



# Express Search, Inc.

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Re: Accelerated Examination Search  
Removal of Surface Multiples  
Express Search Sample Search

October 15, 2009

Dear Mr. Search,

In accordance with your e-mail received on October 02, 2009, an Accelerated Examination Search was conducted.

This accelerated examination search is in accordance with the Federal Register Notice [Docket No.: PTO-P-2006-0014] regarding "Changes to Practice for Petitions in Patent Applications to Make Special and for Accelerated Examination" listed in 71 FR 36323 and MPEP § 708.02(a). This Notice also references the petition to make special, as described by MPEP § 708.02 (viii).

In accordance with section 8 of the Notice, this search includes a statement that a pre-examination search has been conducted, including an identification of the field of search by United States class and subclass and the date of the search, where applicable, and for database searches, the search logic or chemical structure or sequence used as a query, the name of the file or files searched and the database service, and the date of the search. This statement is included as "Pre-Examination Search Document [PDF]."

In accordance with section 8(a) of the Notice, this search involved U.S. patents and patent application publications, foreign patent documents, and non-patent literature.

In accordance with section 8(b) of the Notice, this search was directed to the claimed invention and encompasses all of the features of the claims, giving the claims the broadest reasonable interpretation.

In accordance with section 8(c) of the Notice, this search encompassed the disclosed features that may be claimed as identified by you in attached document.

In accordance with section 8(e) of the Notice, this report is provided on a good faith belief that the pre-examination search has been conducted in compliance with the requirements of MPEP 708.02(a)(i).

The non-patent literature portion of this search utilizes relevant databases listed in the "PCT Minimum Documentation Requirements," the "USPTO Search Templates," and other non-patent literature databases.

The following classes and subclasses were searched:

Class 367 (Communications, Electrical: Acoustic Wave Systems And Devices)

Subs. 21, 24, 40, 42, 43, 46, 50, 52, 57, 73

Class 702 (Data Processing: Measuring, Calibrating, Or Testing)

Subs. 14, 16, 17, 18

The following IPC-8 classes and subclasses were searched:

Class G01V (GEOPHYSICS; GRAVITATIONAL MEASUREMENTS; DETECTING MASSES OR OBJECTS; TAGS)

1/00 Seismology; Seismic or acoustic prospecting or detecting

1/16 Seismology; Seismic or acoustic prospecting or detecting; Receiving elements for seismic signals; Arrangements or adaptations of receiving elements

1/20 Seismology; Seismic or acoustic prospecting or detecting; Receiving elements for seismic signals; Arrangements or adaptations of receiving elements; Arrangements of receiving elements, e.g. geophone pattern

1/28 Seismology; Seismic or acoustic prospecting or detecting; Processing seismic data, e.g. analysis, for interpretation, for correction

1/30 Seismology; Seismic or acoustic prospecting or detecting; Processing seismic data, e.g. analysis, for interpretation, for correction; Analysis

1/36 Seismology; Seismic or acoustic prospecting or detecting; Processing seismic data, e.g. analysis, for interpretation, for correction; Effecting static or dynamic corrections on records, e.g. correcting spread; Correlating seismic signals; Eliminating effects of unwanted energy

1/38 Seismology; Seismic or acoustic prospecting or detecting; specially adapted for water-covered areas

1/40 Seismology; Seismic or acoustic prospecting or detecting; specially adapted for well-logging

- 1/42 Seismology; Seismic or acoustic prospecting or detecting; specially adapted for well-logging; using generators in one well and receivers elsewhere or vice-versa
- 13/00 Manufacturing, calibrating, cleaning, or repairing instruments or devices covered by groups G01V 1/00-G01V 11/00

Class G06F (ELECTRIC DIGITAL DATA PROCESSING)

- 17/10 Digital computing or data processing equipment or methods, specially adapted for specific functions; Complex mathematical operations
- 19/00 Digital computing or data processing equipment or methods, specially adapted for specific applications

Class G06G (ANALOGUE COMPUTERS)

