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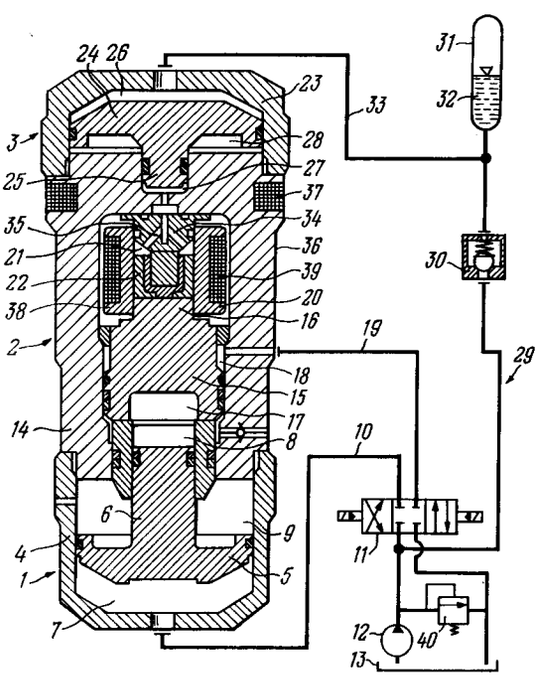
# (54) DEVICE FOR HYDRO-MECHANICAL FORMING OF ARTICLES.

(57) A device for hydro-mechanical forming of articles comprising, all mounted coaxially, a multipier (1), a power cylinder (2) and a demultiplier (3). On the rod of the power cylinder (2) is mounted coaxially to the latter a container (20) provided with a chamber (21) in which is mounted a matrix (22) for the blank, and which at the moment of forming the blank is filled with a plastifying liquid. Between the container (20) and the rod (25) of the demultiplier (3) is mounted a punch (34) sealing the chamber (21) during the forming of the blank. The hydraulic line (29) connecting the low-pressure chamber (26) of the multipier (3) to a source (12) for the working liquid and to a receiver (13) for its discharge is provided with a non-return valve (30), intended to prevent the working liquid flow from the low-pressure chamber (26) of the demultipier (3) to the receiver (13) for the working liquid discharge, and with an accumulator (31) the hydraulic chamber (32) of which is connected to a section (33) of the hydraulic line (29), which is located between the non-return valve (30) and the low-pressure chamber (26) of the demultiplier (3).

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Field of Engineering

The present invention relates to the art of plastic metal working, to equipment for plastic deformation of metals under conditions of high hydrostatic pressures, and, more specifically, to an apparatus for hydromechanically shaping articles.

Review of the Prior Art

Industry makes an over spreading use of metals possessing high-temperature strength and a high chemical resistance to attack by corrosive media. However, many of these metals feature a poor plasticity under plastic metal working conditions. Therefore, there have been developed apparatuses for plastic deformation of metals under conditions of high hydrostatic pressures capable to deform low-plasticity metals. Amongst such apparatuses, there is known in the prior art (SU, A 1 473 218) an apparatus for hydromechanically shaping articles, which apparatus comprises: arranged in a coaxial relationship, a step-up gear having its low-pressure chamber communicated, via a hydraulic distributor, with a working fluid source and with a reservoir adapted to receive discharged working fluid; a power cylinder having its rod end communicated, via a hydraulic distributor, with a working fluid source and with a reservoir adapted to receive discharged working fluid, while its piston is arranged on the side of the step-up gear rod and carries, coaxially secured with respect to the step-up gear rod, a container provided with a chamber accomodating a die adapted to receive a blank, and intended to be filled with a plasticizing liquid during the blank shaping operation; a stepdown gear having its low-pressure chamber communicated, via a hydraulic line, to a working fluid source and to a reservoir adapted to receive discharged working fluid; and a punch which is interposed between the container and the rod of the step-down gear and which has its high-pressure chamber communicated to the chamber of the container during the blank shaping operation. The hydraulic line which serves to put in communication the low-pressure chamber of the step-down gear with a working fluid source and with a reservoir for discharged working fluid, is provided with a hydraulic distributor and a throttling valve.

