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(54) **VERTICAL HYDRAULIC PRESS FOR PRODUCING LARGE-DIAMETER STEEL SEAMLESS PIPES**

(57) The invention relates to plastic metal forming, in particular to pressing pipe-producing facilities. Said invention makes it possible to combine billet punching and pipe pressing operations into a single press operating cycle and to carry out operational punching and pressing strokes by means of a common drive, thereby reducing the number of the required processing facilities, simplifying the structural design, reducing the power, size and the mass of the press and decreasing investment costs.

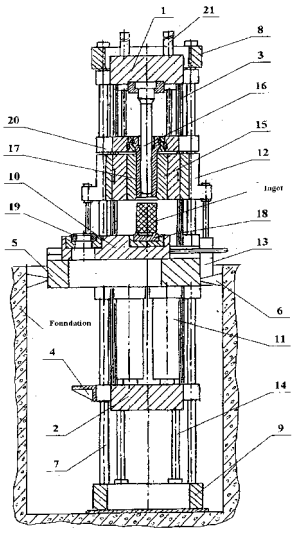


FIGURE 1.

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Description

[0001] The declared invention relates to plastic metal forming, in particular to pressing pipe-producing facilities.

[0002] Large-diameter steel seamless pipes are primarily used in various large scale power plants including nuclear power stations and chemical production units with increased parameters (pressure, temperature) of operating environment. One of most technically advanced and economically feasible technological processes for producing such pipes are those processes which are based upon hot pressing method. This method is characterized with optimal deformation scheme and high degree of one-time deformation. It ensures production of pipes of high quality in regard to size and shape precision, surface conditions, metal structure and mechanical properties.

[0003] Pressing of large-diameter seamless pipes is performed using superpower hydraulic extrusion presses. Tubular billets are used for pressing. It is related to following: if the stated presses are equipped with a supplemental high power drive for piercing a solid billet, the press design would have been complicated and the press height and mass would have been additionally increased.

[0004] Presses with forces of 300 meganewton and 350 meganewton by "Cameron" firm (Avery D. How Cameron Vertically Extrudes Seamless Pipe // Metal Progress, 1977, v.3, No.2, pages 52-57) can be stated as analogs of the proposed invention of vertical hydraulic press for production of large-diameter steel seamless pipes. The presses have a mobile frame and are equipped with an underslung drive thus ensuring easy access to working cylinders and simplifies their maintenance. The mobile frame which carries certain content of kinetic energy allows overcoming initial (peak) resistance of the pressed billet. The pressing is performed using a direct method with a pipe flowing upward. The vertical extrusion scheme provides even distribution of billet metal temperature and technological clearances in the pressing tool in it cross section thus favorably resulting in straightness of the produced pipes. The 350 meganewton press is used for producing pipes with external diameter of 200 mm to 1200 mm with wall thickness of 12 mm to 200 mm and length of up to 13 m.

[0005] The closest analog of the invention which is accepted in the present application as a prototype is a press with force of 450 meganewton jointly designed and developed by NKMZ (Ukraine) and VNIIMETMASH (Russia) (Popov A.K., Kaganovskiy F.I., Shukhat O.M., Press Complex for Production of Large-Diameter Steel Seamless Pipes // Heavy Machinery Building Progress, 1990, pages 18-22).

[0006] Like the invention analogs, the prototype has a mobile frame with the underslung drive. The upper walking beam is mounted to the upper crossbar of the string; and lower walking beam is mounted on the lower crossbar of the string. The fixed tie beam of the press is placed between the walking beams. Conductor strings are fixed in the fixed tie beam corners to guide the mobile frame movement.

[0007] The press is supported against the foundation slab with butt ends of the conductor strings. Housings of six cylinders of the main drive of the press intended for pressing working stroke are mounted on the fixed tie beam. Rams of these cylinders are tied with the lower walking beam. The walking beam lifting cylinders and cylinders of the container holder with a drive are placed in the upper part of the press; and the mandrel drive cylinders are placed in the lower part thereof. There is mounted a table onto the fixed tie beam above the press. The table is equipped with a drive for its displacement from the press vertical axis during change off the container and the extrusion stem.

