1,065,864

PATENT SPECIFICATION

DRAWINGS ATTACHED

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Int. Cl.:—H 01 f 1/02 // A 01 g, C 05 d

COMPLETE SPECIFICATION

A Disintegrable Permanent Magnet for use in the Soil

I, KENKICHI TSUKAMOTO, a Citizen of Japan, of No. 462—1 Fujiwara-Machi, Shioya-Gun, Tochigi Prefecture, Japan, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a disintegrable permanent magnet for use in the soil to accelerate the growth of plants.

Since magnetic force is a vectorial quantity, the use of magnetized powder as a fertilizer to the soil would be advantageous from the standpoint of furnishing the soil with mineral ingredients but would not be advisable if its magnetic force were stronger than the plant needs for its growth. Although the conventional solid magnet can produce a powerful magnetic force in proportion to its size, once applied to the soil the solid magnet tends to remain unchanged even after a harvest. As a consequence, subsequent planting or seeding in the same soil often results in discordant magnetic poles of both new and old solid magnets being so orientated close to one another that their magnetic forces act on the plant in an offsetting and diminishing manner. It will therefore be seen that attempts to provide the required powerful magnetic force which accelerates growth of the plant often face difficulty and cannot sufficiently create the optimum and fixed magnetic gradient in the direction towards which the plants grow.

It is the aim of the present invention to reduce or eliminate these difficulties, and according to the invention a disintegrable permanent magnet for use in the soil to accelerate the growth of plants comprises a magnetized moulded mixture of magnetizable material in powder form and a water-soluble binder, wherein the moulding step is such that the magnet will disintegrate in water over a period of between four and twenty-eight months of 30 days each into powder form, the magnetizable material consisting of or containing one or more metals which are beneficial to the soil and plant growth so that disintegration of the magnet within the soil by reason of the water-content of the latter enriches the soil.

The magnet described above can be applied to the soil so as to provide a powerful magnetic force, and it maintains the correct orientation during the growth of the plants. After the harvest has been gathered, the magnet disintegrates into a mineral-containing substance in which the soil of late years has been deficient and thereby enriches the soil and benefits its biotic function.

The invention also extends to a method of making the disintegrable magnet described above, which method comprises mixing a magnetizable material in powder form with a water-soluble binder, moulding the mixture in a mould, and magnetizing the resultant moulded article, the moulding step being such that the magnet will disintegrate in water over a period of between four and twenty-eight months of 30 days each into powder form, the magnetizable material consisting of or containing one or more metals which are beneficial to the soil and plant growth so that disintegration of the magnet within the soil by reason of the water-content of the latter enriches the soil.

Some examples of magnets in accordance with the invention are described below, with reference to the accompanying drawings, in which:

Fig. 1 schematically illustrates testing apparatus employed for determining the performance of a magnet in accordance with the invention;

Fig. 2 is a plan view taken on the line II—II in Fig. 1;

Fig. 3 schematically illustrates three beakers used in another testing procedure for determining the effectiveness of the magnet;

Fig. 4 is a graph showing the distribution

of magnetic intensity within the beakers shown in Fig. 3;

Fig. 5 illustrates the direction of lines of magnetic force in the beakers of Fig. 3; and

Fig. 6 schematically illustrates the manner of grafting in the presence of a disintegrable permanent magnet in accordance with the invention.

The disintegrable permanent magnet according to the invention is produced by the following process.

A magnetic material in powdery form, for example ultrafine iron powdery magnetizable material, Mn-Bi alloy powdery magnetizable material, or some other suitable powdery magnetizable material, is mixed with a water-soluble binder chosen from various basic salts of organic acids, sulphonated oils, fatty alcohol sulphate or polyvinyl alcohol. After being placed in a suitable moulding frame, the mixture is pressed and finally magnetized. Alternatively, the powdery magnetizable material is mixed with deliquescent materials such as $MgCl_2.6H_2O$, $CaCl_2.6H_2O$, $FeCl_3.6H_2O$ in the presence of a water-soluble binder, and placed in a moulding frame and magnetized. In moulding a large solid magnet having powerful magnetic flux most suited for accelerating the growth of plants, the essential points are that adhesion of the powder particles is good, its hardness and tensile strength are excellent, and it is able to disintegrate in water.