Research has revealed that in the above-described apparatus approximately 60% of total energy consumption per working cycle are required to establish within the container chamber a pressure needed for effecting plastic deformation of a blank with a plasticizing liquid, and also to overcome the resistance offered by the flow of the plasticising liquid as it is forced out of the container chamber into the high-pressure chamber of the step-down gear during the blank shaping operation. In other words, the plasticizing liquid in the course of the blank shaping process builds up a large amount of energy so that by the end of this process this liquid constitutes a power-intensive carrier. As the plasticizing liquid is forced out from the container chamber into the high-pressure chamber of the step-down gear and as the rod and piston of the step-down gear travel to assume their initial position, the energy built up by the plasticizing liquid is transferred to the working fluid in the low-pressure chamber of the step-down gear and in the hydraulic line whereby the low-pressure chamber of the step down gear is communicated with a working fluid source and with a reservoir adapted to receive drained-out working fluid. As the latter passes through the throttling valve of this hydraulic line, its energy is irretrievably lost, whereupon the working fluid that has lost its energy is discharged into a reservoir adapted to receive it. Consequently, the plasticizing liquid energy built up during plastic deformation of a blank is irrevokably wasted in the throttling valve of the hydraulic line instead of being used in the next working cycle of the apparatus, This is one of the main reasons of the poor efficiency of the art-known apparatus for hydromechanically shaping articles.

Disclosure of the Invention

The present invention seeks to solve the problem such an apparatus for hydromechanically shaping articles in which an appropriate change in the design of its hydraulic drive would enable the irretrievable energy losses of the plasticizing liquid to be diminished, and thereby the efficiency of such an apparatus for hydromechanically shaping articles to be increased.

The above-formulated problem is solved by that in an apparatus for hydromechanically shaping articles, comprising the following components arranged in a coaxial relationship: a step-up gear having its low-pressure chamber communicated, via a hydraulic distributor, with a working fluid source and with a reservoir adapted to receive discharged working fluid; a power cylinder having its rod end communicated, via a hydraulic distributor, with a working fluid source and with a reservoir adapted to receive discharged working fluid, while its piston is arranged from the side of the step-up gear rod and carries, arranged coaxially with the latter, a container provided with a chamber adapted to accomodate a die for a blank and intended to be filled up with a plasticizing liquid in the course of a blank shaping operation; a step-down gear having its low-pressure chamber communicated, via a hydraulic line, with a working fluid source and with a reservoir adapted to receive discharged working

fluid; and a punch which is interposed between the containerand the rod of the step-down gear which has its high-pressure chamber communicated with the container chamber during the blank shaping operation, in accordance with the present invention, said hydraulic line for communicating the low-pressure chamber of the step-down gear with the working fluid source and with the reservoir for discharged working fluid is provided with a check valve for the purpose of preventing mvoement of a working fluid flow from the low-pressure chamber of the step-down gear into the reservoir for discharged working fluid, and with an accumulator having its hydraulic chamber communicated with a portion of the hydraulic line lying between the check valve and the low-pressure chamber of the step-down gear.

In such an apparatus for hydromechanically shaping articles, in the course of the blank shaping process, accompanied by forcing the plasticizing liquid out of the container chamber into the high-pressure chamber of the step-down gear, and also accompanied by displacement of the rod and piston of the step-down gear to their initial position, the energy accumulated by the plasticizing liquid is transferred to the working fluid in the low-pressure chamber of the step-down gear and in the portion of the hydraulic line comprised between the check valve and the low-pressure chamber of the step-down gear. Energy is built up in this portion of the line with the help of the accumulator. Upon completion of the blank shaping operation, the nergy built up in the accumulator is passed to the working fluid filling the hydraulic line portion comprised between the check valve and the low-pressure chamber of the step-down gear, and also to the working fluid filling the low-pressure chamber itself. As a result, this working fluid displaces and retains the piston and rod of the step-down gear in a position in which the blank shaping operation takes place. In other words, it became possible to prevent irretrievable wastage of the energy built up by the plasticizing liquid, and to utilize this energy during the subsequent working cycle of the apparatus of the invention for two purposes, namely: in the first place, for causing the piston and rod of the step-down gear to return to a position in which the shaping of a blank takes place, and, in the second place, for creating resistance to the outflow of the plasticizing liquid from the container chamber during the blank shaping operation. Preservation and subsequent utilization of the energy of the plasticizing liquid reduce the energy consumption of the apparatus and, thereby increase its efficiency.

