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The Equipment for Producing Winding Thick Cylindrical Shells

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Abstract

In this paper we propose, in an original way, the equipment for producing the winding thick cylindrical shells, using a tool machine (lathe) found in any chemical and petrochemical equipment plant. This equipment can be used when the tension winding of the strap is made both in cold and in hot environment.

Key words: *winding thick cylindrical shells, equipment*

Generalities

The development of chemical and petrochemical industry led to increasing use of high pressure technology, giving up to the old technologies of producing the large size and weight, thick forged shells, made of carbon steel or alloy.

Producing the forged high pressure containers is limited and can not cope with increasing demands of industry.

Modern methods of producing thick shells of high pressure containers, with multiple layers, made by winding the strap or wire, requires only usual equipments from any petrochemical equipment building plant.

A well functioning of high-pressure containers with shells made by winding the strap or wire (Fig. 1), to the pressure applications and temperature as well as the economic benefits resulted from the producing, requires some researches and studies in order to produce such containers.

Shells producing technology of pressure containers made by winding the profiled strap or calibrated wire, has many advantages in comparison with the ones with big section (one piece), resulted from:

- a low quantity of steel;
- extremely low metal loss;
- excluding scrap (any piece can be repaired);
- opportunity to build larger shells than in case of forged shells;

- heat treatment of the strap provides a complete uniformity of physical and mechanical characteristics of the wall;
- the tensions resulting from internal pressure are distributed more equal on the wall section;
- winding process allows the use of improving steel straps, having reduced characteristics before the heat treatment, which facilitates not only strap rolling but also winding operation;
- compressive stresses induced in the shell during the winding process are favorable for increasingly high operating pressures, offsetting totally or partially the extension stresses generated by internal pressure.

In comparison with high investments that are required by equipments used to produce thick forged one piece shells, very unprofitable investments by the relatively small number of such shells, the subject of this paper namely the winding equipment can be made with the resources from any chemical and petrochemical equipment plant.

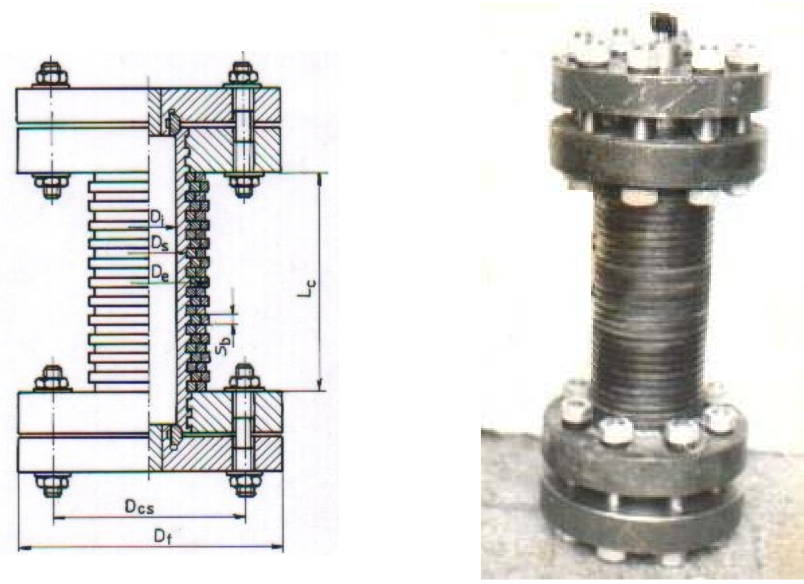


Fig. 1. Container with shell made by winding the square calibrated wire

Representation of Improved Equipment for Producing Winding Thick Cylindrical Shells

In the literature [2], [3] the equipment for producing winding thick cylindrical shells from profiled strap is presented as operation scheme. In this paper we propose, in an original way, such improved equipment, adapted to a tool machine (lathe) from any chemical and petrochemical equipment plant. This equipment can be used when the tension winding of the strap is made both in cold and in hot environment.

