CLAIMS

1. Checking method for checking the presence of a rotating element (3), the checking method includes the steps of:

- obtaining a rotational frequency (RF) of the rotating element (3);
- directing a main electromagnetic radiation (9) towards the rotating element (3) by means of an emitter (8);
- receiving a reflected electromagnetic radiation (11) that has been reflected by the rotating element (3) by means of a receiver (10);
- collecting the reflected electromagnetic radiation (11) to determine a rough signal (S) to be analyzed;
- analyzing the rough signal (S) to verify whether the rough signal (S) includes a periodicity with a frequency corresponding to the rotational frequency (RF) of the rotating element (3); and
- determining that the rotating element (3) is actually present if the rough signal (S) includes a periodicity with a frequency corresponding to the rotational frequency (RF) of the rotating element (3);

the checking method is characterized in that it includes the further steps of:

- analyzing the rough signal (S) in the frequency domain;
- determining the length of the rough signal (S) as a function of the rotational frequency (RF) of the rotating element (3) in such a way that the rough signal (S) includes at least two complete rotations of the rotating element (3); and

- determining that the rough signal (S) includes a periodicity with a frequency corresponding to the rotational frequency (RF) of the rotating element (3), if the frequency content of the rough signal (S) has predominant components at integral multiples of the rotational frequency (RF) of the rotating element (3).

2. Checking method according to claim 1 and including the further steps of:

- determining an exact rotational period of the rough signal (S) by means of an analysis in the time domain of the rough signal (S);
- cutting a part of the rough signal (S) as a function of the exact rotational period of the rough signal (S) in such a way that the cut rough signal (S) exactly includes a whole number of complete rotations of the rotating element (3); and
- analyzing the cut rough signal (S) in the frequency domain.

3. Checking method according to claim 2 and including the further step of determining the exact rotational period of the rough signal (S) by means of an analysis in the time domain which is performed with a pitch detection algorithm.

4. Checking method according to claim 3 and including the further step of determining the exact rotational period of the rough signal (S) by means of an analysis in the time domain which is performed with a pitch detection algorithm using the autocorrelation function AMDF (Average Magnitude Difference Function).

5. Checking method according to claim 2, 3 or 4 and

including the further step of determining the exact rotational period of the rough signal (S) by searching for the exact rotational period within a search interval which is determined as a function of a nominal rotational frequency of the rotating element (3) and as a function of a variability range with respect to the nominal rotational frequency.

6. Checking method according to claim 5 and including the further step of determining that the rotating element (3) can not be recognized and thus is not present if it is not possible to determine the exact rotational period of the rough signal (S) within the search interval.

7. Checking method according to any one of claims 2 to 6 and including the further step of decimating/expanding, by applying a resampling, the cut rough signal (S), before the analysis in the time domain is performed.

8. Checking method according to claim 7 and including the further step of decimating/expanding the rough signal (S) in such a way that the rough signal (S) includes a number of samples that is equal to a power of the number two.

9. Checking method according to any one of claims 1 to 8 and including the further step of applying a Fourier Transform to the rough signal (S) to move from the time domain to the frequency domain.

10. Checking method according to claim 9, wherein said Fourier Transform is a FFT (Fast Fourier Transform).

11. Checking method according to claim 9 or claim 10 and including the further steps of:

- determining the amplitude and the order of the harmonic with the highest amplitude; and
- determining that the rotating element (3) is actually present if the order of the harmonic with the highest amplitude is an integral multiple of the whole number of complete rotations of the rotating element (3) included in the rough signal (S).

12. Checking method according to claim 11 and including the further step of determining that the rotating element (3) is actually present if the order of the harmonic with the highest amplitude is an integral multiple of the whole number of complete rotations of the rotating element (3) included in the rough signal (S), and if, at the same time, the highest amplitude of the harmonic with the highest amplitude is higher than a first threshold value.