- 7/00 Devices in which the computing operation is performed by varying electric or magnetic quantities
- 7/48 Devices in which the computing operation is performed by varying electric or magnetic quantities; Analogue computers for specific processes, systems, or devices, e.g. simulators
- 7/56 Devices in which the computing operation is performed by varying electric or magnetic quantities; Analogue computers for specific processes, systems, or devices, e.g. simulators; for heat flow

Class G10K (SOUND-PRODUCING DEVICES ; METHODS OR DEVICES FOR PROTECTING AGAINST, OR FOR DAMPING, NOISE OR OTHER ACOUSTIC WAVES IN GENERAL; ACOUSTICS NOT OTHERWISE PROVIDED FOR)

- 11/00 Methods or devices for transmitting, conducting or directing sound in general; Methods or devices for protecting against, or for damping, noise or other acoustic waves in general
- 11/178 Methods or devices for transmitting, conducting or directing sound in general; Methods or devices for protecting against, or for damping, noise or other acoustic waves in general; Methods or devices for protecting against, or for damping, noise or other acoustic waves in general; using interference effects; Masking sound; by electro-acoustically regenerating the original acoustic waves in anti-phase

The following U.S. patents were uncovered in the search:

7,515,505	7,505,361	7,489,590	7,123,543	6,889,142	6,735,527
6,678,207	6,654,693	6,493,636	6,188,963	5,995,905	5,661,697
2009/0067285		2009/0048784		2008/0294346	

The following foreign patents were also noted of interest:

WO 2008008651    WO 2008005775    JP 3170897    EP 112715

The following patents appear to be most relevant:

7,505,361 discloses processing seismic data from towed marine seismic streamer with particle motion and pressure sensors by calculating specific order surface related multiples in pressure wave-field using preset product value, least-squares taken at step (Figure 6, Element 64; Column 11, Line 38 to Column 12, Lines 18; synthesizing pairs of readings, Column 6, Lines 60-66).

6,735,527 discloses processing seismic data from stacked formation, generating 3-dimensional pre-stack trace pairs and convolving generated pre-stack traces to compute predicted multiples (Column 3, Lines 11 to Column 4, Lines 45; Claims 23-40).

7,123,543 discloses de-ghosting and water surface multiple reflection attenuation in dual sensor marine seismic data for seismic exploitation by decomposing data at each source position into dual wave field components (Claims 1, 11, 12, 20-21, 31 and 33).

WO 2008005775 discloses Interpolating and/or extrapolating seismic recordings for seismic data from at least one streamer carrying multicomponent receivers as a filter for pressure data.

2008/0294346 discloses attenuating multiples in surface-related seismic waves by convolving primary beam and modeled pegleg beam to obtain convolved multiples beam.

6,678,207 discloses ocean bed seismic data secondary wave-fields removal by estimating down-going wave-field from difference between pressure and velocity signals.

2009/0048784 discloses estimating multiple reflected events at output location to explore for hydrocarbons within subsurface exploration target.

6,654,693 discloses multiple reflection attenuation for 2-component marine seismic data by applying time signal moving average operator to seismic data using specific formula.

The following non-patent literature were uncovered during the search:

Barbel Traub, Anh Kiet Nguyen, and Matthias Riede "Fast free-surface multiples attenuation work-flow for 3D OBS data" SEG Expanded Abstracts 25, 2664 (2006), DOI: 10.1190/1.2370075

<http://dx.doi.org/10.1190/1.2370075>

Disclosing attenuation of free-surface related multiples for 2D and 3D Ocean Bottom Seismic data based on wave equation. Free-surface multiple attenuation is performed in the radon domain. Data are transformed into the Radon (-p-q)

domain by means of a fast Radon Transform using Fourier projection slice theorem then, the wavefield is split into its up-and down-going part to create a deterministic deconvolution filter to identify & attenuate the energy of free-surface multiples.

B. L. N. KENNETT, "THE SUPPRESSION OF SURFACE MULTIPLES ON SEISMIC RECORDS"

<http://www3.interscience.wiley.com/journal/119598632/abstract>

Disclosing the suppression of multiples reflected at the surface of a horizontally layered fluid or elastic medium recorded at non-zero offsets from the source by extracting the effect of the free surface in the frequency-wave number domain and then replacing this surface with a non-reflecting boundary by a multiple suppression operator having detailed knowledge of the source time function and the elastic properties of the medium between the source and the surface.