[0008] Like in above mentioned press analogs, pipe pressing on the press prototype is also performed with metal flowing upward. Prior to pressing, a die is mounted onto the upper end of the container. Then, the heated tubular billet is laid onto the upper end of the extrusion stem with the tubular extrusion stem mandrel withdrawn inside the press fixated on the table. The mandrel is moved into upper position through a hole in the billet. Then the container is lowered downwards until block stop to the upper end of the billet. During the next work stroke of the press, the container and die continue downward movement; and the billet supported against the extrusion stem is extruded in shape of a pipe in upward direction into annular clearance between the die and the mandrel. Separation of the pressed pipe from the press discard is performed using a special cutting machine which is installed on the extrusion stem end.

[0009] The press prototype is designed and intended for pressing steel pipes with external diameter of 530 mm to 1420 mm with wall thickness of 17... 100 mm and length of 4 ... 12 mm.

[0010] Main shortcomings of production of large-diameter steel seamless pipes using hydraulic presses of all known designs include high capital expenditures of establishing main technological equipment and significant current expenses related to maintenance thereof.

[0011] It is primarily resulted by fact that the stated presses provide for pressing pipes using only tubular billets which have been prepared in advance. Thus, apart from the superpower press for pipe pressing and all other required technological equipment (heating, finishing and other equipment), the pipe pressing complex must include pressing and heating equipment for producing a tubular billet for pressing out of a initial solid billet. Thus, when producing pipes using the presses manufactured by "Cameron" firm, tubular billet production is performed using the closed piercing method on the high power vertical presses with force of 90 meganewton and 140 meganewton and heating of ingots for piercing is performed in the large size gas rotary hearth furnaces with rotary bottom. Production of the tubular billets on the 140 meganewton press prototype must be carried out on the forging presses with force of 25 meganewton and 60 meg-

anewton by means of compression, piercing, broaching and rolling of the ingot on mandrels followed by mechanical processing of the tubular billets. Attempts to develop the extrusion presses design for producing large-diameter pipes with high power needle drive to ensure ingot piercing on the same presses do not lead to positive practical results because they are associated with additional complexification of the design as well as increase in size and mass of the presses. At the same time, the 450 meganewton press prototype which does not ensure billet piercing already has impressive size and mass: the size in plan is 15.0x 31.1 m; the full length is 52.7 m; the mass of the press with mechanisms (excluding pipe accumulator plant) is 20000 ton.

[0012] Main objective of this invention according to this application is to reduce capital expenditures during construction of a press complex for production of seamless steel pipes of large diameter as well as operational expenditures for maintenance thereof. It is achieved by cutting down the quantity of main technological equipment, reduction of labor intensiveness and increasing efficiency of pipe production process due to ensuring the piercing the initial ingot on the pipe-extrusion press immediately prior to pressing operation as well as due to simplification of the design, reduction of the press power, size and mass. Thereby, the invention eliminates most serious shortcomings of all know analogs and prototypes.

[0013] The stated objective of the declared invention is achieved in such a manner that the proposed vertical hydraulic press for production of seamless steel pipes of large diameter contains has a mobile frame with upper and lower crossbars as well as a container holder located between the crossbars with a drive and fixed tie beam. Conductor strings are fixed in the fixed tie beam comers; the mobile table is mounted on top thereof, and the main drive is placed underneath and includes a group of working cylinders with casings mounted on the fixed tie beam and plungers connected to the lower crossbar. The press has also the technological press tool consisting of a container, mandrel, extrusion stem and die. The mandrel is mounted on the upper crossbar of the mobile frame. The extrusion stem is installed on a supplemental crossbar located between the upper crossbar and the container and equipped with a supplemental drive for moving the extrusion stem relative to the mandrel. The technological tool package also contains a plug for piercing. The press die and the extrusion plug are placed on the press table. The lower crossbar of the mobile frame contains a stop block for releasing a pressed pipe from the die; a vertical groove is made in the fixed tie beam to ensure movement of the pipe from the press axis to release position.

[0014] The declared invention is illustrated with drawings in Figure 1 and Figure 2 (on two sheets). Figure 1 depicts general view of the press; Figure 2 depicts sequence of technological changeovers for producing a pipe on this press.