## Brief Description of Drawings

In what follows, the present invention will be explained with the help of a specific embodiment of the apparatus for hydromechanically shaping articles, and with the help of an appended drawing which schematically shows in a longitudinal section the apparatus in accordance with the present invention for hydromechanically shaping articles.

## Best Embodiment of the Invention

The present apparatus for hydromechanically shaping articles comprises the following components, arranged therein in a coaxial relationship: a step-up gear 1, a power cylinder 2, and a step-down gear 3. The step-up gear 1 has a housing 4 which accomodates a piston 5 with a rod 6, forming thereby a low-pressure chamber 7 of the step-up gear 1, a high-pressure chamber 8 of the gear 1, and a rod-end chamber 9. The low-pressure chamber 7 of the step-up gear 1 is communicated by a hydraulic line 10, via a hydraulic distributor 11, with a working fluid source 12 and with a reservoir 13 for discharged working fluid. The power cylinder 2 has a housing 14 which accomodates a piston 15 with a rod 16, thereby forming a piston chamber 17 and a rod chamber 18. The rod chamber 18 of the power cylinder 2 is communicated by a hydraulic line 19, via a hydraulic distributor 11, with a working fluid source 12 and with a reservoir for 13 discharged working fluid. The piston 15 of the power cylinder 2 is disposed on the side of the rod 6 of the step-up gear 1. The rod 16 of the power cylinder 2 carries, secured coaxially to the latter, a container 20 having a chamber 21 which accomodates a die 22 adapted to receive a blank and which becomes filled with a plasticizing liquid during the blank shaping operation. The step-down gear 3 has a housing 23 which accomodates a piston 24 with a rod 25, thus forming a low-pressure chamber 26 of the step-down gear 3, a high-pressure chamber 27 of the gear 3, and a rod-end chamber 28 of the gear 3. The low-pressure chamber 26 of the step-down gear 3 is communicated via a hydraulic line 29 with the working fluid source 12 and with the reservoir 13 for discharged working fluid. The hydraulic line 29 which serves to put the low-pressure chamber 26 of the step-down gear 3 in communication with the working fluid source 12 and with the reservoir 13 for discharged working fluid is provided with a check valve 30 designed to prevent an outflow of the working fluid from the low-pressure chamber 26 of the step-down gear 3 into the reservoir 13 for discharged working fluid, and further provided with an accumulator 31 whose hydraulic chamber 32 is communicated with a hydraulic line 29 portion 33 comprised between the check valve 30 and the low-pressure chamber 26 of the step-down gear 3. A punch 34 is mounted on the rod 16 of the power

cylinder 2 between the container 20 and the rod 25 of the step-down gear 3 in a coaxial relationship with the latter. Channels 35 are formed in the punch 34 for the purpose of communicating the high-pressure chamber 27 of the step-down gear 3 with the container 20 chamber 21 during the blank shaping operation. A shroud 37 is mounted on the outside surface 36 of the housing 14 of the power cylinder 2. The outside surface 38 of the container 20 also carries a shroud 39. The working fluid source 12 is provided with a safety valve 40.

The above-described apparatus is operated in the following manner:

Prior to starting a first working cycle, a blank is placed on the die 22 and the chamber 21 of the container 20 is filled up with a plasticizing liquid. The hydraulic distributor 11 is switchedover to a position in which the working fluid source 12 is communicated with the low-pressure chamber 7 of the step-up gear 1, while the rod-end chamber 18 of the power cylinder 2 is communicated with the reservoir 13 for discharged working fluid. Thereupon, the working fluid is fed along the hydraulic line 10, via the hydraulic distributor 11, from the working fluid source 12 into the low-pressure chamber 7 of the step-up gear 1. Under the effect of pressure exerted by the working fluid within the low-pressure chamber 7 of the step-up gear 1, the piston 5 with the rod 6 are caused to move and, as a result, the rod 6 compresses the working fluid in the high-pressure chamber 8 of the step-up gear 1 and in the piston chamber 17 of the power cylinder 2. The pressure exerted by the working fluid in the high-pressure chamber 8 of the step-up gear 1 and in the piston chamber 17 of the power cylinder 2 causes to move the piston 15 with the rod 16 of the power cylinder 2, and their movement is transmitted to the container 20 with the die 22 and a blank placed into the die 22 towards the punch 34. As the piston 15 travels, the volume of the rod-end chamber 18 is reduced, and this causes an outflow of the working fluid filling the chamber 18 along the hydraulic line 19 and via the hydraulic distributor 11 into the reservoir 13 for discharged working fluid. Simultaneously, the working fluid is supplied along the hydraulic line 29 via the check valve 30 into the low-pressure chamber 26 of the step-down gear 3. Under the effect of the pressure exerted by the working fluid in the low-pressure chamber 26 of the step-down gear 3, the piston 24 with the rod 25 are caused to move towards the punch 34. As a result of the above-described movements of the components of the apparatus for hydromechanically shaping articles and of the working fluid in its hydraulic drive, the punch 34 enters the chamber 21 of the container 20, thereby sealing the latter and reducing the volume of the chamber 21. As a result, the pressure exerted by the plasticizing liquid in the chamber 21 of the container 20 exceeds the yield point of the metal constituting the blank, and this, ultimately, leads to a change in the shape of the blank which is definitively shaped by the configuration of the die 22 and by that of the punch 34. As the volume of the container 22 chamber 21 diminishes, the plastizing liquid is forced out of the container 22 chamber 21 through the channels 35 formed in the punch 34 into the high-pressure chamber 27 of the step-down gear 3. This leads to an increase in the volume of the high-pressure chamber 27 of the step-down gear 3 and to a movement of its piston 24 with the rod 25 away from the punch 34. The energy accumulated by the plasticizing liquid is transmitted to the working fluid filling the low-pressure chamber 26 of the step-down gear 3 and the hydraulic line 29 portion 33, wherein energy build-up takes place with the aid of the accumulator 31. It is necessary to note that the check valve 30 prevents an outflow of the working fluid from the low-pressure chamber 26 of the step-down gear 3 into the reservoir 13 for discharged working fluid, whereby the accumulator 31 is enables to build up the energy of the plasticizing liquid. Thereupon, the hydraulic distributor 11 is switched-over to a position in which the working fluid source 12 is put in communication with the rod-end chamber 18 of the power cylinder 2, while the low-pressure chamber 7 of the step-up gear 1 gets communicated with the reservoir 13 for discharged working fluid. As a result, the piston 5 and the rod 6 of the step-up gear 1, and the piston 15 with the rod 16 of the power cylinder 2 are caused to move away from the punch 34. The latter leaves the chamber 21 of the container 22, thereby breaking the seal, and a finished article is taken out of the chamber 21 of the container 22. Thus, the first working cycle of the apparatus is terminated. Each subsequent working cycle is conducted following the procedure described for the first working cycle, with the only difference that the energy built up by the accumulator 31 is transferred to the working fluid filling the hydraulic line 29 portion 33 comprised between the check valve 30 and the low-pressure chamber 26 of the step-down gear 3, and also to the fluid filling the low-pressure chamber 26 of the step-down gear 3. As a result of this arrangement, the working fluid moves and retains the rod 25 and the piston 24 of the step-down gear 3 in such a position in which the shaping of a next-in-turn blank takes place. In other works, it became possible to avoid any irretrievable wastage of the energy of the plasticizing liquid. This energy is thus utilized in each subsequent working cycle of the apparatus of the invention for two purposes, namely: in the first place, for causing the piston 24 and the rod 25 of the step-down gear 3 to return back to their blank shaping position, and, in the

