

5 MAGNETIC RESONANCE TREATMENT APPARATUSField of Invention

10 This invention pertains to the production of
electromagnetic fields for the treatment of materials,
and in particular, to apparatus for simultaneously
subjecting target materials to a low field strength
electromagnetic field (of about 0.5 to 7 G) and an
electromagnetic radiation bath with a frequency profile
falling in the range of about 1 Hz to about 100 kHz.

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Background of the Invention

 The application of a electromagnetic field and the
subsequent measurement of the magnetic resonance
properties of a material is well established. Particles
20 possessing spin angular momentum (such as electrons and
certain atomic nuclei) necessarily also possess a spin
magnetic moment. In the absence of an applied magnetic
field, the spin magnetic moments of identical particles
have identical energies. However, in response to an
25 applied magnetic field, the spin magnetic moments will
align themselves with respect to the applied magnetic
field. In many cases, there are two or more possible
orientations. In the presence of the applied magnetic
field, some of these orientations may be energetically
30 equivalent (degenerate) while others may possess
different energies. That is, the applied magnetic field
may "energy resolve" the different orientations of the
spin magnetic moments. The energy difference between
different orientations is known to vary directly with the
35 applied magnetic field. If the particles are also bathed
in radiation of energy E (and thus frequency $\nu = E / h$

wherein h is Planck's constant) so that the spin magnetic moments are "in resonance" with the radiation (ie. the energy difference between two given orientations equals energy of the radiation), the spins may absorb the incident radiation's energy strongly and "flip" to another, higher energy, orientation. When the radiation bath is discontinued, the excited magnetic spin states will "relax" or "decay", releasing their excess energy (usually) as photons, and return to the natural state (ie. the population distribution of orientations present before the radiation bath was applied) in a process often referred to as "free induction decay" (FID). Sensors may be employed to detect and measure the FID as a function of time; this intensity signal, $I(t)$, may then be analyzed by Fourier transform techniques to yield an intensity signal as a function of frequency, $I(\nu)$.

Two common examples of magnetic resonance techniques are electron spin resonance (ESR) and nuclear magnetic resonance (NMR). For ESR, the particles in question (electrons) possess two spin magnetic moment orientations (commonly referred to as $+1/2$ and $-1/2$). In the presence of an applied magnetic field, the energy difference between the two orientations may be calculated as $\Delta E = g \mu_B B$, where g is the g -value of the electron (which varies slightly from 2), μ_B is the Bohr magneton ($\mu_B = eh/4\pi m_e$, wherein e is the electronic charge and m_e is the mass of an electron), and B is the applied magnetic field. For ESR measurements, an applied magnetic field of 0.1 to 1.0 T (1 T = Tesla = 10,000 G = 10,000 Gauss) is typical. A magnetic field of 0.3 T corresponds to resonance with an electromagnetic field (ie. radiation bath) of frequency about 10 GHz (and wavelength 3 cm); such radiation falls in the X-band of microwaves, and so ESR is commonly considered a microwave technique. Typical ESR frequencies are on the order of 1 GHz and above.

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For NMR, the particles in question (atomic nuclei) possess two or more spin magnetic moment orientations (for example, for ^1H and ^{13}C : $+1/2$ and $-1/2$; for ^{14}N : -1 , 0 , and $+1$; and for ^{35}Cl : $+3/2$, $+1/2$, $-1/2$, and $-3/2$).

5 Again, in the presence of an applied magnetic field, the energy difference between two orientations may be calculated as $\Delta E = -g_I m_I \mu_N B$, where g_I is the nuclear g-value of the nucleus (which varies for different nuclei, but typically varies between about -6 and $+6$), m_I

10 is the change in magnetic spin quantum number (e.g., $m_I = 1$ for a change from orientation $-1/2$ to $+1/2$) μ_N is the nuclear magneton ($\mu_N = eh/4\pi m_p$, wherein m_p is the mass of a proton), and B is the applied magnetic field. For NMR measurements, an applied magnetic field of 1.0 to 10 T is

15 typical. For protons (^1H ; the nuclei of hydrogen atoms), a magnetic field of 1.5 T corresponds to resonance with an electromagnetic field (ie. radiation bath) of frequency about 60 MHz (and wavelength 5 m); such radiation falls in the band of short radio waves, and so

20 NMR is commonly considered a radiowave technique. For other nuclei, resonance frequencies vary between about 1 MHz and 10 GHz. Recently, to improve sensitivity, higher magnetic field (and thus higher frequency) NMR apparatus have been developed, with fields of about 7 T

25 and corresponding resonance frequencies of about 300 MHz (for ^1H).

