Claims

1. A method for actuating an inkjet print head (1), comprising at least one printing system (11) having a nozzle (8) on the side of an ink chamber (12) which faces a substrate to be imprinted, and which is delimited at least in areas, preferably in its area facing away from the print substrate, by a diaphragm (15) that is movable away from the ink chamber (12) by electrically actuating a piezo element (16) that is mechanically coupled to the diaphragm (15), so that ink is drawn into the ink chamber from an ink reservoir (14), and the diaphragm is movable toward or into the ink chamber so that an ink drop (24) is ejected from the ink chamber through the nozzle (8), wherein the printing system (11) made up of the ink chamber (12), diaphragm (15), piezo element (16), and a control circuit (18) thereof represents an oscillatable structure which, when actuated at high energy, is excited to oscillate at a natural frequency f_{res} that exhibits resonance; i.e., the oscillation with the period $T_{res} = 1 / f_{res}$ undergoes little or no attenuation, and wherein the color intensity of a pixel to be printed is varied in that, for each pixel, a sequence of multiple ink drops (24) is ejectable in succession from the same nozzle (8) at a period $T_{drop} = 1 / f_{drop}$, **characterized in that** energy is only introduced into the printing system (11) via an actuation signal precisely when an ink drop (24) is actually to be ejected, wherein the duration of the period T_{drop} for the ejection of an ink drop is reduced in such a way that the following applies:

$$T_{drop} < T_{res} / 1.5,$$

wherein $T_{res} = 1 / f_{res}$ is the oscillation period of the resonant natural frequency f_{res} of the printing system (11).

2. The method according to Claim 1, characterized in that the minimum time interval T_{drop} between chronologically sequential print actuating signals is equal to or less than one half of the oscillation period $T_{res} = 1 / f_{res}$ of the resonant natural frequency f_{res} of the printing system (11):

$$T_{drop} \leq T_{res} / 2.$$

3. The method according to one of the preceding claims, characterized in that the minimum time interval T_{drop} between chronologically sequential print actuating signals is equal to or greater than one-third of the oscillation period $T_{res} = 1 / f_{res}$ of the resonant natural frequency f_{res} of the printing system (11):

$$T_{drop} \geq T_{res} / 3.$$

4. The method according to one of the preceding claims, characterized in that the minimum time interval T_{drop} between chronologically sequential print actuating signals is equal to or greater than two-fifths of the oscillation period $T_{res} = 1 / f_{res}$ of the resonant natural frequency f_{res} of the printing system (11):

$$T_{drop} \geq T_{res} / 2.5.$$

5. The method according to one of the preceding claims, characterized in that the size or the volume of an ink drop (24) is increased by increasing the amplitude of a trigger pulse.

6. The method according to one of the preceding claims, characterized in that the size or the volume of an ink drop (24) is increased by increasing the overall duration of a trigger pulse or the duration of the plateau phase of a trigger pulse.

7. The method according to one of the preceding claims, characterized in that the size or the volume of an ink drop (24) is increased by increasing the duration of the rising and/or falling edge of a trigger pulse.

8. The method according to one of the preceding claims, characterized in that the size or the volume of an ink drop (24) is not a function of the duration or of other properties of a preceding trigger pulse.

9. The method according to one of the preceding claims, characterized in that the sizes of the ink drops (24) of a pixel sequence to be printed are different and/or independent from one another.

10. The method according to one of the preceding claims, characterized in that the series of different drop sizes is nonlinear.

11. The method according to one of the preceding claims, characterized in that in any event for a pixel having an associated color intensity of zero, corresponding to no ink drop, a placeholder signal is emitted which, however, is too weak in its intensity to bring about the triggering of a drop; however, if the color intensity of zero is not associated with a pixel, corresponding to one or multiple ink drops, a nonprinting preliminary signal or intermediate signal is not present either in front of or between the trigger pulses of this pixel sequence.

12. A method for actuating an inkjet print head (1), comprising at least one printing system (11) having a nozzle (8) on the side of an ink chamber (12) which faces a substrate to be imprinted, and which is delimited at least in areas, preferably in its area facing away from the print substrate, by a diaphragm (15) that is movable away from the ink chamber (12) by electrically actuating a piezo element (16) that is mechanically coupled to the diaphragm (15), so that ink is drawn into the ink chamber from an ink reservoir (14), and the diaphragm is movable toward or into the ink chamber so that an ink drop (24) is ejected from the ink chamber through the nozzle (8), wherein the printing system (11) made up of the ink chamber (12), diaphragm (15), piezo element (16), and a control circuit (18) thereof represents an oscillatable structure which, when actuated at high energy, is excited to oscillate at a natural frequency f_{res} that exhibits resonance; i.e., the oscillation with

the period $T_{res} = 1 / f_{res}$ undergoes little or no attenuation, and wherein the color intensity of a pixel to be printed is varied in that, for each pixel, a sequence of multiple ink drops (24) is ejectable in succession from the same nozzle (8) at a period $T_{drop} = 1 / f_{drop}$ for the ejection of an ink drop, **characterized in that** energy is only introduced into the printing system (11) via an actuation signal precisely when an ink drop (24) is actually to be ejected, wherein the duration of the period T_{drop} for the ejection of an ink drop is reduced in such a way that the following applies:

$$T_{drop} < T_{res} / 1.75,$$

wherein $T_{res} = 1 / f_{res}$ is the oscillation period of the resonant natural frequency f_{res} of the printing system (11).