Borselen, et al, " Removal of surface-related wave phenomena - The marine case" *GeoPhysics*, Vol. 61, No. 1 (January-February 1996); P. 202-210

[http://repository.tudelft.nl/file/81750/K\\_1114546052138333411](http://repository.tudelft.nl/file/81750/K_1114546052138333411)

Disclosing using a temporal Fourier transformation with time inversion, leading to a successive removal of the water surface multiples.

Ian Moore, "Overlap and infill requirements for surface-related multiple elimination (SRME)" *The Leading Edge* 25, 560 (2006), DOI:10.1190/1.2202657

<http://dx.doi.org/10.1190/1.2202657>

Weglein et al, "An inverse-scattering series method for attenuating multiples in seismic reflection data" *Geophysics* 62, 1975 (1997), DOI:10.1190/1.1444298

<http://dx.doi.org/10.1190/1.1444298>

Luc T. Ikelle , "Combining two seismic experiments to attenuate free-surface multiples in OBC data" *Geophysical Prospecting*, 1999, 47, 179-193

<http://casp.systemproof.com/papers/paperuu.pdf>

Disclosing multiple attenuation of marine seismic reflection data combining conventional marine surface seismic reflection data (streamer data) to add the wave paths for multiple attenuation, resulting in multiple attenuation which takes into account all free-surface multiples including receiver ghosts and non-linear synthetic data.

LASSE AMUNDSEN, "PLANE-WAVE ANALYSIS OF FREE-SURFACE MULTIPLE REMOVAL BY ITERATIVE PREDICTION AND SUBTRACTION" *JOURNAL OF SEISMIC EXPLORATION* 2002, VOL 10; PART 4, pages 311-322; ISSN: 0963-0651

<http://casp.systemproof.com/papers/2002paperr6.pdf>

Chengliang Fan et al, " Removing free-surface multiples from teleseismic transmission and constructed reflection responses using reciprocity and the inverse scattering series" *GEOPHYSICS*,VOL. 71, NO. 4 JULY-AUGUST 2006; P. SI71-SI78; DOI: 10.1190/1.2217369

<http://pages.csam.montclair.edu/~nita/research/fan.et.al.geophysics.2006.pdf>

Discloses removing free-surface multiples from transmission and constructed reflection responses, considering both the recorded waves under the real

transmission geometry and synthetic constructed waves under a virtual reflection geometry.

Daniel Trad, " Multiple removal based on wavefield extrapolation"  
[http://www.eos.ubc.ca/research/cdsst/members/8\\_98.pdf](http://www.eos.ubc.ca/research/cdsst/members/8_98.pdf)

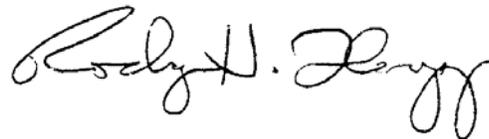
D. J. Verschuur and A. J. Berkhout "Estimation of multiple scattering by iterative inversion, Part II: Practical aspects and examples" GEOPHYSICS, VOL. 62, NO. 5 (SEPTEMBER-OCTOBER 1997); P. 1596-1611, 18 FIGS.

[http://www.delphi.tudelft.nl/People/Berkhout/publications/Verschuur\\_Geoph\\_Vol62-5b.pdf](http://www.delphi.tudelft.nl/People/Berkhout/publications/Verschuur_Geoph_Vol62-5b.pdf)

discloses the use of the inverse source wavelet to provide an accurate estimate by a linear (least-squares) inversion process using an iterative multiple elimination process, together with the source wavelet estimation.

Abstracts and/or full text of the cited references are available by clicking on the links below the cited patents. Most full text documents are available to order for \$25 to \$45 each depending on copyright and database cost. Please advise if you wish to order any of these documents. It will take about one week, and we will bill you only what we are charged to retrieve each document ordered. Please do not hesitate to contact me with any questions regarding this search.

Best Regards,  
EXPRESS SEARCH



Rodger H. Flagg  
President

RHF  
Enclosure: 19 Patents and 10 NPL References  
Ref: E00-93017