The whole diagram of the equipment is shown in Figure 2 and the functional components in Figure 3; the equipment having as component parts both embedded standard elements (e.g. parallel lathe SU125, the device necessary for producing consistently step channel by copying on the support shell) and also parts of winding equipment (e.g. heating, directed and controlled installation, stressing installation, measuring devices).

The technical characteristics of the plant components for processing the profile (the channel) on the support shell and for producing the winding thick shell from strap (calibrated square wire), presented in [4] are:

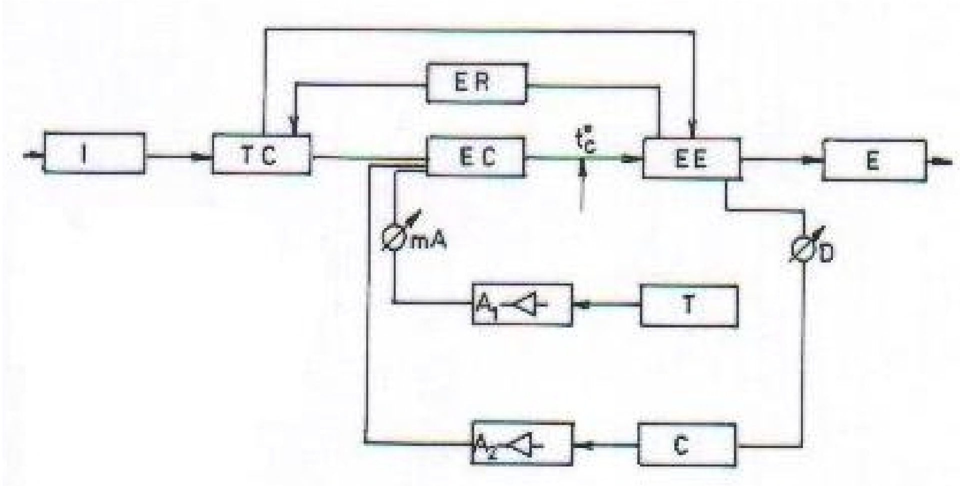


Fig. 2. Block diagram of the winding equipment: I - input size, TC - switchboard, ER - tuning element, EC - command element; EE - execution element, E - output size, T – transducer, A_1 – amplifier, A_2 - amplifier, C - reader, mA – mili-ammeter , D - dynamometer