NMR has been widely used in the field of imaging of the human body, primarily because of the non-invasive nature of the technique and the absence of harmful high

30 energy radiation typically used in conventional radiographic (e.g., x-ray, computed tomography) imaging. However, NMR imaging apparatus still require large magnetic fields and are usually physically quite large. Additionally, NMR imaging apparatus have relatively high

35 electrical consumption loads. In general, NMR imaging apparatus are both expensive to manufacture and operate,

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and thus, have not been used extensively in areas of diagnosis and treatment.

However, one diagnostic application of NMR has been described in U.S. Patent No. 5,072,732 issued to Rapoport et al. on December 17, 1991. This patent describes a NMR apparatus which is used for non-invasively testing body fluids for a particular constituent, for example, glucose in blood, via proton (^1H) magnetic resonance. In this particular NMR apparatus, the device is adapted to receive an extremity of the patient, such as a finger, in order to test the constituents found in the blood. The extremity is exposed to a magnetic field having a field strength of at least 0.5 to 0.6 Tesla. A radio-frequency (RF) generator, in this case a coil apparatus, is used to simultaneously expose the sample extremity to a radiation bath of frequency at least about 20 MHz. This coil apparatus also functions as the sensor for detecting the FID. Analytical means (i.e., electronic circuitry) are connected to the sensor coils for receiving and analyzing the signals emitted, discriminating between various peaks, comparing the amplitude or height of the various peaks that are attributed to the various constituents such as water and glucose, and for normalizing the analysis by reference to a standard sample so as to obtain the concentration of constituents in the tested materials.

Similarly, one treatment method employing ESR is described in U.S. Patent No. 4,455,527 issued to Singer on June 19, 1984. In this apparatus, a sample to be measured (which may be in several different forms including a solid or liquid of a specific column or weight, or a continuous flow of liquid through an electrically insulating conduit) is subjected to microwave radiation in the presence of an applied magnetic field. Singer admits that, as is known in the art, the local electromagnetic field around the sample

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must be at a level for which the sample exhibits a maximum resonance absorption, and that for microwave frequencies, such a field is "much higher than the magnetic field produced by the earth" (which is about 0.2 to 1.0 Gauss). Thus, as discussed above, for microwave resonance, the applied magnetic field in Singer must be about 0.1 to 10 T.

As can be observed from the above discussion, known NMR and ESR devices employ relatively strong magnetic fields, that is, field strengths above 100 G (ie., 0.01 T), and usually above 1000 G (ie., 0.1 T). In contrast, the magnetic resonance device of the present invention uses a significantly lower magnetic field strengths, specifically, in the range of about 0.5 to 7 G. Consequently, it is safer and has fewer and milder side effects than the high-field strength devices of the prior art. For example, a magnetic field of strength 0.5 G corresponds to resonance with an electromagnetic field (ie. radiation bath) of frequency about 2.1 kHz for ^1H (99.9% nat. abund.); about 850 Hz for ^{31}P (100% nat. abund.); about 560 Hz for ^{23}Na (100% nat. abund.); about 530 Hz for ^{13}C (1.1% nat. abund.); about 310 Hz for ^6Li (6.3% nat. abund.); about 210 Hz for ^{35}Cl (75% nat. abund.); about 150 Hz for ^{14}N (99.6% nat. abund.); about 130 Hz for ^{25}Mg (10.1% nat. abund.); and about 100 Hz for ^{39}K (93% nat. abund.).