A number of disintegrable permanent magnets in accordance with the invention are described in the following Table 1. These magnets were each obtained by mixing calcined metal oxide magnetizable powder consisting mainly of cobalt oxide and iron oxide with polyvinyl alcohol as a water-soluble binder and magnesium chloride ($MgCl_2.6H_2O$) as a deliquescent material, both in varying ratios, then moulding the admixture under pressure. After drying, the moulded mixture was then magnetized.

For each sample set out Table 1, the composition of Co—Fe ferrite, polyvinyl alcohol, and magnesium chloride is given in percentages by weight. The magnetic flux densities of the samples (which were moulded into discs of 8.2 cm outside diameter and 3.5 cm thickness) are also given, as well as the number of days required by each sample to disintegrate in water into powder that is almost impossible to feel when rubbed between fingers.

TABLE I

Sample No.	Co-Fe ferrite powder (%)	Magnesium chloride (%)	Polyvinyl alcohol (%)	Magnetic flux density Br (Gauss)	Number of days required for disintegration
1	99	0.5	0.5	1350	4 × 30
2	„	0.1	0.9	1320	9.5 × 30
3	„	0	1	1300	28 × 30
4	98	0.5	1.5	1180	6 × 30
5	„	0.1	1.9	1155	10 × 30
6	„	0	2	1150	25 × 30
7	95	0.5	4.5	1025	7 × 30
8	„	0.1	4.9	1015	9.5 × 30
9	„	0	5	1000	21 × 30
10	90	0.5	9.5	885	7 × 30
11	„	0.1	9.9	870	8.5 × 30
12	„	0	10	865	19 × 30
13	80	0.5	19.5	780	7 × 30
14	„	0.1	19.9	775	8 × 30
15	„	0	20	770	17 × 30
16	70	0.5	29.5	650	5.5 × 30
17	„	0.1	29.9	635	7 × 30
18	„	0	30	630	16 × 30

As is clear from the above Table, the greater the proportion of water-soluble binder (polyvinyl alcohol in these tests) in the mixtures, the smaller becomes Br value. Accordingly, a practical Br value can be maintained by fixing the blending ratio of polyvinyl alcohol. Also, by adjusting the amount of deliquescent material ($MgCl_2.6H_2O$ in these tests) to be added and blended, it is possible to select from among a wide range of hours those required before disintegration takes place.

Test results are given below for the purpose of illustrating the behaviour of magnets in accordance with the invention.

1st Growth Test of Plants

Object: To observe the effect of the magnetic body (N pole or S pole) on the growth of plants.

Results: In the N pole plot, both the germination percentage and plant height were far better (about 63%) than those in the untreated plot.

The tests were carried out using radish seeds which were seeded on November 19 and measured on November 27 of the same year. The results are tabulated below:

TABLE 2

Plant Height (mm)

No.	1	2	3	4	5	6	7	8	9	*	Germination %	Ungerminant	Total
Untreated	25	29	27	30	19	5	7	0	0	16	78	2	142
Magnet N pole	47	40	39	30	21	23	20	10	5	26	100	0	235
Magnet S pole	36	31	24	26	20	15	11	4	0	19	89	1	167

*Arithmetic mean value of the height of 9 plants.

2nd Growth Test of Plants

Object: As it was observed from the 1st test that the N pole plot had shown far better germination percentage and plant height than in the untreated plot, in order to check if such results were reproducible, this test was conducted under the same conditions as the 1st test.

Results: Same as the 1st test, both the germination percentage and plant height were far better than those observed in the untreated plot.

Test methods: These were the same in both tests, using a shallow glass vessel 10 (see Figure 1) and putting thereon 3 sheets 12 of absorbent cotton. Nine seeds 14 were sown on the sheets 12 and 24 cc of water was added. To prevent the level of water from getting low, the vessel 10 was put in another larger glass vessel 16 full of water (taking care that the water in the vessel 16 did not come into the smaller vessel 10) and covered with an unglazed pot 18 to shut out the light. In those cases where the seeds were magnetically influenced, a magnet 20 in accordance with the invention was placed in the vessel 10 below the sheets 12.

