Innovation Method of Production of Extremely-Thin-walled Welded Tubes on the Tube-electric Welding Machine TESA 10-20

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***Abstract*—Today, thin-walled and extra-thin-walled welded tubes of various diameters have high reliability and resistance to corrosion, which allows them to be used in many industries. For example, when creating frames for metal structures, manufacturing furniture, commercial and warehouse equipment, as well as in the oil and gas industry (trunk pipes for transporting fuel, casing and tubing). . Thin-walled pipes are pipes with a ratio of the outer diameter of the pipe to the wall thickness from 12.5 to 40, and extra-thin-walled pipes with a ratio exceeding 40. The technology of steel tube production is well known and used all over the world. However, in the manufacture of ultra-thin tube there are many problems. To ensure the production of welded pipes with the specified ratio of diameters to wall thickness, it is necessary to solve a number of technological problems, such as the choice of type and optimal welding parameters, optimal rolling pattern of the tube blank and process stability. Difficulties in the process of continuous roll forming of thin-walled and extra-thin-walled pipes are associated with ensuring the stability of the process and accurate feeding of the edges for welding. A common type of rejects when rolling a pipe billet is corrugation, which does not allow for high-quality pipe welding. Until recently, Russia did not have the technology to implement the production of ultra-thin steel tubes. The proposed technology allows to produce high-quality products.**

***Index Terms*—thin-walled welded profile, thin-walled welded tube, steel tube, high-frequency welding,**

I. Introduction

Depending on the purpose of the tubes, characteristics and sizes, the source material, welded tubes are obtained in several ways, each of which has its own technological disadvantages and advantages.

Methods for the production of welded tubes can be classified according to two main distinguishing features.

According to the temperature of the metal being formed: cold sheet forming (all types of modern tube welding units); hot molding (units for continuous furnace tube welding).

By the method of obtaining the final dimensions of the finished tubes on the calibration stands of the molding and welding units; obtaining on tube welding units a limited number of sizes of tube blanks and the final formation of the diameter and wall thickness on the reduction and expansion mills of hot and cold reduction.

Other factors are also used for the classification of production methods of welded tubes: the nature of the process(incessant or discrete), the number and direction of the seams on the tubes (single-seam and two-seam, straight-seam and spiral-seam), the method of forming a tube billet out of a sheet(rolling, pressing, roll-framing and half-sleeve types), welding method(stove, shielded metal arc, delectric resistance welding, induction welding, high frequency welding, plasma arc welding and ultrasonic welding) and the number of layers in the tube (single-layer and multi-layer). Especially thin-walled (with a wall thickness of 0.15 ... 0.5 mm) welded profile tubes (rectangular, flat-oval, etc.) made from aluminum, copper, latten and stainless steel have found extensive application.

In recent years, the development of nuclear energy, aerospace, automotive and domestic engineering requires improving the quality of manufactured welded thin-walled core tube (thickness 0.15-0.5 mm) made of nonferrous metals. Known technology production thin sheets and tubes [4, 6-8]. However, in the manufacture of ultra-thin tubes there are a number of problems [1, 3, 5]. They are also associated with the deviation of the properties of metals [9]. In Russia, especially thin-walled welded profile tubes are not produced and purchased by import. Therefore, the development of a technological process and equipment for the production of especially thin-walled welded profile tubes is an important task of metallurgical engineering. instructions give you basic guidelines for preparing camera-ready papers.

II. Description of Innovative Technology

The existing equipment does not provide opportunities for the manufacture of ultra-thin tubes [2]. The article describes the innovation technology for production of this type of tubes on the tube-electric welding machine TESA 10-20. This assembly allows to produce wide range of the electric welding steel 10-20 mm by continuous molding of billets in cold strip rolls, its welding by high frequency currents and the calibration or profiling to the

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predetermined resolution. Electric-welded tube plant TESA 10-20 is constructed for production of precise welded straight-seam cold-deformed tubes with small diameter in skein or measured lengths used in the production of various details for automobile industry and machine building in general.

