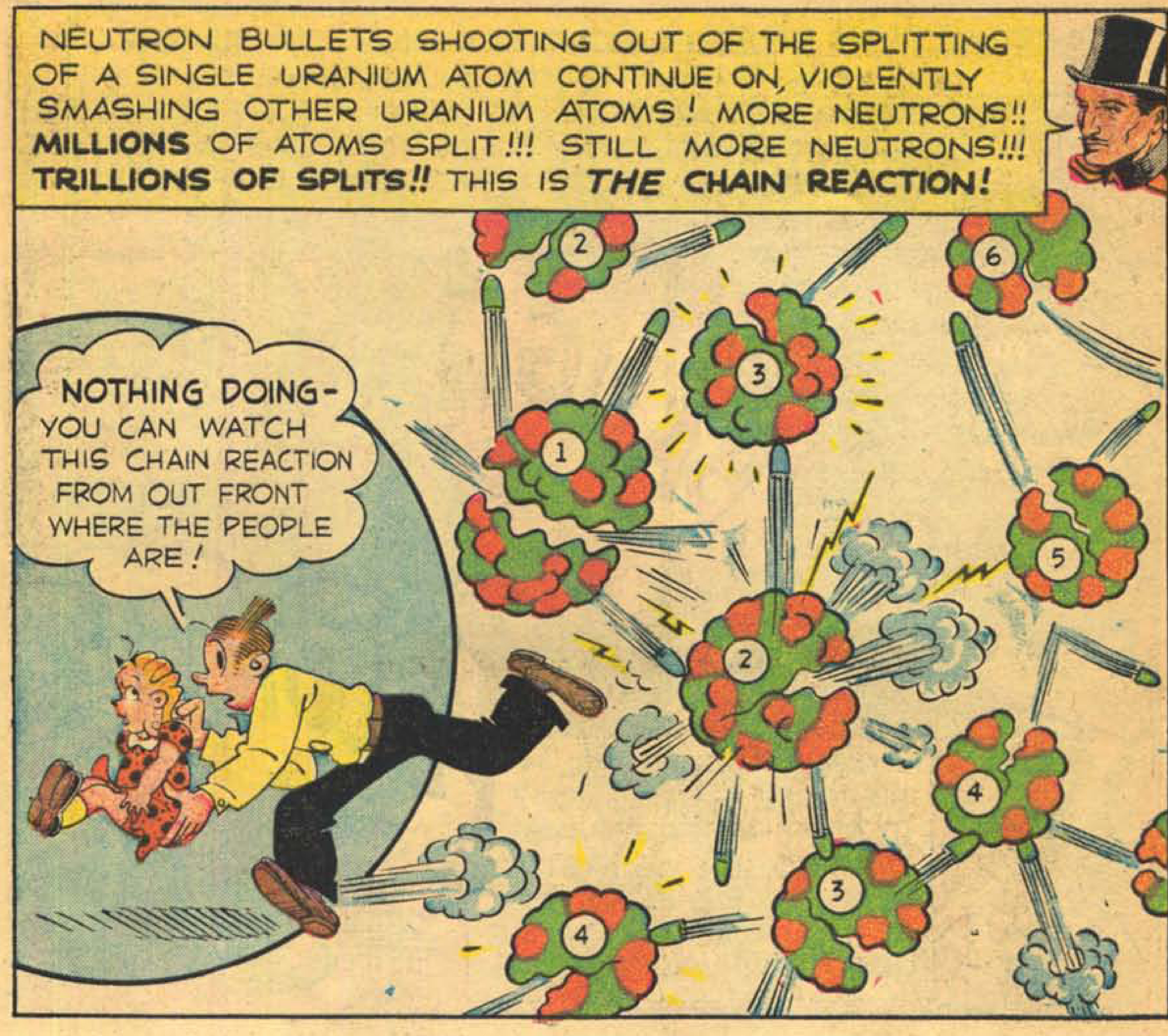
No wonder Dagwood is happy about getting more than one neutron from the splitting of the uranium 235 nucleus. The neutrons given off can split other uranium nuclei, and in this way the splitting process can continue on its own. This splitting process is sometimes called atomic fission.

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."