In the 2nd test, three batches of radish seed were untreated and three batches of seed were grown with a magnet 20 in the vessel 10. The seeds were sown on December 8 and were measured on December 28 of the same year. The results obtained are tabulated below:

TABLE 3

Plant Height (mm)

No.		1	2	3	4	5	6	7	8	9	Germination %	Average size of plant (mm)
Untreated	1	50	40	37	28	20	20	12	5	0	88.8	24
	2	66	65	60	38	42	5	5	3	0	88.8	32
	3	50	41	40	26	14	15	5	2	0	88.8	21
Magnet N pole	4	39	53	50	43	54	43	27	32	30	100.0	41
	5	55	35	42	32	50	40	27	28	0	88.8	34
	6	52	53	49	48	46	43	16	15	2	100.0	36

3rd Test of Soil Cultivation for Plants

Object: To observe how the growth and harvest of plants would be affected by differing intensities of magnetic body (N pole).

Results: In the N pole plot (intensity .... in Gauss), the harvest increased over that of the untreated plot by a maximum 180% and on an average 73%.

Test methods: Each plot had 550 gr. of soil which was fertilized with Hypones scattered and mixed all over at the rate of 0.5gr/3kg of soil. The water content of the soil was kept at 30% throughout the period of plant growth. Each plant was cultivated in a hothouse (15°—30°C. temperatures) using a 500 ml beaker 22 (see Figure 3). In those cases where the plant was magnetically influenced, a magnet 24 in accordance with the invention having a diameter of 3 mm, a height of 5 mm, and a surface magnetic flux density of 330 Gauss was located on the centre line of the beaker with the N pole upward. As shown in Figure 3, in some cases the magnet was at the surface 26 of the soil, while in other cases it was 5 cm or 10 cm below the surface. Figure 4 indicates the distribution of magnetic flux intensity within the beaker 22, while Figure 5 shows the direction towards which the magnetic force works.

In all cases, the plants were radish seeds which were seeded on January 10 and surveyed for harvesting on February 20 of the same year. The results obtained are tabulated below:

TABLE 4

			Test Results				
	Exp. No.	No. of seeds planted	No. of plant	Root wgt/ plant	Leaf length/ plant	Leaf wgt/ plant	Total root weight*
Untreated	1	9	7	1.5	8.5	1.1	
	2	„	6	1.8	9.7	1.1	
	3	„	8	1.1	7.5	0.9	
	Average	„	7.0	1.5 (100)	8.6	1.0	10.5 (100)
N pole at surface	4	„	4	3.1	10.0	1.7	
	5	„	6	1.5	9.6	1.3	
	6	„	6	1.8	8.0	1.2	
	Average	„	5.3	2.5 (167)	9.2	1.4	13.3 (127)
N pole 5cm beneath surface	7	„	5	2.7	9.5	1.3	
	8	„	7	2.0	9.0	1.1	
	9	„	5	3.1	8.0	1.3	
	Average	„	5.7	2.6 (173)	8.9	1.2	14.8 (141)
N pole 10 cm beneath surface	10	„	7	1.1	8.8	1.0	
	11	„	7	1.2	8.5	1.0	
	12	„	5	2.3	7.8	1.0	
	Average	„	6.3	1.9 (127)	8.4	1.0	12.0 (114)

* Rootweight/plant × number/plot.

Similar tests have also been carried out on other plants, details of these tests being given below in tabular form.

TABLE 5

Specimen subjected to test	Lettuce
Grade	Great Lake No. 366
Test place	Kofukabori, Nasu-machi, Nasu Gun, Tochigi Prefecture, Japan.
Man in charge	Yoshio Saito
Investigators	The Nasu Agricultural Improvement Publicity Centre, Japan. The Nasu-machi Association of Vegetable & Fruit Production and Sales, Nasu-Gun, Tochigi Prefecture, Japan. The Technical Department of Yamato Nursery and Farm Appliances Company, Ltd. Japan
Plants seeded:	July 26, 1963
Transplanted	August 25, 1963 (transplanted); August 17, 18, 1963 (plot)
Surveyed	October 24, 1963 and October 30, 1963
Main points of cultivation	Started with transplanting (potato was previous crop); and fertilizer.
Plots surveyed	A plot: Seeds were sown in a 6 cm diameter pot. B „ Seeds were sown in a 6 cm diameter pot. C „ Seeds were sown in a 6 cm diameter pot within which a magnet in accordance with the invention was placed. D „ Young plants raised in cold seed-beds were transplanted. E „ Same as D plot.