The analysis of the inquiries of customers widely using ultra-thin-walled profiles in building structures, household machineries and automobile industries, revealed the following parameters necessary as the main technical characteristics of tube producing mills of the given assortment:

Primary blank
Sheet roll:
Aluminum and its alloys
Sheet thickness 0,15…0,5 mm
Sheet width max. 80 mm
Exactness of the sheet in the width ±0.02 mm
Outside diameter of the rolls up to 1600 mm
Inside diameter of the rolls 250 mm
Ready production:
Welded tube diameter 10-20 mm
Thickness 0.15-0.5 mm
Shaped tube types square, rectangular, oval, profile
Shaped tubes size within the perimeter of welded tubes
Profile length 4-6 m
High frequency tube welding with induction coil
Power consumption kW 87
Power output kW 60
Operating frequence MHz 0.44
Welding speed 20-80 m/min
Hourly performance 650-2500 m/h

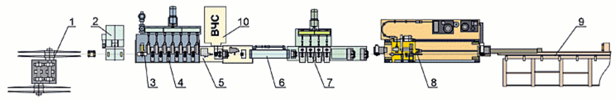

Figure 1. Composition of TESA 10-20 equipment.

Fig. 1 shows the composition of TESA 10-20 equipment. The General scheme includes:

1. Two-position tape unwinder, consisting of the position of the preparation in the roll ki for unwinding and the position of its unwinding in the mill line.
2. The machine for spot welding the ends stainless steel womb, nonferrous metals and alloys.
3. Crate for perforation of the tape.
4. Forming and welding mill
5. Welding section
6. Fridge
7. Profiling mill
8. Flying saw
9. Tube cleaning section
10. Microwave welding device

One of the main stages of the production of extremely-thin-walled welded tubes takes place in a molding and welding mill. The TESA 10-20 forming and welding mill for forming tube of a cooking, its welding and removing the outer burr.

The molding mill consists of seven two-rolling horizontal driving stands and one non-driven. The non-driven horizontal stand is intended, if necessary, for applying perforation holes and marks on the forming tape. Part of the horizontal stands are withe open grooves and another with the closed grooves.

Between the seven horizontal stands there are six vertical non- driven stands.

Stands are driving through the cardan shafts from the total gears mill and theb from regulated electric motor.

The molding of longitudinal tubes consists in the fact that the metal strip is first bent in the rolls, taking the form of a trough, and then rolled into a cylindrical billet of round and oval cross-section with straight edges. The molding of extremely-thin-walled welded tubes according to previously known technologies did not allow to achieve high quality. Because of manufacturing errors and roll adjustments, as well as fluctuations in the thickness of the workpiece, in the open-gauge rolls, along with the plastic bends of the tape, local changes in its thickness occur, which is significant in percentage terms. Asymmetric loads also arise, which tend to push the tape from the gauges to the side . The only method of application of opposing forces are the side surfaces of the edges of the tape, so the thinner and more plastic tape, the harder it is to keep it in passes without damaging the edges.

It was also found that in rolls with a closed caliber, the cylinder and the billet are shaped in cross section into a circle or oval shape symmetrical with respect to the horizontal axis, which divides the resulting profile into two parts that are unequal around the perimeter. The perimeter of one of them because of the gap between the edges is always smaller than the perimeter of another. When rollers squeezing a tubular blank during the welding the metal from the part with most perimeter is moved to a smaller to form a welded joint edges. As a result of movement of said metal and dissimilar from a lovy friction welding caliber rolls twisting occurs tubular blank around its longitudinal axis and variable direction. To hold the thin-walled tube preform from twisting by roller seam-directed mill is usually not possible.

Finally, another feature characteristic of high-frequency welding of thin-walled longitudinal welded tubes. Due to inaccuracies of manufacture and cutting tool metal strip pressure rollers to the weld and libre varies from the minimum to the excess magnitude. The edges of a thin-walled tube billet heated to a welding temperature, when squeezed by their rolls at excess pressure, lose stability. Welding mills of traditional construction does not allow us to solve this problem.

Analysis of these features of molding and high-frequency welding of thin-walled tubes allowed us to formulate the basic requirements for the technology and equipment for welding of extremely-thin-walled non-ferrous metal tubes.

A thin-walled tube is successfully formed and welded, if the strip is not ejected from the caliber rolls, the edges of preformed tubular blank have undamaged surface and a rectilinear shape and torsional vibrations in its caliber welding have a minimum value.

