Alto, CA) is employed to make multiple small acoustic oscillators which are enclosed in filter material, the filter material preventing passage of the oscillators but allowing the passage of blood cells and blood components. The nanite virosonic filter is sterilized and attached in line on an extracorporeal system or in a blood products system.

In another embodiment, the resonant and/or harmonic acoustic frequencies are generated using acoustic laser or maser systems. In similar fashion, the whole or fractionated blood is passed extra corporeally over or through a laser or maser acoustic filter.

The method also provides a means to disrupt viruses *in vivo* and intracorporeally in animals as shown in Figure **15**, using intravascular devices. Nanosystem technology is employed to make multiple small acoustic oscillators which are enclosed in filter material, the filter material preventing passage of the oscillators but allowing the passage of blood cells and blood components. The nanite virosonic filter is attached in line on a CVP type catheter or in a Greenfield-type filter.

In another embodiment, a central venous catheter as known to one skilled in the art (produced commercially by Arrow, Baxter, etc.) is engineered and fitted with a transducer of appropriate frequency at the tip. The catheter is inserted using standard technique into a large vein such as the subclavian, jugular, or femoral vein. Resonant acoustic energy is then delivered to the circulating blood, thereby disrupting virus *in vivo*.

In another embodiment, the transducer is fitted as an acoustic filter on a larger intravascular device such as a Greenfield filter-type device for the inferior vena cava. The device is fitted with a battery that is rechargeable through the skin, as currently practiced with rechargeable cardiac pacemakers. Once inserted, the acoustic filter reduces viral load in the vena caval blood flow, without the need for the patient to be restricted by catheters.

In another embodiment, inclusion of a receiving acoustic transducer may also detect qualitative and quantitative resonant acoustic frequencies of the virus in the multicellular organism to determine efficacy and duration of treatment.

The methods of the present invention also provide a means to augment and/or disrupt viruses *in vivo* in a multicellular organism, as shown in Figure **16**, using resonant acoustic fields. The organism is placed in a form-fitting tub filled either with water or a coupling medium such as castor oil (reflection coefficient 0.0043) or mineral oil, or such other acoustic conductive gel as is available commercially. Acoustic transducers are either fitted into the

walls and floor of the tub, or are themselves the walls and floor of the tub (i.e., piezoelectric polymer sheets or ceramics). A predetermined acoustic field (frequencies, harmonics, amplitude, mode, shape, etc., at a specific intensity) is delivered to the organism from the transducer tub through the coupling medium.

In another embodiment, a receiving acoustic transducer mode also detects qualitative and quantitative resonant acoustic frequencies of the virus in the multicellular organism to determine efficacy of treatment.

The present invention also provides a method to augment and/or disrupt viruses *in vivo* in a portion of a multicellular organism as shown in Figure 17, using a resonant acoustic field probe. Acoustic transducers of desired frequency are fitted into the end of a hand-held probe device, as currently known to those skilled in the art of medical ultrasonography. A predetermined acoustic field (frequencies, harmonics, amplitude, mode, shape, etc. at the required intensity to effect the organism) is delivered to a predetermined portion of the organism, from the hand-held transducer probe. Attenuation in air is eliminated by use of a commercially available acoustic coupling medium such as castor oil. For example, in a person afflicted with hepatitis, the treatment is delivered through the skin over the liver. Subharmonics of the resonant acoustic frequencies can be used to minimize acoustic attenuation at the higher frequencies.

In another embodiment, receiving acoustic transducer mode also detects qualitative and quantitative resonant acoustic frequencies of the virus in the multicellular organism to determine efficacy and duration of treatment.

The present invention also provides a method to disrupt viruses *in vivo* in a portion of a multicellular organism as shown in Figure 18, using a resonant acoustic field sheet. Piezoelectric polymer material of desired frequency is fashioned into a flexible transducer sheet device. A predetermined acoustic field (frequencies, harmonics, amplitude, mode, shape, etc.) is delivered to a predetermined portion of the organism, from the transducer sheet device. Attenuation in air is eliminated by use of a commercially available acoustic coupling medium such as castor oil. For example, in a person afflicted with hepatitis, the treatment is delivered by placing the sheet in contact with the skin over the liver. Subharmonics of the resonant acoustic frequencies can be used to minimize acoustic attenuation at the higher frequencies.

In another embodiment, receiving acoustic transducer mode also detects qualitative and quantitative resonant acoustic frequencies of the virus in the multicellular organism to determine efficacy and duration of treatment.

The present invention also provides a means to determine qualitative and quantitative resonant acoustic and/or acousto-EM frequencies *in vitro* as shown in Figure 19 A&B. A test device, as described above and shown in Figure 12, with any and all embodiments, is fitted with transmitters and receivers to transmit, detect, measure, and analyze EM energy. When the resonant acoustic frequencies are applied to the virus test disk, a unique electromagnetic energy pattern is generated, according to the structure and composition of the virus and test disk under study, referred herein as the resonant acousto-EM signature. Mechanisms producing the resonant acousto-EM signature include, but are not limited to piezoelectricity, acoustoelectricity, magnetoacoustics, and/or intrinsic energy dissipation. The resonant acousto-EM signature represents one or more of several electromagnetic properties and/or fields including, but not limited to, direct current, alternating current, magnetic field, electric field, EM radiation, and/or acoustic cyclotron resonance (standard or Doppler shifted).