The survey was carried out on October 24 1963, the results being shown in the following tables 6-9.

TABLE 6

Plots	A	B	C	D	E
Total weight/plant (A)	gr 1,458.5	gr 1,530.7	gr 1,382.2	gr 1,136.8	gr 850.2
Weight of developed heart (B)	552.7	547.3	567.2	397.4	297.4
Weight of outer leaves (C)	905.8	982.8	815.0	739.4	552.8
B/A × 100	37.9	35.8	41.0	34.9	34.3
Number of outer leaves (pcs)	14.3	14.8	12.4	11.9	11.8
Shape of heart AA%	5.0		7.6		
A%	60.0	72.0	67.5	30.0	5.7
B%	25.0	17.5	17.5	32.5	11.4
C%	5.0	10.0	2.5	30.0	43.5
Citron base (within heart) %		2.5			
Those suffered "soft rot" %			7.5		7.5
Over 700 gr %	15.0	25.0	22.5	7.5	
600—690 gr %	52.5	40.0	55.0	25.0	11.4
400—490gr %	10.0	20.0	12.5	10.0	2.6
300—390gr %	5.0	2.5	2.5	17.5	11.4
Under 300gr %	12.5	12.5	32.5	32.5	40.0
Heart underdeveloped %	5.0		5.0	7.5	30.1

TABLE 7

Percentage of Ripeness (hearts formed) = Weight of hearts formed / Weight of (plant %

A plot	B plot	C plot	D plot	E plot	
37.9	35.8	41.0	34.9	34.9	Percentage of hearts formed
0.8%	14.5%		17.5%	17.5%	× 90 days
7 days	13 days		16 days	16 days	* Harvest could be advanced by these days

* Harvest could be advanced by 7 to 16 days, i.e. on average about two weeks.

TABLE 8

Crop Differences (according to weight of bulbs formed)

A plot	B plot	C plot	D plot	E plot
553gr	548gr	567gr	397gr	297gr
			−43%	−91%

TABLE 9

Marketability (product over 400gr of weight)

A plot	B plot	C plot	D plot	E plot
77.5%	85%	90%	43%	14%
about −40.000	Aabout −15.000	(these are per 0.21 acre income as compared with that of C plot)		

Further tests have also been carried out on the grafting of trees using a magnet in accordance with the invention the relevant details and results of the tests being given in table 10 below.

In each case the graft 28 (see figure 6) was covered with earth 30 laid on the ground 32, and in those cases where the growth of the graft was magnetically influenced the magnet 34 was located in the mound of earth 30 so as to be close to the bottom portion of the graft with the N pole uppermost.

TABLE 10

upon which grafted Experimental stock	Citrus Trifoliata (two years of age)		
Kind of tree grafted	Early-ripening variety "Miyakawa".		
Test place	Aza Ohkusa, Kajiya, Yugawara-machi, Kanagawa Prefecture, Japan.		
Man in charge	Iwao Hayafuji		
Investigated by	The Kajiya Agricultural Cooperative Association, Yugawara-machi, Kanagawa Prefecture, Japan, and The Citrus Fruits Society, "Koso (Ferment) no Sekai-Sha", Japan .		
Method of Grafting	Grafting	Number tested	Percentage of successful grafts
	A Plot (magnet applied)	120	98%
	B Plot (magnet not applied)	130	86%
Date of grafting	March 20 and 21, 1963		
Date of survey	September 28, 1963		
Growth in height	A Plot: over 3ft (60%); over 2ft (35%); under 1 ft (3%) B Plot: over 3 ft (30%); over 2 ft (48%); under 1 ft (8%)		
Classification	Those over 3 ft high are regarded as "Top Grade"; those over 2ft high as "1st Grade", and both of these grades are to be transplanted this autumn; all the rest are to be controlled by applying manure and those found growing well will be transplanted next spring.		
Additional information	Sprouting in A plot occurred four days earlier than in B plot. Both in A plot and B plot, the barnyard manure treated with enzyme was applied as initial manure; thereafter ammonium sulfate was sprinkled thrice as additional manure.		

The detailed descriptions given above illustrate the uses to which a disintegrable permanent magnet in accordance with the invention can be put and demonstrate the beneficial effects which the magnet has on the growth and development of plants.