These requirements can be ensured, firstly, by tracking the rolls for geometric and force changes occurring in open gauges. Tracking is carried out the upper rollers rolling units forms a novel developing mill set relatively low, with the free resilient axial and radial movement, the upper rollers are pressed by springs to the bottom with a force which is provided as a plastic bending of the tape and its longitudinal movement. During the entire molding process flow sections calibers adjust themselves directly bend the workpiece, the greater effort, the ejecting belt in the direction of the caliber, and defects arise at its edge not formed.

Secondly, in a closed caliber rolls of the last stand tube blank should be formed as a profile of oval shape with a slit, asymmetrical about the horizontal axis of its cross section and separated by a second horizontal axis at evenly on the perimeter part, the perimeter portion with a gap must exceed another part of the perimeter by the value in s crowding in the beads. In this case, welding connection is formed only by the difference of perimeters without moving from one metal to another part of the profile and without concomitant such movement of the weld metal to a libre twisting tubes.

The molding of a flat tube billet (sheet, tape, strip) into a cylindrical billet is one of the principal operations of all technological processes for the production of welded tubes. In order to implement the molding, significantly lower costs are required than during rolling, which has a decisive influence on the technical and economic indicators of the production of welded tubes.

Continuous molding, also called "roller molding" of straightened tape or a thick sheet (in the form of individual strips or an endless blank), results in a slotted tube with a given geometry, designed for welding.

A number of features characterizes the process of continuous tube welding.:

1. The projection of the strip edge on a horizontal plane to the weld point is a curve approximately corresponding to a sinusoid.

2. The trajectory of the middle line of the strip can be both horizontal or at an angle to the welding part

3. Section profiles i.e. geometrical forms of gauges should be consistent

4. The ratio of the length of the molding section to the diameter of the tube should be determined.

Fig. 2 illustrates the simplest case of forming tubes with a continuously changing radius, with the middle line of the strip passing at a constant height. The projection of the strip edges onto the horizontal plane (curve a) of a sinusoidal shape. It is calculated by the formula

$$y_a = \frac{b}{4} \cdot [1 + \cos\left(\frac{\pi x}{L}\right)]$$

Curve b is the projection of the trajectory of the strip edges on a vertical plane and is determined from the formulas:

$$b = r \cdot 2a$$

$$y_a = r \cdot \sin\alpha$$
$$h = r \cdot (1 - \cos\alpha)$$
$$y_c = r_x$$

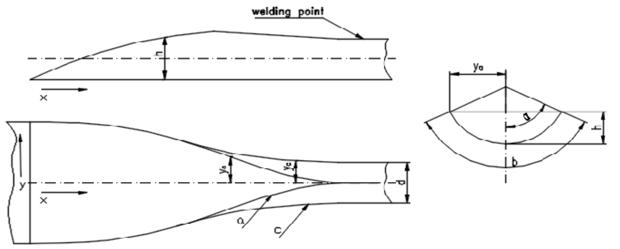

Figure 2. Tube forming

All these equations combine the width of the strip B, the radius of the profile r, the height of the edges h and the value of y for the case of a sinusoidal path of the edges. Using these equations for each point of the molding section, it is possible to calculate the corresponding profile radius [10].

There are a number of other possible molding options (Fig. 3). For example, gradual bending from the edges to the middle of the strip, i.e. first, they bend along the radius of the strip edge, and then gradually capture new sections of the strip up to the midline.

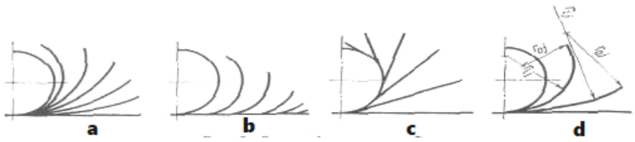

Figure 3. Schemes of tube forming: a - bending with a constant radius; b - bending from the edges to the middle of the strip; c — bending from the middle to the edges of the strip; d — bending using conjugate radiuses

The case, when the edges of the strip remain straight, i.e. they do not deform, and bending deformation begins from the middle of the strip and reaches the edges only in the last stands, represents a completely different way of molding.