[0015] The press (Figure 1) consists of following main components: the mobile frame, fixed tie beam, conductor strings, table, container holder and technological tool. The mobile frame contains the upper 1 and lower 2 crossbars connected with two built-up plate-type frames 3. The lower crossbar of the mobile frame contains the stop block 4 for releasing a pressed pipe from the die. The fixed tie beam 5 is located between the frame crossbars and it is fixed in a horizontal surface relative the foundation with four side supports 6. Four conductor strings 7 are fixed in corners of the fixed tie beam and serve as guidance the frame movement. Upper ends of the conductor strings are connected with each other by the crossbar 8; and the lower ends are connected by the base 9 through which the press is supported against the foundation. The table is enabled to move in horizontal direction powered by a drive (not shown in the drawing). The main drive is placed underneath the fixed tie beam and includes a group of working cylinders 11. Casings of the cylinders are mounted on the fixed tie beam and the plungers are connected to the lower crossbar. A vertical groove is made in the fixed tie beam to ensure movement of the pipe from the press axis to release position. The container holder 12 with a drive 13 is located between the upper crossbar and the press table in order to move the container holder along the press axis. The press is equipped with a drive for lifting the mobile frame with the plungers 14. The technological press tool consists of the container 15, mandrel 16, extrusion stem 17, plug 18 for billet piercing and die 19 for pipe pressing. The container is placed into the press container holder and the mandrel is fixed in the upper crossbar of the frame. The extrusion stem is installed in the supplemental crossbar 20. This crossbar is located between the upper crossbar and the container. It is equipped with an supplemental drive which ensures movement of the extrusion stem relative to the mandrel. The cylinders 21 of this drive are mounted on the upper crossbar of the frame. The plug and die are placed on two working positions of the press table.

[0016] Pipe production on the press is performed in following manner (Figure 1 and Figure 2).

[0017] In its initial position (Figure 1), mobile frame with the mandrel and the container holder with the container are placed in their uppermost position. The supplemental crossbar with the extrusion stem is lowered relative the upper crossbar in such a way as the lower end of the extrusion stem is placed at exit of the work space of the container. The table is placed in a position when the plug occupies a position on the press axis. The heated solid billet with a working glass-graphite based lubricant lubricated onto lateral side thereof is delivered by the handling device (not shown) to the press axis into a space between the container and the table and is mounted onto the plug. Then the container is lowered downwards until block stop to the table; and, thus, the billet is placed inside the container.

[0018] Piercing of the billet is commenced. Initially, the extrusion stem is lowered onto the billet. Then, powered by the main press drive, the working stroke of the frame with the mandrel begins. In the first place, the mandrel

forges (presses) the billet until clearances between its lateral side and the container disappear. The billet is shortened in due course of immersion. At the same time, the extrusion stem moves downward as usually with support onto the press disc face. After pressing of the billet is accomplished, the mandrel, while continuing its downward movement, is penetrated into the billet, thus piercing the billet and generating an inner cylindrical cavity inside the billet (Figure 2., position "a"). At the same time, the extruded billet metal is moved upwards in the direction of mandrel movement and, by affecting the extrusion stem end, moves thereof upwards with the supplemental crossbar on which the extrusion stem is mounted. Thereby, during the ingot piercing, the upper crossbar of the frame and the supplemental crossbar move to each other. At final stage of piercing, both crossbars became interlocked. After piercing, a partition (a base) of small thickness remains in the pierced ingot at its lower face.

[0019] The pipe pressing is performed after the billet piercing. In the first place, the container holder with the container, frame with the extrusion stem and supplemental crossbar are displaced at a small distance in upward direction. The table delivers the die installed thereon to the press axis; the upper die face has a working glass-graphite lubricant in form of the press disc (Figure 2., position "b"). The container is lowered onto the die. Then, the working stroke of pressing takes place. The mandrel and extrusion stem move downward powered by the main drive of the press. Under pressure generated by the extrusion stem, the tubular billet metal is extruded in form of a pipe into an annular clearance between the die and the mandrel (Figure 2., position "c"). Pressing is completed when a portion (the press discard) of under pressed billet of small thickness is generated in the container next to the die; and a distance which is equal to this thickness (Figure 2., position "d") is maintained between the extrusion stem crossbar and the upper face of the container. During piercing and pressing operations, the glass-graphite based lubricant lubricated on the contacting surface between the ingot and container, the extrusion stem and the die effectively prevents the pressing tool from heating and reduces friction between the ingot and the tool thanks to its high heat insulating and anti-friction properties. At the same time, under influence of temperature, the glass component of the lubricant transforms into free-running state and the lubricant is thinly extruded onto the contact surfaces of the extrusion stem and die.

