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**PATENT WRITE-UPS:  
PATENTS AVAILABLE FOR LICENSING**

1Lt Yolanda B. Allen (editor)

26 June 1992



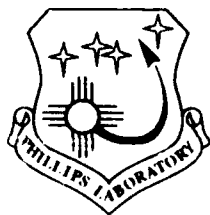
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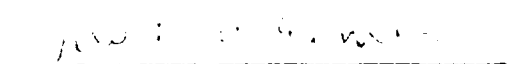
92-22579




**PHILLIPS LABORATORY  
DIRECTORATE OF GEOPHYSICS  
AIR FORCE SYSTEMS COMMAND  
HANSCOM AIR FORCE BASE, MA 01731-5000**

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This special report has been reviewed and is approved for publication.

  
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REPORT DOCUMENTATION PAGE			Form Approved OMB No. 0704-0188	
<small>Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.</small>				
1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE 26 June 1992	3. REPORT TYPE AND DATES COVERED Scientific Interim		
4. TITLE AND SUBTITLE Patent Write-Ups: Patents Available For Licensing		5. FUNDING NUMBERS 6106GL 9991ORTA		
6. AUTHOR(S) Hlt Yolanda B. Allen (editor)				
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Phillips Laboratory/XPG Hanscom AFB, MA 01731-5000		8. PERFORMING ORGANIZATION REPORT NUMBER PL-TR-92-2166 SR, No. 271		
9. SPONSORING MONITORING AGENCY NAME(S) AND ADDRESS(ES) Phillips Laboratory/XPG Hanscom AFB, MA 01731-5000		10. SPONSORING MONITORING AGENCY REPORT NUMBER		
11. SUPPLEMENTARY NOTES				
12a. DISTRIBUTION AVAILABILITY STATEMENT Statement A - Approved for public release; distribution unlimited.			12b. DISTRIBUTION CODE	
13. ABSTRACT (Maximum 200 words)  These patent write-ups were put together as a Phillips Laboratory technology transfer initiative. The write-ups are one page explanations of all the Phillips Laboratory, Geophysics Directorate, patents and patent pending inventions. Each write-up describes what the invention is, explains the background of the technology behind the invention, and lists the special features and performance characteristics of the invention. The hope for these write-ups is that they will "get the word out" about the patents that are available for licensing from the Geophysics Directorate of Phillips Laboratory.				
14. SUBJECT TERMS technology transfer, patents, patent licensing, invention, antenna, waveguide mixer, fourier spectroscopy, azimuth monitoring, laser beam, meridian, azimuth, particulate matter, stealth aircraft, noise, insulators, LOWTRAN, stealth			15. NUMBER OF PAGES 34	
			16. PRICE CODE	
17. SECURITY CLASSIFICATION OF REPORT unclassified	18. SECURITY CLASSIFICATION OF THIS PAGE unclassified	19. SECURITY CLASSIFICATION OF ABSTRACT unclassified	20. LIMITATION OF ABSTRACT none	

Keywords Continued:

atmospheric propagation, spectrograph, satellite imaging, laser separation  
double-beaming, spectroscopy, position-fixing, optical plummet, rain rate  
meter, snow rate meter, snowflakes, ion bombardment, inertial navigation  
system, optical systems

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PLANS AND PROGRAMS DIRECTORATE**



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## INTRODUCTION

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### LABORATORY BACKGROUND

The Phillips Laboratory, Geophysics Directorate, is located at Hanscom Air Force Base, Massachusetts. The mission of the Geophysics Directorate is to conduct basic research and exploratory and advanced development in space and ionospheric physics, atmospheric and earth sciences, and optical and infrared technologies. The Geophysics Directorate is the primary environmental science organization in the Air Force.

The Geophysics Directorate is a part of the Phillips Laboratory headquartered at Kirtland Air Force Base, New Mexico. The Phillips Laboratory is recognized as a national leader in research and development. The laboratory concentrates its research and development in five other technical areas as well as geophysics: propulsion, space and missiles technology, lasers and imaging, advanced weapons and survivability, and space experiments.

The Phillips Laboratory was formed in 1990 and replaced the Air Force Space Technology Center and Weapons Laboratory, both located at Kirtland Air Force Base, New Mexico; the Astronautics Laboratory at Edwards Air Force Base, California; and the Geophysics Laboratory, now the Geophysics Directorate.

### PURPOSE

Technology transfer is a process where federally-funded knowledge, capabilities, information, and ideas are used to help strengthen the United States economy and competitive technological edge. In 1980 the Stevenson-Wydler Technology Innovation Act (Public Law 96-480) was passed to encourage federal laboratories to make technology transfer a part of the laboratory mission. Each laboratory was required to establish an office of research and technology application (ORTA) to help facilitate technology transfer.

The Federal Technology Act of 1986 (Public Law 92-502) amended the Stevenson-Wydler Act by giving federal agencies the authority to enter cooperative research and development agreements, and to negotiate patent licensing agreements. Air Force policy (AFR 110-33) on patent licensing states:

Federally owned inventions in the custody of the Department of the Air Force normally will best serve the public interest when they are developed to the point of practical application and made available to the public in the shortest possible time. Nonexclusive, partially exclusive, or exclusive licenses for the practice of these inventions may be granted to applicants who agree to develop and/or market the inventions. All Air Force inventions normally will be made available for the granting of licenses to responsible applicants.