Another molding option can be regarded as a compromise solution obtained from the two previous ones. It consists in molding using profiles described by mating arcs. Moreover, the smaller radius describes the zones adjacent to the edges of the strip, large radii are used for its middle sections.

To assure the stability of the process, it is desirable that the longitudinal deformations of the edges of the strip resulting from the forming of the tubes do not extend beyond the elastic region. At the same time, for optimum tube forming, it is necessary that the difference in lengths of all beams extending parallel to the strip axis in the forming portion is minimal.

Typically, in practice, the sheet is transformed into a tube in 8-10 passes, i.e., a step-by-step forming of the profile.

The forming mill includes 6...8 vertical idle rolls. The vertical rolls are designed to prevent the tube billet from falling apart, but are sometimes used to increase bend deformation as well. The sequence of the forming operation on the continuous rolling mills is determined by the selected bending conditions of the strip, ensuring processability of the process and minimum tension in the strip.

In the first forming stands open-type passes are used, in the latter - closed-type passes are used. Upper rollers of stands with closed calibres have suture-guiding washers, which keep tube blank from turning and ensure its correct entry into welding stand.

In a step-by-step forming process, the strip after each pass(groove) tends to elastic restoring of its shape as force is applied to the strip at a point or along a line starting from the edges of the strip. Only in the plane passing through the axes of both rollers, the groove covers the entire section of the strip, and molding is carried out in a new stand. As soon as this plane passes, forces are again applied to the strip, causing its elastic recovery until it enters the zone of influence of the next forming stand. In this case, there is always non-uniform deformation of the longitudinal elements of the strip, and the elements at the edges experience maximum stretching. Nonuniformity of deformation of longitudinal elements decreases with an increase in length of transition zone, and can be absent only at infinite length of deformation zone.

The bending and torsional stresses of axial tension act in accordance with the circumflection of the section, particularly in the area of the edges of the strip[11]. Relative speeds of the forming rolls also have a certain effect.

The body of the formed tube billet and welded edges need to be warmed extremely quickly (not less than 5000°C/sec)and sent to welding stand, then it is necessary to hold a point of a convergence of edges in a gap of welding rolls, to squeeze by the proportional effort, to remove external burr and to cool.

The above-mentioned requirements determine the composition and design of the welding section equipment, which includes a seam guide stand, a welding stand, a burr-collector and a refrigerator.

The purpose of seam guide stand is to direct the edges of the formed thin-walled tube billet warmed in the inductor at a specific angle to thew elding stand and hold a point of a convergence of edges in a gap of welding rolls.

Traditional rolling seam guide stands are of little value use for this aim.

The seam guide stand, the working element of which is made in the form of a profiled mineraloceramic plate fixed on a non-magnetic rod and located in the immediate vicinity of the welding site, is better suitted for the purpose.

In order to ensure the desired quality of the high-duty cast iron welding of the thin walled tubes, it is necessary to use a welding stand, the distinctive features of which are that the pressure produced by the elastic element in the welding pass is constant, in spite of the change in the geometric dimensions of the billet and the errors in the production of the rolls.

A major problem in the production of thin walled tubes is the removal of the outer burr. The most known defect of thin-walled tubes is the so-called "apple" effect, where when attempting to remove the burr completely, the wall of the tube falls in due to the cutter or the incompletely removed burr has the same effect on the rollers of the calibration mill.

The shape of the cutter, the prop on which the tube extends in the burr collector and its position relative to the welding site are crucial in this operation.

All metals forming solid solutions and mechanical mixtures at certain temperatures have the ability to be welded. Bonding during welding takes place due to interatomic action by coupling of atoms. For welding to occur, the edges of the tube billte must be joined. At close enough convergence, the outer electrons of the metal atoms of the joined edges of the tube blank form a common system, whereby welding is achieved. Welding thus creates intracrystalline bonds between the joined edges of the workpiece (or of the seam of joined edges and metal).

The convergence of atoms is hampered by the irregularities of the edge surface and the presence of contaminants (oxides, organic compounds, etc.) on these surfaces. According to the method used to remove these obstacles and provide with the necessary convergence of atoms for welding, all existing welding methods are divided into two main groups:

Methods of joint plastic deformation welding at heating above recrystallization temperature (pressure welding);

Methods of joint melting of edges (Fusion welding)

The mechanism for creating an intracrystalline bond between the metal edges for these two groups of welding methods is different.

