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DRIVE DEVICE FOR AN INJECTION DEVICE

Abstract

A drive device includes an output for an injection piston of an injection device to be acted upon to generate an injection force, a hydraulic drive mechanically connected to the output for the injection piston, and an electric drive. The electric drive is mechanically connected to the output for the injection piston via the hydraulic drive, so that the drive force generated by the electric drive can be transmitted together with the drive force generated by the hydraulic drive via the hydraulic drive to the output for actuating the injection piston. The electric drive is at least partially integrated into the hydraulic drive, and has an electric motor and a coupling device. The coupling device of the electric drive is arranged completely in a cylinder of the hydraulic drive.

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Background/Summary

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a drive device for an injection device, an injection device with at least one such drive device, and an injection molding machine with at least one such injection device.

[0002] It is known to transmit the injection force required for injection to the injection piston by means of an output, which is connected to both a hydraulic drive and an electric drive (for example EP 760 277 B1 and WO 2016/050002 A1). Such drive devices have a long construction.

[0003] It is an object to provide a drive device, an injection device with at least one such drive device and an injection molding machine with at least one such injection device, which have a shorter construction compared to the prior art.

SUMMARY OF THE INVENTION

[0004] This object is achieved by a drive device as described below, an injection device having at least one such drive device, and an injection molding machine having at least one such injection device.

[0005] Such a drive device has at least: [0006] an output for an injection piston of an injection device to be acted upon in order to generate an injection force, [0007] at least one hydraulic drive mechanically connected to the output for the injection piston, and [0008] at least one electric drive. The electric drive is mechanically connected to the output for the injection piston via the hydraulic drive, so that the drive force generated by the electric drive can be transmitted together with the drive force generated by the hydraulic drive via the hydraulic drive to the output for actuating the injection piston

[0009] In such a drive device, the electric drive is only mechanically connected to the output through the hydraulic drive, so that the entire drive force generated by the electric drive can be transferred to the output for the injection piston together with the drive force generated by the hydraulic drive. Because the at least one electric drive is at least partially integrated into the at least one hydraulic drive, the result is a design that is reduced in length compared to the prior art.

[0010] Preferably, the at least one hydraulic drive comprises a piston-cylinder unit with a piston mounted in a cylinder. The cylinder is divided into two chambers by the piston. One of these chambers is filled with pressurized hydraulic oil to generate force. In the case of a double-acting piston-cylinder unit, both chambers are filled with oil; in the case of a single-acting piston-cylinder unit, only one chamber is filled with oil.

[0011] If the at least one hydraulic drive has a piston-cylinder unit with a piston mounted in a cylinder, in one exemplary embodiment the at least one electric drive is at least partially integrated into the at least one hydraulic drive in such a way that the at least one electric drive is at least partially arranged in the cylinder of the at least one hydraulic drive (in the case of a single-acting piston-cylinder unit, preferably not in the chamber which is filled with pressurized hydraulic oil to generate force). Preferably, the piston has a recess for receiving a part of the at least one electric drive.

[0012] Furthermore, the at least one electric drive has at least one electric motor and a coupling device. A rotary movement of the electric motor can be converted into a linear movement by the coupling device, for example in the form of a spindle drive with a spindle and a spindle nut, and preferably the spindle nut is arranged in a rotationally fixed manner and the spindle can be rotated by the electric motor. For example, the spindle nut can be connected to the piston in a rotationally fixed manner.

[0013] In one embodiment, the spindle drive is designed as a ball screw drive.

[0014] The coupling device of the at least one electric drive is integrated into the at least one