WHAT I CLAIM IS:—

1. A disintegrable permanent magnet for use in the soil to accelerate the growth of plants, comprising a magnetized moulded mixture of magnetizable material in powder form and a water-soluble binder, wherein the

moulding step is such that the magnet will disintegrate in water over a period of between four and twenty-eight months of 30 days each into powder form, the magnetizable material consisting of or containing one or more metals which are beneficial to the soil and plant growth so that disintegration of the magnet within the soil by reason of the water-content of the latter enriches the soil.

2. A magnet according to claim 1, in which the magnetizable material is one of the following substances in powder form: iron, Co—Fe ferrite, or a manganese-bismuth alloy.

3. A magnet according to claim 1 or claim 2, in which the binder comprises a basic salt of an organic acid, a sulphonated oil, a fatty alcohol sulphate or polyvinyl alcohol.

4. A magnet according to any one of claims 1—3, in which the mixture includes a deliquescent material.

5. A magnet according to claim 4, in which the deliquescent material comprises $MgCl_2.6H_2O$, $CaCl_2.6H_2O$ or $FeCl_3.6H_2O$.

6. A magnet according to any preceding claim having the following composition, the proportions being given in percentages by weight:

Co—Fe ferrite powder	: 70	—	99
Magnesium chloride	: 0	—	0.5
Polyvinyl alcohol	: 0.5	—	30

7. A magnet according to claim 6 having the following composition, the proportions being given in percentages by weight:

Co—Fe ferrite powder	: 95	—	99
Magnesium chloride	: 0	—	0.5
Polyvinyl alcohol	: 0.5	—	5

8. A magnet according to any preceding claim having the form of a disc.

9. A magnet substantially as described with reference to any one of samples 1—18 in the preceding Table 1.

10. A method of making a disintegrable magnet according to any preceding claim, which comprises mixing a magnetizable material in powder form with a water-soluble binder, moulding the mixture in a mould, and magnetizing the resultant moulded article, the moulding step being such that the magnet will disintegrate in water over a period of between four and twenty-eight months of 30 days each into powder form, the magnetizable material consisting of or containing one or more metals which are beneficial to the soil and plant growth so that disintegration of the magnet within the soil by reason of the water-content of the latter enriches the soil.

11. A method according to claim 10, in which a deliquescent material is added to the mixture before the moulding step.

12. A method of making a disintegrable magnet according to claim 10 substantially as described herein.

BROMHEAD & CO.,
Chartered Patent Agents,
St. Paul's Chambers,
19—23 Ludgate Hill,
London, E.C.4.

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1065864 COMPLETE SPECIFICATION

1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

Fig.1.

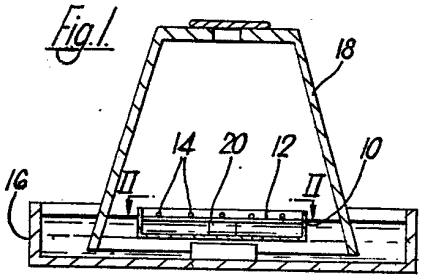

Fig.2.

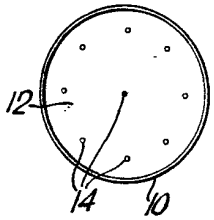

Fig.3.

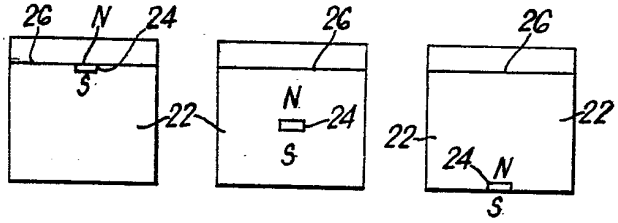

Fig.4.

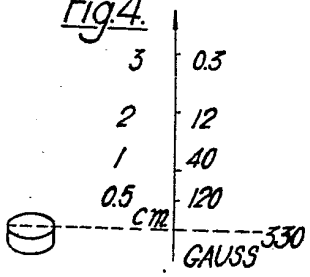

Fig.5.

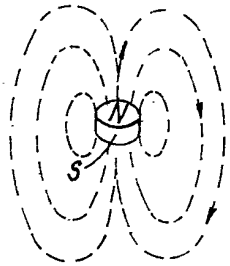

Fig.6.