During fusion welding, tube edges are connected due to melting of metal of welded elements (main metal along edges in places of their contact or main metal of edges and additional metal of electrode). Molten metal of welded edges spontaneously (without application of external force) is fused between each other and additional metal, forming so-called welding bath. After removing the heat source, the metal in the bath solidifies (crystallizes) to form a welded joint.

When melting tubes, various heating sources are used to melt the weld metal, creating a temperature of at least 2000 °C. Depending on the heat source used to melt the metal, electric and chemical welding are distinguished.

In electrofusion welding, the tube weld metal heating source is an electric arc or electron beam (cathode beam or plasma welding).

In chemical melting welding, the combustion reaction of gases (gas welding) is used as a heat source.

During pressure welding of tubes, connecting edges is achieved by heating them to high temperature and subsequent joint plastic deformation at the point of contact.

The pressure welding process occurs at high temperatures when the metal of the edges of the workpiece is in a plastic state but is not melted. In various tube manufacturing methods, the edges are heated by flame heat (furnace welding); heat generated when passing electric current is in contact edges (contact welding by resistance); Heat generated when the induced current passes (induction welding).

In addition to temperature and pressure, the strength of the weld joint is also affected by the time period of the required high temperature and pressure. The longer is the pressure time, the higher is the weld strength .

To ensure the weld quality of welded tubes, it is necessary to exert a sufficiently high welding pressure at the edges of the workpiece to be welded; This pressure shall be ensured by appropriate calibration of the working tool [12].

The molded tube is welded with high frequency currents, which has several advantages:

1) the possibility of a significant increase in the welding speed of tubes (up to 120 m / min or more) and carbon, alloy and high alloy steels, including stainless, non-ferrous and rare metals and alloys;

2) the ability to obtain high quality tubes with the seam of hot n e pickled tape;

3) a significant reduction in the specific energy consumption per ton of finished tubes.

One important advantage of this process is also the possibility of using the same welding equipment for welding Various hours non ferrous metals. In this case, only the power consumption and welding speed are changed.

Apply two ways high frequency current supply by the source of its claim on radiation to the edges of the tubular blank - contact and induction (Fig 4 a,b).

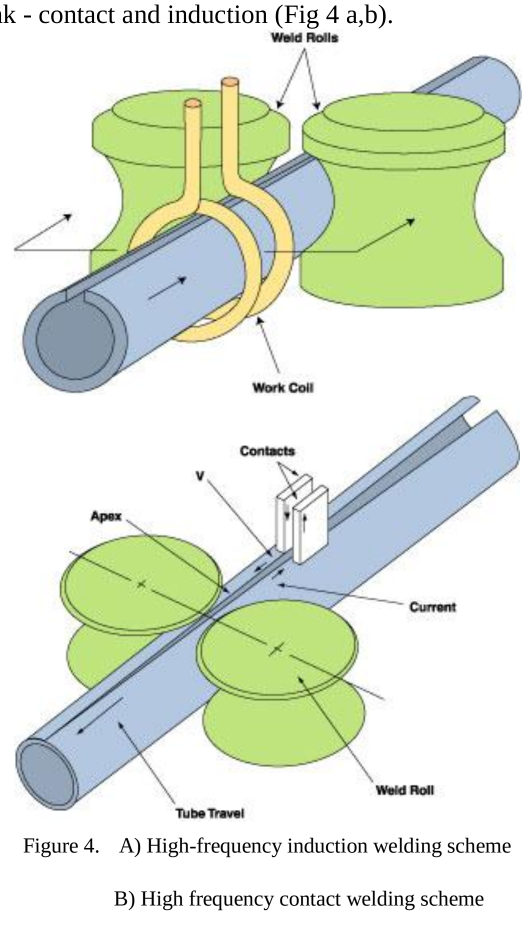

Figure 4. A) High-frequency induction welding scheme

B) High frequency contact welding scheme

In both cases, the intensity of edge heating depends on the frequency of the current.

The types of weld pressure rolls, or squeeze boxes as they sometimes are called, that apply the pressure required for the weld are as varied as the welding units used to supply the heat. Squeeze boxes for rotary contact wheel welding typically have two or three roll units, with the contact wheel serving as one of the rolls.

