Abstract: An apparatus (1) for injection of plastic materials has: a tubular frame (8); an injection cylinder (9), fixed to the tubular frame (8); a shaft (10), which extends along a longitudinal axis (A) and has a first portion (26), shaped like a screw conveyor and set within the injection cylinder (9) for feeding and fluidifying the plastic material, and a second portion (28); and an actuation assembly (11), which can be selectively coupled to the second portion (28) of the shaft (10) for selectively rotating the shaft (10) about the longitudinal axis (A) in the step of fluidification and advance of the plastic material and for pushing the shaft (10) along the longitudinal axis (A) in the step of injection of the plastic material.
APPARATUS FOR INJECTION OF PLASTIC MATERIALS

TECHNICAL FIELD
The present invention relates to an apparatus for injection of plastic materials.

In particular, the present invention regards an apparatus for injection of a complex product.

BACKGROUND ART
Generally, a complex product is a product comprising at least two materials, which are joined together and are defined by plastic materials having different colours and/or different mechanical characteristics in order to meet given aesthetic and/or structural requirements for the product. A technique of production of a complex product envisages moulding a semifinished product formed only by the first material using a press and injecting the second material onto the semifinished product with the technique of injection moulding. For this purpose, an injection apparatus is used having an injection cylinder designed to inject the plastic material precisely in a mould contiguous to the semifinished product. Generally, said injection apparatus is coupled to the press used for making the semifinished component and must be able to assume different positions with respect to the press. For this purpose, it is important that the injection apparatuses should be as light as possible, of small dimensions and manageable.

Injection apparatuses of a known type fail to meet fully the requirements of manageability imposed by their use. In fact, actuation of the injection cylinder is performed by a hydraulic cylinder, with the result that there is the need to have available on board the machine a pump, an oil tank, and relatively rigid pipes that tend to hamper any displacement of the injection apparatus.
DISCLOSURE OF THE INVENTION
The aim of the present invention is to provide an apparatus for injection of plastic materials, in particular for injection of a component of a complex product, that will be light, of small dimensions, and manageable and, at the same time, will be practical and simple to use.

According to the present invention there is provided an apparatus for injection of plastic materials comprising: a tubular frame; an injection cylinder, fixed to the tubular frame; and a shaft, which extends along a longitudinal axis and comprises a first portion, shaped like a screw conveyor and set within the injection cylinder for feeding and fluidifying the plastic material, and a second portion; the injection apparatus being characterized in that it comprises an actuation assembly which can be selectively coupled to the second portion of the shaft for selectively rotating the shaft about the longitudinal axis in the step of fluidification and advance of the plastic material and for pushing the shaft along the longitudinal axis in the step of injection of the plastic material.

BRIEF DESCRIPTION OF THE DRAWINGS
For a better understanding of the present invention, a preferred embodiment thereof will now be described, purely by way of non-limiting example, with reference to the attached plates of drawings, wherein:
- Figure 1 is a partially cross-sectional view in side elevation, with parts removed for reasons of clarity, of the injection apparatus forming the subject of the present invention;
- Figure 2 is a side elevation, with parts in cross-sectional view and parts removed for reasons of clarity and at an enlarged scale, of the injection apparatus of Figure 1;
- Figure 3 is a cross-sectional view, at an enlarged scale with parts removed for reasons of clarity, of the apparatus of
Figure 2 according to the section lines IH-III;
- Figures 4 and 5 are views in front elevation, with parts removed for reasons of clarity and at an enlarged scale, of components of the injection apparatus of Figure 2;
- Figure 6 is a cross-sectional view, at an enlarged scale with parts removed for reasons of clarity, of the apparatus of Figure 2 according to the section lines VI-VI; and
- Figures 7 and 8 are views in front elevation, with parts removed for reasons of clarity and at a further enlarged scale, of further components of the injection apparatus of Figure 1.

BEST MODE FOR CARRYING OUT THE INVENTION
In Figure 1, the reference numeral 1 designates as a whole an injection apparatus, designed to be mounted on a moulding press. The injection apparatus 1 extends prevalently in a direction Dl and comprises: a supporting bracket 2; and a moving assembly 3, which moves in the direction Dl and is slidably coupled to the supporting bracket 2 by means of guides 4 fixed to the bracket 2.