All of the above mentioned forms of EM energy are detected, measured, and analyzed with devices and methods known to those skilled in the art. (It should be noted that useful information may also be derived from application of nonresonant frequencies, ie. current characterization of semiconductor biologics via the acoustoelectric effect.) This data in combination with resonant signatures yields even greater sensitivity and specificity to the method. For example, Herpes simplex virus (HSV) I and II will have nearly identical resonant acoustic signatures because they are virtually identical in size and shape. They differ in molecular protein configuration, however, and can be distinguished by their acousto-EM signatures. This includes, but is not limited to, characterization at nonresonant and resonant frequencies of acoustoelectric currents, acousto-EM signatures produced via intrinsic energy dissipation, of acoustic modulation or attenuation in the presence of a magnetic field via the magnetoacoustic effect, and of electric or magnetic fields induced or affected by any of the above processes.

In another embodiment, the test device is also fitted with any and all combinations of resonant acoustic and acousto-EM generating equipment. A sample of unknown composition

is exposed to the frequency energy pattern which is included in the acousto-EM signature for a particular structure. Detection of the associated resonant acoustic waves from the sample confirms the presence of the structure in the sample. Further analysis of amplitude would indicate the relative quantity of those particular structures in the sample. For instance, the combined use of resonant acoustic and acousto-EM signatures could be used to search a tissue slice first for the presence of HSV, and then to specify whether it is HSV I, HSV II, or a previously unknown and uncharacterized HSV. In addition, a quantitative assessment of viral load in the sample could also be performed based on relative amplitudes. Thus, the application of resonant acoustic and/or acousto-EM energy fields, in respect to organic or biologic organisms and structures, yields a form of resonant acousto-EM spectroscopy, with three basic stimulation and detection modes (1. acoustic, 2. EM, 3. acoustic and EM), producing nine basic combinations:

1. Acoustic stimulation, acoustic detection;
2. Acoustic stimulation, EM detection;
3. Acoustic stimulation, acoustic and EM detection;
4. EM stimulation, acoustic detection;
5. EM stimulation, EM detection;
6. EM stimulation, acoustic and EM detection;
7. Acoustic and EM stimulation, acoustic detection;
8. Acoustic and EM stimulation, EM detection; and
9. Acoustic and EM stimulation, acoustic and EM detection.

The more sophisticated the stimulation and detection/ analysis modes are, the more sensitive and specific the spectroscopy apparatus will be. It should be noted that the use of resonant acousto-EM spectroscopy alone or in combination with resonant acoustic spectroscopy in the present invention is not limited to biological materials and can be utilized to detect and identify inorganic materials or structures as discussed below.

The present invention also provides a method to assess the effects of resonant acoustic and/or acousto-EM energy on viruses using any and all devices which produce acoustic and/or EM energy including, but not limited to, all devices and embodiments previously described. For instance, as shown in Figure 20, to assess the piezoelectric effects of EM radiation on the crystalline structure of viruses, a test system is used which employs

EM radiation of the same frequency as at least one of the resonant acoustic frequencies of the virus. In the case of HIV, the frequency is approximately 15 GHz. A test box made of EM absorptive material is fitted with a 15 GHz EM transmitter, with the EM radiation directed towards the floor of the box. Uninfected T-lymphocyte host cells are first assessed in the test box with the 15 GHz intervention with varying exposure patterns (resonant frequencies in varying waveform patterns for varying periods of time and at varying intensities) using the trypan blue dye exclusion test, which excludes anomalous viral results by assessing the effects of the acousto-EM intervention on the host cells alone. Step 2 involves placing HIV infected T-lymphocytes in the test box, where the acousto-EM intervention is delivered. The results are then assessed using standard in vitro testing of anti-HIV methods such as the Coulter HIV-1 p24 antigen kit, HIV cultures, HIV-1 DNA by PCR, and viral load measurement.

The present invention also provides a method to disrupt viruses extracorporeally and/or intravascularly in animals using resonant acoustic and/or acousto-EM fields as shown in Figure 21. For example, in humans infected with HIV, an extracorporeal blood circulation system is established using techniques known to those in the art. The extracorporeal blood is passed over transducers as described in Figure 14, including any and all embodiments. Acoustic penetration into the blood may be increased using acoustoelectric gain by passing a direct current into the blood parallel with the acoustic waves.

The present invention also provides a method to augment and/or disrupt viruses in an organ of a multicellular organism, as shown in Figure 22, using resonant acoustic and/or acousto-EM fields. For instance, as in Figure 16, including any and all embodiments, a human cadaver cornea for transplantation is placed in a form-fitting cup filled either with water or such other non-toxic acoustic conductive gel as is available commercially. A predetermined acoustic field (frequencies, harmonics, amplitude, mode, shape, etc.) is delivered to the cornea from a transducer tub through the coupling medium. Utilizing the magnetoacoustic effect, a magnetic field is placed perpendicular to the direction of the acoustic wave propagation, at a field strength which is a multiple of the acoustic frequency, thereby generating sinusoidal or peak-type resonance spikes in the acoustic power, and improving resonant acoustic penetration into the cornea without injuring the cornea tissue itself.

The present invention also provides a means to disrupt viruses *in vivo* in a portion of