The number of rolls in the weld squeeze box is proportionate to the size and shape of the product being welded. There are no hard and fast rules; however, common guidelines for round tube or pipe size ranges are as follows [13]:

3/8 to 2 in. uses two-roll units.

1/2 to 3 1/2 in. uses three-roll units.

2 to 10 in. uses four-roll units.

Larger than 10 in. uses five or more rolls.

Today, much more so than in the past, many shapes--square, rectangular, hexagonal--are welded in the finished shape rather than being reshaped after being welded round. The weld boxes used for the shapes are custom-designed for each application and usually have no more than five rolls.

Both with contact and with induction current supply, the workpiece is molded into a tube in roll mills, after which the edges come closer with the help of crimp rollers. In the manufacture of tubes by radio frequency currents, the quality of the welded joint increases with increasing welding speed. This is because the heating time is reduced and the width edges of the heating zone, and reduced n e IRS heavy metal oxidation time.

In the case of induction welding the workpiece to be welded is placed in a cylindrical inductor . At the same time the current induced in the workpiece, passing along its perimeter, reaches the maximum concentration on the welded edges and closes at the point of their convergence. To enhance the effect, a magnetic core is inserted into the tube, typically drawn from ferrite rings.

Heating of tube billet edges with radio frequency currents allows welding both with melting of edges as well as without it; meanwhile three modes of edge heating are possible.

Heating of edges of welded billet at the temperature lower than required for melting the metal with subsequent reduction in bearing rolls.

Heating the edges of welded billet with melting edges at the point of their convergence with subsequent reduction in bearing rolls. At the same time liquid metal with oxides is easily removed by pressure of compressive rolls

The edges are heated to melt as they approach the convergence point and are additionally overheated at the joint. Further, when the edges converge, there is an intense release of molten metal, accompanied by the destruction of oxides and their removal from the seam zone.

The choice of a welding process option depends on the properties of the pipe metal, the surface quality of the workpiece, and the requirements for internal burr;

If there are dense refractory oxides on the metal surface, for example, when welding stainless steels, the third welding method is the most effective for their removal from the seam zone, with preliminary melting of edges before their convergence.

Low-carbon steels are well welded both when the edges are heated below the melting point and in the molten state.

However, in the former case, the pressure on the edges to be welded should be greater than in the case of melt welding, resulting in a flat but significant inner burr. Therefore, it is advantageous to carry out the melting process at the converging point of the edges.

When manufacturing pipes with radio frequency currents, quality of welded joint increases with increase of welding speed. This is due to the fact that the heating time and the width of the edge heating zone are reduced, as well as the time period of intensive metal oxidation is reduced.

The condition of the tape surface significantly affects the quality of the weld joint [14].

The quality of the welded joint of pipes made by radio frequency welding is checked by standard methods: flattening till the cracks appear and distributing a cone mandrel [15]. Test results demonstrate that mechanical properties of welded seam of pipes welded with radio frequency currents significantly exceed the requirements of GOST, so that when the pipe is extended by a cone, the external diameter increases up to 20-25%. At the same time destruction takes place mainly on the main metal far from the seam and the zone of thermal influence. Pipes withstand flattening till walls contact. The stability of the resulting weld quality at two-radius calibration of the forming mill rolls is higher than at one-radius. This is due to the better forming of the pipe blank in the edge area.

In the absence of a filter in the anode circuit of the transmitting tube, the significant amplitude of oscillations of the rectified voltage leads in some cases to the production of non-welded sections. The installation of the filter allows the production of pipes with all along the length well-welded seam.

The size and shape of the inner burr in RF welding is determined by the heat mode of welding and the pressure in the welding assembly. In appearance, a continuous drop-like grate is distinguished; Drop-like discontinuous; Solid trapezoidal section.

A continuous drop-like burr is produced at relatively low welding speeds (38-40 m/min) and rarely at higher speeds. Its height varies between 0.3-0.45 mm.

At welding speeds greater than 0.75 m/s (45 m/min), the more peculiar is an intermittent drop-like burr 0.3 mm high. At the same speeds, trapezoidal section burr up to 0.15mm high is less common. In all cases, the burr is more or less fused.