The following pages highlight the patents that are available for licensing from the Geophysics Directorate. The write-ups give a brief description of the inventions and list the inventions' special features and performance characteristics.

If you are interested in licensing any of these federally owned patents, contact:

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**GASEOUS INFRARED WAVEGUIDE MIXER**

Patent No: 4,006,363  
Issued: February 1, 1977

**INVENTION**

A waveguide mixer that uses a gas to produce a high output laser beam of preselected frequency or wavelength.

**RELATED TECHNOLOGY BACKGROUND**

Laser separation is a process used to produce macroscopic amounts of elements such as boron, chlorine, and sulfur from isotopically enriched compounds. The process requires excitation of the desired element and removal (separation) of the element from the source compound.

There are two methods of performing laser separation. The first method uses two laser beams - one for excitation, the other for separation. The second method uses one laser beam for excitation and a chemical scavenger for excitation.

There are some compounds where laser beams are not powerful enough to excite and remove the desired element. These compounds require laser beams of a predetermined frequency that are capable of producing hundreds of watts of average power.

**FEATURES**

- Uses a symmetric molecular gas whose resonance frequencies are close to the frequency of the input laser. The gas is then subjected to a DC field in an infrared waveguide.
- Applicable in radar, infrared illuminators, line scan imagers, infrared diagnostics, and other like studies.
- Economical to produce and uses conventional, currently available components.

**PERFORMANCE CHARACTERISTICS**

- One or more input laser beams are sent through the gas, thus generating second harmonic, sum, or difference frequencies. This produces a powerful coherent laser beam at a preselected frequency.
- The power range of the output laser beam is in the 1000's range of watts of power.
- Highly reliable in operation.

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CIRCULARLY POLARIZED, BROADSIDE FIRING,  
MULTIHELICAL ANTENNA

Patent No: 4,011,567  
Issued: March 8, 1977

INVENTION

A circularly polarized antenna for use in FM radio or television broadcasting.

RELATED TECHNOLOGY BACKGROUND

Horizontally polarized antennas are widely used in the United States. Equal coverage is difficult to achieve with this type of antenna system because the support mast must be made larger to reach a bigger area. These type of antennas radiate in cloverleaf patterns to achieve omnidirectional coverage, but equal coverage also becomes difficult when the antenna is put in a circularly polarized mode.

FEATURES

- Signals are radiated in an omnidirectional pattern about the mast and broadside the mast which results in equal coverage.
- Four conductors are helically wrapped around the mast so that the antenna radiates over a given range of frequencies.
- The conductors are powered with equal power signals at a frequency within the range of given frequencies. A conductor is  $180^\circ$  out of phase with the two adjacent conductors and in phase with the alternate conductor.
- The pitch angle of the conductors is selected to radiate circularly polarized signals broadside the mast. The angle is different for each given radial distance.
- The number of conductors  $N$  can be increased if needed.  $N$  is equal to  $2M$  where  $M$  is the number of  $360^\circ$  linear phase changes.  $M$  is an integer greater than 2.
- The support mast may be made of conductive material.
- Low cost.

PERFORMANCE CHARACTERISTICS

- Test results show that circularly polarized broadcasting improves television reception both in large metropolitan areas and in outlying areas.

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**APPARATUS FOR DOUBLE-BEAMING  
IN FOURIER SPECTROSCOPY**

Patent No: 4,095,899

Issued: June 20, 1978

**INVENTION**

A technique for performing double-beaming in Fourier spectroscopy which measures the spectra of a desired radiation while suppressing the spectra of unwanted radiation. The spectra is produced "real time" rather than produced sequentially.

**RELATED TECHNOLOGY BACKGROUND**

Spectroscopy is the production, measurement, and interpretation of electromagnetic spectra produced from the emission or absorption of radiant energy. The spectra provides information on atomic and molecular energy levels, electronic configuration of atoms and ions, molecular geometries, and chemical bonds. Fourier spectroscopy is the most superior form of spectroscopy.

Double-beaming is a spectroscopy technique which looks alternatively at the desired radiation and a sample beam. The resulting output is an interferogram which is related to the spectra of the desired radiation by a transformation. A problem encountered in double-beaming is dynamic range where the interferogram contains information on the desired radiation and the unwanted radiation.

**FEATURES**

- Utilizes a beamsplitter which results in an output obtained from the sum of three interferograms.
- Requires only one detector (current methods require two detectors or one detector and a chopper).
- Economical to produce and uses conventional, currently available components.

**PERFORMANCE CHARACTERISTICS**

- The output interferogram describes the spectra of the desired radiation; unwanted radiation is reduced or eliminated.
- Less radiation falls on the detector, therefore decreasing the likelihood of saturating the detector.
- The dynamic range problem that typically occurs in double-beaming is greatly reduced.

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**AZIMUTH MONITORING SYSTEM**

Patent No: 4,105,339  
Issued: August 8, 1978

**INVENTION**

A system for monitoring changes in relative azimuth due to geological features of the earth's surface.

**RELATED TECHNOLOGY BACKGROUND**

The surface of the earth consists of plates which move and shift as the earth expands. This movement has a direct effect on an azimuth reference system that is laid out on the earth's surface. Every time the azimuth station shifts, new observations of the azimuth must be taken to determine if the azimuth should be measured again. These observations and measurements are time consuming and require expensive equipment.