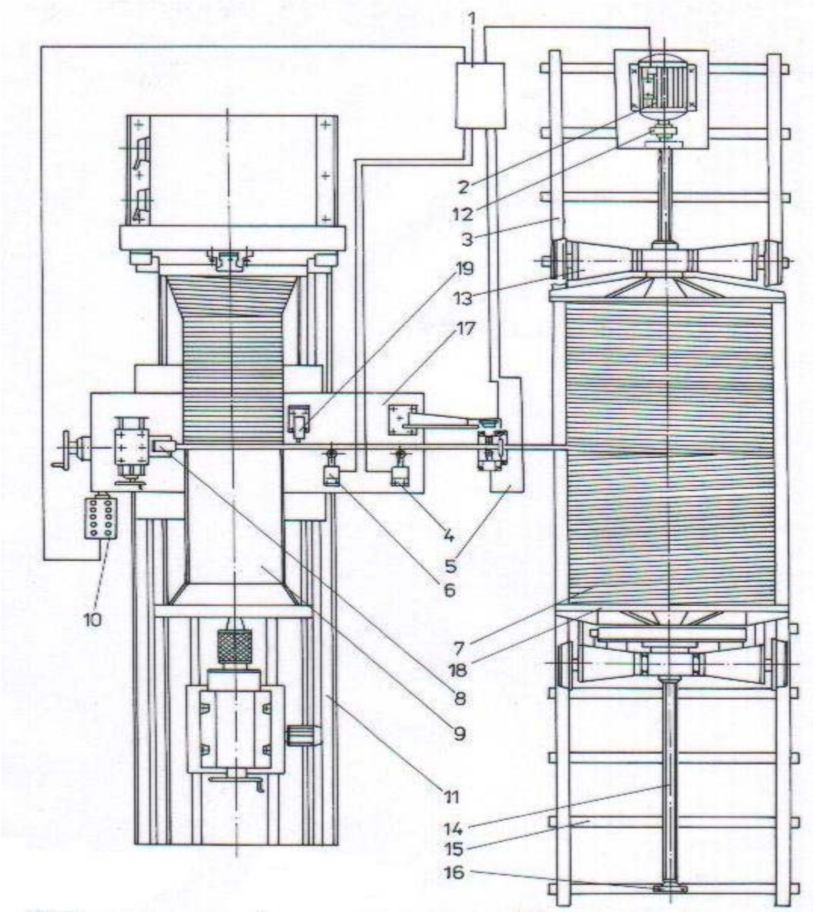


Fig. 3. Winding equipment: 1 - switchboard, 2 - motor drive, 3 – rolling track, 4 – contact, 5 - resistive detector, 6 – contact, 7 – band, 8 - pressing roll, 9 – container, 10 - control desk, 11 – lathe, 12 - coupling, 13 - support frame, 14 - screw driver, 15 - crossbar, 16 - bearing, 17 - cross sled, 18 - support band, 19 – pyrometer

Graft machine

To achieve the equipment any parallel lathe can be used in order to execute threads, and the lathe has to permit the container gripping and fixing. On the blade holder base of the lathe is installed either the special device made for constant tension of the strap (for winding in cold environment) or the pressing roll for the strap in the channel (for winding hot environment).

Copying device used to produce the profile (the channel) on the support shell

For a more precise producing of the profile (the channel) on the support shell, in order to wind the first layer of strap, the hydraulic copying device shown in [4] is used. This device is installed on the lathe; the profile being checked by the test indicator, the movement is transmitted to splitting knife.

Winding strap equipment (the wire), in stress mode (in cold environment)

Regarding the notations in Figure 3, winding strap on the support shell equipment consists of motor drive (2) of the strap drum (18) which is fixed to the screw driver (14). During winding, the strap drum moves towards the rolling track (3), fixed on the strap support carriage shown in Figure 4.

