

A FORM LOCKING DEVICE FOR INJECTION MOLDING MACHINES

The present invention relates to a form locking device for injection molding machines which device is provided with a fixed form top plate carrying half of a tool, a movable form top plate carrying the second half of the tool, with motion spindles, which spindles are freely rotatable in the fixed form top plate and are located therein in one direction axially supported and are located in the movable form top plate in a spindle nut mounted therein, with a rotary drive for the actuation of the motion spindles for the locking-and opening hub of the movable form top plate and with a hydraulic piston-cylinder unit for the locking power construction being in connection in an effective manner with the motion spindles.

A form locking device of this kind is known from DE 37 18 106 A 1 (embodiment according to Fig. 5). In said known embodiment the movable form top plate is movable by the motion spindles supported in the fixed top plate in the locking- and opening hub and in which the locking pressure construction is obtained by hydraulic piston cylinder units supported in the fixed form top plate and engaging the motion spindles. In said embodiment the spindles take over, besides the opening- and locking hub to be performed quickly, also the entire tensile force in the generation of the locking force by the hydraulic piston-cylinder units. The motion spindles are thus used both for overcoming the motion-and the locking force function. The motion spindles can thus be carried out only with difficulty.

There is known from EP 0 381 107 A2 a further form molding device in which the motion spindles mounted in the fixed form top plate are coupled with the movable form top plate by spindle nuts, which cause by a rotary drive the opening- and locking movement. In view of the fact that the locking pressure construction is obtained via hydraulic piston-cylinder units which are supported by spindle



nuts, also in this case the motion spindles are used for taking over the tension forces resulting from the high locking pressure.

The object of the present invention is thus to design a form locking device (as herein defined) in which in ascertaining the high locking pressure by a hydraulic piston-cylinder unit, the motion drive obtained by motion spindles is only that required for quick opening- and locking movements.

The present invention thus consists in a form locking device (as herein defined), characterized in that the movement- and force transfer of the movable form top plate, in quick motion, in the course of the opening and locking operation is performed only by the motion spindles, and in that the hydraulic piston-cylinder unit consists of one or more pistons and hydraulic cylinders in which the application of hydraulic pressure for the locking force construction is performed by piston-cylinder units actuated by the motion spindles by interconnection of one or more pressure transmission units.

One embodiment of the above form locking device may be characterized in that

two kinds of piston columns units are mounted at the movable form top plate, which columns penetrates through the fixed form plate and are guided therein by pistons in hydraulic cylinders, wherein the piston column units of one kind are provided with a motion spindle device and the piston column units of the other kind are provided with a pressure transmission unit;

the pistons divide the hydraulic cylinders in a locking side cylinder room and in an open side cylinder room;

all locking side cylinder rooms are connected to each other by way of channels;



the pressure transmission units consist each of a pressure transmission piston, a pressure transmission cylinder and a valve unit, the pressure transmission piston dividing the pressure transmission cylinder in a locking side pressure transmission room and an open side pressure transmission room, and the valve body being switchable between a position setting free and closing a passage from the locking side cylinder room to the open side cylinder room;

the motion spindle arrangements consist each of a spindle nut mounted within the piston and a motion spindle being located therein in the thread engagement, which motion spindle dips with one end into a cylindric groove of the piston column unit and with the other end penetrates through the main hydraulic cylinder and is guided with one to a second hydraulic cylinder with a piston unit and with a second penetrates through the second hydraulic cylinder and is coupled with the end part with a drive gear;

the piston unit of each motion spindle divides the second hydraulic piston in a second locking side cylinder room and a second open side cylinder room;

in a first function position (closing movement in quick motion) of a hydraulic system a first multi-path valve is switchable into switching position c, in which the second locking side cylinder room is connectable with a pressure means source, and a second multi-path valve is switchable into switching position b, in which a hydraulic conduit guiding from the second locking side pressure cylinder room to the open side pressure cylinder room is interrupted, wherein the pressure transmission piston and the valve shell are located in a basic position setting a passage free;



in a second function position (locking pressure construction) of the hydraulic system the second locking side cylinder room is connectable with the open side pressure transmission room, wherein the first multi-path valve is in switching position b and the second multi-path valve in switching position a;

in a third function position (pressure reduction) of the hydraulic system the second locking side cylinder room and the open side pressure transmission room are switchable without pressure, wherein the first multi-path valve and the second multi-path valve are each time in switching position a; and in a fourth function position, corresponding to the first function position, (opening movement in quick motion) of the hydraulic system the first multi-path valve is switchable into switching position c and the second multi-path valve is switchable into switching position b.