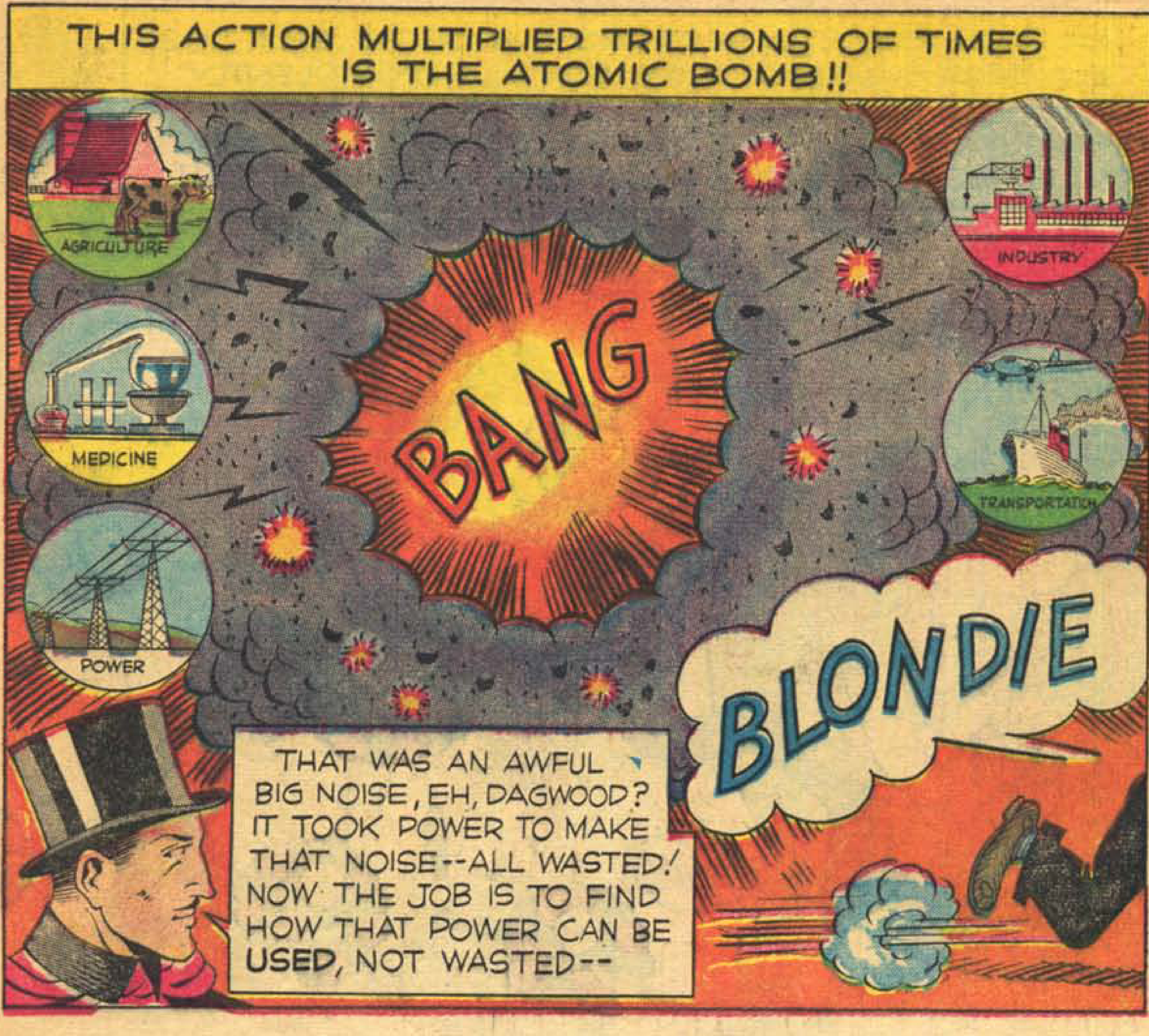



## A CHAIN REACTION IS NOT REALLY NEW

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

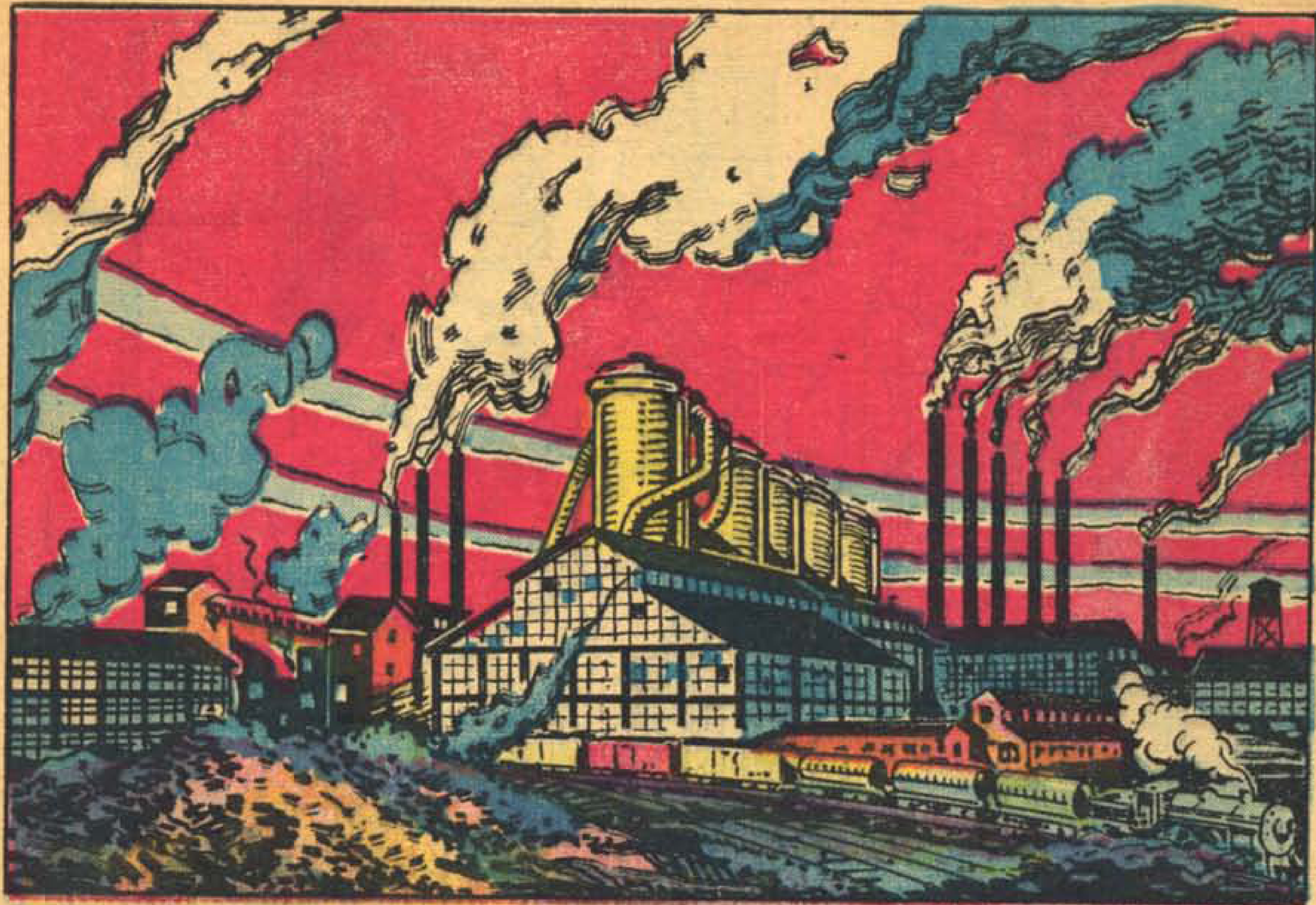
WHEN medical history comes to be written in the year 2000, radioactive isotopes will be recognized as making the most important contributions of this century. Used to trace the intricate process which a chemical undergoes from the time it enters the human body until it leaves, radioactive isotopes also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