**FEATURES**

- Uses a collimated laser beam as a light source and a novel combination of plane mirrors and prismatic reflectors as targets.
- Three target stations are used together to eliminate movement ambiguities.
- Can operate in manual or automatic mode.
- Easily maintained.

**PERFORMANCE CHARACTERISTICS**

- Indicates whether the azimuth station has moved and the amount, type, and direction of the movement, including rotational and translatory movements.
- Minute changes are detected and recorded.
- More accurate than any similar system known in prior art.

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**SHIELD FOR HIGH-POWER INFRARED  
LASER BEAM**

Patent No: 4,114,985  
Issued: September 19, 1978

**INVENTION**

A device for terminating and providing shielding from high-power laser beams.

**RELATED TECHNOLOGY BACKGROUND**

When working with high-power lasers, it is important to provide for shielding and termination of the laser beam because of the damage the laser beam could do. This device provides for shielding and termination by using two ceramic sheets. The laser beam is first intercepted by the first ceramic sheet which causes the portion of the sheet being illuminated by the laser beam to turn from an opaque ceramic to a translucent jewel-like material. This translucent material behaves like a Rayleigh-type lens, thus scattering the laser beam into diffused light. The second ceramic sheet then absorbs and dissipates the heat energy generated from the diffused laser beam.

**FEATURES**

- The device is simple; only requires two ceramic sheets.
- The thickness of the first ceramic sheet has a relationship with the beam power density. The relationship allows the transformation of the ceramic from an opaque ceramic to a translucent material.
- The distance of the second ceramic sheet from the first ceramic sheet is determined by the appropriate length that permits Rayleigh scattering and efficient heat transfer.

**PERFORMANCE CHARACTERISTICS**

- The device is suitable for all applications; only the appropriate thickness and distance of the ceramic sheets needs to be calculated.
- Provides new and improved shielding from high-power laser beams.
- Provides shielding from high-power laser beams without damage to the shield.
- Provides termination of high-power laser beams without damage to the surrounding equipment and personnel.

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**MEANS AND METHOD FOR DETERMINING  
MERIDIAN LOCATION AND AZIMUTH**

Patent No: 3,981,588  
Issued: September 21, 1979

**INVENTION**

An apparatus that determines meridian location and azimuth using time matched photo-electric signals from star passages.

**RELATED TECHNOLOGY BACKGROUND**

Position-fixing by means of stars is not new. However, current devices and techniques used for position-fixing by star observations are time consuming, require delicate equipment and involve the use of an equation. There is no accurate, rapid, and convenient method for position-fixing on the earth's surface.

**FEATURES**

- The apparatus consist of an optical system mounted on a rotatable disk that is adjustable in elevation. Stellar light passes through a lens in the optical system.
- The reticle design is based on the optical principle that a reticle consisting of straight lines emanating from the center field of view and separated by equally inscribed angles, will be subject to star crossings evenly spaced in time only when the center line of the reticle is vertically aligned with the observer's meridian.
- The invention is lightweight.

**PERFORMANCE CHARACTERISTICS**

- A computer records the time interval of each stellar event and determines a difference and ratio factor by comparing the signals. The difference in signals is used to adjust the plummet to the appropriate elevation to determine the meridian.
- Provides accurate information in the shortest amount of time.
- Easy to operate, and is completely automatic.



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**OPTICAL PLUMMET AZIMUTH  
REFERENCE ASSEMBLY**

Patent No: 4,198,759  
Issued: April 22, 1980

**INVENTION**

An azimuth reference assembly that attaches to an optical plummet.

**RELATED TECHNOLOGY BACKGROUND**

Whenever an optical plummet is used for precise vertical alignment of an elevated or underground target, it may also be necessary to use the optical plummet to align a reference mark on the target to the vertical and to the azimuth plane passing through the target. For example, this situation occurs frequently in the construction of mining shafts in the laying of underground pipes and in the referencing of targets located in space. The problem with this type of alignment is that the alignment is based upon inaccurate trial and error procedures.

**FEATURES**

- Capitalizes on the design symmetry of the optical plummet.
- The azimuth reference assembly attaches to a conventional optical plummet in such a way that the centerline of the azimuth reference assembly is co-planar with the centerline reticle of the optical plummet.
  - When the plummet's centerline is oriented with respect to the target, the azimuth reference line will be identically oriented and can be immediately used to establish a line or azimuth reference mark with respect to the target.
- Useful in establishing the azimuthal orientation of objects placed underground or in space.
- Economical to produce and uses conventional, currently available components.

**PERFORMANCE CHARACTERISTICS**

- Easy to use; The observer sights through and aligns the crosses formed by the vertical and horizontal reticles of the azimuth reference assembly.
  - Because of the relationship between the plummet and the assembly, the observer is also looking in the direction of the vertical reticle of the plummet.
  - The observer can visually sight the horizontal azimuth of the target and can also align the horizontal azimuth by using programmed instrumentation.
- By varying the attachment of the azimuth reference assembly, the assembly can be used on any zenith/nadir optical plummet or detachable theodolite tribrach which has an optical plummet associated with it.

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**RAIN RATE METER**

Patent No: 4,476,718  
Issued: October 16, 1984

**INVENTION**

A rain rate meter capable of recording short-term variations in rain-rate.