The previous embodiment may be varied by an embodiment that is characterized in that

the motion spindle arrangements consist each of a spindle nut mounted within the piston and a motion spindle being located therein in the thread engagement, which motion spindle is guided with one end with a spindle piston into a spindle cylinder formed in the piston column unit and with the other end penetrates through the main hydraulic cylinder and is guided with one to a second hydraulic cylinder with a piston unit; and with a second penetrates through the second hydraulic cylinder and is coupled with the end part with a drive gear;

the piston unit of each motion spindle divides the second hydraulic cylinder into a second locking side cylinder room



and into a second side open side cylinder room;
in a first function position (closing movement in quick motion) of a hydraulic system a first multi-path valve is switchable into switching position c, in which the second locking side cylinder room is applicable with a pressure medium of a pressure means source, a second multi-path valve is switchable into switching position a, in which the spindle cylinder is connectable with a tank and a third multi-path valve is switchable into switching position b, with which the hydraulic conduit to the pressure transmission system is interrupted;
in a second function position (locking pressure construction) of the hydraulic system the first multi-path valve is switchable into switching position a, in which the pressure medium being present in the second locking side cylinder room may expand towards said tank, the second multi-path valve is switchable into switching position b and the third multi-path valve is switchable into switching position a, in which the second multi-path valve shuts off the conduit to said tank and the third multi-path valve connects the spindle cylinder with the open side pressure transmission room;
in a third function position (pressure reduction) of the hydraulic system the first multi-path valve is switchable into switching position a, in which the pressure medium being present in the second locking side cylinder room may expand towards said tank, the second multi-path valve and the third multi-path valve being be switchable into switching position a, whereby the pressure from the open side pressure transmission room and of the spindle cylinder may expand towards said tank; and



in a fourth position (corresponding to the first function position, (opening movement in quick motion) the first multi-path valve is switchable into switching position c, in which the second locking side cylinder room is connectable with the pressure means source, the second locking side cylinder room being connectable with the pressure means source, the second multi-path valve being switchable in switching position a, the hydraulic oil may be sucked from the tank into the spindle cylinder, and the third multi-path valve is switchable in the switching position b, in which the hydraulic conduit to the open side pressure transmission room is interrupted.

The previous embodiments may be varied by a further embodiment which is characterized in that

the motion spindle arrangements consist each of a spindle nut mounted within the piston and a motion spindle being located therein in the thread engagement, which motion spindle dips with one end into a cylindric groove of the piston column unit and with the other end penetrates through the hydraulic cylinder and is supported by one by an axial bearing and with the other end part is coupled with a drive gear;

in the first function position (closing movement in quick motion) of a hydraulic system a multi-path valve is switchable into switching position b, in which the open side pressure transmission room is connected with said tank essentially without pressure;

in a second position (locking pressure construction) in which both halves of the tool adjoin each other a multi-path valve is switchable in indexing position c, in which the open side pressure transmission room is connected via the hydraulic conduit to the pressure means source;



in a third function (pressure reduction) of a hydraulic system a multi-path valve is switchable in switching position a, in which the pressure medium may expand to said tank from the open side pressure transmission room via the hydraulic conduits;

in a fourth position (opening movement in quick motion) of the hydraulic system a multi-path valve is switchable into switching position b, in which the pressure transmission device is kept in a position leaving the passage free.

The above embodiments may additionally be characterized in that

in the fixed form top plate are arranged four pistons of piston column units in which each are arranged diagonally each opposite another two motion spindle arrangements and two pressure transmission devices.

