MANUFACTURING OF THE RECEPTION SLEEVES FOR PROSTHETIC APPLIANCES BY THE METHOD OF PULSE STAMPING

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A lower extremity prosthetic appliance includes both masspreduced and individually fitted components and assmblies. Development of efficient technologies of prosthetic appliance components manufacture is one of the urgent problems of prosthetics directly affecting functional and service characteristics of the products as well as technical and economical indices of the products as well as technical and economical indices of the enterprises involved.

A prosthetic appliance socket which to a great extent determines both appliance quality and required production time, its prime cost and longevity, is virtually one of the most complex, important and labour-consuming individually fitted components.

This socket should meet the following quality requirements:

- exact correspondence to the clinical and anatomical peculiarities of the stump;
- durability and longevity;
- little weight;
- hygienity;
- production feasibility, including the possibility of relief local correction while fitting the socket;
- simple and reliable connection with other appliance assemblies.

The extent to which the abovementioned requirements are satisfied is determined by the design and materials used for its fabrication.

Of all the materials used in prosthetic industry ror socket manufacturing (leather, wood, plastics, metals) the light metal alloys most fully satisfy here quality requirements. Plastic properties of such metals permit to obtain complex form products thus providing exact correspondence to the stump relief. Many metals and allouscombine stkength little specific weight, are hygienic and allow sanitary treatment of the socket inner cavity. In the process of fitting socket form can be locally corrected and recesses or convexities on the socket walls be made; there are different ways of connecting metal sockets with other components and assenblies: welding, riveted and screw connection, clamps etc.

Metal sockets, however, have some disadvantages, such as increased heat-conductivity, which may lead to patient's having unpleasant sensations in the cold time of the year. Moreover, some patients can hardly endure the contact with an absolutely rigid socket, even if it is exactly fitted. These disadvantages can be eliminated by means of lathered polymeric coverings, them having good adhesion to metals and being biologically inert.

The abovementioned positive features of the metal sockets permit to consider them quite perspective for wide practical application.

In practice, however, metal sockets manufacture is limited to the devices used only for thigh prosthetic appliances which is accounted for by the lack of effective technological means for obtaining relief on the blank, which corresponds to the stump anatomical structure peculiarities.

Proceeding from the advantages of metal as a construction material, we have developed technology and equipment for mechanized socket manufacturing.

The concept of blanks pulse stumping in correspondence to the mould representing the stump anatomical structure provided the basis for the development.

Production process diagram is shown in the Fig.1.

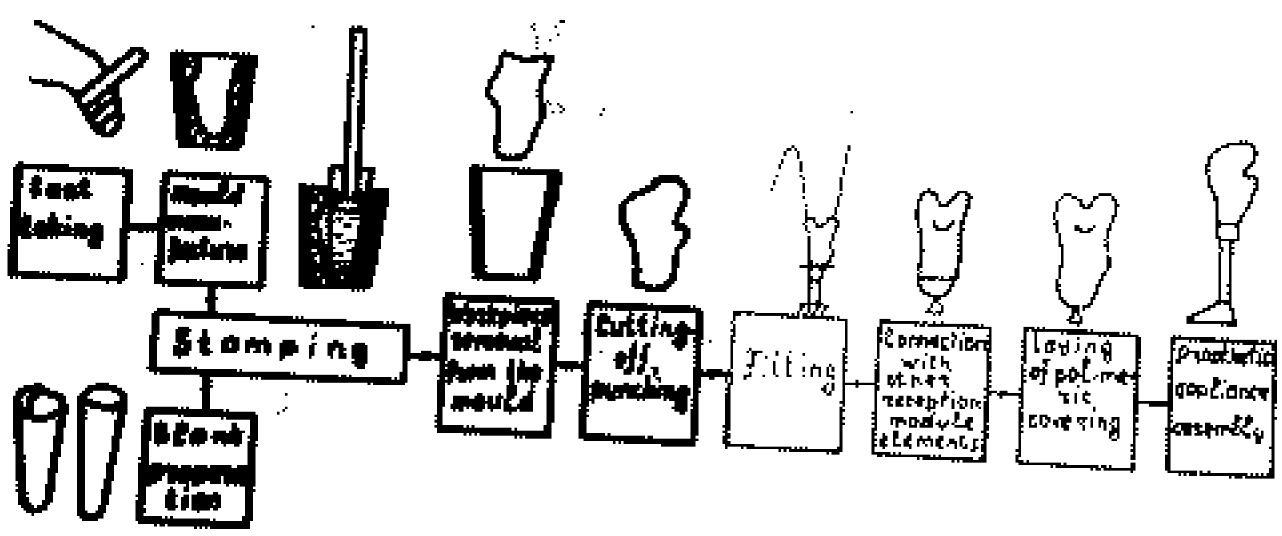

Fig. 1.