In addition, the present inventions have a greater range of applications than the prior art devices and can be optimized for a given task by the use of the appropriate frequency profile or magnetic resonance pattern.

The MRTA of the present invention can be used in the treatment of living biological structures, including, for example, microorganisms, plants, and higher animals. In one embodiment, the MRTA may be used in the treatment of human tissues, including, for example, soft tissues,

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musculature, vasculature, nervous tissue, blood and lymph tissue, and the like as well as human physiological systems such as the digestive, endocrine, cardiovascular, respiratory, reproductive, urinary, and orthopedic systems. In particular, the MRTA of the present invention may be used in the treatment of pain, to improve the rate of wound healing, and in dialysis applications.

In another embodiment, the MRTA of the present invention can be used in the treatment of microorganisms, including, for example, eukaryotes such as yeast, and prokaryotes, such as bacteria. For example, treatment with an appropriate magnetic resonance patterns may increase the activity and proliferation of microorganisms, such as yeast (which may be useful in fermentation process) and bacteria (which may be useful in industrial waste treatment). Alternatively, treatment with a different magnetic resonance pattern may decrease activity and proliferation of microorganisms, such as bacteria, which may be useful in treating infections in living animals, such as humans.

Additionally, this treatment with an applied magnetic resonance pattern can be used to adjust (for example, by augmenting or diminishing) the natural magnetic resonance pattern of the substance, such as water.

Summary of the Invention

This invention is directed to an apparatus for simultaneously subjecting target materials to a low field strength electromagnetic field (of about 0.5 to 7 G, more preferably about 2 to 7 G, yet more preferably about 2 to 5 G, still more preferably about 3 G) and an electromagnetic radiation bath with a frequency profile falling in the range of about 1 Hz (wavelength of

300,000 km) to about 100 kHz (wavelength of 3 km). This apparatus comprises:

(i) a frequency profile generator providing a frequency profile signal;

5 (ii) a carrier frequency generator providing a carrier frequency output signal;

(iii) a modulator providing a modulated frequency profile signal in response to said frequency profile signal and said carrier frequency output signal;

10 (iv) a pattern generator for simultaneously generating a magnetic field with field strength between 0.5 and 7 G and an electromagnetic radiation bath with a frequency profile falling in the range of 1 Hz to about 100 kHz, in response to said modulated frequency profile
15 signal, said pattern generator being adapted to subject said target materials to said magnetic field and radiation bath.

In one embodiment, the apparatus of the invention comprises:

20 (i) a controller for providing first and second control signals;

(ii) two or more frequency profile generators, each providing a frequency profile signal in response to a first control signal;

25 (iii) a carrier frequency generator providing a carrier frequency output signal in response to said second control signal;

(iv) a modulator providing a modulated frequency profile signal in response to said frequency profile
30 signal and said carrier frequency output signal;

(v) a pattern generator providing simultaneously a magnetic field with field strength between 0.5 and 7 G and an electromagnetic radiation bath with a frequency profile falling in the range of 1 Hz to about 100 kHz, in
35 response to said modulated frequency profile signal, said

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pattern generator being adapted to subject said target materials to said magnetic field and radiation bath.

In a preferred embodiment, each of said frequency profile generators is low voltage circuit which

5 comprises:

- (i) a selector for selecting a frequency profile;
- (ii) a coder for providing a digitally coded frequency profile in response to the frequency profile selected;
- 10 (iii) a digital to analog converter for converting said digitally coded frequency profile to an analog frequency profile.

In another preferred embodiment, a wave shaper receives the output carrier signal and provides a shaped output carrier signal to the modulator.

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It is another object of the present invention to provide a method for altering the resonance pattern of a target material. In this embodiment, the method comprises the steps of:

- 20 (i) simultaneously generating a magnetic field with field strength between 0.5 and 7 G and an electromagnetic radiation bath with a frequency profile falling in the range of 1 Hz to about 100 kHz; and

- (ii) subjecting a target material to said magnetic field and radiation bath.