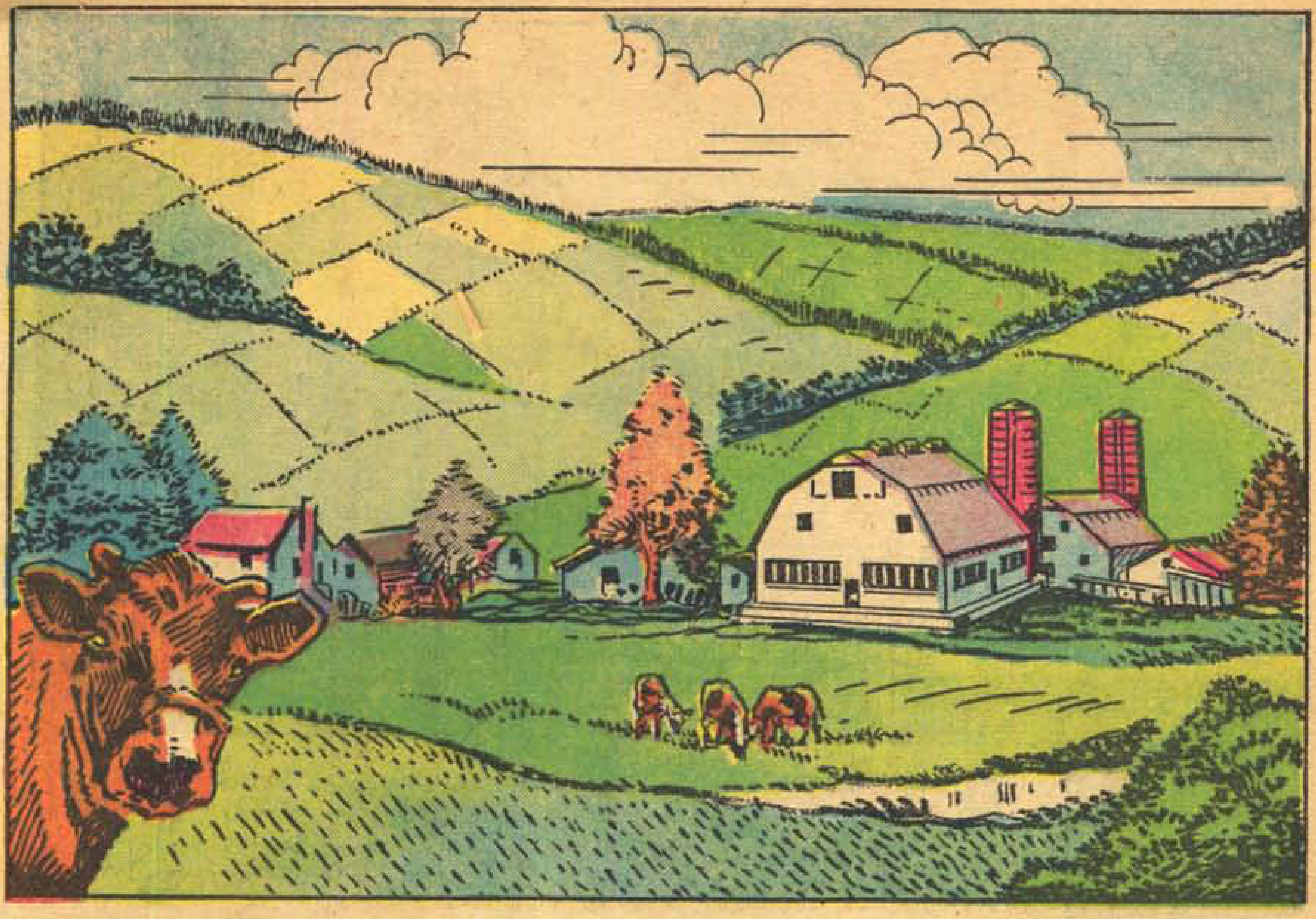
Now industry has a new tool—atomic energy in the form of radioactive isotopes—and is making quick use of it.

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.

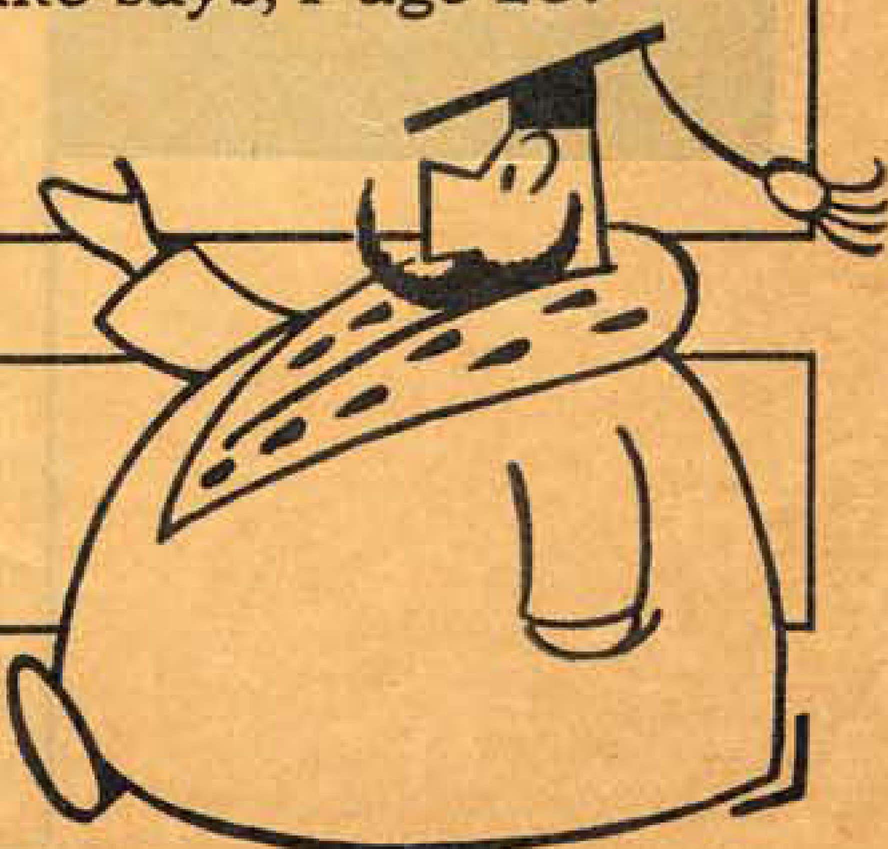
You can do this about atomic energy: first, find out more about it—what it is and what it is not, what it should do and what it shouldn't. Then you can talk with other people about it and gain their interest. The full use of atomic energy for *good* purposes should be your goal.

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*