Claims

1. Cylinder (100; 200; 400; 500), particularly for use in hydraulic system, comprising

a cylinder casing (102) with a cylindrical side wall (103);

an axial slidable piston (101) located in the cylinder casing (102);

at least one signal feeding device (106; 201; 401) being located at the cylinder casing (103) and arranged to send out an ultrasonic signal (108) in such way that the ultrasonic signal (108) will propagate along an inner face (103a) of the side wall (103) of the cylinder casing (102);

at least one receiving device (107; 201; 401) being located at the cylinder casing (102) and arranged in such way to receive an ultrasonic signal (108) being reflected from the piston (101); and

one evaluation device (112) being arranged in such way to determine a position (x) of the piston (101) by a runtime (Δt) of the ultrasonic signal (108) between the sending of the ultrasonic signal (108) by the signal feeding device (106; 201; 401) and the receiving of the ultrasonic signal (108) by the receiving device (107; 201; 401).

2. Cylinder (100; 200; 400; 500) according to claim 1, wherein the signal feeding device (106; 201; 401) comprising:

one top piece (106a) being located at the side wall (103) of the cylinder casing (102); and

one sender (106b) located on the top piece (106a), wherein the sender (106b) is arranged in such way to send out the ultrasonic signal (108) through the top piece so that the ultrasonic signal (108) will strike the cylinder casing (102) under an incidence angle (ϕ_1),

wherein the incidence angle (ϕ_1) is selected so that an ultrasonic wave carrying the ultrasonic signal (108) will be refracted on an interface (110) of the top piece (106a) and the cylinder casing (102) in such way that the ultrasonic signal (108) will propagate alongside an inner face (103a) of the side wall (103) of the cylinder casing (102).

3. Cylinder (100; 200; 400; 500) according to claim 1, wherein the signal feeding device (106; 201; 401) is located at the side wall (103) of the cylinder casing (102), and comprises at least two electrodes (201a-1, 201a-2) being located comb-like and arranged in such way to send out an ultrasonic signal (108).

4. Cylinder (100; 200; 400; 500) according to claim 1, wherein the signal feeding device (106; 201; 401) is located at an outside wall (104) in axial direction of the cylinder casing (102), and has at least one shear plate (403) being slidable in a direction (404) parallel to the outside wall (104) of the cylinder casing (102) and is coupled with the cylinder casing (102) by friction,

wherein an ultrasonic signal (108) can be transferred to the cylinder casing (102) by periodical shifting of the shear plate (403) at the outside wall (104) of the cylinder casing (102), which will propagate alongside an inner face (103a) of the side wall (103) of the cylinder casing (102).

5. Cylinder (500) according to one of the claims 1 to 4,

wherein the signal feeding devices (502a to 502d) and the receiving devices (502a to 502d) are located in axial direction being spaced from each other, and

wherein the cylinder (500) comprises a control device (111) being arranged in such way to control sending of an ultrasonic signal (108) by the signal feeding devices (502a to 502d) and receiving of the ultrasonic signal (108) reflected by the receiving devices (502a to 502d) in a multiplexing technique, particularly in a time-multiplexing technique or in a frequency-multiplexing technique.

6. Cylinder (500) according to claim 5,

wherein the control device (111) is arranged to control the signal feeding devices (502a to 502d) in such way that the signal feeding devices (502a to 502d) will send out time-staggered ultrasonic signals (105),

wherein a time difference between the sending of two ultrasonic signals (108) by different signal feeding devices (502a to 502d) is bigger than the runtime (Δt) of the signals of ultrasonic signals (108).

7. Method to determine a position (x) of a piston (101) in a cylinder (100; 200; 400; 500), particularly for use in a hydraulic system with steps:

sending out (S1) of an ultrasonic signal (108) on a cylinder casing (102) of the cylinder (100; 200; 400; 500) with cylindrical side wall (103) in such way that the ultrasonic signal (108) will propagate alongside an inner face (103a) of the side wall (103) of the cylinder casing (102),

receiving (S2) of the ultrasonic signal (108) reflected from the piston (101) located axial slidable in the cylinder casing (102),

computing (S3) a position (x) of the piston (101) by a runtime (Δt) of the ultrasonic signal (108) between sending and receiving of the ultrasonic signal (108).

8. Method according to claim 7,

wherein the sending of the ultrasonic signal (108) takes place through a top piece (106a) being located at the side wall (103) of the cylinder casing (102),

wherein the ultrasonic signal (108) will strike the cylinder casing (102) under an incidence angle (ϕ_1), and

wherein the incidence angle (ϕ_1) is selected so that the ultrasonic signal (108) will be refracted at an interface of the top piece (106a) and the cylinder casing (102) in such way that the ultrasonic signal (108) will propagate alongside an inner face (103a) of the side wall (103) of the cylinder casing (102).

9. Method according to claim 7, wherein the sending of the ultrasonic signal (108) takes place by means of at least two electrodes (201a-1, 201a-2) being located comb-like at the side wall (103) of the cylinder casing (102).

10. Method according to claim 7, wherein the sending of the ultrasonic signal (108) takes place by shifting a shear plate (401) on an outside wall (104) in a radial direction (403), wherein the shear plate (401) is coupled with the outside wall (102) by friction.

11. Method according to one of the claims 7 to 10, wherein the sending of the ultrasonic signal (108) and the receiving of the reflected ultrasonic signals (108) take place at different positions of the cylinder casing (102) in a multiplexing technique, particularly in a time-multiplexing technique or in a frequency-multiplexing technique.

12. Method according to claim 11,

wherein the ultrasonic signals (105) are sent out time-staggered at the different positions of the cylinder casing (102), and

wherein a time difference between the sending of two ultrasonic signals (108) at different positions of the cylinder casing is larger than the runtime (Δt) of the signals of ultrasonic signals (108).