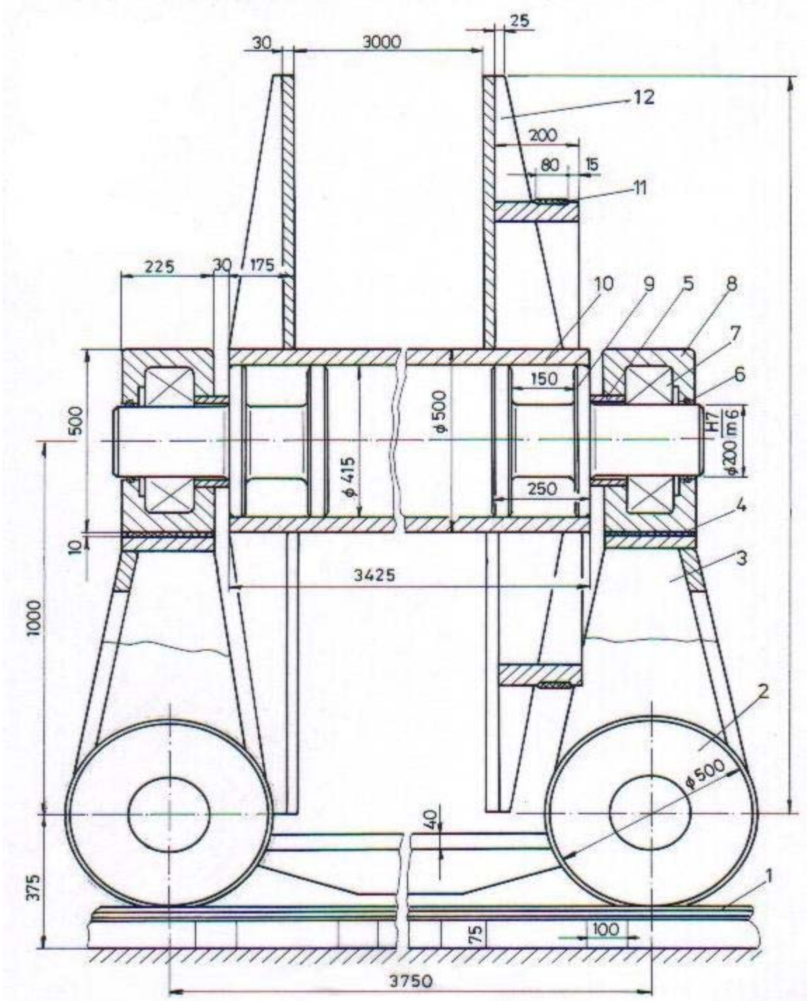


Fig. 4. The strap support carriage: 1 – rolling track, 2 – rolling roll, 3 – frame, 4 – insulation support, 5 - spacer, 6 – gasket, 7 – bearing roll, 8 - bearing, 9 – shaft, 10 - pipe, 11 – brake strap, 12 – end plate.

The tight winding of the strap and the measurement of the winding's force are made with the help of a drag wheel strap type (Fig. 5) installed on the shaft of the support strap drum.

The way of winding and keeping the strap' squareness on the axis of the support shell, requires changes in the speed of direct current engine (2). The lathe and the winding equipment are controlled from the control panel (1), installed on lathe.

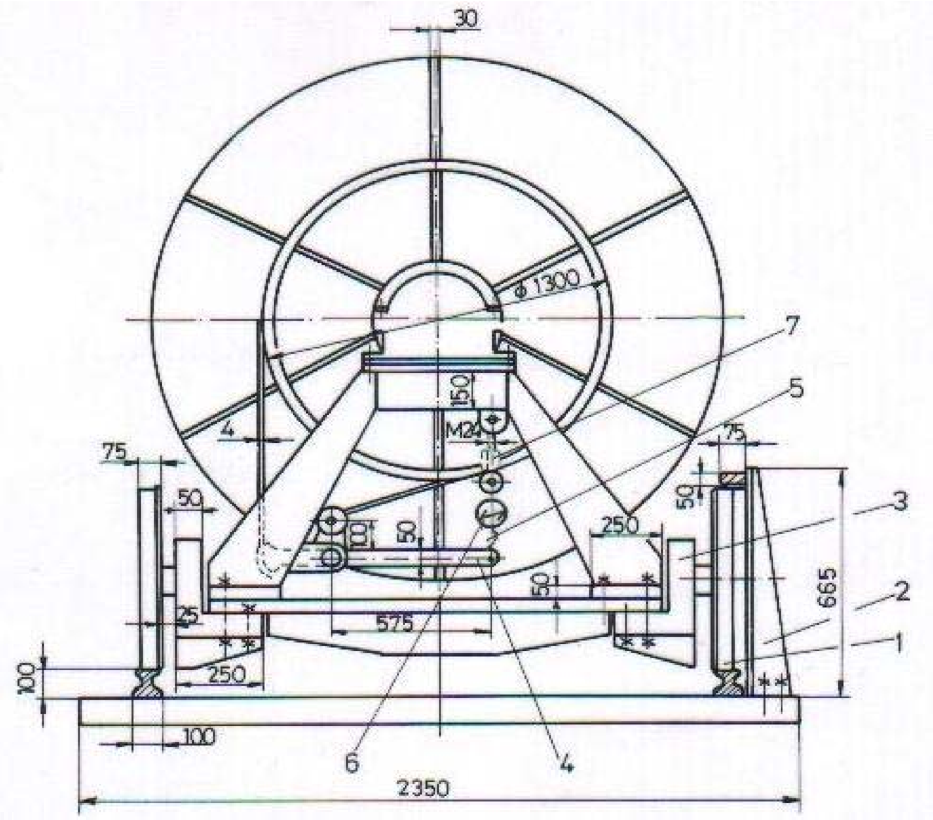


Fig. 5. Drag wheel strap: 1 – wheel, 2 – support, 3 – frame, 4 – lever, 5 - arch, 6 – dynamometer, 7 – tensioner