The bracket 2 comprises: a plate 5, which is parallel to the direction Dl and fixed to which are the guides 4; and a plate 6, which is orthogonal to the direction Dl, is fixed to the plate 5, and has a hole 7 (Figure 2).

The moving assembly 3 comprises: a tubular frame 8; an injection cylinder 9, fixed to the tubular frame 8; a shaft 10, which extends along a longitudinal axis A, is set in part within the injection cylinder 9, and has both the function of plasticating screw, and the function of injection piston; and an actuation assembly 11, designed to move the shaft 10.

With reference to Figure 2, the actuation assembly 11 comprises: an electric motor 12, fixed to the tubular frame 8; a tubular element 13, rotatably mounted about the longitudinal
axis A on the tubular frame 8; an auxiliary shaft 14, which shares the same axis as and is aligned to the shaft 10; a friction clutch 15, designed to connect the shaft 10 to the tubular element 13; and a friction clutch 16, designed to connect the auxiliary shaft 14 to the tubular frame 8.

The tubular frame 8 defines the load-bearing structure of the moving assembly 3 and comprises: a motor reducer 17, set around the shaft 10 and the tubular element 13; a pneumatic distributor 18, set around the tubular element 13; and an annular block 19, which is set around the auxiliary shaft 14 and is connected to the bracket 2 in order to bring about displacement of the moving assembly 3 in the direction D1. The motor reducer 17, the pneumatic distributor 18, and the annular block 19 are elements that are distinct from the structural standpoint and are distributed along the longitudinal axis A and connected to one another. In particular, the motor reducer 17 comprises a casing 20, which is joined to the pneumatic distributor 18 via a slide 21, engaged in the guides 4, whilst the annular block 19 is connected to the pneumatic distributor 18 via screws 22 and spacers 23, uniformly distributed about the longitudinal axis A.

With reference to Figure 1, the injection cylinder 9 extends along the longitudinal axis A, is fixed to the casing 20, and comprises: a supply hopper 24; an injection nozzle 25; resistors and thermocouples, of a known type and not illustrated in the attached plates of drawings, for plasticating the plastic materials fed along the injection cylinder 9 itself and monitoring the temperature, respectively.

The shaft 10 comprises in succession: a portion 26, which is shaped like a plasticating screw and is housed in the injection cylinder 9; a cylindrical portion 27; and an axially
grooved portion 28, which extends within the tubular frame 8 and the tubular element 13. The shaft 10 moreover comprises a piston 29, which is set at the free end of the portion 26.

With reference to Figure 2, the auxiliary shaft 14 comprises: a screw portion 30 (in practice, the portion 30 has a helical groove); and a prismatic portion 31.

The tubular element 13 is defined by a number of components joined together for simplifying assembly and that, for simplicity of description, are all designated by the same number 13 in Figure 2. The tubular element 13 is connected to the motor reducer 17 for receiving rotary motion about the longitudinal axis A and is connected to the auxiliary shaft 14 by a ball-screw coupling 32. Basically, the tubular element 13 has a section provided with a helical groove, is set around the screw portion 30 of the auxiliary shaft 14, and is connected to the screw portion 30 by means of the balls 33.

In addition, the tubular element 13 defines a compartment for housing the friction clutch 15 in a position corresponding to the grooved portion 28 of the shaft 10.

The friction clutch 15 comprises: a hub 34, slidably coupled to the grooved portion 28 of the shaft 10; three disks 35, perpendicular to the longitudinal axis A and coupled in rotation to the tubular element 13; three disks 36, perpendicular to the longitudinal axis A and coupled in rotation to the hub 34; and an annular piston 37, designed to compress the disks 35 and 36 against one another and against the tubular element 13 so as to drive the shaft 10 in rotation about the longitudinal axis A. The annular piston 37 is mobile in the direction D1 and is actuated in the direction D1 by compressed air supplied by a duct 38, which extends through the pneumatic distributor 18 and the tubular element 13 and comprises an annular chamber 39, formed between the pneumatic
distributor 18 and the tubular element 13.