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In another embodiment of the invention, the method comprises the steps of:

- (i) selecting a frequency profile;
- (ii) providing a carrier frequency signal;
- 30 (iii) modulating said frequency profile and carrier frequency signal to provide a modulated frequency profile signal;

- (iv) simultaneously generating a magnetic field with field strength between 0.5 and 7 G and an electromagnetic radiation bath with a frequency profile falling in the

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range of 1 Hz to about 100 kHz in response to said modulated frequency profile; and

(v) subjecting a target material to said magnetic field and radiation bath.

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Brief Description of the Drawings

FIG. 1 is a schematic block diagram of the magnetic resonance treatment apparatus of the present invention.

10 FIG. 2 is a schematic block diagram of a first embodiment of the magnetic resonance treatment apparatus of the present invention.

FIG. 3 is a schematic block diagram of a second embodiment of the magnetic resonance treatment apparatus
15 of the present invention.

FIGS. 4A, 4B, and 4C are schematic block diagrams of a treatment device which employs the magnetic resonance treatment apparatus of the present invention.

FIG. 5 is a graph of rate of fermentation data
20 obtained in an experiment employing the magnetic resonance treatment apparatus of the present invention.

Detailed Description of the Invention

The present invention is directed to magnetic
25 resonance instrumentation and methods using this instrumentation. One aspect of the invention is the magnetic resonance treatment apparatus (hereinafter referred to as the "MRTA") which can be used to treat target material. In general, the MRTA is used to
30 transmit a synthesized magnetic resonance pattern into the target material, thereby altering (e.g., augmenting or diminishing) the target material's inherent or natural magnetic resonance pattern or state to achieve a desired final magnetic resonance pattern or state.

35 These inventions can be used to treat a variety of substances including, but not limited to, elements,

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molecules (including, for example, H_2O), and living or non-living biological structures (including, for example, cells, tissues and organs).

5 In general, the material to be treated is placed adjacent to or within a synthesized magnetic resonance pattern comprising a magnetic field with field strength between 0.5 and 7 G and an electromagnetic radiation bath with a frequency profile falling in the range of 1 Hz to about 100 kHz.

10 Typically, the synthesized pattern is generated by passing a current through a winding. Types of structures which are suitable for the winding include, but are not limited to, cylindrical, conical, and flat (for example, circular or rectangular) coils. The winding may be
15 electromagnetically shielded to eliminate any influence or interference from an external electromagnetic field. In addition, it is contemplated that the winding might be used in conjunction a permanent magnet having a field strength in the range of about 0.5 to 7 G.

20 Alternatively, the synthesized pattern may be generated by employing a high voltage discharge tube.

The MRTA of the invention, as shown in Figure 1, comprises at least one frequency profile generator 20, a carrier frequency generator 30, a modulator 40, and an
25 pattern generator 50. Each of the frequency profile generators (which includes a low voltage oscillator circuit consisting of amplifiers and passive components) comprises the same major components: a selector 22, a coder 24, and an digital to analog converter 26. The
30 selector 22 provides a "raw" frequency profile signal (for example, in the form of a frequencies-intensity envelope function, $I(\nu)$) to the coder 24, which generates a digitally "coded" frequency profile (for example, in binary). This output is subsequently provided to the
35 digital to analog converter 26 which yields an analog

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frequency profile signal. This analog frequency profile signal is provided to the modulator 50.

A carrier frequency generator 30 converts a carrier frequency signal to an output carrier frequency signal of
5 desired frequency. The output carrier frequency signal of generator 30 is provided to the modulator 40.

The modulator 40, receiving signals from the carrier frequency generator 30 and the frequency profile generator(s) 20, yields a modulated frequency profile
10 signal in which the carrier frequency signal has been amplitude and/or frequency modulated by the analog frequency profile signal(s).

The pattern generator 50, receiving the modulated frequency profile signal from the modulator 40,
15 simultaneously generates a low intensity magnetic field and a radiation bath with frequency profile determined by the selected frequency profiles, subjecting the target material 60 to said magnetic field and radiation bath.