By means of plaster bandages a cast of the patient's stump is taken to be used later as a main article for mould manufacture.

When taking the cast, the covers are put on the stump, their thickness corresponding to that of metal and plymeric covering. The mould is a taper snap flask which is made of steel and can be split along its generating line. The cast placed into the flask and the clearance between the flask walls and the cast is fitted with earily hardening material, e.g. paraffin-stearin mixture melt. Taking into account the cast size and plastic properties of the metal used, metal tubular blank is selected or fabricated by the involute of the taper inscribed into the mould.

When selecting an appropriate metal, the following factors are to be considered good: stambility and weldability, strength and light weight. With respect to the stump configuration different methods of blank preparation may be applied. Preliminarily joint-welded blanks are used for short and medium length stumps; unwelded blanks with extra overlapped material - - for complex form stumps when the depth of relief exceeds plastic defermation limits of the material used and compround blanks are used - for long stumps.

The mould containing a blank is placed into the stamping installation, the blank cavity is fitted with water, the latter serving as a transmission medium from the pulse load source to the blank material. Depending on blank dimensions and relief complexity relation to the pulse source effective zone, the required number of stamping cycles is determined. Stamping is carried out successively, section after section.

After stamping the workpiece is removed from the mould and the metal is cut off according to the fit ring profite, after which the socket is ready for fitting. It should be noted, that if the cast is taken correctly, the stamped socket exactly corresponds to the stump anatomic relief causing no painful sensations when loaded. With the purpose of rational pressure distribution on the stump surface only inner surface socket convexity from in the patella chord area can be corrected, since it is rather difficult to obtain its required convexity while taking the cast. In the process of fitting the socket walls may be punched so as to increase ventilation and hence improve microclimate. At this stage the required plymeric covering thickness is also determined from the conditions of the stump fit in the socket.

The fitted socket is then connected with other prosthetic appliance components such as cup and binding elements after which polimeric covering in laid on.

Shown in the Fig. 2 are metal blank, the stamped workpience and the socket, trimmed according to the fit king profile. After laying the polymeric covering supporting and moisture-absorbing elements are installed within the socket, and reception module manufacture is finished. This module is connected with other appliance assemblies by means of an adjusting-and-connecting element, then the appliance is fitted for determining construction parameters.