**RELATED TECHNOLOGY BACKGROUND**

Many storms produce unexpected, localized "shafts" of severe/heavy concentrations of rain fall. These shafts occur in a wide range of storm situations, not just in heavy rain. These shafts are continuously in a state of change, forming, growing, and dissipating, which makes them unpredictable in terms of occurrence, size, and intensity. These shafts can attenuate electro-optical and communication systems, and may contribute to airplane accidents, especially during landings and takeoffs.

The current method of using tipping bucket gauges is not accurate for rain rates of 700mm/hr and higher because the water starts to spill. At about 1,000mm/hr, the bucket gauges completely fail.

**FEATURES**

- Electronically weighs naturally falling rain in order to determine rain rate information.
- The rain meter has a specially designed transfer mechanism that allows water to pass through the meter in small amounts. The small amounts do not disturb the sensitivity of the electronic balance.
- Economical to produce and uses conventional, available components.

**PERFORMANCE CHARACTERISTICS**

- Accurate in light and heavy rainfall situations. More accurate than existing rain gauges.
- Capable of providing data over a short time period, thus describing short-term variations in rain rate.
- Produces data that can be converted into terms of rain rate. The data can be read directly or be recorded on tape for later analysis.

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**SNOW SCALE/RATE METER**

Patent No: 4,499,761  
Issued: February 19, 1985

**INVENTION**

A device to weigh snow, to determine snowfall rate, and to accurately determine short term variations in snow weight measurements.

**RELATED TECHNOLOGY BACKGROUND**

Electro-optical and communication systems are susceptible to attenuation because of falling snow. Therefore, it is necessary to document the amount of snow deposited on a surface in a given amount of time so that the intensity of falling snow can be determined. Current devices are limited to determining the weight of snow over long periods of time. Short term variations are commonly inferred from the longer time rates by a probability model.

**FEATURES**

- Uses a conventional electronic balance sensitive to approximately .01 grams.
- Uses a wind shield to keep blowing snow from damaging sensitive electronics.
- When weighing snow, the snow must have a trajectory of 45° or less from the vertical. An adjustable wind screen surrounds the device to limit the measurement of falling snow to a trajectory of 45° or less.
- Another larger wind screen surrounds the smaller wind shield to disrupt severe horizontal wind components and to protect the equipment from wind damage.
- The snow collection bucket has calibration marks around the circumference for depth measurements.
- Economical to produce and uses conventional, currently available components.

**PERFORMANCE CHARACTERISTICS**

- Accurately measures falling snow in short-time intervals.
- Provides data that can be conveniently converted into terms of snow rate.

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**HEAVY RAIN RATE WARNING INDICATOR**

Patent No: 4,504,823  
Issued: March 12, 1985

**INVENTION**

A rain rate indicator that is capable of providing a warning when heavy or localized concentrations of rainfall occur.

**RELATED TECHNOLOGY BACKGROUND**

Many storms produce unexpected, localized "shafts" of severe/heavy concentrations of rainfall. These shafts occur in a wide range of storm situations, not just in heavy rain. These shafts are continuously in a state of change - forming, growing, and dissipating, which makes them unpredictable in terms of occurrence, size, and intensity.

Aircraft is exceptionally vulnerable to external conditions that can alter its aerodynamic efficiency, especially during landings and takeoffs. Therefore, it is possible that heavy rain can be a contributing factor in aircraft accidents. If a significant amount of rain strikes an aircraft, the plane could lose aerodynamic lift, become heavier with the weight of the water, face an increase in drag because of the force of the rain, and possibly have an engine malfunction.

The present method of detecting heavy rain "shafts" is radar. However, detecting small "shafts" close to the ground requires a highly sophisticated and expensive weather radar system. Other rain indicators are too slow and do not give a warning of heavy rainfall.

**FEATURES**

- Applicable to any area where indication of severe/heavy rain is required. Can be used as a rain rate measuring device with minor modifications.
- Readily adaptable for use on airport runways.
- Works by the force of the rain drops, not by the weight of collected water. This eliminates the force of momentum collected water contains, which can affect the accuracy of the device and the need for expensive bearings.
- When heavy rainfall occurs, an electrical switch is triggered activating an alarm system. The alarm system can be a simple buzzer or a complicated computerize graphic system that records and plots the output of several rate indicators.
- A rain shield can easily be attached to protect the electronic components and a wire mesh can be used to prevent large pieces of debris from clogging the indicator.

**PERFORMANCE CHARACTERISTICS**

- Simple to construct and highly reliable in operation.
- Can be operated without constant supervision.
- Virtually maintenance-free in operation.

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**FALL VELOCITY INDICATOR/VIEWER**

Patent No: 4,514,758  
Issued: April 30, 1985

**INVENTION**

A device that determines velocity of natural falling snowflakes and provides a clear observation area for viewing the snowflakes.

**RELATED TECHNOLOGY BACKGROUND**

Electro-optical and communication systems are susceptible to attenuation because of snow fall. By determining the velocity and by observing the characteristics of the snow, it is possible to take steps to lessen the attenuation effects of snowfall.

**FEATURES**

- Uses a video recording instrument to continually monitor snowflakes as they fall through a preselected viewing area.
- The port opening to the sampling area is adjustable which allows the field of view to be changed.
- A collar above the port prevents entry of accumulated snow. The collar height is adjustable which limits the sampled snowfall to trajectories within a specified range or angle.
- Uniform lighting of the viewing area is achieved through placing strobe lights at strategic points. The strobe lights also provide velocity information on the falling snowflakes.
- Mirrors are used to provide front and top views of the snowflake so that characteristics such as orientation, crystal type, and size can be determined.
- Can be used with other "hydrometeors."
- Economical to produce; uses conventional, currently available components.