13. Checking method according to claim 9 or claim 10 and including the further steps of

- calculating a signal-to-noise ratio as a function of the whole number of complete rotations of the rotating element (3) included in the rough signal (S); and
- determining that the rotating element (3) is actually present if the signal-to-noise ratio is higher than a second threshold value.

14. Checking method according to claim 13, wherein in calculating the signal-to-noise ratio all the amplitudes of the harmonics the order of which is an integral multiple of

the whole number of complete rotations of the rotating element (3) included in the rough signal (S) are considered as useful signal, and all the amplitudes of the harmonics the order of which is not an integral multiple of the whole number of complete rotations of the rotating element (3) included in the rough signal (S) are considered as noise.

15. Checking method according to claim 13 or 14 and including the further step of calculating the signal-to-noise ratio as a fraction where the numerator is a sum of the amplitudes of the harmonics the order of which is an integral multiple of the whole number of complete rotations of the rotating element (3) included in the rough signal (S), and the denominator is a sum of all the amplitudes of the harmonics the order of which is not an integral multiple of the whole number of complete rotations of the rotating element (3) included in the rough signal (S).

16. Checking method according to claim 13 or 14 and including the further step of calculating the signal-to-noise ratio as a fraction where the numerator is a sum of the amplitudes of the harmonics the order of which is an integral multiple of the whole number of complete rotations of the rotating element (3) included in the rough signal (S), and the denominator is the difference between the sum of all the amplitudes and the numerator.

~~17. Checking method according to any one of claims 1 to 16 and including the further step of determining the length of the rough signal (S) as a function of the rotational frequency (RF) of the rotating element (3) in such a way that the rough signal (S) includes at least two complete rotations of the rotating element (3).~~

17~~18~~. Checking method according to any one of claims 1 to 16~~17~~ and including the further step of varying the sampling frequency of the reflected electromagnetic radiation (11) as a function of the rotational frequency (RF) of the rotating element (3) in such a way that the sampling frequency increases as the rotational frequency (RF) increases.

18~~19~~. Checking method according to any one of claims 1 to 17~~18~~ and including the further step of varying the number of complete rotations of the rotating element (3) included in the rough signal (S) as a function of the rotational frequency (RF) of the rotating element (3) in such a way that the number of complete rotations of the rotating element (3) included in the rough signal (S) increases as the rotational frequency (RF) increases.

19~~20~~. Checking apparatus for checking the presence of a rotating element (3) at a known or determinable rotational frequency (RF); the checking apparatus (6) comprises:

- an emitter (8) for directing a main electromagnetic radiation (9) towards the rotating element (3);
- a receiver (10) for receiving a reflected electromagnetic radiation (11) which has been reflected by the rotating element (3); and
- a processing unit (12) which samples the reflected electromagnetic radiation (11) to determine a rough signal (S) to be analyzed, analyzes the rough signal (S) to verify if the rough signal (S) includes a periodicity with a frequency corresponding to the rotational frequency (RF) of the rotating element (3),

and determines that the rotating element (3) is actually present if the rough signal (S) includes a periodicity with a frequency corresponding to the rotational frequency (RF) of the rotating element (3);

the checking apparatus (6) is characterized in that the processing unit (12)

- ~~the processing unit (12)~~ analyzes the rough signal (S) in the frequency domain;
- determines the length of the rough signal (S) as a function of the rotational frequency (RF) of the rotating element (3) in such a way that the rough signal (S) includes at least two complete rotations of the rotating element (3); and
- ~~the processing unit (12)~~ determines that the rough signal (S) includes a periodicity with a frequency corresponding to the rotational frequency (RF) of the rotating element (3) if the frequency content of the rough signal (S) has dominant components at integral multiples of the rotational frequency (RF) of the rotating element (3).

20~~21~~. Checking apparatus according to claim 19~~20~~, wherein said main electromagnetic radiation is a pulsed laser beam.