Strap heating system

Electrical diagram of the strap heating system is shown in Figure 6, and contactor (5) is detailed in Figure 7.

The perpendicularity of the strap on the axis of the winding container is controlled by the resistive detector (5) shown in Figure 8.

In order to measure the strap temperature before winding, the optical pyrometers is used (temperature transducer (19), made from K42 (K56) transducer of total radiation and ELT161 adapter, produced by IEA, and that converts the tension into voltage signal i = 2 ... 10mA) according to various measure range of temperature (Fig. 9).

Heating the strap to the winding temperature is made by the CSR 2000A transformer.

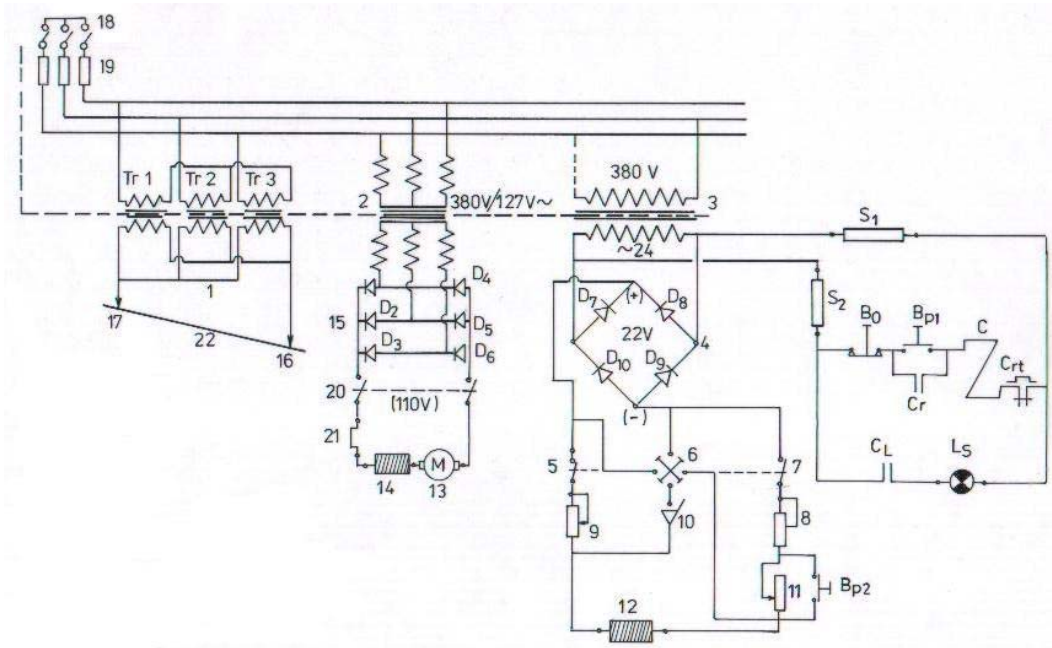
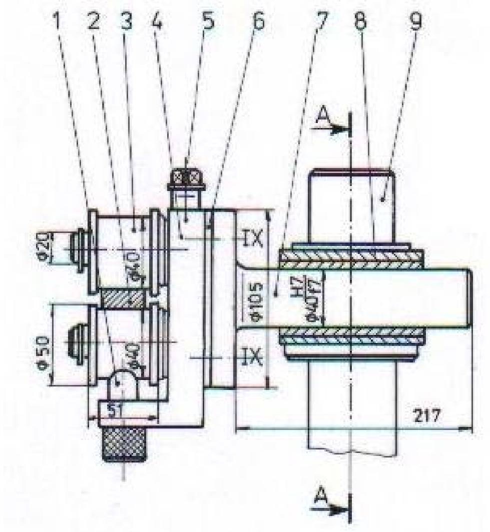