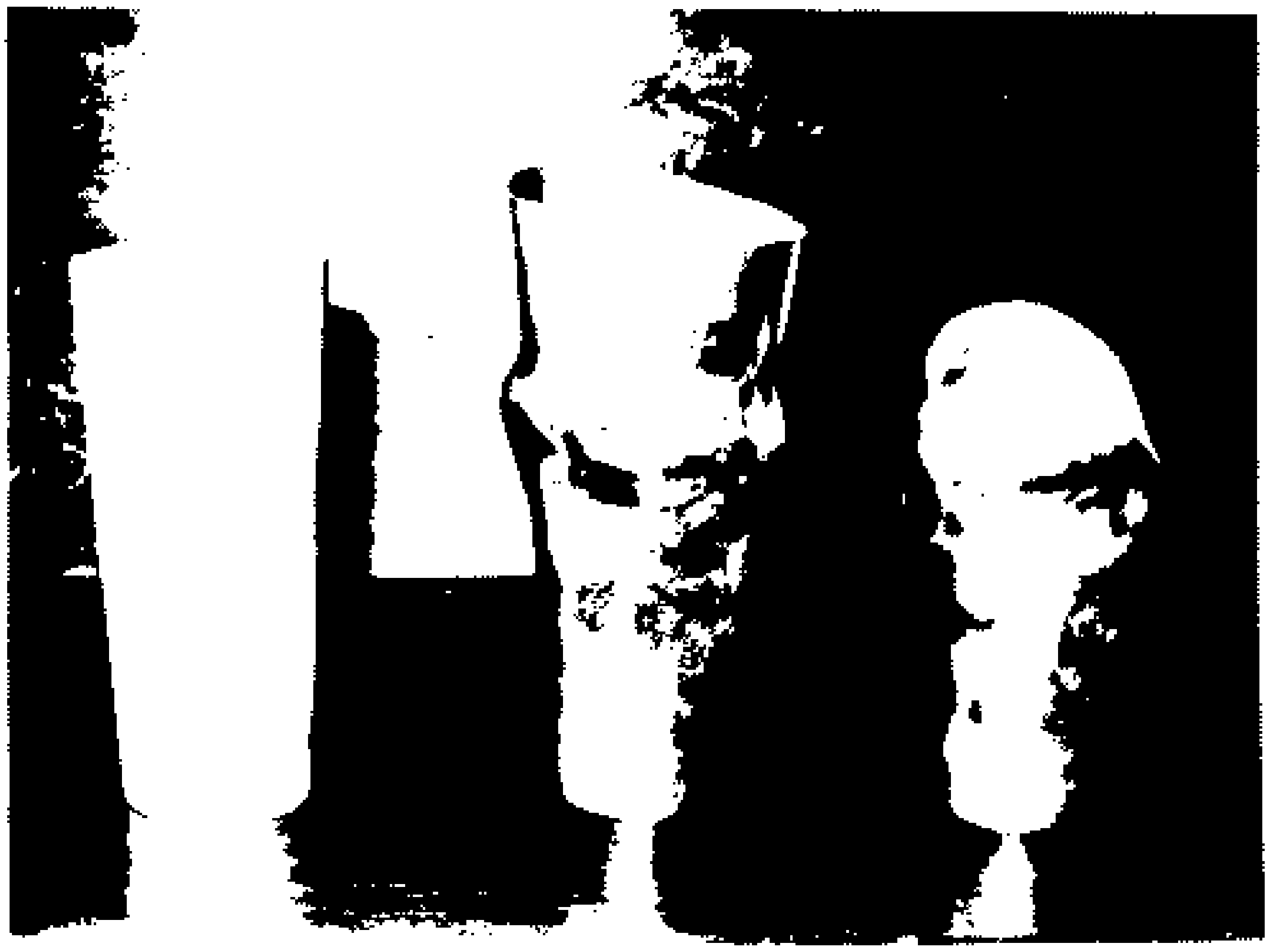

Fig. 2

General view fo such prosthetic appliance is shown in the Fig. 3. When a cosmetic cover is set., prosthetic appliance production process is completed. Broad supply of such appliances to the disabled proved them to be functionally effective.

Decisive factor of the production process described above is the application of the pulse stamping method for sockets manufacturing. On the basis of technical and economical indices and proceeding from process simplicity and safety considerations we have developed the Pulse Stamping Installation (PSI). Its operation is based on the use of gas charge detonation explosion energy, this gas charge exploding in semi-closed fluid volume. A simplified functional diagram of the installation is shown in the Fig. 4.

The main installation component is a detonation tubular gas source (DTGS) this being a thick-walled tube, one end of which is blind with

Fig. 3.

