(broadband) or for one specific frequency (narrowband).

Commercially available acoustic amplifiers include but are not limited to Matec gated amplifier systems (100 KHZ-200 MHz), and EM broadband amplifier model 607L (0.8 - 1,000 MHz.)

Complete acoustic systems including power frame, computer interface, pulse width generator, gated amplifier, broadband receiver, and phase detector (100 KHZ- 100 MHz) can be purchased commercially from sources such as Matec.

The acoustic delivery system is variable depending on the application. Acoustic energy waves can be transmitted into gaseous, liquid, or solid media either by direct contact of the transducer with the target structure medium, or by coupling of transmission of the acoustic wave through other structures or mediums one of which is in direct contact with the target structure. In the case of biologic structures, coupling through multiple structures or media is a likely occurrence, as the acoustic wave travels through multiple layers of biologic tissue to reach its target structure. If the target structure is a liquid, a transducer can be placed into the liquid in direct contact with it, or the liquid can be placed in a container whose walls are themselves transducers, in direct contact with the liquid. Also, a transducer can be placed on the outside of the walls of a container in which the liquid is placed.

If the target structure is a solid, a transducer can again be placed in direct contact with it. The solid can be placed in a gas or liquid which is used as a coupling agent. A liquid or gel-type coupling agent can also couple between a free-standing solid and a transducer, when the transducer is placed on a surface of the solid.

The present invention also comprises receiving and analyzing acoustic energy derived from an inorganic or biologic structure as shown in Figure 2. Using methods known to those skilled in the art, any device capable of receiving and analyzing acoustic energy through any medium can be used to detect the resonant acoustic and/or acousto-EM frequencies utilized by the invention.

Detection of acoustic energy waves is basically the reverse process of producing acoustic energy waves. Acoustic energy waves striking a transducer apply a mechanical stress, producing electric polarization proportional to the mechanical stress via the piezoelectric effect. The resultant EM energy is converted electronically via oscilloscope type devices to a readable format.

EM energy ← piezoelectric transducer ← acoustic energy waves.

Thus, piezoelectric transducers may be used to both produce and detect acoustic energy, using the reversible piezoelectric effect.

The structure after being induced into an acoustic resonance state will emit vibrational waves that will cause mechanical stress in the transducer. In turn, an alternating potential difference having the same frequency as the acoustic wave appears as voltage across electrodes connected to a transducer. This voltage is converted via oscilloscope type devices to a readable format.

Oscilloscopes that may be utilized in the present invention include but are not limited to those such as the BK Precision 21 60A (0-60 MHz), the Tektronix TDS 784A (0-1 GHz), the Tektronix TDS 820 (6-8 GHz), the Tektronix 1180 a B (0-50 GHz); and spectrum analyzers such as Hewlett-Packard 8577A (100 Hz-40 GHz), HP 8555A (10 MHz -40 GHz), Tektronix 492 (50 KHZ-21 GHz), Anritsu MS62C (50 Hz-1.7GHz), and Polarad 640B (3 MHz-40 GHz) which are all commercially available.

Complete acoustic detection and analysis systems (50 KHz-100 MHz) including power frame, computer interface, pulse width generator, gated amplifier, broadband receiver, phase detector, control software, pre-amplifiers, diode expander, diplexer, filter, and attenuators can be purchased commercially from Matec Instruments Inc. or from other sources.

The acoustic energy under examination can be either reflected or transmitted. For example, in traditional medical ultrasound methods, an acoustic wave is produced from a single transducer. The acoustic wave strikes various structures. Some of the acoustic wave is reflected back from the structures and is detected as reflected waves by the same single transducer. Some of the acoustic wave may also be transmitted through the structures. Many industrial applications of acoustic energy utilize the transmitted, rather than reflected waves.

The present invention also comprises delivering EM energy at resonant acoustic and/or resonant acousto-EM frequencies to a targeted structure as shown in Figures 3- 7.

If a resonant system is embedded in a fluid environment (as is the case with most biologic structures) the dissipation of energy occurs through an intrinsic source in the system (i.e. via conversion to EM energy), or through loss to the nearby medium (via coupling and transmission of acoustic energy). Using methods known to those skilled in the art, any device capable of generating and transmitting EM energy through any medium can be used to generate the resonant acoustic and/or acousto-EM energy utilized by the present invention including, but not limited to, stationary and oscillating magnetic field (Figure 3 and 4), direct or alternating current (Figure 5), static charge (Figure 6), electric field, and EM radiation (Figure 7).

Electrodes for delivering direct and alternating current are available commercially from a wide variety of sources.

Magnetic field generators are commercially available and include Radio Shack Rare-earth magnets 64-1895, GMW Model 5403AC and the like. Oscillators and signal generators as listed above in Figures 1 and 2 are commercially available. Likewise, numerous EM radiation delivery systems are commercially available including Waveline Model 99 series Standard Gain Horns (1.7-40 GHz), and JEMA JA-1 50-MS.

Systems known to those skilled in the art for exposing biologic structures to EM energy include anechoic chambers, transverse electromagnetic cells (TEM), resonant cavities, near-field synthesizer, waveguide cell culture exposure system, and coaxial transmission line exposure cells.