**PERFORMANCE CHARACTERISTICS**

- Can monitor fallout from any natural or man-made conditions, for example, explosions, volcanic eruption, and smoke stack emissions.
- Provides continuous recording of "naturally falling" snowflakes and other hydrometeors.
- Capable of determining variations in size and orientation of naturally falling particles.
- Can provide multiple images of individual particles on a single video frame.

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**APPARATUS FOR CONTINUOUSLY INSPECTING  
THE PHYSICAL CHARACTERISTICS OF  
PARTICULATE MATTER**

Patent No: 4,561,018  
Issued: December 24, 1985

**INVENTION**

An apparatus capable of continuously inspecting snowflakes to determine the physical characteristics of their crystalline structure.

**RELATED TECHNOLOGY BACKGROUND**

Electro-optical and communication systems are susceptible to attenuation because of falling snow. Other types of hydrometeors or particulate matter also have adverse affects on electro-optical and microwave systems as well as communication systems. Therefore it is important to study the characteristics of the crystalline structure of hydrometeors, such as snow or ice, to relate their crystalline forms to changes in electromagnetic attenuation, fall velocity, and other characteristics. The viewing of such hydrometeors should take place in the field in the exact conditions where electro-optical, microwave, and communication systems are affected.

**FEATURES**

- Consist of a particulate matter collecting and conveying system, a sampling compartment, and a camera system. The conveyor is made of non-absorbent material and provides sufficient cushioning for falling snow.
- The interior surface of the conveyor is slotted to accommodate a gear drive for positive and accurate movement of the conveyor as well as provide smooth movement so as not to shock the particulate matter.
- A strobe lighting unit or a pair of incandescent lamps can be used to illuminate the sampling compartment and a heating device can be used in the sampling compartment to study snowflake or ice particle melting.
- A heating element can be used to maintain the video camera at ideal operating temperature.
- Can be used with other types of particulate matter.

**PERFORMANCE CHARACTERISTICS**

- A conventional video camera continuously monitors the snowflakes. Information can be recorded on video tape.
- The housing contains an adjustable opening for regulated particle entry.
- Capable of providing a greatly magnified image of the particulate matter that can be displayed on a television or video screen and recorded on video tape. These observations can be made over an extended period of time.
- Can take measurements of various sizes of particles by using the image of a removable plastic grid that adjusts for magnification.

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**SEISMO-ACOUSTIC DETECTION, IDENTIFICATION,  
AND TRACKING OF STEALTH AIRCRAFT**

Patent No: 4,811,308  
Issued: March 7, 1989

**INVENTION**

A system for detecting and tracking stealth aircraft using seismic and acoustic signatures.

**RELATED TECHNOLOGY BACKGROUND**

Conventional radio frequency (RF) radar systems possess certain natural limitations in the detection of low-flying aircraft. With the advent of advanced weapons and aircraft technology, especially stealth technology, radar has become even less reliable in detecting hostile aircraft. However, stealth aircraft are still subject to detection from their seismic and acoustic signatures.

**FEATURES**

- Uses arrays of seismic and acoustic sensors, junction and sub-array circuits, slave computers, a master computer, and a central data computer.
- Based on the fact that stealth aircraft may be invisible to radar, but have seismic and acoustic signatures that can be detected.
- Does not rely on RF transmitted signals which can be jammed.
- The master computer controls the system and provides access to users.
- The master computer performs near real-time analysis from acoustic and seismic data. The data is collected by using arrays of seismic and acoustic sensors.

**PERFORMANCE CHARACTERISTICS**

- Detects stealth aircraft passively without using radar.
  - Tracks low-flying aircraft; determines velocity and position.
- Can identify the aircraft by the characteristics of their seismic and acoustic signatures.

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**PARTICULATE MASS MEASURING APPARATUS**

Patent No: 4,815,314  
Issued: March 28, 1989

**INVENTION**

A particulate mass measuring device that overcomes the disadvantages of previous devices.

**RELATED TECHNOLOGY BACKGROUND**

The atmosphere of the Earth and other planets is not only composed of gas, but also contains particulate matter such as snow, raindrops, hail mist, cloud vapor, and dust. One effort to weigh the particulate matter is a pre-weighed filter that is towed through the air to collect a sample. The collected particulate matter is then weighed. However, the weight is not accurate because some particulate matter evaporates before it is weighed, and the spacial-temporal resolution of the filter is large.

Other devices used to weigh particulate matter are mounted near the ground and are fed by gravity or forced airflow. The disadvantages are that these devices are stationary, are limited to the type of samples they can collect, and are susceptible to meteorological conditions that could distort the sample.

**FEATURES**

- The device is made of a housing, a spinner, a heater in the spinner, a wedge ring, a needle, a needle heater, and required electronics.
- Can measure integrated mass flow or individual particulate matter.
- Can measure the mass of both liquid and solid particulate matter.
- Mounts on an aircraft - mobile.
- Positive airflow exist inside the housing to prevent entry of moisture.