Fig. 6. Electrical diagram of the strap heating system: 1 – converter block, 2 – converter, 3 – converter, 4 – rectifier bridge, 5 - shutter, 6 – shutter, 7 – shutter, 8 – potentiometer, 9 – potentiometer, 10 – length trip, 11 – detector, 12 - reel, 13 – driving motor, 14 – reel, 15 – rectifier bridge, 16 – contact, 17 – contact, 18 – shutter, 19 – wire fuse, 20 – contactor, 21 – thermo relay, 22 – wire



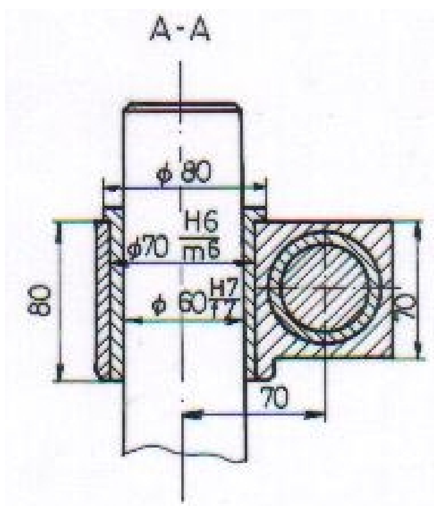


Fig. 7. Contactor: 1 – brush, 2 – strap, 3 – roll, 4 – roll support, 5 – control screw, 6 – textolite board, 7 – bracket, 8 – support bracket, 9 – column

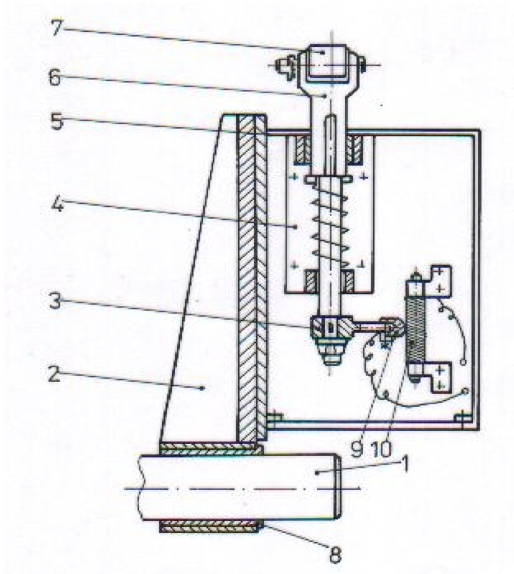


Fig. 8. Resistive detector: 1 – column, 2 – support, 3 – detector, 4 – detector support, 5 – casing, 6 – ball support, 7 – roll, 8 – bushed bearing, 9 – pastille, 10 – resitance