[0020] When the pressing operation is finished, removal of the thus produced pipe is performed off the press. Powered by the drive, the press frame is lifted upwards thus releasing the mandrel from the press discard and the container (Figure 2., position "d"). Thereafter, the container containing the press discard is lifted above the table until block stop into the supplemental crossbar. At the same time, supported with immovable extrusion stem from above, this press discard is released from the container. Then the die containing a pipe is moved by the table to a pipe removal position; and the piercing stand appears on the press axis. At the same time, the pipe is moved in the longitudinal groove of the fixed tie beam (Figure 2., position "e"). Afterwards, the press frame starts moving into the utmost upper position. In due process of such movement, the block stop mounted on the lower frame crossbar affects the lower end of the pressed pipe pushing it through the die in upward direction. Subsequently, the pipe is completely removed from the die behind the press discard using a bridge crane (Figure 3, position "f"). The press pipe production cycle is completed at this stage.

[0021] It is evident from the description of the design and working process of the press that main distinctive features are:

- use of solid billets on the press for pipe production;
- combination of the billet piercing and pipe pressing operations in a single working cycle of the press;
- implementation of working strokes for piercing and pressing powered from one common drive;
- it is made possible for piercing thinner barrels and decreasing deformation rate resulting from pressing;
- pipe pressing is carried out in vertical downward direction;
- pressing is performed by a mobile extrusion stem and the container is immobile during piercing and pressing operations;
- the press discard is not separated from the pressed pipe on the press.

[0022] The above stated objective is achieved owing to the listed distinctions.

[0023] Application of the declared invention for production of steel seamless pipes of large-diameter will allow significantly increase technical and economic performance of production of such pipes which are used in fundamental sectors of economy such as energy intensive machinery building, oil and gas sectors, chemical industry and some other.

Claims

1. Vertical hydraulic press for producing large-diameter seamless steel pipes, containing a mobile frame with upper and lower crossbars, a container holder with a drive located between the crossbars, a fixed tie beam, conductor strings fixed in the fixed tie beam corners, a mobile table mounted on top of the fixed tie beam, a main drive placed underneath the fixed tie beam and including a group of working cylinders with casings mounted on the fixed tie beam and plungers connected to the lower crossbar, and a technological press tool consisting of a container, mandrel, extrusion stem and die, **characterized in that** the mandrel is mounted on the upper crossbar of the mobile frame, the extrusion stem is installed

on a supplemental crossbar located between the upper crossbar and the container and equipped with a supplemental drive for moving the extrusion stem relative to the mandrel, the technological press tool also contains a plug for piercing, the press die and the extrusion plug are on the press table, the lower crossbar of the mobile frame contains a stop block for releasing a pressed pipe from the die and a vertical groove is made in the fixed tie beam to ensure movement of the pipe from the press axis to release position.