Said embodiments may further be characterized in that the pressure transmission piston consists of a piston part having a larger diameter and a piston part having a smaller diameter, wherein on the latter the valve body consisting of a valve shell is axially movable located which is coupled with the pressure transmission piston with the proviso that in the course of the movement of the pressure transmission piston the valve shell is moved simultaneously in a direction opposite to that of the piston which is provided at its circumference with an axial notch over which the pressure medium may be guided from the passage to the ring piston surface of the pressure transmission piston.

The present invention will now be illustrated with reference to the accompanying drawings without being limited by same. Identical parts appearing in various Figs. will be referenced by



the same numerals. In said drawings:

Fig. 1 shows a schematic longitudinal section of a form locking device of an injection molding machine along line I - I of Fig. 4;

Fig. 2 shows a schematical longitudinal section of another embodiment of a form locking device;

Fig. 3 shows a schematical longitudinal section of a further embodiment of a form locking device; and

Fig. 4 shows a cross-section, which is common for all form locking devices of Fig. 1 to 3, along line IV -IV of Fig. 1.

Fig. 1 shows a form locking device for an injection molding machine being provided with fixed form top plate 1 carrying first tool half 2 and movable form top plate 4 carrying second tool half 3. In form top plate 4 are mounted four piston column units 5 to 8, which units 5 to 8 penetrates through form top plate 1 and are movably guided therein in four main hydraulic cylinders 9 to 12 by pistons 13 to 16.

Piston column units 5 to 8 consist of two kinds, in which piston column units 5 and 7 are each provided with a pressure transmission unit; and piston column units 6 and 8 are each provided with a motion spindle arrangement.

The pressure transmission devices of piston column units 5 and 7 consist each of pressure transmission cylinder 17 in which is guided two-step transmission piston 18 which is provided with larger pressure piston 19 which corresponds to the diameter of pressure transmission cylinder 17, and a smaller pressure piston 20, which is surrounded by a valve body constituted by valve shell 21. The circumference diameter of valve shell 21 corresponds essentially to the diameter of pressure transmission cylinder 17 and is axially movable in it as well against pressure piston 20.



Valve shell 21 has at its outer surface at least one axially penetrating notch 22. The axial movement of valve shell 21 is limited in the locking direction by outer ring stop 23 and in the opening direction by stop devices (not shown) acting between the end part of pressure piston 20 and the end part of the inner circumference of valve shell 21 adjoining said stop devices.

Pressure transmission piston 18 divided pressure transmission cylinder 17 in lock side pressure transmission room 24 and in open side pressure transmission room 25.

Open side pressure transmission room 25 is part of passage 26 in piston 13, 15 which divides main hydraulic cylinder 9, 11 in lock side cylinder room 27, 28 and open side cylinder room 31, 32. Passage 26 may be locked by valve shell 21.

In a similar manner pistons 14 and 16 of piston column units 6 and 8 each being provided with a motion spindle arrangement divide main cylinder rooms 10 and 12 in locking side cylinder rooms 29 and 30 and in open side cylinder rooms 33 and 34, respectively.

All locking side cylinder rooms 27, 28 and 29, 30 are connected to each other by channels 35.

The motion spindle arrangements of piston column units 6 and 8 consist each of motion spindle 36, 37, 38 which is located with spindle nut 39 being mounted in piston 14 in the thread engagement and dips into groove 40 of piston column unit 6 and 8.

Motion spindles 36, 37, 38 are also provided with axial bearing 41 and with end part 42, with which the motion spindle is coupled axially movable with a gear drive. Only drive pinion 43 is shown of said gear drive, which pinion 43 may be driven via belt drive 44 with a servo motor having a position regulation. The servo motor is preferably an electro motor.

The above features and devices are identical for all embodi-

ments according to Figs. 1 to 3. Thus hereinafter only the special features of each embodiment will be described.

1. Embodiment according to Fig. 1

1.1 Constructive structure

Motion spindle 36 of the embodiment according to Fig. 1 penetrates through open side cylinder room 32 and extends into adjoining second cylinder room 45 in which motion spindle 36 with axial bearing 41 is located in piston unit 46. Said piston unit 46 divides second cylinder room 45 in second locking side cylinder room 47 and a second open side cylinder room, (not shown in the drawing of piston unit 46).