The present invention also comprises receiving and analyzing EM energy derived from a targeted structure as shown in Figure 8 - 11. Using methods known to those skilled in the art, any device capable of sensing and analyzing EM energy through any medium can be used to detect the resonant acoustic and/or acousto-EM frequencies utilized by the invention. Direct and alternating current can be assessed by measuring voltage changes (Figure 11) with 15 voltmeters such as the BK Precision 283 lA (0-1200V, 0.1 mV resolution, or the BK Precision 3910-1 OOOV, 10 uV resolution), detection of static charge (Figure 9) and by measuring stationary and oscillating magnetic field changes (Figure 8) with a system such as HET Micro Switch 5594A1F transducer by Honeywell, and instrumentation amplifier chip AD524 by Analog Devices. Monitoring electrodes which are EM field compatible and nonperturbing are made of carbon loaded Teflon by Technical 20 Fluorocarbons Engineering and by Polymer Corp.

Broadband survey meters are commercially available such as Aeritalia RV and 307 series (1 - 1,000 MHZ), General Microwave Raham 12 (10 MHZ- 18 GHz), Holaday

Industries 3000 series (5-300 MHz and 500 MHz-6 GHz), Narda Microwave 8608 (10 MHz-26 GHz), and Instruments for Industry RHM- 1(10 KHz-220 MHZ) and the like.

Electric field strength meters are commercially available through sources including but not limited to Rohde & Schwarz MSU (25-1000 MHz), Rohde & Schwarz MSU (0.1-30 MHz), Scientific Atlanta 1640APZ (20 MHz-32 GHz), Electro-Metrics EMS-25 (20 KHz-1 GHz), Anritsu M, NM series (500 KHz-1 GHz) and the like.

Magnetic fields may be assessed using the Bartington Fluxgate Nanoteslameter, Mag-01 and the like.

Spectrum analyzers are commercially available through sources including but not limited to HP 8566A (100 Hz-40GHz), HP 8555A (10 MHz-40 GHz), Tektronix 492 (50 kHz- 21 GHz), Anritsu M562C (50 Hz- 1.7 GHz), and Polarad 640B (3 MHz-40 GHz) and the like.

Thermocouple E-field probes are manufactured by Narda, and tissue implantable E-field probes include, for example, the Narda 26088, the EIT 979, and the Holaday IME-O1. Field probes can be connected with the external circuitry by optical-fiber telemetry. This limits perturbation of the test field and eliminates RF interference, thus improving signal to noise detection. Optical fiber kits with transmitter and receiver are commercially available from Hewlett-Packard and Burr-Brown.

EM transmitters, include but are not limited to the JEMA, model JA-150-MS (139-174MHz) and the like.

While the invention is described in relation to certain specific embodiments and certain system components, it will be understood that many variations are possible, and alternative equipment and/or arrangement of components can be used without departing from the invention. In some cases such variations and substitutions may require some experimentation, but will only involve routine testing.

The following examples and descriptions of the specific embodiments will so fully reveal the general nature of the invention that others can, by applying current knowledge, readily modify and/or adapt for various applications such specific embodiments without departing from the generic concept, and therefore such adaptations and modifications are intended to be comprehended within the meaning and range of equivalents of the disclosed embodiments and system components.

Example 1

Disruption, Augmentation, Detection and/or Identification of Viruses

Since the induction of resonance in a structure can lead to sudden and irreversible structural failure due to rupture of one or more components of that structure, biologic structures can be selectively disrupted using resonant acoustic energy. The present invention takes advantage of the rigid, crystalline structure of viruses for the purposes of detection, augmentation, identification and/or physical disruption of the virion structure using acoustic energy and/or acousto-EM at the resonant frequencies unique to each specific virus. Viruses may be considered piezoelectric crystals, and therefore, can act as living transducers.

Human illnesses caused by viruses include hepatitis, influenza, chicken pox, mumps, measles, small pox, acquired immune deficiency syndrome (AIDS), ebola, polio, hemorrhagic fever, herpes, and hairy cell leukemia.

Diseases in animals caused by viruses include but are not limited to parvo infection in dogs, feline leukemia, cowpox, rabies, and avian plague.

One of the most notable examples of viral diseases in plant life is the historical potato famine in Ireland, caused by a virus which infects potato plants.

There are two major types of virus symmetry - icosahedral and helical. The icosahedral shape is roughly equivalent to a soccer ball, while the helical shape looks like a toy slinky. The majority of viruses fall into one of these groups, the remainder being complex or unknown. The icosahedral is roughly a spherical shape made up of 20 identical, equilateral triangles, with 3 axes of five-fold symmetry. In the helix, the units of the capsid spiral out around the nucleic acid, which runs down the center of the virus, and there is only one axis of spiraling symmetry.

Within each symmetry group, viruses can further be separated into DNA and RNA groups. Viruses have a central core of nucleic material, either DNA or RNA. This nucleic core is surrounded by a symmetrical protein shell, called a capsid or protein coat. The capsid is composed of individual capsomere morphological units, which are in turn composed of individual structural units. The structural units are also called crystallographic units, because they form a repeating pattern and can be demonstrated with X-ray crystallographic diffraction techniques. Structural units are the building blocks of the virus structure and are usually