hydraulic drive. Preferably, the piston has a recess for receiving a part of the at least one electric drive.
[0015] If the at least one electric drive has at least one electric motor and a coupling device and the at least one hydraulic drive has a piston-cylinder unit with a piston mounted in a cylinder, at least the coupling device of the at least one electric drive is arranged completely in the cylinder of the at least one hydraulic drive. The piston can have a recess for receiving a part of the coupling device.
[0016] In one embodiment, the piston has a piston plate and a piston rod connected thereto or formed in one piece therewith. If the piston has a recess for receiving part of the coupling device, this can extend through the piston plate over a large part of the length of the piston rod.
[0017] For example, the output can be formed from the at least one cylinder of the hydraulic drive, possibly an injection block, a spindle of a spindle drive and an electric motor of the at least one electric drive.
[0018] Preferably, the drive device is a drive device for an injection unit for a plastic injection molding machine, the injection unit is an injection unit for a plastic injection molding machine, and the injection molding machine is a plastic injection molding machine.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
[0019] Various embodiments will be discussed below with reference to the drawings, in which:
[0020] FIG. **1** is a partial sectional view of a first embodiment in a first operating position,
[0021] FIG. **2** is a partial sectional view of the first embodiment in a second operating position,
[0022] FIG. **3** is a partial sectional view of a second embodiment in the first operating position, and
[0023] FIG. **4** is a longitudinal view of a third embodiment.
DETAILED DESCRIPTION OF THE INVENTION
[0024] The embodiments described below are examples in the case of processing of plastic. Differently from what has been discussed, the plasticization of the plastic material can take place spatially separated from the injection cylinder.
[0025] FIG. **1** shows an injection device **1** with a drive device **2**.
[0026] In the embodiments discussed, the plastic material is plasticized by a plasticizing screw (not visible) arranged in the injection cylinder **11** in a dosing process (in which it is rotated by a dosing motor **24**; an optional encoder **24***a* for the dosing motor **24** is also shown), which plastic material is then injected into a mold cavity (not shown) by the plasticizing screw acting as an injection piston. The injection force required for injection is generated by the drive device **2**. Unlike the configuration shown, a piston could be arranged in the injection cylinder **11**, which piston injects already plasticized melt into a mold cavity.
[0027] The drive device **2** has an injection block, two hydraulic drives **21**, **23** and two electric drives **26**, **26***a*, **27**. For injection, cylinder **21** together with the components arranged thereon is pulled towards the stationary carrier plate **22** and the injection cylinder **11** fixed thereto (i.e. it is moved to the left in FIGS. **1** and **2**).
[0028] The hydraulic drives **21**, **23** have a cylinder **21** and a piston **23** movably arranged in the cylinder **21**. In this embodiment, the piston-cylinder units are single-acting units.
[0029] The piston **23** has a piston plate and a piston rod connected thereto. Alternatively, a one-piece configuration is possible.
[0030] The piston **23** has a recess for receiving a part of the coupling device (here-depending on the respective operating position-a part of the spindle **26** and a part of the spindle nut **26***a*), which extends through the piston plate over a large part of the length of the piston rod. In the piston plate, the recess can have a wider part in which the spindle nut **26***a* is at least partially arranged, and a narrower part which serves for the passage of the spindle **26**. Since the piston **23** is single-acting in

this embodiment, the coupling device does not come into contact with hydraulic oil.

[0031] To partially generate the injection force (that portion which is to be supplied by the hydraulic drive **21**, **23**), the chamber of the piston **23** which is located closer to the injection cylinder **11** is filled with hydraulic oil via lines not shown. The piston **23** is mechanically connected to a carrier plate **22**. The temperature of the hydraulic oil can be detected via a temperature sensor **29***a*.

[0032] The electric drives **26**, **26***a*, **27** have an electric motor **27** (optional encoders **27***a* are also shown) and a coupling device in the form of a spindle drive **26**, **26***a* with a spindle **26** and a spindle nut **26***a*. The spindle nut **26***a* is connected to the piston **23** in a rotationally fixed manner. The spindle **26** can be rotated by the electric motor **27**. This rotary movement is converted into a linear movement of the spindle nut **26***a*, whereby the cylinder **21** is pulled towards the stationary carrier plate **22**, so that the portion of the injection force to be applied by the electric drive **26**, **26***a*, **27** is transferred together with the portion of the injection force to be applied by the hydraulic drive **21**, **23** to the output and thus to the injection piston.

[0033] An injection stroke can be determined via a distance sensor **28**, which in this embodiment is connected both to the carrier plate **22** and to one of the cylinders **21**.

[0034] By means of a first force measuring device **25***a* (here in the form of a pressure sensor), the contribution of the hydraulic drive **21**, **23** to the injection force can be measured.

[0035] The total injection force can be measured by a second force measuring device **29** (here in the form of a strain gauge).

[0036] The first force measuring device **25***a* and the second force measuring device **29** can be provided together or alternatively. If both are provided, the difference can be used to determine the contribution of the electric drive **26**, **26***a*, **27** to the injection force. Alternatively or additionally, the contribution of the electric drive **26**, **26***a*, **27** to the injection force can be measured from a measurement of the current absorbed by the electric motor **27**.

[0037] The hydraulic drives **21**, **23** and the electric drives **26**, **26***a*, **27** can be synchronized in a known manner, for example in the form of a synchronous control.

[0038] The electric motors **27** can be controlled or regulated by a control or regulating device (not shown) to apply a dynamic pressure and to carry out a screw retraction. The first operating position shown in FIG. **1** corresponds the state before injection.

[0039] The distance between the output and the carrier plate **22** is maximum. The injection cylinder **11**, the carrier plate **22** and the pistons **23** connected to the carrier plate **22** are arranged in a stationary manner. If those chambers of the hydraulic drives which are located closer to the injection cylinder **11** and the carrier plate **22** (the left chambers in FIGS. **1** and **2**) are now filled with pressurized hydraulic oil, the injection piston which is firmly connected to the cylinders **21** via the output is moved for injection (to the left in FIGS. **1** and **2**).