From second locking side cylinder room 47 hydraulic conduit 48 conducts to first multi-path valve 49 (4/3-path valve) with switching positions a, b and c. Hydraulic conduit 50 branches of hydraulic conduit 48 towards multi-path valve 51 (4/2-path valve) with switching positions a and b over which a connection between second locking side cylinder room 47 and open side pressure cylinder room 25 may be formed or interrupted. Hydraulic conduit 48 is switchable over first multi-path valve 49 optionally either to pressure means source P or via return valve 52 with back pressure (6 bar) to tank T. Hydraulic liquid may be taken from tank T over return valve 53 functioning as secondary suction valve. Open side cylinder room 31 is connected with tank T via hydraulic conduit 54 and return valve 52 with back pressure.

1.2 Function description

1.2.1 Closing of the form locking device in quick motion.

For this purpose second locking side cylinder room 47 is applicable over switching position c of first multi-path valve 49, with pressure medium of pressure means source



P. Thereafter piston unit 46 reaches the stop position illustrated in Fig. 1. Second multi-path valve 51 is in switching

position b, which ascertains that pressure transmission piston 18 holds valve shell 21 in the position illustrated in Fig. 1, in which passage 26 between locking side cylinder room 27 and open side cylinder room 31 is open.

By the rotation of motion spindle 36 tool halves 2 and 3 are moved one toward another until they are stopped by each other. Thus on the basis of the drive of motion spindle 31 via a servo motor with position regulation a precise positioning can be obtained. In the course of the movement of tool halves 2 and 3 one towards another a re-laying of the hydraulic oil from open side cylinder rooms 31 and 33 over passages 26 and channels 35 to locking side cylinder rooms 27 to 30 is performed. Missing quantities of hydraulic oil may be replaced over conduit 54 and return valve 53.

1.2.2. Locking pressure construction.

For this purpose first multi-path valve 49 is brought into switching position b and second multi-path valve 51 into switching position a. By further rotating of motion spindle 51 in the locking side direction piston unit is moved left side in the description according to Fig. 1, whereafter the hydraulic oil being located in second locking side cylinder room 47 reaches via hydraulic conduits 48 and 50 and second multi-path valve 51 open side pressure transmission room 25 and causes a movement of pressure transmission piston 18 and valve shell 21, so that passage 26 is closed by valve shell 26. By further movement of pressure transmission piston 18 there is achieved on the basis of differential pressure



surfaces 19' and 19" an elevated pressure, which extends through notch 22 into valve shell 21 and forms at ring piston surfaces 13' to 16' the required locking pressure.

1.2.3 Pressure reduction.

For the relief of the locking pressure acting on ring piston surfaces 13' to 16' second multi-path valve 51 is brought into switching position a and first multi-path valve 49 into switching position a, whereafter pressure transmission piston 18 is switched without pressure to tank T. Second locking side cylinder room 47 is connected to pressure means source P so that the piston unit is put back into the stop position illustrated in Fig. 1.

1.2.4 Opening of the form locking device in quick motion.

The first and second multi-path valves 49 and 51 are brought into the same switching positions as in the course of the locking operation. The rotation direction of motion spindle 36 is however the reverse direction so that tool halves 2 and 3 are moved from each other.

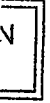
2. Embodiment according to Fig. 2.

2.1 Constructive structure.

In the embodiment according to Fig. 2 motion spindle 37 is located freely rotatable by axial bearing 41 in housing 55 adjoining hydraulic cylinder 10, but it is not axially movable. The hydraulic system consists of pressure means source P, multi-path valve 56 with switching positions a, b and c, freely switchable return valve 57, return valve 53, return valve 52 with counter pressure, tank T as well as of hydraulic conduits 58 to 61.