With reference to Figure 3, the hub 34 is slidably coupled to the grooved portion 28 of the shaft 10 and in turn has external grooves 40. Illustrated in Figure 4 is a friction disk 35, which can turn freely about the hub 34 and has teeth 41, designed to engage axial grooves 42 (Figure 2), made in the tubular element 13. In Figure 5, the friction disk 36 is mounted so that it can turn freely with respect to the tubular element 13 and has internal teeth 43 engaged in the grooves 37 of the hub 34.

With reference to Figure 2, the pneumatic distributor 18 is formed by a number of elements assembled together, which, for simplicity of description, are all designated by the same reference number 18.

Also the annular block 19 is formed by a number of components assembled together, which, for simplicity of description, are all designated by the same reference number 19. The annular block 19 defines a compartment for housing the friction clutch 16 in a position corresponding to the prismatic portion 31 of the auxiliary shaft 14.

The friction clutch 16 comprises: three disks 44, perpendicular to the longitudinal axis A and coupled to the annular block 19; three disks 45, perpendicular to the longitudinal axis A and prismatically coupled to the prismatic portion 31 of the auxiliary shaft 14; and an annular piston 46, designed to compress the disks 44 and 45 against one another and against the annular block 19 so as to block rotation of the auxiliary shaft 14 about the longitudinal axis A. The annular piston 46 is mobile in the direction D1 and is actuated in the direction D1 via compressed air supplied through a duct 47 that extends through the annular block 19.
With reference to Figure 6, the prismatic portion 31 of the auxiliary shaft 14 has two plane parallel and opposite faces 48 in such a way that the cross section of the prismatic portion appears substantially rectangular, whilst the annular block 19 has axial grooves 49. With reference to Figure 7, each friction disk 44 can turn freely about the portion 31 and has teeth 50 engaged in the grooves 49 of the annular block 19. With reference to Figure 8, each friction disk 45 can turn freely with respect to the annular block and has an opening 51 designed to couple prismatically the friction disk 45 to the portion 31 so as to enable axial sliding of the friction disk 45 along the longitudinal axis A.

With reference to Figure 2, the annular block 19 defines an annular cylinder 52 and comprises: an annular piston 53 mobile in the direction D1 and housed in the annular cylinder 52; and a number of stems 54, each of which has one end connected to the annular piston 53 and one end connected to the bracket 2, in particular to the plate 6. The annular cylinder 52 is a double-acting pneumatic cylinder and is designed to displace the moving assembly 3 selectively with respect to the bracket 2.

In use, in a first operating step, the tubular element 13 is coupled to the shaft 10 by the friction clutch 15, whilst the auxiliary shaft 14 and the tubular frame 8 are uncoupled. Consequently, the shaft 10 is rotated about the longitudinal axis A in order to plasticate the plastic material contained in the injection cylinder 9 and feed the plastic material between the piston 19 and the nozzle 25. In a second operating step, the tubular element 13 and the shaft 10 are uncoupled, whilst the auxiliary shaft 14 and the tubular frame 8 are coupled by the friction clutch 16. Consequently, the auxiliary shaft 14 translates in the direction indicated by the arrow D1 along the longitudinal axis A thanks to the ball-screw coupling 32 and pushes the shaft 10 so as to expel the plastic
material from the nozzle 15. When the injection apparatus 1 is again in the first operating step, the plastic material that has accumulated progressively between the piston 29 and the nozzle 25 brings about translation of the shaft 10 and of the auxiliary shaft 14 in the direction opposite to the direction indicated by the arrow D1.

The injection apparatus described is particularly advantageous for its compactness and versatility, and also from the standpoint of operation it requires only to be connected up to the power-supply mains and to the compressed-air system.
CLAIMS

1. An apparatus for injection of plastic materials comprising:
a tubular frame (8); an injection cylinder (9), fixed to the
tubular frame (8); and a shaft (10), which extends along a
longitudinal axis (A) and comprises a first portion (26)
shaped like a screw conveyor and set within the injection
cylinder (9) for feeding and fluidifying the plastic material,
and a second portion (28); the injection apparatus being
characterized by comprising an actuation assembly (11),
which can be selectively coupled to the second portion
(28) of the shaft (10) for selectively rotating the shaft (10)
about the longitudinal axis (A) in the step of fluidification
and advance of the plastic material, and for pushing the shaft
(10) along the longitudinal axis (A) in the step of injection
of the plastic material.