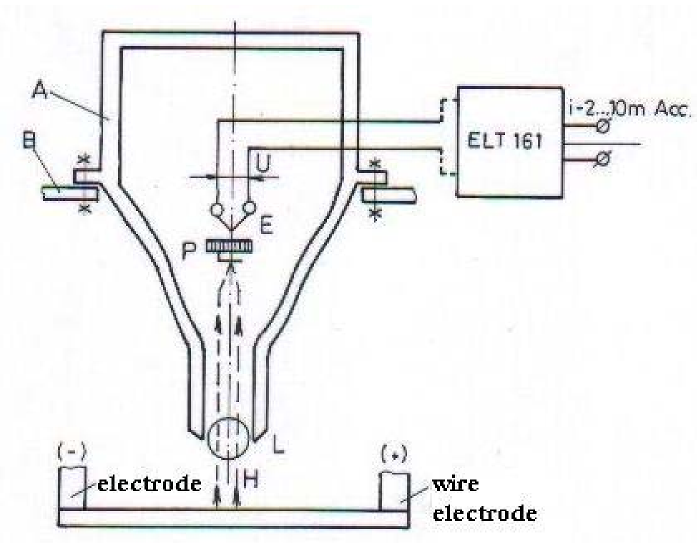


Fig. 9. Optical pyrometer: A – metallic box; B – support; P – platinum bar; E – thermocouples; U – tension; L – lens system; H – caloric radiation

The Equipment Functioning

The functioning of the cold winding stressed strap equipment requires the following steps:

- fixing the container (shell support) in the lathe;
- bundling the lathe in the position that establishes the profile's interval from the support shell. In our case, for strap (wire) of 5x5 section, it must be coupled at 10 mm interval;
- the drum for winding strap is brought in front of the container and the end of the strap is welded in the point where the winding starts;

- the way of winding is determined, from left to right;
- the brake system's lever of the rotation axis of the strap support drum is actuated, after finding by calculation the strap's pressure and establishing by means of tensioning system, the force that can be read on the dynamometer. The container rotates a little using pulse method, in the direction that the strap is stretched;
- the starting of the lathe is coupled in the direction of winding up to the obtaining the needed wound length;
- the rotating of the container is stops, the strap is welded and cut.

The steps from above are repeated for each layer of winding strap until the necessary thickness of the shell is achieved.

The functioning of the warm winding stressed strap equipment requires the following steps:

- the first four steps from the cold stressed winding will be also used;
- it is established the position of the two contacts between which the heating strap is made (temperature determined by calculation), ensuring a permanent contact with the strap during the winding;
- the resistive controller is adjusted, so that the perpendicularity of the strap on the container axis be ensured;
- the optimal pyrometer's position is adjusted in order to determine the temperature of warming the strap;
- the roll for pressing the strap in the shaped channel is fixed in the support knife of the lathe.

After these steps are done, the transformer that heats the strap is connected. The optical pyrometer will indicate a temperature, and when the needed temperature is obtained the turning of the lathe is engaged for the winding direction. Using the roller the strap is pressed into the profiled channel following the process until the wound required length is reached. The rotation of the container is stopped; the strap is welded and debited. During the winding, the strap that already is pressed into the profiled channel is cooled. The cooling is made by air or liquid (water). These steps are repeated for each layer of wound strap until the required thickness of the strap is reached.

Conclusions

In this paper the main technical economic aspects regarding the producing of the thick cylindrical shells from wound straps and channels were presented, in order to adopt these technologies.

Apart from the detailed conclusions included in this paper, it can be mentioned the most important aspects from the technical economic point of view, being in the same time, original elements of this paper, such as:

- using the bibliography, a technical economic analysis of the pressure containers with the shell made by winding the profiled straps or the calibrated square wire is made. The advantages resulted impose the using of this technology in Romania;
- a first step in using this technology consists in the producing the winding shells from calibrated square wire;

- the indicated equipment can be used not only for stressed winding with a constant force in the strap (in cold environment) but also for winding in warm environment.

The main aspects in this paper, due to the approaching point of view, are the answer of an issue not studied enough in the local technical literature, permitting the designing and producing of high pressure containers with shell made by strap winding for both cold and warm environments.

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Instalaţie pentru realizarea mantalelor cilindrice groase prin înfăşurare

Rezumat

În prezenta lucrare se propune, cu caracter original, o instalaţie pentru realizarea mantalelor cilindrice groase prin înfăşurare, folosind o maşină unealtă (strung) existentă în orice întreprindere de utilaj chimic şi petrochimic. Instalaţia propusă se poate folosi atât în cazul înfăşurării tensionate a benzii la rece cât şi la cald.