2.2 Function description.

2.2.1 Locking of form locking device in quick motion.



Multi-path valve is switched in the position illustrated in Fig. 2 in which it is ascertained that passage 26 in piston 13, 15 is left open. Thus, in the rotation movement of motion spindle 37 and the movement of working tools 2 and 3 one towards the other caused by said movement, the hydraulic oil can flow from both open side cylinder rooms 31 and 33 into locking side cylinder rooms 27 to 30. Missing oil volumes may be sucked by return valve 53 and hydraulic conduit 61. The rotation of motion spindle 37 is stopped when both tool halves touch each other.

2.2.2 Locking force construction

Multi-path valve 56 is brought into switching position c in which the hydraulic oil reaches pressure transmission room 24 from pressure means source P over hydraulic conduit 58 and causes by pressure transmission piston 18 the locking force construction described in 1.2.2.

2.2.3 Pressure reduction

For the relief of the locking pressure acting on ring piston surfaces 13' to 16" multi-path valve 56 is brought into switching position a, in which return valve 57 is switched free over hydraulic conduit 59, so that the pressure acting on pressure transmission piston 18 can expand via hydraulic conduits 58 and 60 towards tank T.

2.2.4 Opening of the form locking device in quick motion.

Multi-path valve 56 is brought into switching position b. By the rotation of motion spindle 37 in the direction in which tool halves move from each other a pressure is formed in locking side cylinder rooms 27 which causes via passage 26 a return movement of pressure transmission piston 18 and valve shell 21 into the position illustrated in Fig. 2, so that



passage 26 between locking side cylinder rooms 27, 29 is completely free, so that in the reverse movement a volume compensation between locking side cylinder rooms 27 to 30 and open side cylinder rooms 31 to 33 may be obtained. Excess hydraulic oil is removed to tank T via hydraulic conduit 61.

3. Embodiment according to Fig. 3

3.1 Constructive structure.

Motion spindle 38 according to Fig. 3 corresponds in the driving side part to motion spindle 36 according to Fig. 1. At the end dipping into piston column unit 6 (8) motion spindle 38 has hydraulic spindle piston 62, which is conducted in spindle cylinder 63. The hydraulic system consists of pressure means source P, first multi-path valve 64 having three switching positions a to c, second multi-path valve 65 having two switching positions a and b and third multi-path valve 66 having switching positions a and b. Said multi-path valves 64 to 66 are connected via hydraulic conduits 67 to 70 to open side transmission room 24, spindle cylinder 63, second locking side cylinder room 47, open side cylinder room 31, 33 and to tank T.

3.2 Function description.

3.2.1 Locking of form locking device in quick motion.

First multi-path valve 64 is switched into switching position c, as the result thereof second locking side cylinder room 47 is applicable with pressure means from pressure means source P and piston unit 46 is in the right stopping position illustrated in Fig.3. Second multi-path valve is switched into switching position a, as the result thereof in the course of the movement of tool halves 2 and 3 one towards another, caused by the spindle rotation the hydraulic oil displaced by



spindle piston 62 out of spindle cylinder 63 can flow to tank T via hydraulic conduit 67. Third multi-path valve 66 is switched into switching position b in order to ascertain that pressure transmission piston 18 and valve shell 21 remain in the position illustrated in Fig. 3, in which, in the cause of moving pistons 13 to 16 into the locking position, an exchange of oil volumes between open side cylinder rooms 31 and 33 and locking side cylinder rooms 27 to 30 may be performed.

3.2.2 Locking pressure construction.

First multi-path valve 64 is switched into switching position a, as the result thereof the hydraulic oil being within in locking side cylinder room 47 may flow to tank T via hydraulic conduit 69, when motion spindle 38 is rotated further while pistons 13 to 16 are in the locking position, so that spindle piston 62 may penetrate further into spindle cylinder 63 in order to form hydraulic pressure for the application of pressure transmission piston 18. As pistons 13 to 16 are in the locking position, in which tool halves 2 and 3 adjoin each other, the rotation of motion spindle 38 causes a movement 46 left side to the extent that spindle piston 62 penetrates into spindle cylinder 63. Second multi-path valve 65 is then switched into switching position a and third multi-path valve 66 is switched into switching position a, so that the hydraulic pressure formed in spindle cylinder 63 may be transferred via conduits 68 and 67 to pressure transmission piston 18. By pressure transmission 18 the elevation of the pressure appropriate for the locking force construction according to the function description of 1.2.2 is achieved.