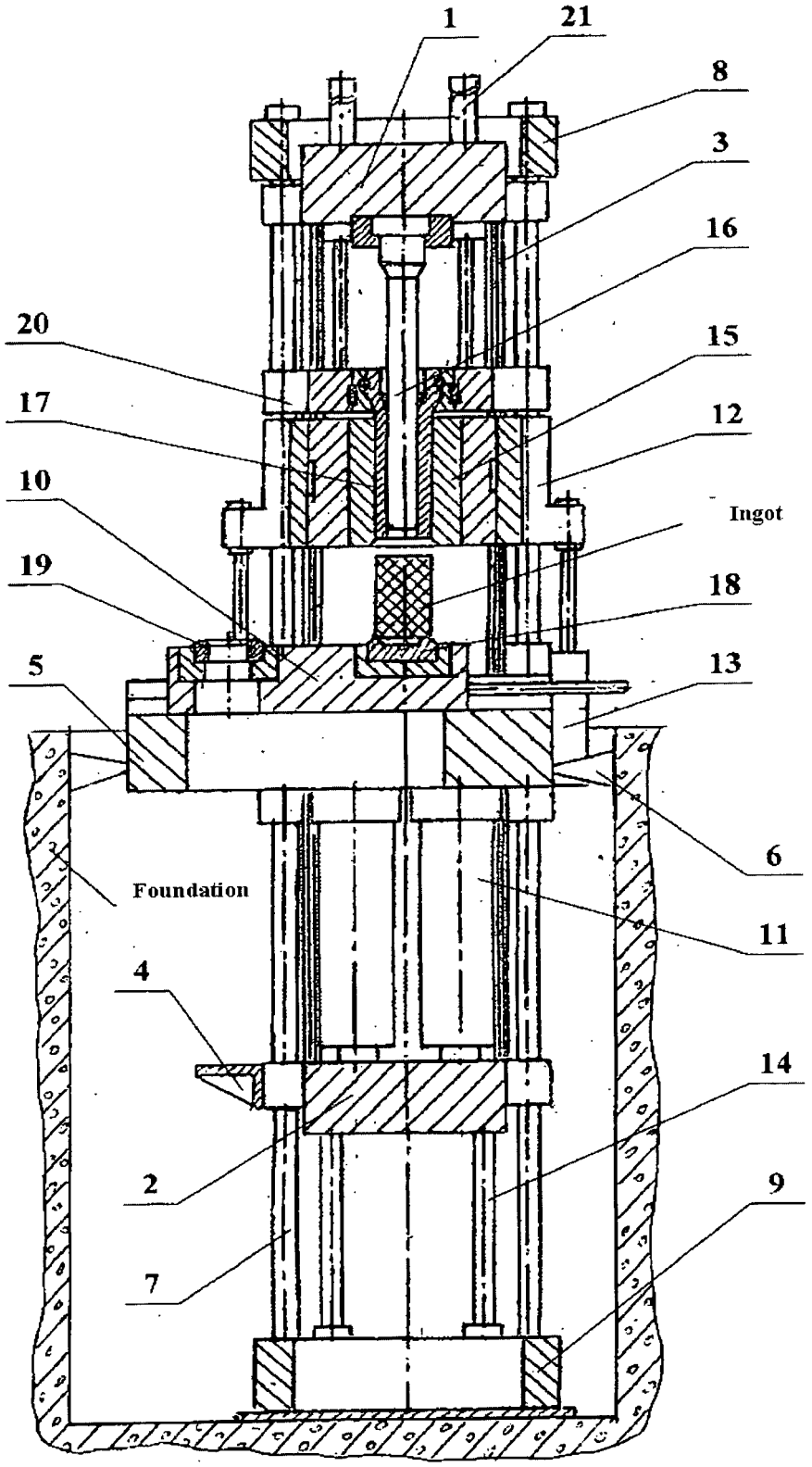


FIGURE 1.