[0040] In the second operating position shown in FIG. **2**, injection has just taken place. The distance between the output and the carrier plate **22** is at a minimum. By introducing hydraulic oil into the cylinders **21** in a manner coordinated with the driving of the spindle nuts **26***a* by the electric motors **27** and the spindles **26**, the injection force was generated partly by the electric drives **26**, **26***a*, **27** and partly by the hydraulic drives **21**, **23** and transmitted to the output only via the hydraulic drives **21**, **23** (here via their pistons **23**).

[0041] In the second embodiment shown in FIG. **3**, no distance sensor is provided. Here (possibly also additionally or alternatively in the other embodiments) a distance measurement can be carried out via an encoder (**27***a*) of the at least one electric motor (**27**).

[0042] FIG. **4** shows a third embodiment in which an electric drive **26**, **26***a*, **27** is provided, wherein the force of an electric motor **27** is transmitted to the spindles **26** via a belt drive **3**. Otherwise, this embodiment is identical to the first or second embodiment.

[0043] The belt drive **3** has a toothed pulley **31**, a pinion **32** connected to the electric motor **27** and a toothed belt **33** for transmitting the rotary movement to the spindles **26**. A deflection pulley **34**

and a tension pulley **35** are provided for the toothed belt **33**.
[0044] FIG. **4** shows a guide unit **4** that can be provided in all embodiments.
REFERENCE NUMERALS
[0045] **1** injection device [0046] **11** injection cylinder [0047] **2** drive device for the injection device [0048] **21** cylinder of the hydraulic drive [0049] **22** carrier plate [0050] **23** piston of the hydraulic drive [0051] **24** dosing motor [0052] **24***a* encoder [0053] **25** injection block [0054] **25***a* first force measuring device [0055] **26** spindle of the spindle drive [0056] **26***a* spindle nut of the spindle drive [0057] **27** electric motor [0058] **27***a* encoder [0059] **28** distance sensor [0060] **29** second force measuring device [0061] **29***a* temperature sensor [0062] **3** belt drive [0063] **31** toothed disc [0064] **32** pinion [0065] **33** toothed belt [0066] **34** pulley [0067] **35** tension pulley [0068] **4** guide unit

Claims

1. A drive device for an injection device, comprising: an output for an injection piston of an injection device to be acted upon in order to generate an injection force, at least one hydraulic drive mechanically connected to the output for the injection piston, at least one electric drive, wherein the electric drive is mechanically connected to the output for the injection piston via the hydraulic drive, so that the drive force generated by the electric drive can be transmitted together with the drive force generated by the hydraulic drive via the hydraulic drive to the output for actuating the injection piston, wherein the at least one electric drive is at least partially integrated into the at least one hydraulic drive, wherein the at least one electric drive has at least one electric motor and a coupling device, wherein at least the coupling device of the at least one electric drive is arranged completely in a cylinder of the at least one hydraulic drive.
2. The drive device according to claim 1, wherein the at least one hydraulic drive has a piston-cylinder unit with a piston mounted in a cylinder.
3. The drive device according to claim 2, wherein a rotary movement of the electric motor can be converted into a linear movement by the coupling device.
4. The drive device according to claim 1, wherein the coupling device is formed by a spindle drive with a spindle and a spindle nut, wherein it is preferably provided that the spindle nut is arranged in a rotationally fixed manner and the spindle is rotatable by the electric motor.
5. The drive device according to claim 4, wherein the spindle drive is a ball screw drive.
6. The drive device according to claim 2, wherein the at least one electric drive is at least partially integrated into the at least one hydraulic drive in such a way that the at least one electric drive is at least partially arranged in the cylinder of the at least one hydraulic drive.
7. The drive device according to claim 1, wherein the at least one electric drive is at least partially integrated into the at least one hydraulic drive in such a way that at least the coupling device of the at least one electric drive is integrated into the at least one hydraulic drive.
8. The drive device according to claim 2, wherein: at least one second force measuring device for detecting an injection force is arranged on the piston of the at least one hydraulic drive, and/or a distance measurement is carried out via an encoder of the at least one electric motor.
9. The drive device according to claim 2, wherein the cylinder of the at least one hydraulic drive is designed as a single-acting cylinder.
10. The drive device according to claim 1, wherein a control or regulating device is provided by which the at least one hydraulic drive and/or the at least one electric motor can be controlled or regulated for applying a dynamic pressure and for carrying out a screw retraction.
11. The drive device according to claim 1, wherein: at least one distance sensor is provided for measuring an injection stroke, and/or a distance measurement is carried out via an encoder of the at least one electric motor.
12. An injection device for an injection molding machine with at least one drive device according

to claim 1.

13. An injection molding machine with at least one injection device according to claim 12.