The frequency profile of the electromagnetic bath
20 may fall in the range of 1 Hz to about 100 kHz. In a preferred embodiment, the frequency profile of the electromagnetic bath may fall in the range of 1 to 500 Hz, more preferably 1 to 200 Hz, still more preferably 2 to 20 Hz. In one embodiment, the frequency
25 profile falls in the range of about 3 Hz to 14 Hz. In another embodiment, the frequency profile falls in the range of about 10 Hz to 350 Hz. In yet another embodiment, the frequency profile falls in the radio frequency range of about 1 Hz to 100 kHz.

30 The frequency or spectral content of the frequency profile can be narrowed using any techniques that are known in the art. However, two techniques that are well suited for these inventions include (i) the use of high Q signal generators, with or without filters, and (ii) the
35 use of a series of filters including, but not limited to, low pass, band-pass, high-pass, passive, and active. In

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this latter technique, the series of filters should be optimally selected so as to eliminate all unwanted spectral contents of the frequency profile generators while transmitting a signal within a desired frequency range.

The analog frequency profile signal may be simple, such as a single-frequency single-amplitude $I(t)$ function, but more commonly is a complex $I(t)$ function which may be represented as a sum of individual $I(\nu)$ functions of specified amplitude. In addition, the frequency profile generator 20 may comprise a user-friendly "cassette" unit, whereby the operator is provided with a choice of several pre-encoded frequency profiles. Such a "cassette" would include means to offer the operator a selection of profiles, means to encode the desired profile, and convert said profile to an analog signal to be fed to the modulator 40. In another embodiment, a "cassette" might offer only a single frequency profile, for use in dedicated MRTA which do not require more flexibility (e.g., commercial water treatment plants). Specific frequency profiles useful for particular applications may be determined from actual samples or standards, such as purified water, healthy tissue, and the like. Methods and apparatus for determining such profiles are described in Weinstock et al., U.S.P. 5,317,265.

The carrier frequency signal may be a simple single frequency sinusoidal signal with a frequency between about 1 Hz and 100 kHz with a voltage of about 0 to 200 V, preferably 0 to about 100 V, more preferably about 0 to 20 V for low frequencies (e.g., about 1 to 500 Hz), and a voltage of about 0.5 to 20 kV, more preferably about 0.5 to 5 kV, still more preferably about 0.5 to 2 kV. The waveform of the carrier frequency signal may be adjusted to yield, for example, square, rectangular, round, saw-tooth waveforms.

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One embodiment of the inventive MRTA, which comprises two frequency profile generators, 20, is shown in Figure 2. In this embodiment, a controller 10, which may be a computer or programmable electronic circuit, provides first control signals to the frequency profile generators 20 and a second control signal to the carrier frequency generator 30. The carrier frequency generator 30, such as a low frequency pulse generator, receives said second control signal and converts a carrier frequency signal (for example, a rectangular wave of amplitude about 10 V) to an output carrier frequency signal of desired frequency (for example, a frequency of about 1 to 500 Hz). The output carrier frequency signal of generator 30 is then provided to a wave shaper 32 (which may act to alter the waveform), from which the output is provided to the modulator 40. Output from the modulator 40 is provided to the pattern generator 50, for example, an inductor such as winding or coil, to yield the desired magnetic field and radiation bath.

Another embodiment of the inventive MRTA, which employs a high voltage RF carrier signal, is shown in Figure 3. In this embodiment, a single frequency profile generator 20 is employed in conjunction with a carrier frequency generator 30 (for example, a circuit which employs a high voltage tube, a tuned circuit and a series of chokes to isolate the power supply from the output circuit to provide a high voltage radio-frequency (RF) carrier frequency signal), from which outputs are provided to a modulator 40. Output from the modulator is provided to the pattern generator 50, in this case a high voltage discharge tube. The high voltage discharge tube in this configuration may only have two electrodes, but will usually have a third control electrode to which the output from the modulator 40 is applied. Any of the connecting means 91, 92, and 93 may be electrical or optical in nature.

