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(54) Title: SPECTRAL FITTING OF COMPACT LASER-BASED TRACE GAS SENSOR MEASUREMENTS FOR HIGH DYNAMIC RANGE (HDR)

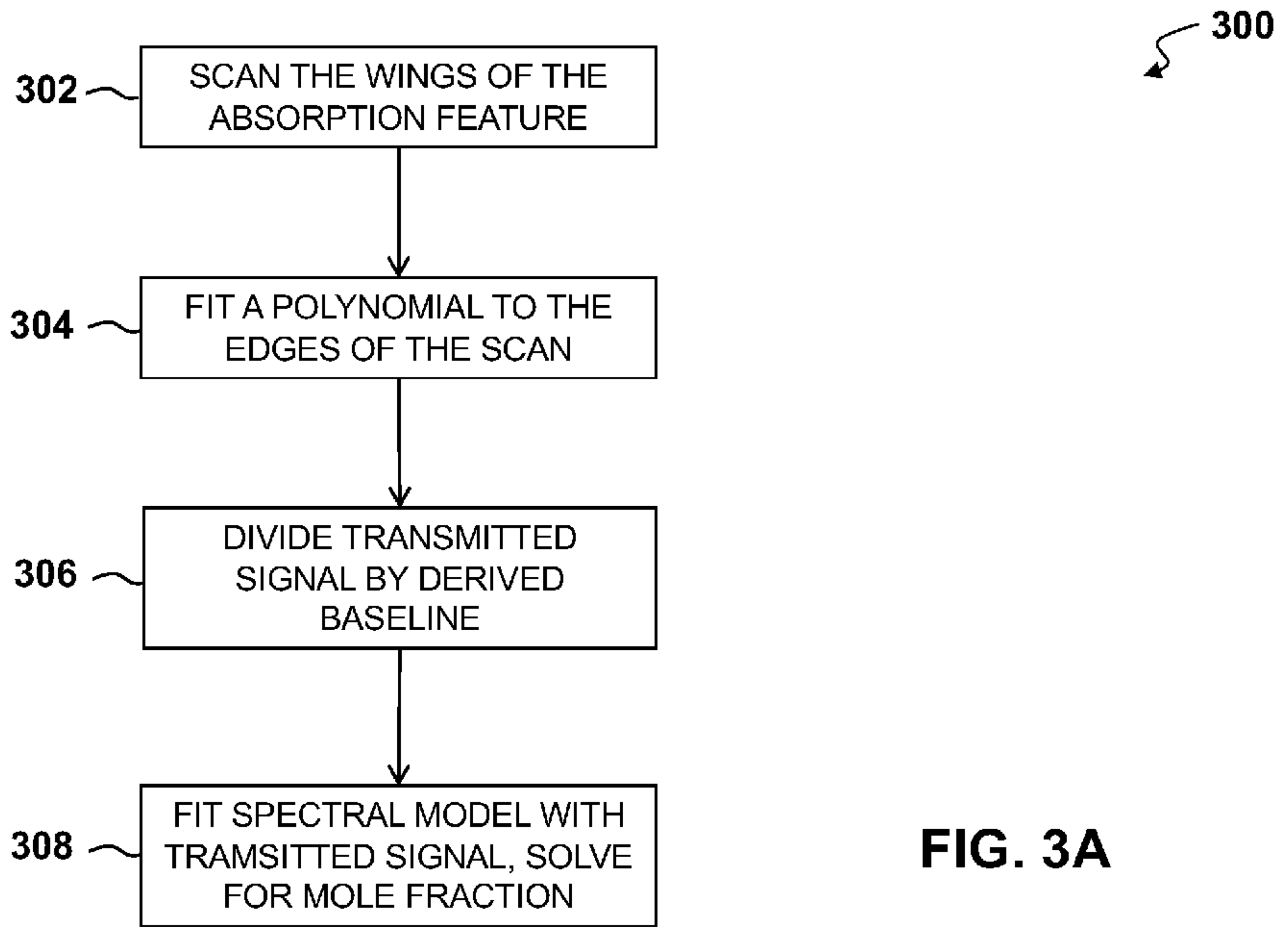

FIG. 3A

(57) **Abstract:** Systems, devices, and methods for scanning a laser into wings of an absorption feature (302); fitting a polynomial to the edges of the scan; dividing a transmitted signal by a fit-derived baseline to compute a transmission of the light (306); fitting a spectral model with the transmitted signal (308); and solving for a mole fraction (308).