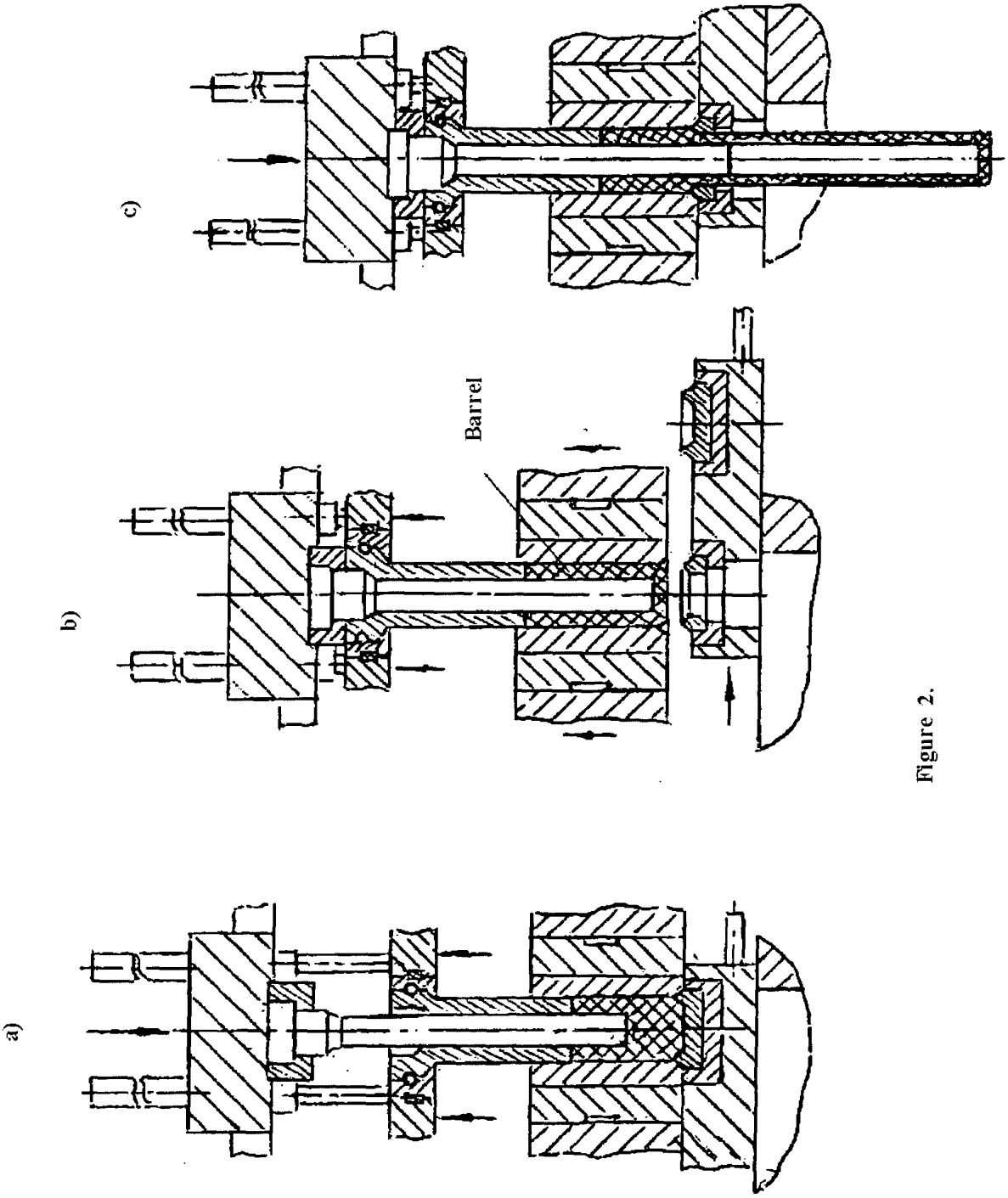


Figure 2.