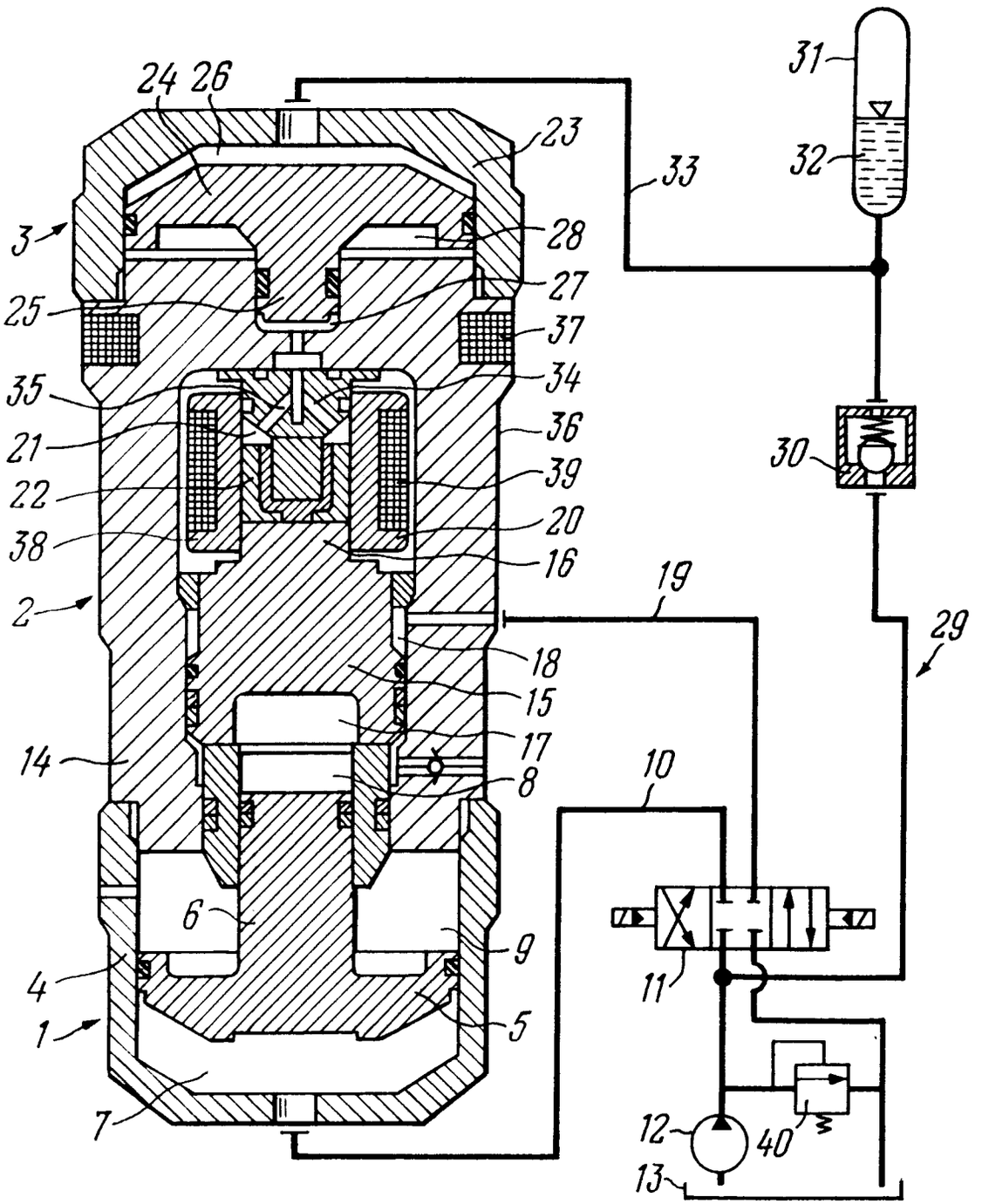
second place, for offering resistance to a flow of the plasticizing liquid from the chamber 21 of the container 22 during the blank shaping operation. Storage and subsequent re-use of the energy of the plasticizing liquid bring down the energy consumption for running the apparatus and, thereby, increase its efficiency.