**PERFORMANCE CHARACTERISTICS**

- Particulate matter is drawn into the spinner, which slows down the spinner from a predetermined speed, thus, enabling the mass of the particulate to be measured by the change in speed. The particulate matter is eventually ejected out by aerodynamic and centrifugal forces - no need to weigh.
- Has a computer to process measurement information about the particulate mass.



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**PROCESS FOR THE ELIMINATION OF  
NOISE FROM DATA**

Patent No: 4,884,440  
Issued: December 5, 1989

**INVENTION**

A data analysis process which reduces the effects of noise on data in a data stream.

**RELATED TECHNOLOGY BACKGROUND**

Data analysis is complicated by the problem of determining true values of measurements from those contaminated by extraneous signals referred to as noise. In such cases averaging the raw data over a period of time so that the resulting mean values approximate true readings is effective. However, there are cases where noise is biased in magnitude and polarity so that averaging doesn't work. Numerical averaging can be used in these cases, but if the noise is asymmetrical in polarity and/or magnitude, the resulting averaging will exhibit a similar symmetry.

**FEATURES**

- The process has three steps:
  - 1) Identifying quiescent periods within a given data stream;
  - 2) Calculating a weight for each of these quiescent periods;
  - 3) Interpolating the data by assigning an interpolated weight value to individual data points, thus giving an estimate of the actual data which is uncontaminated by noise.
- The data stream can be any set of collected data.
- Can be used on any data processing system.
- The process compensates for the effects of severe noise that is based on magnitude and polarity.

**PERFORMANCE CHARACTERISTICS**

- The output is a plot which represents an estimate of the actual data stream when uncontaminated by noise.
- The process mimics the logic of human reasoning when a person plots a hand-drawn, best-given curve of noisy data samples.
- The resulting output is within acceptable error boundaries.

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ION BOMBARDMENT OF INSULATOR SURFACES

Patent No: 4,957,771  
Issued: September 18, 1990

INVENTION

A method of improving the flashover strength of high-voltage insulators in a vacuum.

RELATED TECHNOLOGY BACKGROUND

High-voltage insulators are prone to breakdown across surfaces (flashover) at voltages which are much lower than desired when in a vacuum. Treatments to improve the flashover strength (increase voltage where breakdown occurs) involve depositing a small amount of metal on the insulator, either through firing in place as in the case of a ceramic insulator, or through vacuum depositing as on a polymeric insulator.

Polymers are practical for insulator applications because they have superior mechanical properties and are available in large sizes. However, the current techniques of depositing metals on insulators involve high temperatures and are unsuitable for polymeric materials. Also vapor deposits of metal onto polymeric materials can result in a surface coating that is susceptible to damage.

There is an ongoing need for improved flashover performance in situations where it is necessary to operate with high voltage in a vacuum.

FEATURES

- Applies commercial ion-implantation techniques to achieve a quasi-metallized surface on a vacuum insulator. The insulator surface is exposed to a beam of high energy metal ions from a commercially available accelerator.
- Can be used with various insulator materials but is especially useful on polymeric materials.

PERFORMANCE CHARACTERISTICS

- The ion bombardment process makes the metal a part of the surface structure of the insulator. The resultant surface has the same electrical properties of a metallized surface and has the additional advantage of mechanical and electrical ruggedness.
- Penetration of the metal into the insulator can reach a depth of 100 atomic diameters. The concentration of metal on the insulator surface can reach up to  $5 \times 10^{17}$  particles/cm<sup>2</sup>. This maximum concentration can be reached in the order of a few minutes per square centimeter of insulator surface.
- Useful wherever an insulator must operate at high voltage in a vacuum, for example, spacecraft systems and particle beam accelerators.

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SYSTEM FOR MODELLING LOW RESOLUTION  
ATMOSPHERIC PROPAGATION  
LOWTRAN7

Patent No: 5,075,856  
Issued: December 24, 1991

INVENTION

A low resolution propagation model and computer system for predicting atmospheric transmittance background radiation from 0 - 50,000 $\text{cm}^{-1}$  increments at a resolution of 20 $\text{cm}^{-1}$ . The model also calculates single scattered solar and lunar radiance, direct solar radiance, and multiple scattered solar and thermal radiance.

RELATED TECHNOLOGY BACKGROUND

LOWTRAN is an updated version of the previous LOWTRAN codes - 6, 5, 4, 3, and 2. These codes are used with systems that measure atmospheric transmittance and background radiation. These systems experience attenuation due to atmospheric particulates such as water, vapor, and other gases. LOWTRAN7 gives these systems an ability to obtain more exact estimates of transmittance and radiation despite the effects of atmospheric particulates.

FEATURES

- Several new parameters are included with LOWTRAN7 - multiple scattered radiation, new molecular band model parameters, and new ozone and molecular oxygen absorption parameters for the UV.
- New models have been added - a wind-dependent desert model, new cirrus cloud models, new cloud and rain models, and aerosol models.
- An improved extra-terrestrial solar source function is also included.
- Six modes of program execution are allowed for a given slant pitch geometry.
- A new model for calculating air masses has been added. The code also presents calculations of air masses for several representative atmospheric paths.
- Provides a refined estimate of transmittance and multiple scattered radiation using an atmospheric data base that includes molecular profiles for thirteen minor and trace gases.
- Has six reference atmospheric models to define temperature, pressure, and density as a function of altitude.
- Calculates the effects of weather on the transmission of infrared and optical beams.