In some embodiments of the invention, the pattern generator, which may be an inductor (such as a winding or coil) or a high voltage discharge tube, may be contained within an enclosure. The target material may then be introduced into the enclosure for exposure to the magnetic resonance pattern. This embodiment may be particularly useful for the treatment of inanimate materials, including, for example, fluids such as water and water-containing liquids. For example, the MRTA may be used to expose a fermentation mixture, for example, the fermentation mixture used in the production of alcoholic beverages such as beer and wine, for at least a portion of the total fermentation time.

Alternatively, if the enclosure is not sealed or is constructed at least partially of essentially electromagnetically transparent material, the target material may be placed near or adjacent to the enclosure for exposure to the magnetic resonance pattern. This embodiment of the invention may be particularly useful for precisely treating localized or specific targets, for example, certain organs, tissues, or nerves of the human body. In such an embodiment, the pattern generator may be in the form of a hand-held probe. For example, use of the MRTA of the present invention to alleviate pain in human subjects, including, but not limited to, arthritis, fibromyalgia, neuralgia, neuropathy, joint injury, and migraine headaches. Treatment times (e.g., times of exposure to the magnetic resonance pattern) may vary from a few seconds to several minutes to several tens of minutes. Repeated treatments may be necessary, and pain relief may be immediate or gradual over a period of a few weeks.

Described below is an example of the present inventions which is provided for illustrative purposes only, and not to limit the scope of the present invention. In light of the present disclosure, numerous

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embodiments within the scope of the claims will be apparent to those of ordinary skill in the art.

Example 1

5 Water Treatment and Filtration Device

Schematic block diagrams of water treatment and filtration units which employs the MRTA of the present invention are shown in Figure 4.

10 In Figure 4A, the control panel 100 comprises a frequency profile generator, a carrier frequency generator and modulator. In addition, the control panel 100 may further comprise interface means to permit the operator to control or adjust operating parameters.

15 Also, the control panel may be adapted to receive a "cassette" which provides one or more pre-selected frequency profiles. Output from the control panel 100, a modulated frequency profile signal, is provided to a pattern generator 200. A conduit 300 for material flow

20 from a source ("in") to a destination ("out") is placed in or near the generated magnetic resonance pattern. Preferably, the material is a liquid. In one embodiment, the liquid consists essentially of water. The pattern generator 200 may be contained in an enclosure and the

25 conduit 300 may pass within, through, or near the enclosure, so as to subject the material in the conduit to the magnetic resonance pattern. A portion of the conduit, particular a portion within or near to the magnetic resonance pattern may be enlarged to reduced in

30 size to affect flow-through rate and therefore time the liquid is to be exposed to the electromagnetic resonance signal (e.g., the residence time).

In Figure 4B, a conventional water filtration device 400 has been added to the embodiment of Figure 4A, in

35 this instance, in or near the generated magnetic resonance pattern. The water filtration device 400 is of

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conventional design to accommodate commercially available filters.

In Figure 4C, a power booster 500 (to amplify the modulated frequency profile signal), a shut-off valve 600 (to regulate the flow through the treatment/filtration device, and a flow meter 700 to measure the rate of flow of material, have been added to the embodiment of Figure 4B. Both the shut-off valve 600 and the flow meter 700 may be connected to the control panel to provide flow control including flow rate. The feedback signal from the flow meter may be used to alter the intensity and/of frequency profile of the magnetic resonance pattern in accordance with the changes in the flow rat.

The MRTA of the present invention, and particularly the treatment/filtration embodiment described above, may be used to cause the division of large particles and group of molecules into smaller particles and groups of molecules, causing, among other effects, a reduction viscosity of the liquid and dissolution of other components contained in the liquid.