3.2.3 Pressure reduction



First multi-path valve 64 is switched into switching position a in order to relief the locking pressure acting on ring piston surfaces 13' to 16", thus second locking side cylinder room 47 is in return sucking connection with tank T. Second multi-path valve 65 and third multi-path valve 66 are both switched into switching positions a, so that the pressure from open side pressure transmission room 25 and spindle cylinder 63 may expand to tank T.

3.2.4 Opening movement of the form locking device in quick motion.

First multi-path valve 64 is switched into switching position c in which second locking side cylinder room 47 is applicable with pressure means from pressure means source P as the result of which piston unit 46 is moved into the stopping position illustrated in Fig. 3. Therefore a simultaneous rotation of motion spindle 38 is performed in order to enable the return positioning of piston unit 46 and after stopping thereof to enable the opening movement. Second multi-path valve 65 is switched into switching position a, so that hydraulic oil can be sucked from tank T into spindle cylinder 63 via hydraulic conduits 68 and 67. Third multi-path valve 66 is switched into switching position b, in which it is ascertained that pressure transmission piston 18 and valve shell 21 in back drawn position setting free passage 26 so that in the course of the opening movement an uninterrupted exchange between the oil volumes of locking side cylinder rooms 27 to 30 and open side cylinder rooms 31 and 33 may be achieved. Excess oil volume may be removed to tank T via hydraulic conduit 61.



Claims

1. A form locking device for injection molding machines which device is provided with a fixed form top plate carrying half of a tool, a movable form top plate carrying the second half of the tool, with motion spindles, which spindles are freely rotatable in the fixed form top plate and are located therein in one direction axially supported and are located in the movable form top plate in a spindle nut mounted therein, with a rotary drive for the actuation of the motion spindles for the locking-and opening hub of the movable form top plate and with a hydraulic piston-cylinder unit for the locking power construction being in connection in an effective manner with the motion spindles, characterized in that the movement- and force transfer of the movable form top plate, in quick motion, in the course of the opening and locking operation is performed only by the motion spindles, and in that the hydraulic piston-cylinder unit consists of one or more pistons and hydraulic cylinders in which the application of hydraulic pressure for the locking force construction is performed by piston-cylinder units actuated by the motion spindles by interconnection of one or more pressure transmission units.
2. A form locking device according to Claim 1, characterized in that

two kinds of piston columns units are mounted at the movable form top plate, which columns penetrates through the fixed form plate and are guided therein by pistons in hydraulic cylinders, wherein the piston column units of one kind are provided with a motion spindle device and the piston column units of the other kind are provided with a pressure transmission unit;





the pistons divide the hydraulic cylinders in a locking side cylinder room and in an open side cylinder room;

all locking side cylinder rooms are connected to each other by way of channels;

the pressure transmission units consist each of a pressure transmission piston, a pressure transmission cylinder and a valve unit, the pressure transmission piston dividing the pressure transmission cylinder in a locking side pressure transmission room and an open side pressure transmission room, and the valve body being switchable between a position setting free and closing a passage from the locking side cylinder room to the open side cylinder room;

the motion spindle arrangements consist each of a spindle nut mounted within the piston and a motion spindle being located therein in the thread engagement, which motion spindle dips with one end into a cylindric groove of the piston column unit and with the other end penetrates through the main hydraulic cylinder and is guided with one to a second hydraulic cylinder with a piston unit and with a second penetrates through the second hydraulic cylinder and is coupled with the end part with a drive gear;

the piston unit of each motion spindle divides the second hydraulic piston in a second locking side cylinder room and a second open side cylinder room;

in a first function position (closing movement in quick motion) of a hydraulic system a first multi-path valve is switchable into switching position c, in which the second locking side cylinder room is connectable with a pressure means source, and a second multi-path valve is switchable into switching position b, in which a hydraulic conduit guiding