PERFORMANCE CHARACTERISTICS

- Can be used on almost all data processing systems that can operate FORTRAN.
- Can be used with external sensor systems that provide meteorological atmospheric data, or can use one of the six internal reference atmospheric models to estimate atmospheric conditions as a function of altitude.

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HADAMARD SPECTROGRAPH

Patent Pending

INVENTION

A Hadamard spectrograph configuration which significantly increases throughput and sensitivity of conventional, single-split, planar detector array electronic spectrographs.

RELATED TECHNOLOGY BACKGROUND

In conventional spectroscopy a beam of light is passed through a narrow slit, collimated, and then passed through a dispersive element to spread out the spectrum. The spectrum is then decollimated to spatially spread out the wavelengths on a plane. The individual wavelengths can be analyzed by passing a narrow band of the spectrum through another slit onto a detector, or by scanning the spectrum using a mechanically mobile dispersive element or slit.

In Hadamard spectroscopy a Hadamard mask is used at the entrance plane of a single-slit photodiode-array spectrograph. The mask breaks up the spectrum into groups. The intensity of each group is measured simultaneously on a single detector, which helps reduce the signal-to-noise ratio, resulting in a more accurate analysis of wavelengths.

FEATURES

- A cyclic mask is used to measure the intensities of different groups.
- Two masks are used to offer the advantages of multiplexing and wide aperture, hence, double encoded Hadamard spectroscopy.
- No moving parts.

PERFORMANCE CHARACTERISTICS

- The mask effectively enlarges the aperture to half the number of detector elements, thus, increasing throughput. In conventional spectroscopy, the aperture is only equal to one element.
- There is greater sensitivity and an improved signal-to-noise ratio resulting in a more accurate spectrograph.
- The detectors are able to pick up weak signals that cannot be picked up by conventional spectroscopic systems.

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**INERTIAL NAVIGATION SYSTEM (INS)  
INTERFACE BOX**

Patent Pending

**INVENTION**

A data interface box that allows the transfer of inertial navigation system data to a personal computer for flexible use.

**RELATED TECHNOLOGY BACKGROUND**

An INS is a self-contained system that can automatically determine the position, velocity, and attitude of a moving vehicle for directing its future course. Such systems are applied in the guidance and control of submarines, ships, aircraft, missiles, and spacecraft. Data from INS systems is used for special purpose computers that generally are unable to record data. There is special hardware available to record the data for on-board recording of INS data for later processing.

**FEATURES**

- The real-time availability of INS data provides a flexible in-flight research asset.
- Electronically modifies the INS data stream to allow data transfer to a personal computer.

**PERFORMANCE CHARACTERISTICS**

- Facilitates on-board data analysis on airborne data gathering missions by providing INS data for personal computers.
- Permits the quick reformatting/use of INS data in response to changing research requirements.
- Can use an interface circuit between the PC and INS system to record all readings from a flight for later use and to observe and convert data for real-time analysis.

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**METHOD FOR CONFOCAL CHECK OF BEAM PATH  
IN REFLECTIVE FTIR OPTICS**

Patent Pending

**INVENTION**

A method for visibly checking the beam path and focus of an infrared beam in a reflective IR optical system.

**RELATED TECHNOLOGY BACKGROUND**

Optical systems that use radiation outside of the visible spectrum are widely used in Government laboratories. These optical systems use various infrared sensor systems that produce IR beams that are invisible. The path and focus of an invisible IR beam must be identified so that the optical system used to process the IR beam can be aligned. Other methods of finding the beam path and focus are complicated and/or error prone.

**FEATURES**

- Uses a collimated beam of visible light that is transmitted along the optical path of the invisible IR beam by using a reflecting plane mirror.

**PERFORMANCE CHARACTERISTICS**

- A sheet of white paper is used to interrupt the optical path of the beams, illuminating the paper with a spot where the path intercepts the paper. The spot shows the location of the beams (hence the location of the invisible IR beam) and provides a focus to help align the optical system.

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**A PROCESS AND APPARATUS FOR PREVENTING  
THE PULSE DISCHARGE OF INSULATORS  
IN IONIZING RADIATION**

Patent Pending

**INVENTION**

A semi-insulating paint that is applied on insulating materials that are exposed to ionizing radiation. The paint prevents or substantially reduces pulse discharges.

**RELATED TECHNOLOGY BACKGROUND**

Electronic devices will be able to survive increasingly higher levels of environmental irradiation as radiation hardness improves. However insulating materials, such as electronic circuit boards and integrated circuit packages, are prone to pre-breakdown discharges caused from photon or electron irradiation. These discharges can produce voltage pulses strong enough to damage or electrically disrupt adjacent electronic devices. When the insulating material is coated with a "grounded" conductor, the pulses don't occur.

**FEATURES**

- The paint is made from tin oxide and phenoxy resin. Other coatings made of semi-insulating materials can also be used.
- The paint can be used alone or with other materials, for example, a coating to stabilize the surface components.

**PERFORMANCE CHARACTERISTICS**

- The paint continually conducts an electrical charge between the insulated electronic devices and the spacecraft frame or another suitable ground so that surface voltage remains very low at all times.
- Spontaneous discharges are only small pulses in the electrical circuits and the number of spontaneous discharges is greatly reduced.