Example 2

Method for Improving Germination Process

Using the water treatment and filtration embodiment described earlier in a germination experiment led to surprising and unexpected results. In an experiment, barley seeds were germinated in petri dishes on Number 1 Watman Filter Paper. A first group of seeds were irrigated with unresonated filtered water (e.g., water not exposed to a magnetic resonance pattern), a second group of seeds was irrigated with resonated filtered water (e.g., water which had been exposed to a magnetic resonance pattern). A third group of seeds were irrigated with unresonated filtered water and placed into a resonance well and constantly subjected to an magnetic

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resonance pattern. A fourth group of seeds were irrigated with resonated filtered water and placed into a well and constantly subjected to an magnetic resonance pattern. In all cases the applied magnetic resonance pattern was the same. For each group, the number of germinated seeds were counted approximately daily for four days. Results for duplicates of the study are shown in Tables 1 and 2, where seed were irrigated with 5 mL and 8 mL of water, respectively. The results of the experiments showed that the germination process using resonated water increased over that using unresonated water. Subjecting seeds to the magnetic resonance pattern showed another increase in germination.

TABLE 2: Irrigation with 5 ml water

Date	Filtered Water (Group 1)	Filtered/ resonated Water (Group 2)	Filtered Water, Constant Treatment (Group 3)	Filtered/ Resonated Water, Constant Treatment (Group 4)
12/2/92 16:30	0	0	0	0
12/3/92 16:30	4	7	13	14
12/4/92 20:40	23	24	32	35
12/5/92 16:30	25	27	32	35

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TABLE 3: Irrigation with 8 ml water

Date	Filtered Water (Group 1)	Filtered/ resonated Water (Group 2)	Filtered Water, Constant Treatment (Group 3)	Filtered/ Resonated Water, Constant Treatment (Group 4)
12/7/92 15:30	0	0	0	0
12/8/92 15:30	10	14	13	19
12/9/92 19:30	25	33	33	41
12/10/92 15:30	33	36	36	43

Example 3Method for Improving the Fermentation Process

Use of the MRTA of the present invention in a fermentation experiment led to surprising and unexpected results, in particular, the observation that in the production beer or similar products the fermentation time can be reduced.

In an experiment, wort was divided in two 5-gallon carboys (e.g., two "batches"). One batch was subjected to a magnetic resonance pattern with a selected frequency profile, while the second batch was not subjected to the magnetic resonance pattern, but otherwise treated and stored as the first batch. It was observed that the fermentation process of the treated wort (e.g., that wort exposed to the magnetic resonance pattern) was 23% faster than the untreated wort; that is, about three days versus four days to reach complete fermentation. Subsequent analysis showed that, at the end of the fermentation process, both batches contained substantially the same concentration of alcohol. Additional analysis confirmed that end product of the

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treated wort and the end product of the untreated wort were substantially the same.

In a second experiment, a second batch treated and untreated wort was prepared and fermented while exercising closer control over parameters such as temperature. In this experiment the rate of bubble evolution (e.g., the number of bubbles of gas evolved unit time) were periodically counted as a measure of the fermentation process. The results of this experiment are illustrated in Figure 5, wherein the time during the fermentation process is plotted on the horizontal axis, and the rate of bubble evolution is plotted on the vertical axis. The fermentation process of the treated wort was about 17% faster than that of the untreated wort. The deviation from the earlier experiment is attributed to the greater control exercised over the temperature during the fermentation process.

While the taste of the beer from the first experiment was considered to be unacceptable, the beer of the second experiment was judged quite palatable.

All publications, patents, and patent applications cited in this specification are herein incorporated by reference as if each individual publication, patent, or patent application were specifically and individually indicated to be incorporated by reference.

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We claim:

1. A magnetic resonance treatment apparatus comprising:

- 5 (i) a frequency profile generator providing a frequency profile signal;
- (ii) a carrier frequency generator providing a carrier frequency output signal;
- 10 (iii) a modulator providing a modulated frequency profile signal in response to said frequency profile signal and said carrier frequency output signal;
- (iv) a pattern generator for simultaneously generating a magnetic field with field strength between 0.5 and 7 G and an electromagnetic radiation bath with a
- 15 frequency profile falling in the range of 1 Hz to about 100 kHz, in response to said modulated frequency profile signal, said pattern generator being adapted to subject said target materials to said magnetic field and radiation bath.

