

27 MEI 1937

PATENT SPECIFICATION

Convention Date (Italy): Oct. 26, 1934.

465,045

Application Date (In United Kingdom): Oct. 25, 1935. No. 29521/35.

Complete Specification Accepted: April 26, 1937.



COMPLETE SPECIFICATION

Method for Increasing the Efficiency of Nuclear Reactions and Products thereof

We, G. M. GIANNINI & Co., Inc., of 30, Rockefeller Plaza, New York City, New York, United States of America, a corporation organized and existing under the laws of the said State of New York, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

In many substances radio-activity may be artificially produced, as is well-known, by subjecting these substances under suitable conditions to a bombardment by neutrons. When studying the behaviour of the substances thus treated, which behaviour also depends on the nature and on the density of the medium provided between said substances and the irradiating body, the applicants observed in the intensity of the activation anomalies which could not be explained up to the present.

When working, for example, with silver we have found that if between the silver and the source is interposed a layer of paraffin which takes the place, entirely or partly, of the intermediate layer of air, the activation increases instead of decreases.

A similar and more obvious result is obtained by surrounding the system formed by the source and the object irradiated by large blocks of paraffin. The intensity of the activation may be increased in this case by a factor which ranges from a few tens to a few hundreds of times dependent on the substance employed and on the geometrical configuration of said system.

In pursuance of these observations further experiments were made by the applicants in order to find out the particular conditions under which the phenomenon manifests itself in a more obvious manner. The following has been found:—

(1) An effect with an intensity substantially equal to that obtained with paraffin is obtained with some hydrocarbons, with water and with other sub-

stances containing hydrogen.

(2) Substances containing oxygen but no hydrogen, such as for example NaNO_3 , give no increase of the activity or at any rate no increase of the same order of magnitude. 55

(3) The phenomenon observed in the case of silver does not occur with every element activated by means of neutrons. Thus for example, an appreciable increase of the intensity does not occur with silicon, zinc and phosphorus, whereas copper, silver and iodine give results much better than those which are obtained without the presence of an intensifying substance such as water or paraffin. 60

To judge from these results, it consequently seems that the phenomenon only occurs with those elements with which by bombardment, radioactive substances are produced which are isotopes of the original element. 65

With these substances the phenomenon may be utilised for the production of radioactive substances in quantities of practical importance, which substances have existed hitherto in very small quantities. 70

The increase of the efficiency under the above-mentioned conditions may be explained as follows:—

Due to subsequent impacts with the hydrogen atoms the neutrons lose energy and their speed decreases. It is probable that when the energy decreases the probability of impacts between neutrons and protons increases and that consequently after a few impacts the neutrons will move in a similar way to molecules diffusing in a gas, viz. with energy comparable with that of thermal agitation, so that they place themselves around a source like a solution of neutrons in water, paraffin or other substance employed with the result that per unit of volume a concentration of neutrons is obtained which is larger than that occurring in air under ordinary conditions. 75 80 85 90 95 100

The substances which have this

property of reducing the speed of neutrons are substances containing elements of low atomic weight, i.e., of atomic weight less than 14.

5 Accordingly, the process of producing radioactive elements by means of neutron bombardment according to the invention is characterised in that between the source of neutron irradiation and the
10 body irradiated is interposed a layer of a substance which contains an element of atomic weight less than 14, which layer of substance has the property of reducing the speed of the neutrons.

15 The process according to the invention may be carried out for example as follows:—

A quantity of paraffin is moulded into a definite shape and is provided with two
20 apertures. Into one aperture is introduced a source of neutrons, and in the other is placed the substance to be irradiated, for example silver. The latter is subjected to a bombardment by
25 neutrons which reach it through the paraffin, the latter having the property of increasing the effect of the action exerted by the neutrons.

The interposed substance is preferably
30 arranged around the source and the body irradiated so as to surround them. Instead of paraffin other substances comprising hydrocarbons may be used, or
35 other substances which contain hydrogen nuclei in their composition, such as for example water.

Having now particularly described and

ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we
40 claim is:—

1. A process of producing radioactive elements by means of neutron bombardment, characterised in that between the
45 source of neutron irradiation and the body irradiated is interposed a layer of a substance which contains an element of atomic weight less than 14, which layer of substance has the property of reducing the speed of the neutrons.
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2. A process as claimed in claim 1, in which the interposed substance is arranged around the source and the body irradiated so as to surround them.

3. A process as claimed in claim 1 or
55 2, in which the interposed substance contains hydrogen nuclei in its composition.

4. A process as claimed in claim 3, in which the interposed substance comprises
60 a hydrocarbon.

5. A process as claimed in claim 3, in which the interposed substance comprises
65 water.

6. A process as claimed in claim 3, in which the interposed substance consists of
paraffin.

7. Radioactive substances when produced by the process claimed in any of the preceding claims.

Dated this 25th day of October, 1935.

G. M. GIANNINI & CO., INC.
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