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A METHOD OF DISPLAYING COMPOSITE  
SATELLITE IMAGERY

Patent Pending

**INVENTION**

A method of producing a single 8-bit composite image from two 8-bit satellite channels with different spectral information for display on an 8-bit color display device.

**RELATED TECHNOLOGY BACKGROUND**

Composite satellite imagery is the combination of two coincident images into a single image where color reflects the radiant differences between the two images. The standard method of generating composite imagery requires display devices that can simultaneously display 16-24 bits. However these devices are expensive and most meteorological researchers and operational forecasting facilities do not have access to these displays. Also most displays don't support 16 or 24 bits of magnitude.

**FEATURES**

- The method is a space transformation  $((i,j) \text{ transformed into } (i',j'))$  where  $i'=j$  and  $j'=i-1$  where unused grayshade (no or little image) combinations are eliminated and the remaining "color space" (image) is sub-divided into 255 colors.
- The transformation is based on two characteristics of most meteorological satellite images:
  - 1) For almost any combination of two coincident satellite images, most of the 2-dimensional pixel-value  $(i,j)$  space (the space the image takes up) is empty.
  - 2) Most of the pixel-value combinations lie near the line  $i=j$ , therefore, the grayshade values of the primary image are nearly the same as the secondary.
- The transformation results in the  $i'$  axis being proportional to the mean intensity of the two images and the  $j'$  axis being proportional to the differences in grayshades and colorshade of the composite image.
- The pixel-value space is divided into 255 bins; each bin is assigned a central value  $(i',j')$ . The colors of the bins are based upon the central value of the bin and the color masks (one primary, one secondary) specified by the user. The color masks define the color so that if pixels show a positive radiance is shaded toward the primary mask; negative radiant differences are shaded toward the secondary. The bin values are loaded into the display device color look-up table and assigned an entry number.

**PERFORMANCE CHARACTERISTICS**

- The color image produced using this method generally has a better color contrast than the sometimes fuzzy nature of the 16-bit color image.
- There are 51 different grayshade values of intensity which are sufficient enough to provide smooth, noise-free, easily interpretable grayshade images.
- The colors of the composite images are generated by assigning each pixel of the image to the entry number that corresponds to the bin where the associated values of  $i'$  and  $j'$  are located. The image is then simply loaded into the display device.



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**PATENT LIST**

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<u>DATE ISSUED</u>	<u>PATENT TITLE</u> <u>INVENTOR/S</u>	<u>PATENT NO.</u>
February 1, 1977	Gaseous Infrared Waveguide Mixer Howard R. Schlossberg	4,006,363
March 8, 1977	Circularly Polarized, Broadside Firing, Multihelical Antenna Oded Ben-Dov	4,011,567
June 20, 1978	Apparatus for Double-Beaming in Fourier Spectroscopy George A. Vanasse	4,095,899
August 8, 1978	Azimuth Monitoring System Theodore E. Wirtanen	4,105,339
September 19, 1978	Shield for High-Power Infrared Laser Beam Jerome D. Friedman	4,114,985
September 21, 1979	Means and Method for Determining Meridian Location and Azimuth Theodore E. Wirtanen	3,981,588
April 22, 1980	Optical Plummet Azimuth Reference Assembly Theodore E. Wirtanen Ronald M. Hitchcock	4,198,759
October 16, 1984	Rain Rate Meter Vernon G. Plank Stephen D. Crist Dennis L. LaGross	4,476,718
February 9, 1985	Snow Scale/Rate Meter Vernon G. Plank Anthony J. Matthews Robert O. Berthel Dennis L. LaGross	4,499,761
March 12, 1985	Heavy Rain Rate Warning Indicator Robert O. Berthel	4,504,823

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April 30, 1985	Fall Velocity Indicator/Viewer	4,514,758
	Robert O. Berthel Vernon G. Plank Stephen H. Jones Anthony J. Matthews	
December 24, 1985	Apparatus for Continuously Inspecting the Physical Characteristics of Particulate Matter	4,561,018
	Robert O. Berthel Vernon G. Plank Dennis L. LaGross	
March 7, 1989	Seismo-Acoustic Detection, Identification, and Tracking of Stealth Aircraft	4,811,308
	Howard E. Michel	
March 28, 1989	Particulate Mass Measuring Apparatus	4,815,314
	Vernon G. Plank	
December 5, 1989	Process for the Elimination of Noise from Data	4,884,440
	Robert O. Berthel	
September 18, 1990	Ion Bombardment of Insulator Surfaces	4,957,771
	Carl L. Enloe	
December 24, 1991	System for Modelling Low Resolution Atmospheric Propagation LOWTRAN7	5,075,856
	Francis X. Kneizys Eric P. Shettle Leonard W. Abreu James H. Chetwynd Gail P. Anderson Shepard A. Clough William O. Gallery John E. A. Selby	

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Patent Pending	Method for Confocal Check of Beam Path in Reflective FTIR Optics Frederic E. Volz
Patent Pending	A Process and Apparatus for Preventing the Pulse Discharge of Insulators in Ionizing Radiation Arthur R. Frederickson Joseph E. Nanevich Jeffery S. Thayer Dean B. Parkinson
Patent Pending	Hadamard Spectrograph Roger A. Van Tassel Wallace K. Wong
Patent Pending	Inertial Navigation System (INS) Interface Box John W. F. Lloyd
Patent Pending	A Method of Displaying Composite Satellite Imagery Larry W. Thomason Robert P. d'Entremont

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