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2. A magnetic resonance treatment apparatus comprising:

- (i) a controller for providing first and second control signals;
- 25 (ii) two or more frequency profile generators, each providing a frequency profile signal in response to a first control signal;
- (iii) a carrier frequency generator providing a carrier frequency output signal in response to said
- 30 second control signal;
- (iv) a modulator providing a modulated frequency profile signal in response to said frequency profile signal and said carrier frequency output signal;
- (v) a pattern generator providing
- 35 simultaneously a magnetic field with field strength between 0.5 and 7 G and an electromagnetic radiation bath



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with a frequency profile falling in the range of 1 Hz to about 100 kHz, in response to said modulated frequency profile signal, said pattern generator being adapted to subject said target materials to said magnetic field and radiation bath.

3. The magnetic resonance treatment apparatus of claim 1 wherein said frequency profile generator is a low voltage circuit comprising:

- 10 (i) a selector for selecting a frequency profile;
- (ii) a coder for providing a digitally coded frequency profile in response to the frequency profile selected;
- 15 (iii) a digital to analog converter for converting said digitally coded frequency profile to an analog frequency profile.

4. The magnetic resonance treatment apparatus of claim 2 wherein each of said frequency profile generators is a low voltage circuit comprising:

- 20 (i) a selector for selecting a frequency profile;
- (ii) a coder for providing a digitally coded frequency profile in response to the frequency profile selected;
- 25 (iii) a digital to analog converter for converting said digitally coded frequency profile to an analog frequency profile.

5. The magnetic resonance treatment apparatus of claim 2 further comprising a wave shaper for providing a shaped output carrier signal to said modulator in response to said carrier frequency output signal.

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6. The magnetic resonance treatment apparatus of claim 1 wherein said pattern generator is coil or winding.

5 7. The magnetic resonance treatment apparatus of claim 1 wherein said pattern generator is a high voltage discharge tube.

10 8. The magnetic resonance treatment apparatus of claim 1 wherein said frequency profile falls in the range of about 1 Hz to about 500 Hz.

15 9. The magnetic resonance treatment apparatus of claim 1 wherein said frequency profile falls in the range of about 1 Hz to about 200 Hz.

20 10. The magnetic resonance treatment apparatus of claim 1 wherein said frequency profile falls in the range of about 2 Hz to about 20 Hz.

 11. The magnetic resonance treatment apparatus of claim 1 wherein said magnetic field has a field strength of about 2 to 7 Gauss.

25 12. The magnetic resonance treatment apparatus of claim 1 wherein said magnetic field has a field strength of about 3 Gauss.

30 13. A method of altering a resonance pattern of a target material, said method comprising the steps of:

 (i) simultaneously generating a magnetic field with field strength between 0.5 and 7 G and an electromagnetic radiation bath with a frequency profile
35 falling in the range of 1 Hz to about 100 kHz; and



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(ii) subjecting a target material to said magnetic field and radiation bath.

14. The method of claim 13 wherein said
5 frequency profile falls in the range of about 1 Hz to about 500 Hz.

15. The method of claim 13 wherein said
10 frequency profile falls in the range of about 1 Hz to about 200 Hz.

16. The method of claim 13 wherein said
15 frequency profile falls in the range of about 2 Hz to about 20 Hz.

17. A method of altering a resonance pattern of a target material, said method comprising the steps of:

20 (i) selecting a frequency profile;
(ii) providing a carrier frequency signal;
(iii) modulating said frequency profile and carrier frequency signal to provide a modulated frequency profile signal;

25 (iv) simultaneously generating a magnetic field with field strength between 0.5 and 7 G and an electromagnetic radiation bath with a frequency profile falling in the range of 1 Hz to about 100 kHz in response to said modulated frequency profile; and

30 (v) subjecting a target material to said magnetic field and radiation bath.

18. The method of claim 17 wherein step (i) further comprises selecting a plurality of frequency profiles and wherein step (iii) further comprises
35 modulating said frequency profiles and carrier frequency signal to provide a modulated frequency profile signal.



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19. The method of claim 17 wherein said frequency profile falls in the range of about 1 Hz to about 500 Hz.

5 20. The method of claim 17 wherein said frequency profile falls in the range of about 1 Hz to about 200 Hz.

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This Sheet Has Been Replaced