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— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*
— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*
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AMENDED CLAIMS
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1. A method comprising:
scanning a laser into wings of an absorption feature (302);
fitting, by a processor (124) of a computing device (110), a polynomial to edges of the scan to derive a baseline signal (304);
dividing, by the processor, a transmitted signal by the derived baseline signal to compute a light signal (306);
fitting, by the processor, a spectral model with the computed light signal (308); and
solving, by the processor, for a mole fraction (308) based on the fit spectral model.

2. The method of claim 1, wherein the wings comprise 10-20 times a full-width half-max (FWHM) of an absorbing line.

3. The method of claim 2, wherein fitting the polynomial to edges of the scan to derive the baseline further comprises:
discarding data within five times the FWHM of the absorbing line.

4. The method of claim 1, further comprising:
deriving a new baseline signal for each scan due to non-ideal perturbations.

5. The method of claim 1, wherein solving for the mole fraction further comprises:
querying, by the processor, a lookup table, wherein the lookup table comprises a spectral model to interpolate for mole fraction.

6. The method of claim 5, wherein the lookup table is based on a spectroscopy model based on a reduced set of parameters.

7. A method comprising:
characterizing a physical gas sensor in terms of the gas sensor scan and modulation frequencies and any filters that exist in a signal acquisition electronics (402);
applying a lock-in amplifier to the characterized physical gas sensor to simulate harmonic absorption signals (404);
fitting, by a processor (124) of a computing device (110), the simulated harmonic absorption signals to acquired data (406); and

solving, by the processor for a mole fraction left as a free parameter (408).

8. The method of claim 7, wherein the signal acquisition electronics comprise one or more discrete filters.

9. The method of claim 7, wherein the signal acquisition electronics comprise one or more implicit filters.

10. The method of claim 7, wherein the lock-in amplifier extracts a signal with a known carrier eave from a noisy environment.

11. The method of claim 7, wherein the lock-in amplifier comprises one or more low pass filters to reduce electromagnetic (EM) noise.

12. The method of claim 11, wherein the one or more low pass filters comprise at least one of: an opamp-based active filter, an opamp-based passive filter, and a multipole filter.

13. A method comprising:

defining, by a processor (124) of a computing device (110), a reduced set of parameters from a measurement of a gas sensor (502);

generating, by the processor, a multidimensional lookup table of the reduced set of parameters (504);

loading, by the processor, the multidimensional lookup table onto a sensor processor of the gas sensor (506);

acquiring, by the processor, signals from the sensor (508);

measuring, by the processor, one or more parameters from the acquired signals (508); and

solving, by the processor, for a mole fraction based on plugging measured parameters into the multidimensional lookup table (508).

14. The method of claim 13, wherein the reduced set of parameters includes at least one of: a maximum, a minimum, a distance between peaks, and a full width half maximum.

15. The method of claim 13, wherein the reduced set of parameters are taken from a direct absorption signal.

16. The method of claim 13, wherein the reduced set of parameters are taken from at least one of: a 2f signal and a 2f/1f signal from a lock-in.

17. The method of claim 13, wherein the multidimensional lookup table is generated over a range of expected mole fractions.

18. A system comprising:

a sensor (102) configured to detect incident photons (104) from a trace gas and output (108) a spectrum (106);

a processor (110) having addressable memory (127), wherein the processor is configured to:

receive the spectrum from the sensor;

fit a polynomial to edges of a scanned laser into wings of an absorption feature (302) to derive a baseline signal (304);

divide a transmitted signal by the derived baseline signal to compute a light signal (306);

fit a spectral model with the computed light signal (308); and

solving for a mole fraction (308).

19. The system of claim 18, wherein the wings comprise 10-20 times a full-width half-max (FWHM) of an absorbing line.

20. The system of claim 18, wherein the processor is further configured to:

derive a new baseline signal for each scan due to non-ideal perturbations.