Industrial Applicability

Research has been conducted to assess energy requirements for hydromechanically shaping articles with sophisticated external configurations, necessitating the use of split dies, such as, e.g. axle boxes of railway cars, by the above-described apparatus for hydromechanically shaping articles and by using the above-described process which makes provision for complete retrieval by the hydraulic drive of the apparatus of the energy losses to increase the pressure of the plasticizing liquid. The results of this research show that, as compared to similar art-known apparatuses, the present apparatus makes it possible to reduce the power input required for hydromechanical shaping by more than one half.

## Claims

**1.** An apparatus for hydromechanically shaping articles, which apparatus comprises, arranged in a coaxial relationship therein, the folowing components: a step-up gear (I) having its low-pressure chamber (7) communicated, via a hydraulic distributor (11), with a working fluid source (12) and with a reservoir (13) adapted to receive discharged working fluid; a power cylinder (2) having its rod-end chamber (18) communicated, via a hydraulic distributor (11), with a working fluid source (12) and with a reservoir (13) adapted to receive discharged working fluid, while its piston (15) is disposed on the side of the rod (6) of the step-up gear (I) whose rod (16) carries, arranged coaxially to the latter, a container (20) having a chamber (21) which houses a die (22) adapted to receive a blank and which is filled up with a plasticizing liquid during the blank shaping procedure; a step-down gear (3) having its low-pressure chamber (26) communicated, via a hydraulic line (29), with said working fluid source (12) and with said reservoir (13) adapted to receive discharged working fluid; and a punch (34) interposed between said container (20) and the rod of said step-down gear (3) whose high-pressure chamber (27) is put in communication with the chamber (21) of said container (20) during the blank shaping procedure, **characterized** in that said hydraulic line (29) which serves to put the low-pressure chamber (26) of said step-down gear (3) in communication with said working fluid source (12) and said reservoir (13) for discharged working fluid is provided with a check valve (30) intended to prevent an outflow of the working fluid from the low-pressure chamber (26) of said step-down gear (3) into said reservoir (13) for discharged working fluid; and is further provided with an accumulator (31) having its hydraulic compartment (32) communicated with a hydraulic line (29) portion (33) comprised between saud check valve (30) and the low-pressure chamber (26) of said step-down gear (3).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# INTERNATIONAL SEARCH REPORT

International Application No PCT/SU 91/00044

**I. CLASSIFICATION OF SUBJECT MATTER** (If several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC 5 B21 J 5/04

**II. FIELDS SEARCHED**

**Minimum Documentation Searched**[7]

| Classification System | Classification Symbols |
|---|---|
| IPC[5] | B21 J 5/04 |

**Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched**[8]

**III. DOCUMENTS CONSIDERED TO BE RELEVANT**[9]

| Category * | Citation of Document,[11] with indication, where appropriate, of the relevant passages[12] | Relevant to Claim No.[13] |
|---|---|---|
| A | SU, A1, 984600 (DNEPROPETROVSKY METALLURGICHESKY INSTITUT), January 5, 1983 (05.01.83) | 1 |
| A | SU, A1, 1049153 (INSTITUT FIZIKI VYSOKIKH DAVLENY AN SSSR), October 23, 1983 (23.10.83) | 1 |
| A | GB, B, 1109841 (UNITED KINGDOM ATOMIC ENERGY AUTHORITY), April 18, 1968 (18.04.68) | 1 |
| A | GB, B, 1096522 (UNITED KINGDOM ATOMIC ENERGY AUTHORITY), December 29, 1967 (29.12.67) | 1 |
| A | GB, B. 1584215 (TRANSFORM VERSTARKUNGSMASCHINEN AKTIENGESELLSCHAFT), February 11, 1981 (11.02.81) | 1 |

* Special categories of cited documents :[10]

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"P" document published prior to the international filing date but later than the priority date claimed

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

**IV. CERTIFICATION**

| Date of the Actual Completion of the International Search | Date of Mailing of this International Search Report |
|---|---|
| May 28, 1991 (28.05.91) | June 24, 1991 (24.06.91) |
| **International Searching Authority** ISA/SU<br>EUROPEAN PATENT OFFICE | **Signature of Authorized Officer**<br>A.N.Pavlovsky |