2. The apparatus according to Claim 1, characterized in that
the actuation assembly (11) comprises a single motor member
(12), fixed to the tubular frame (8) for selectively rotating
the shaft (10) about the longitudinal axis (A) and pushing the
shaft (10) along the longitudinal axis (A).

3. The apparatus according to Claim 1 or Claim 2,
characterized in that the actuation assembly (11) comprises a
first friction clutch (14) and a second friction clutch (15).

4. The apparatus according to Claim 3, characterized in that
the first and second friction clutches are controlled
pneumatically.

5. The apparatus according to Claim 3 or Claim 4,
characterized in that the actuation assembly (11) comprises a
tubular element (13), set around the second portion (28) of
the shaft (10) and rotatable about the longitudinal axis (A)
with respect to the tubular frame (8); the first friction
clutch (15) being suitable to couple the second portion (28) of the shaft (10) to the tubular element (13) for rotating the shaft (10) together with the tubular element (13).

6. The apparatus according to any one of Claims 3 to 5, characterized in that the actuation assembly (11) comprises an auxiliary shaft (14), which is aligned with and shares the same axis as the shaft (10), is set in frontal contact with the shaft (10), comprises a screw portion (30) coupled to the tubular element (13) via a ball-screw coupling (32), and a prismatic portion (31), designed to be coupled by the second friction clutch (16) to the tubular frame (8) for blocking rotation of the auxiliary shaft (14) and determining translation of the auxiliary shaft (14) along the longitudinal axis (A) so as to push the shaft (10) in the step of injection of the plastic material.

7. The apparatus according to Claim 5 or Claim 6, characterized in that the first friction clutch (15) comprises: at least one first friction disk (34), coupled in rotation to the tubular element (13); at least one second friction disk (35), coupled in rotation to the second portion (28) of the shaft (10); and a first piston (37), housed in a compartment made in the tubular element (13) and designed to compress selectively the first and the second friction disks (35, 36) one against the other and against the tubular element (13).

8. The apparatus according to Claim 6, characterized in that the second friction clutch (16) comprises: at least one third friction disk (44), coupled in rotation to the tubular frame (8); at least one fourth friction disk (45), coupled in rotation to the second section of the auxiliary shaft (14); and a second piston (46), housed in a compartment made in the tubular frame (8) and designed to compress selectively the third and fourth friction disks (44, 45) one against the other.
and against the tubular frame (8).

9. The apparatus according to Claim 7 or Claim 8, characterized in that the first and second pistons are annular pistons (37, 46).

10. The apparatus according to any one of Claims 7 to 9, characterized in that it comprises a first duct (38) for supply of the compressed air to the first piston (37); the first duct (38) extending through the tubular frame (8) and the tubular element (13) and comprising an annular chamber (39), set between the tubular frame (8) and the tubular element (13).

11. The apparatus according to any one of Claims 5 to 10, characterized in that the second portion (28) of the shaft (10) has a groove parallel to the longitudinal axis (A) and is coupled to the second friction disk (36) by means of a hub (34), which is slidably coupled to the second portion (28) and is provided with grooves (40) parallel to the longitudinal axis (A); the second friction disk (36) being provided with teeth (43) engaged in said grooves (40).

12. The apparatus according to any one of Claims 5 to 11, characterized in that the prismatic portion (31) of the auxiliary shaft (14) is coupled to the fourth friction disk (45) by means of a prismatic fit.

13. The apparatus according to any one of the preceding claims, characterized in that it comprises a bracket (2) and a moving assembly (3), slidably mounted on the bracket (2); said tubular frame (8) forming part of said moving assembly (2) and defining a pneumatic cylinder (52) connected to the bracket (2) via stems (4).

14. The apparatus according to Claim 13, characterized in that said pneumatic cylinder (52) is an annular cylinder.