from the second locking side pressure cylinder room to the open side pressure cylinder room is interrupted, wherein the pressure transmission piston and the valve shell are located in a basic position setting a passage free;

in a second function position (locking pressure construction) of the hydraulic system the second locking side cylinder room is connectable with the open side pressure transmission room, wherein the first multi-path valve is in switching position b and the second multi-path valve in switching position a;

in a third function position (pressure reduction) of the hydraulic system the second locking side cylinder room and the open side pressure transmission room are switchable without pressure, wherein the first multi-path valve and the second multi-path valve are each time in switching position a; and in a fourth function position, corresponding to the first function position, (opening movement in quick motion) of the hydraulic system the first multi-path valve is switchable into switching position c and the second multi-path valve is switchable into switching position b.

3. A form locking device according to Claim 1 characterized in that

two kinds of piston column units are mounted at the movable form top plate, which columns penetrates through the fixed form plate and are guided therein by pistons in hydraulic cylinders, wherein the piston column units of one kind are provided with a motion spindle device and the piston column units of the other kind are provided with a pressure transmission unit;

the pistons divide the hydraulic cylinders in a locking side



cylinder room and in an open side cylinder room;

all locking side cylinder rooms are connected to each other by way of channels;

the pressure transmission units consist each of a pressure transmission piston, a pressure transmission cylinder and a valve unit, the pressure transmission piston dividing the pressure transmission cylinder in a locking side pressure transmission room and an open side pressure transmission room, and the valve body being switchable between a position setting free and closing a passage from the locking side cylinder room to the open side cylinder room;

the motion spindle arrangements consist each of a spindle nut mounted within the piston and a motion spindle being located therein in the thread engagement, which motion spindle dips with one end into a cylindric groove of the piston column unit and with the other end penetrates through the main hydraulic cylinder and is guided with one to a second hydraulic cylinder with a piston unit and with a second penetrates through the second hydraulic cylinder and is coupled with the end part with a drive gear;

the piston unit of each motion spindle divides the second hydraulic piston in a second locking side cylinder room and a second open side cylinder room;

in a first function position (closing movement in quick motion) of a hydraulic system a first multi-path valve is switchable into switching position c, in which the second locking side cylinder room is connectable with a pressure means source, and a second multi-path valve is switchable into switching position b, in which a hydraulic conduit guiding from the second locking side pressure cylinder room to the



open side pressure cylinder room is interrupted, wherein the pressure transmission piston and the valve shell are located in a basic position setting a passage free;

in a second function position (locking pressure construction) of the hydraulic system the second locking side cylinder room is connectable with the open side pressure transmission room, wherein the first multi-path valve is in switching position b and the second multi-path valve in switching position a;

in a third function position (pressure reduction) of the hydraulic system the second locking side cylinder room and the open side pressure transmission room are switchable without pressure, wherein the first multi-path valve and the second multi-path valve are each time in switching position a;

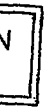
the motion spindle arrangements consist each of a spindle nut mounted within the piston and a motion spindle being located therein in the thread engagement, which motion spindle is guided with one end with a spindle piston into a spindle cylinder formed in the piston column unit and with the other end penetrates through the main hydraulic cylinder and is guided with one to a second hydraulic cylinder with a piston unit; and with a second penetrates through the second hydraulic cylinder and is coupled with the end part with a drive gear;

the piston unit of each motion spindle divides the second hydraulic cylinder into a second locking side cylinder room and into a second side open side cylinder room;

in a first function position (closing movement in quick motion) of a hydraulic system a first multi-path valve is switchable into switching position c, in which the second