13. The method according to Claim 12, characterized in that the minimum time interval T_{drop} between chronologically sequential print actuating signals is equal to or less than one half of the oscillation period $T_{res} = 1 / f_{res}$ of the resonant natural frequency f_{res} of the printing system (11):

$$T_{drop} \leq T_{res} / 2.$$

14. The method according to Claims 12 or 13, characterized in that the minimum time interval T_{drop} between chronologically sequential print actuating signals is equal to or greater than one-third of the oscillation period $T_{res} = 1 / f_{res}$ of the resonant natural frequency f_{res} of the printing system (11):

$$T_{drop} \geq T_{res} / 3.$$

15. The method according to one of Claims 12 to 14, characterized in that the minimum time interval T_{drop} between chronologically sequential print actuating

signals is equal to or greater than two-fifths of the oscillation period $T_{res} = 1 / f_{res}$ of the resonant natural frequency f_{res} of the printing system (11):

$$T_{drop} \geq T_{res} / 2.5.$$

16. The method according to one of Claims 12 to 15, characterized in that the size or the volume of an ink drop (24) is increased by increasing the amplitude of a trigger pulse.

17. The method according to one of Claims 12 to 16, characterized in that the size or the volume of an ink drop (24) is increased by increasing the overall duration of a trigger pulse or the duration of the plateau phase of a trigger pulse.

18. The method according to one of Claims 12 to 17, characterized in that the size or the volume of an ink drop (24) is increased by increasing the duration of the rising and/or falling edge of a trigger pulse.

19. The method according to one of Claims 12 to 18, characterized in that the size or the volume of an ink drop (24) is not a function of the duration or of other properties of a preceding trigger pulse.

20. The method according to one of Claims 12 to 19, characterized in that the sizes of the ink drops (24) of a pixel sequence to be printed are different and/or independent from one another.

21. The method according to one of Claims 12 to 20, characterized in that the series of different drop sizes is nonlinear.

22. The method according to one of Claims 12 to 21, characterized in that in any event for a pixel having an associated color intensity of zero, corresponding to no ink drop, a placeholder signal is emitted which, however, is too weak in its

intensity to bring about the triggering of a drop; however, if the color intensity of zero is not associated with a pixel, corresponding to one or multiple ink drops, a nonprinting preliminary signal or intermediate signal is not present either in front of or between the trigger pulses of this pixel sequence.

23. A method for actuating an inkjet print head (1), comprising at least one printing system (11) having a nozzle (8) on the side of an ink chamber (12) which faces a substrate to be imprinted, and which is delimited at least in areas, preferably in its area facing away from the print substrate, by a diaphragm (15) that is movable away from the ink chamber (12) by electrically actuating a piezo element (16) that is mechanically coupled to the diaphragm (15), so that ink is drawn into the ink chamber from an ink reservoir (14), and the diaphragm is movable toward or into the ink chamber so that an ink drop (24) is ejected from the ink chamber through the nozzle (8), wherein the printing system (11) made up of the ink chamber (12), diaphragm (15), piezo element (16), and a control circuit (18) thereof represents an oscillatable structure which, when actuated at high energy, is excited to oscillate at a natural frequency f_{res} that exhibits resonance; i.e., the oscillation with the period $T_{res} = 1 / f_{res}$ undergoes little or no attenuation, and wherein the color intensity of a pixel to be printed is varied in that, for each pixel, a sequence of multiple ink drops (24) is ejectable in succession from the same nozzle (8) at a period $T_{drop} = 1 / f_{drop}$ for the ejection of an ink drop, **characterized in that** energy is only introduced into the printing system (11) via an actuation signal precisely when an ink drop (24) is actually to be ejected, wherein the duration of the period T_{drop} for the ejection of an ink drop is reduced in such a way that the following applies:

$$T_{drop} < T_{res} / 2,$$

wherein $T_{res} = 1 / f_{res}$ is the oscillation period of the resonant natural frequency f_{res} of the printing system (11).

24. The method according to Claim 23, characterized in that the minimum time interval T_{drop} between chronologically sequential print actuating signals is equal to or greater than one-third of the oscillation period $T_{res} = 1 / f_{res}$ of the resonant natural frequency f_{res} of the printing system (11):

$$T_{drop} \geq T_{res} / 3.$$

25. The method according to Claims 23 or 24, characterized in that the minimum time interval T_{drop} between chronologically sequential print actuating signals is equal to or greater than two-fifths of the oscillation period $T_{res} = 1 / f_{res}$ of the resonant natural frequency f_{res} of the printing system (11):

$$T_{drop} \geq T_{res} / 2.5.$$

26. The method according to one of Claims 23 to 25, characterized in that the size or the volume of an ink drop (24) is increased by increasing the amplitude of a trigger pulse.