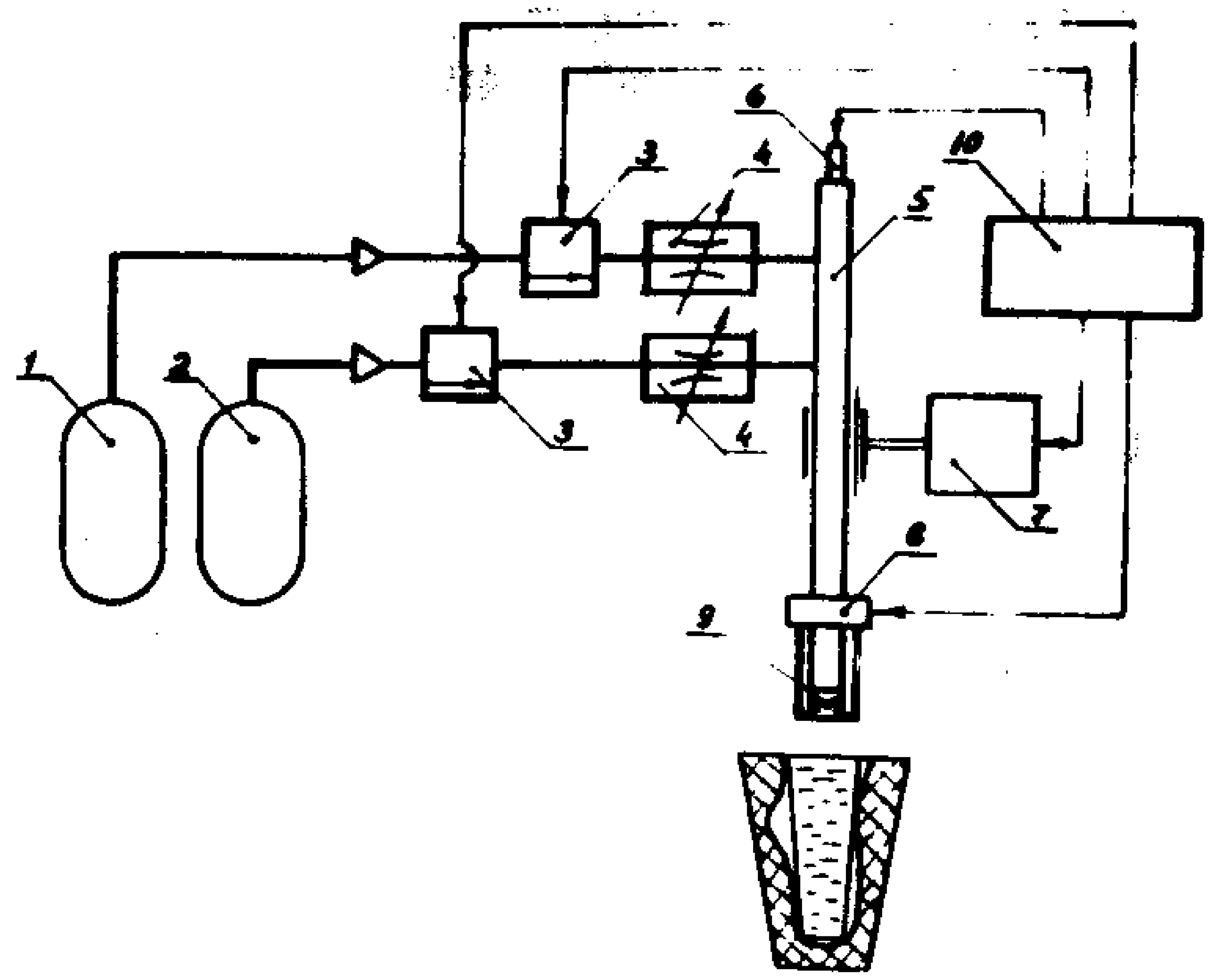

Fig. 4.

an electric ignition plug screwed into it, and the other end is sealed with a provisional locking element (in the form of a discard-type membrane) by means of a special clamping device. Following the signals given by the operator at the control panel DTGS is fitted with oxygen-propane stoichiometric mixture flowing to it from gas bottles through valves and throttles Mixtures of methane, propane and butane can also be used.

After filling the DTGS, the detonation tube sealed end is submerged into the mould fluid medium and the gas charge is ignited. Pressure build-up caused by detonation burning of mixture leads to the membrane burst to be followed by pulse load generation in the fluid medium, this load forming the metal blank according to the mould relief.

The PSI installation also contains a device providing operation safety and operator protection, control instruments and other elements designed for semi-automatic operation mode. General view of-the installation industrial standard is shown in the Fig. 5. Only one operator is required.

Installation performance:

Overall dimensions, mm - 850x850x2500

Production area, m^2 - 48

Mass, kg - 500

Pneumoautomatic system feed - compressed air

Combustible gas flow rate per I cycle, m^3, not more than - $I:IO^{-3}$

Workpiece dimensions

(stamped from tubular blanks) - diametre, mm from 60 to 250

- height, mm, not more than 450

Maximum workpiece thickness:

- from aliminum alloy, mm - 3
- from titan alloys, mm - 1,5

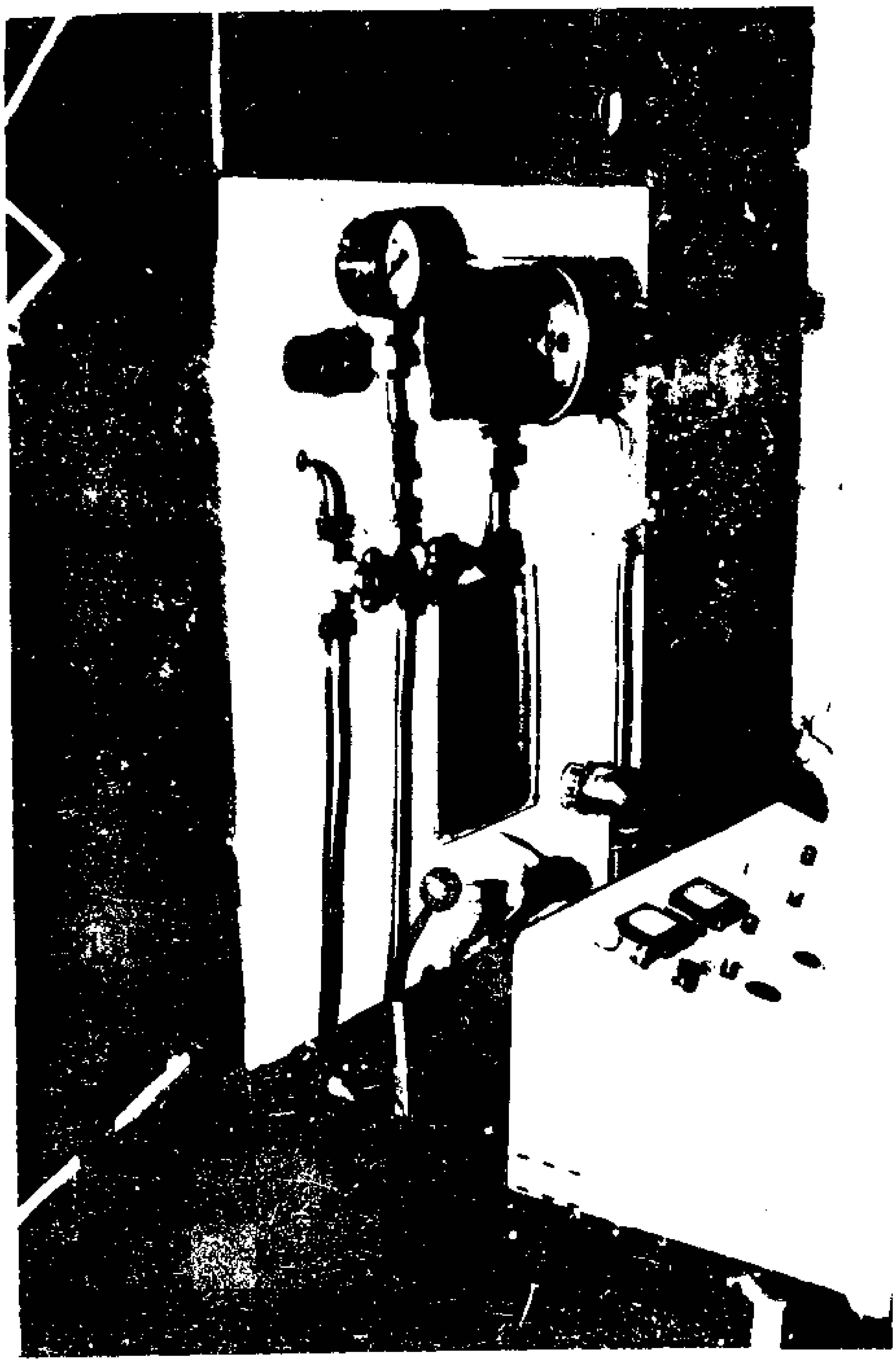

Fig. 5.

from stainless steel, mm - 1,5

from costruction steel, mm - 2.

Stamping cycle duration not more than 1 minute.

Application of given technology and equipment in prosthetic industry allows:

- to improve prosthetic and orthopedic products quality due to increased socket fitting precision;
- to minimize prosthetic appliance weight due to light metal alloys application;
- to improve cosmetic characteristics owing to little socket thickness;
- to reduce prosthetic appliance production time due to mechanization and automatization;
- to increase appliance life due to increased metal socket durability;
- to reduce product prime cost due to exclusion of manual labour and use of relatively low-cost equipment and materials.

UNDER-FIGURE INSCRIPTIONS:

Fig. 1. Metal socket manufacturing by the pulse stamping method - production process diagram.

Fig. 2. Metal blank, stamped workpiece and trimmed socket.

Fig. 3. Shank prosthetic appliance in assembly (without cosmetic cover). Lathered polymeric covering is laid on the reception module.

Fig. 4. Simplified PSI functional diagram

1. Combustible gas bottle
2. Oxygen bottle
3. Valve
4. Throttle
5. Detonation tubular gas source
6. Ignition plug
7. Ligting device
8. Clamping device
9. Discard-type membrane
10. Control panel.

Fig. 5. Pulse Stamping Installation (PSI) - general view.