Thus, TESA 10-20 has a number of advantages over other rolling equipment. Namely, TESA 10-20 allows to produce special-walled pipes of non-ferrous metals with a wall thickness of 0.15-0.5 mm. in our time of rapid development of the construction industry, thin-walled pipes have become a very important element for the manufacture of all kinds of metal parts and structures. For example, they have important qualities such as high strength, ductility, good weldability, dimensional accuracy, and excellent surface quality. All these qualities help to find wide application of thin-walled pipes in the manufacture of rather complex metal structures. In addition, they are used in the creation of lightweight structures, which are not provided for heavy loads. As for the use of thin-walled pipes, they have now become very popular in industry and in everyday life. And due to the fact that this product is reliable and durable, they are very often used in the aviation and space industry. It is worth noting that the extra-thin-walled pipes are light in weight, compared with steel pipes of the same diameter, which makes them more compact, they are also resistant to the external environment. As a result, most of the advantages and positive characteristics are thin-walled welded pipes.

The main production units of TESA 10-20 are forming-welding and profiling mills. The profiling mill is intended for calibration of pipes (round, oval), and also for profiling of square rectangular pipes and special closed profiles.

The profiling mill consists of 4 universal stands with driven horizontal rolls and a pair of vertical non-driven rolls. Horizontal rolls through the cardans are rotated by a common gear stand and then by an adjustable electric motor.

In addition, the profiling mill consists of two four-roll regular stands.

The stands of the profiling mill are universal. This means that it is possible to produce profiles of different sections on the same profiling mill. Elements of the universal stand do not experience heavy loads.

The universal crate is mounted on the frame of the profiling mill without working tools, i.e. rolls. It is the rolls that have a cross-section of the produced profile. To mount the rolls on the axis of rolling steel wire is stretched, on which the rolls are exposed in accordance with the calibration. The movement of the rolls relative to the string is carried out by means of guide screws. In the design of the universal stand there are five units. Two screws are responsible for moving the upper, lower and left rolls in the horizontal plane (left – right), two screws for moving in the vertical plane. Adjusting the position of the rolls is carried out manually.

III. Results

Described in the article equipment should be adapted to the frequent change of the pipes or profiles being discharged, as well as the considerable length of the thin-walled belt in the roll, we believe that in general this type of mill should have a discontinuous process with a stop during the joining of the ends of the roll.

Nevertheless, this does not exclude the possibility of creating continuous cycle mills for large volumes of similar profiles (pipes).

The results of technological tests of tubes show that the quality of tubes welded RF-current is higher than the tubes welding by resistance method and is approaching to the quality of weldess tubes.

The welded tube with the removed external burr is sent to the profiling mill, where in universal 4-rolling stands it takes the required profile shape. Then the tube is straightened in two flatter four-rolling stands, cut into a flying saw and fed into the receiving pockets.

In this way the use of innovative technology of production of extremely-thin-walled welded tubes would eliminate the import of similar products that will contribute to the development of the economy, including the development of the automotive, energy, aerospace and metallurgical industries.

IV. Conclusion

1. To ensure the production of welded pipes, it is necessary to solve a number of technological problems, such as the choice of type and optimal welding parameters, optimal layout rolling the billet and steel the instability of process. The problems arising in the manufacture of thin-walled steel tubes are investigated.
2. The innovative technology of production of thin-walled steel tubes is developed. This technology has a number of advantages, such as: increased tube welding speed, the ability to produce tubes with high quality seam and a decrease in energy consumption per ton of finished tubes.
3. One of the important advantages of this technology is also possibility of using the same welding different metals. In this case, only the power consumption and the welding speed change.
4. The application of the developed technology increases the efficiency of production, provides jobs and therefore increases not only productivity but also the standard of living of workers.
5. The proposed design of TESA 10-20 is multifunctional, because it includes a roll forming mill that allows the production of profiles of various sections. This is achieved by changing rolls with a specific gauge. The property of versatility allows you to save on equipment for the production of various profiles, and the property of the compactness of the unit - to reduce the area for its placement.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

D. A. Mkrtychyan analyzed the data, collected and generalized exploitation experience.

O.O. Baryshnikova made a conclusion and wrote the paper.

All authors accepted the paper.

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