27. The method according to one of Claims 23 to 26, characterized in that the size or the volume of an ink drop (24) is increased by increasing the overall duration of a trigger pulse or the duration of the plateau phase of a trigger pulse.

28. The method according to one of Claims 23 to 27, characterized in that the size or the volume of an ink drop (24) is increased by increasing the duration of the rising and/or falling edge of a trigger pulse.

29. The method according to one of Claims 23 to 28, characterized in that the size or the volume of an ink drop (24) is not a function of the duration or of other properties of a preceding trigger pulse.

30. The method according to one of Claims 23 to 29, characterized in that the sizes of the ink drops (24) of a pixel sequence to be printed are different and/or independent from one another.

31. The method according to one of Claims 23 to 30, characterized in that the series of different drop sizes is nonlinear.

32. The method according to one of Claims 23 to 31, characterized in that in any event for a pixel having an associated color intensity of zero, corresponding to no ink drop, a placeholder signal is emitted which, however, is too weak in its intensity to bring about the triggering of a drop; however, if the color intensity of zero is not associated with a pixel, corresponding to one or multiple ink drops, a nonprinting preliminary signal or intermediate signal is not present either in front of or between the trigger pulses of this pixel sequence.

33. A method for actuating an inkjet print head (1), comprising at least one printing system (11) having a nozzle (8) on the side of an ink chamber (12) which faces a substrate to be imprinted, and which is delimited at least in areas, preferably in its area facing away from the print substrate, by a diaphragm (15) that is movable away from the ink chamber (12) by electrically actuating a piezo element (16) that is mechanically coupled to the diaphragm (15), so that ink is drawn into the ink chamber from an ink reservoir (14), and the diaphragm is movable toward or into the ink chamber so that an ink drop (24) is ejected from the ink chamber through the nozzle (8), wherein the printing system (11) made up of the ink chamber (12), diaphragm (15), piezo element (16), and a control circuit (18) thereof represents an oscillatable structure which, when actuated at high energy, is excited to oscillate at a natural frequency f_{res} that exhibits resonance; i.e., the oscillation with the period $T_{res} = 1 / f_{res}$ undergoes little or no attenuation, and wherein the color intensity of a pixel to be printed is varied in that, for each pixel, a sequence of multiple ink drops (24) is ejectable in succession from the same nozzle (8) at a period $T_{drop} = 1 / f_{drop}$ for the ejection of an ink drop, **characterized in that** energy

is only introduced into the printing system (11) via an actuation signal precisely when an ink drop (24) is actually to be ejected, wherein the duration of the period T_{drop} for the ejection of an ink drop is reduced in such a way that the following applies:

$$T_{drop} < T_{res} / 2,$$

wherein $T_{res} = 1 / f_{res}$ is the oscillation period of the resonant natural frequency f_{res} of the printing system (11), and wherein for the duration T_{plat} of a plateau phase (23') of a print pulse (22') the following applies:

$$T_{plat} < T_{rising},$$
$$T_{plat} < T_{falling},$$

wherein T_{rising} is the duration of the rising ramp of the print pulse (22'), and $T_{falling}$ is the duration of the falling ramp of the print pulse (22').

34. The method according to Claim 33, characterized in that the minimum time interval T_{drop} between chronologically sequential print actuating signals is equal to or greater than one-third of the oscillation period $T_{res} = 1 / f_{res}$ of the resonant natural frequency f_{res} of the printing system (11):

$$T_{drop} \geq T_{res} / 3.$$

35. The method according to Claims 33 or 34, characterized in that the minimum time interval T_{drop} between chronologically sequential print actuating signals is equal to or greater than two-fifths of the oscillation period $T_{res} = 1 / f_{res}$ of the resonant natural frequency f_{res} of the printing system (11):

$$T_{drop} \geq T_{res} / 2.5.$$

36. The method according to one of Claims 33 to 35, characterized in that the size or the volume of an ink drop (24) is increased by increasing the amplitude of a trigger pulse.

37. The method according to one of Claims 33 to 36, characterized in that the size or the volume of an ink drop (24) is increased by increasing the overall duration of a trigger pulse or the duration of the plateau phase of a trigger pulse.

38. The method according to one of Claims 33 to 37, characterized in that the size or the volume of an ink drop (24) is increased by increasing the duration of the rising and/or falling edge of a trigger pulse.

39. The method according to one of Claims 33 to 38, characterized in that the size or the volume of an ink drop (24) is not a function of the duration or of other properties of a preceding trigger pulse.

40. The method according to one of Claims 33 to 39, characterized in that the sizes of the ink drops (24) of a pixel sequence to be printed are different and/or independent from one another.

41. The method according to one of Claims 33 to 40, characterized in that the series of different drop sizes is nonlinear.

42. The method according to one of Claims 33 to 41, characterized in that in any event for a pixel having an associated color intensity of zero, corresponding to no ink drop, a placeholder signal is emitted which, however, is too weak in its intensity to bring about the triggering of a drop; however, if the color intensity of zero is not associated with a pixel, corresponding to one or multiple ink drops, a nonprinting preliminary signal or intermediate signal is not present either in front of or between the trigger pulses of this pixel sequence.