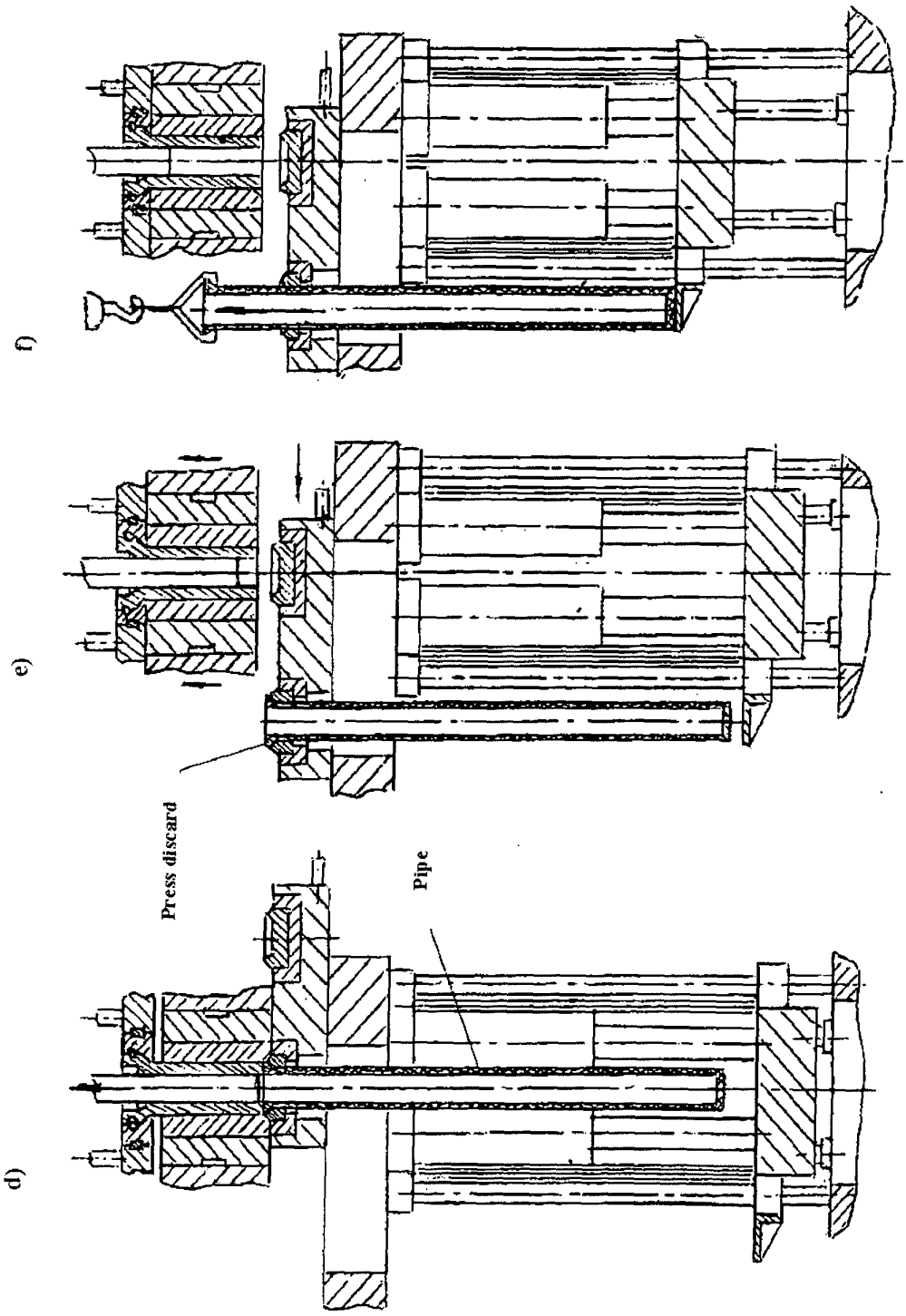


Figure 2.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/RU 2008/000281

A. CLASSIFICATION OF SUBJECT MATTER

B30B 7/04 *(2006.01)*
B30B 1/32 *(2006.01)*
B21C 23/21 *(2006.01)*

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

B30B 1/00-1/42, 15/00-15/34, 7/00-7/04, B21C 23/00-23/21, 25/00-25/10

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	SU 1802798 A3 (PROIZVODSTVENNOE OBEDINENIE "URALMASH") 15.03.1993	1
A	RU 2006366 C1 (AKTSIONERNOE OBSCHESTVO OTKRYTOGO TIPA "URALSKII ZAVOD TYAZHELOGO MASHINOSTROENIYA") 30.01.1994	1
A	GB 840457 A (SCHLOEMANN AKTIENGESELLSCHAFT) 06.07.1960	1

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"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

Date of the actual completion of the international search	Date of mailing of the international search report
02 October 2008 (02.10.2008)	09 October 2008 (09.10.2008)
Name and mailing address of the ISA/ **RU**	Authorized officer
Facsimile No.	Telephone No.

Form PCT/ISA/210 (second sheet) (July 1998)

REFERENCES CITED IN THE DESCRIPTION

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Non-patent literature cited in the description

- Cameron. *Avery D. How Cameron Vertically Extrudes Seamless Pipe // Metal Progress,* 1977, vol. 3 (2), 52-57 **[0004]**
- **Popov A.K. ; Kaganovskiy F.I. ; Shukhat O.M.** *Press Complex for Production of Large-Diameter Steel Seamless Pipes // Heavy Machinery Building Progress,* 1990, 18-22 **[0005]**