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locking side cylinder room is applicable with a pressure medium of a pressure means source, a second multi-path valve is switchable into switching position a, in which the spindle cylinder is connectable with a tank and a third multi-path valve is switchable into switching position b, with which the hydraulic conduit to the pressure transmission system is interrupted;

in a second function position (locking pressure construction) of the hydraulic system the first multi-path valve is switchable into switching position a, in which the pressure medium being present in the second locking side cylinder room may expand towards said tank, the second multi-path valve is switchable into switching position b and the third multi-path valve is switchable into switching position a, in which the second multi-path valve shuts off the conduit to said tank and the third multi-path valve connects the spindle cylinder with the open side pressure transmission room;

in a third function position (pressure reduction) of the hydraulic system the first multi-path valve is switchable into switching position a, in which the pressure medium being present in the second locking side cylinder room may expand towards said tank, the second multi-path valve and the third multi-path valve being be switchable into switching position a, whereby the pressure from the open side pressure transmission room and of the spindle cylinder may expand towards said tank; and

in a fourth position (corresponding to the first function position, (opening movement in quick motion) the first multi-path valve is switchable into switching position c, in which the second locking side cylinder room is connectable with the



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pressure means source, the second locking side cylinder room being connectable with the pressure means source, the second multi-path valve being switchable in switching position a, the hydraulic oil may be sucked from the tank into the spindle cylinder, and the third multi-path valve is switchable in the switching position b, in which the hydraulic conduit to the open side pressure transmission room is interrupted.

4. A form locking device for injection molding machines which device is provided with a fixed form top plate carrying half of a tool, a movable form top plate carrying the second half of the tool, with motion spindles, which spindles are freely rotatable in the fixed form top plate and are located therein in one direction axially supported and are located in the movable form top plate in a spindle nut mounted therein, with a rotary drive for the actuation of the motion spindles for the locking-and opening hub of the movable form top plate and with a hydraulic piston-cylinder unit for the locking power construction being in connection in an effective manner with the motion spindles,

characterized in that

two kinds of piston columns units are mounted at the movable form top plate, which columns penetrates through the fixed form plate and are guided therein by pistons in hydraulic cylinders, wherein the piston column units of one kind are provided with a motion spindle device and the piston column units of the other kind are provided with a pressure transmission unit;

the pistons divide the hydraulic cylinders in a locking side cylinder room and in an open side cylinder room;

all locking side cylinder rooms are connected to each other by



way of channels;

the pressure transmission units consist each of a pressure transmission piston, a pressure transmission cylinder and a valve unit, the pressure transmission piston dividing the pressure transmission cylinder in a locking side pressure transmission room and an open side pressure transmission room, and the valve body being switchable between a position setting free and closing a passage from the locking side cylinder room to the open side cylinder room;

the motion spindle arrangements consist each of a spindle nut mounted within the piston and a motion spindle being located therein in the thread engagement, which motion spindle dips with one end into a cylindric groove of the piston column unit and with the other end penetrates through the hydraulic cylinder and is supported by one by an axial bearing and with the other end part is coupled with a drive gear;

in the first function position (closing movement in quick motion) of a hydraulic system a multi-path valve is switchable into switching position b, in which the open side pressure transmission room is connected with said tank essentially without pressure;

in a second position (locking pressure construction) in which both halves of the tool adjoin each other a multi-path valve is switchable in indexing position c, in which the open side pressure transmission room is connected via the hydraulic conduit to the pressure means source;

in a third function (pressure reduction) of a hydraulic system a multi-path valve is switchable in switching position a, in which the pressure medium may expand to said tank from the open side pressure transmission room via the hydraulic



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conduits;

in a fourth position (opening movement in quick motion) of the hydraulic system a multi-path valve is switchable into switching position b, in which the pressure transmission device is kept in a position leaving the passage free.

5. A form locking device according to any of Claims 1 to 4 characterized in that

in the fixed form top plate are arranged four pistons of piston column units in which each are arranged diagonally each opposite another two motion spindle arrangements and two pressure transmission devices.

6. A form locking device according to any of Claims 1 to 5 characterized in that

the pressure transmission piston consists of a piston part having a larger diameter and a piston part having a smaller diameter, wherein on the latter the valve body consisting of a valve shell is axially movable located which is coupled with the pressure transmission piston with the proviso that in the course of the movement of the pressure transmission piston the valve shell is moved simultaneously in a direction opposite to that of the piston which is provided at its circumference with an axial notch over which the pressure medium may be guided from the passage to the ring piston surface of the pressure transmission piston.

For the Applicant: