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# Development of Software for the Automated Calculation Performance Induction Heating Gradient Blanks

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## Relevance of the topic

**Cable sheath pressing in a double-container press**

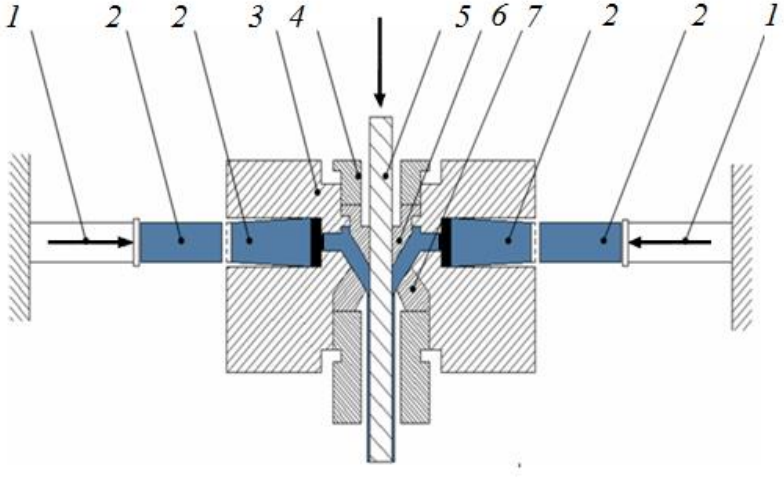


Fig. 1. 1 - stamp, 2 - blank, 3 - container, 4 - press head, 5 - cable core, 6 - body holder, 7 - matrix holder.

**Drawing method for cable core**

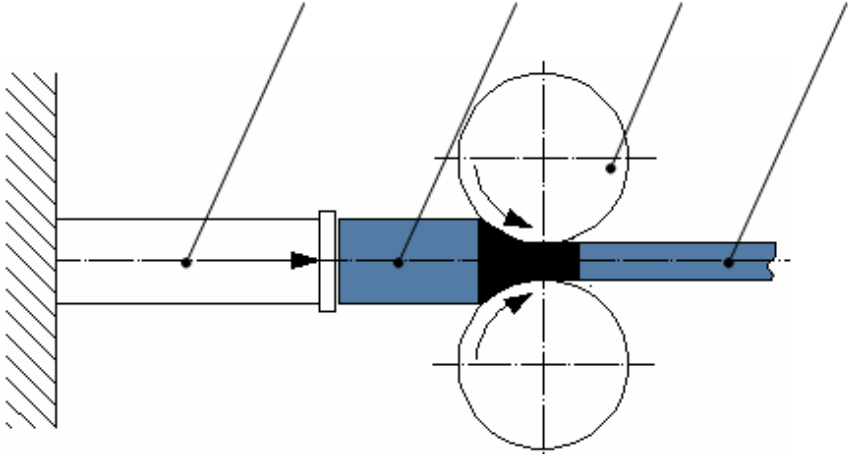

Fig. 2. 1 - stamp, 2 - blank, 3 - rolls, 4 - core

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## Design of an induction gradient heating installation

To implement the gradient pressure, two device variants can be used: a single-section inductor with an asymmetric working filling in it (Fig. 3) or a two-section inductor in which the workpiece is located symmetrically (Fig. 4b).

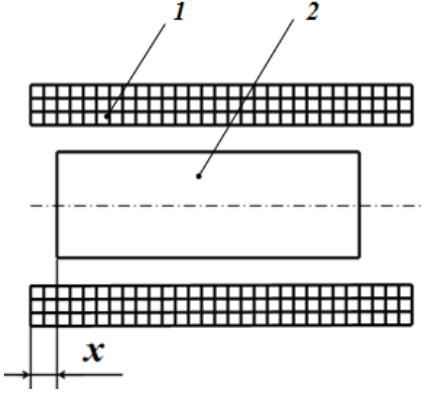


Fig. 3

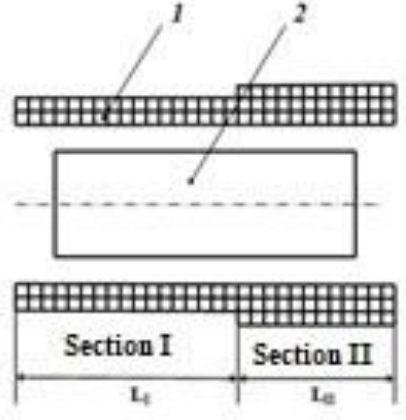


Fig. 4

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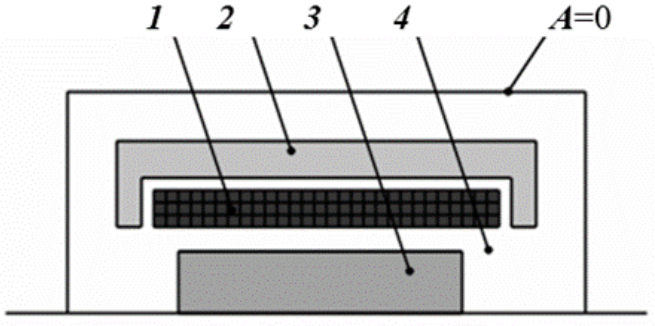
## Development of mathematical models

Geometry and boundary conditions




The initial data from the physical entity, taking into account mathematical models, made it possible to obtain a satisfactory estimate of the calculations of electromagnetic and temperature fields:

1. When solving the electromagnetic problem at the boundaries of the computational domain, the value of the magnetic potential A = 0
2. When solving the heat problem at the borders of the workpiece, the value of the heat flux q (t) is set in order to ensure a non-zero value of heat losses at the borders of the blank.
3. It is accepted that the magnetic circuit has the shape of a pipe and the losses in it are not taken into account.
4. Inductor turns are solid
5. The electro- and thermophysical characteristics of the workpiece material for each stage of heating are taken constant

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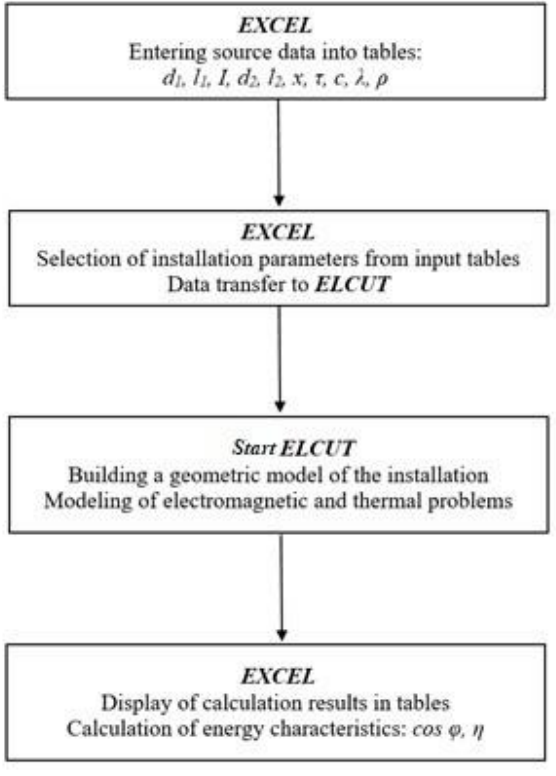
## CALCULATION METHOD



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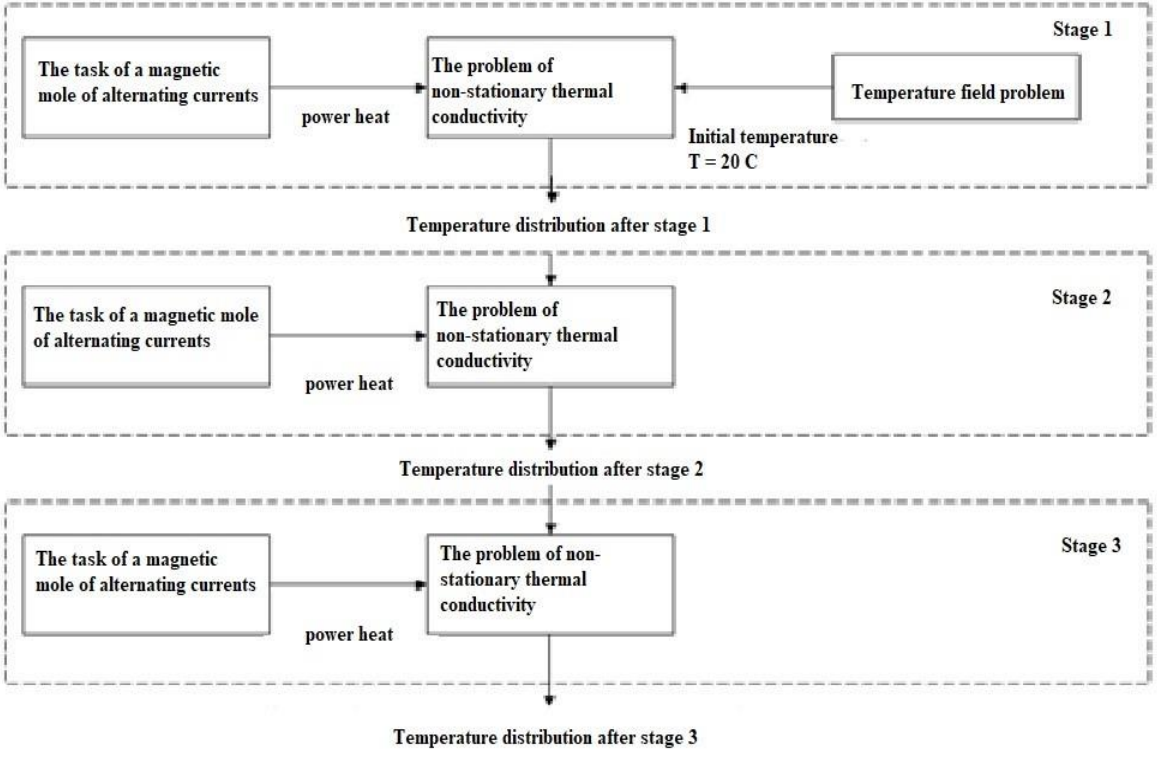
## CALCULATION METHOD



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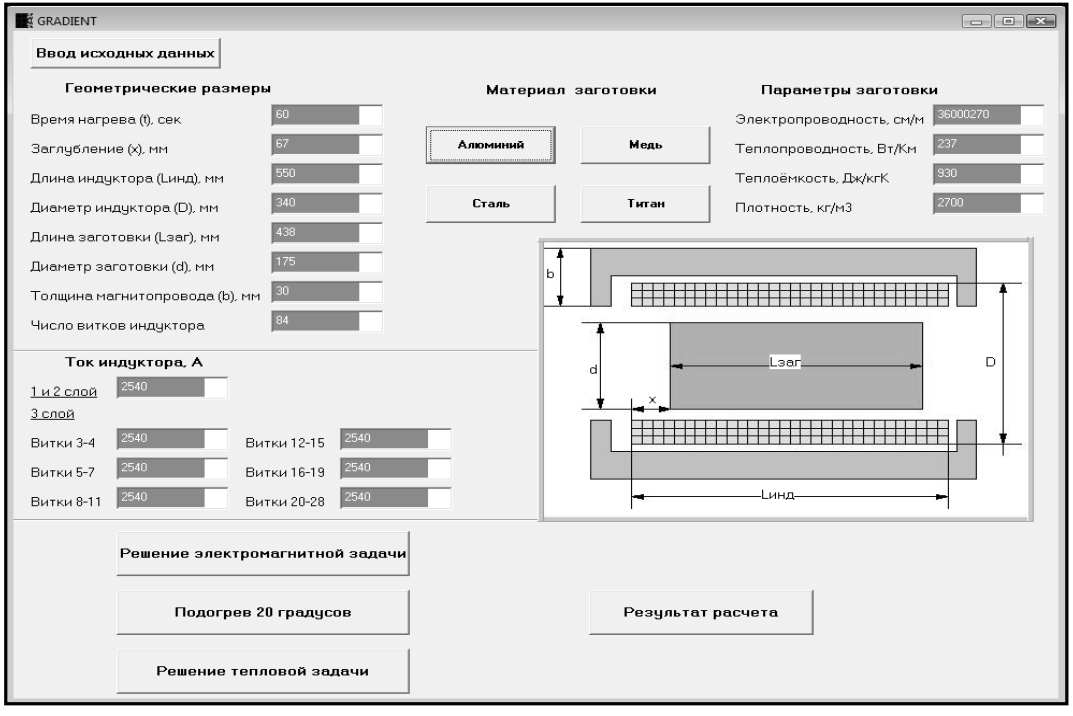


Data entry window in the GRADIENT program

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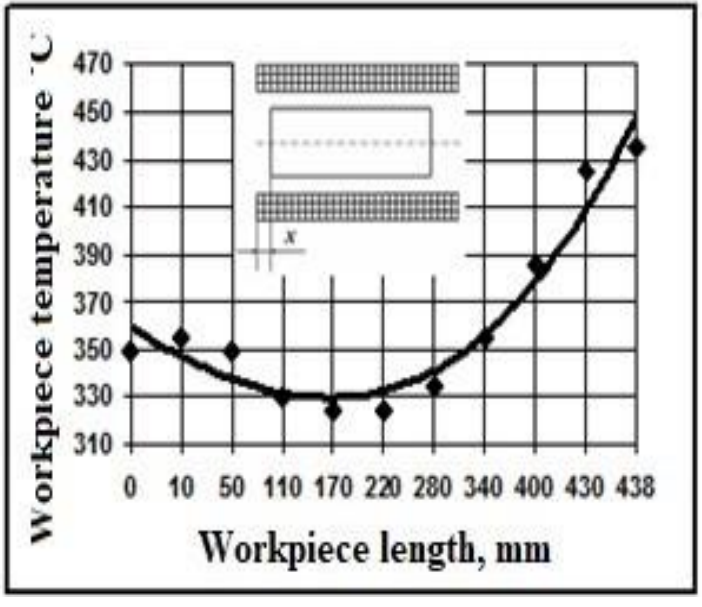
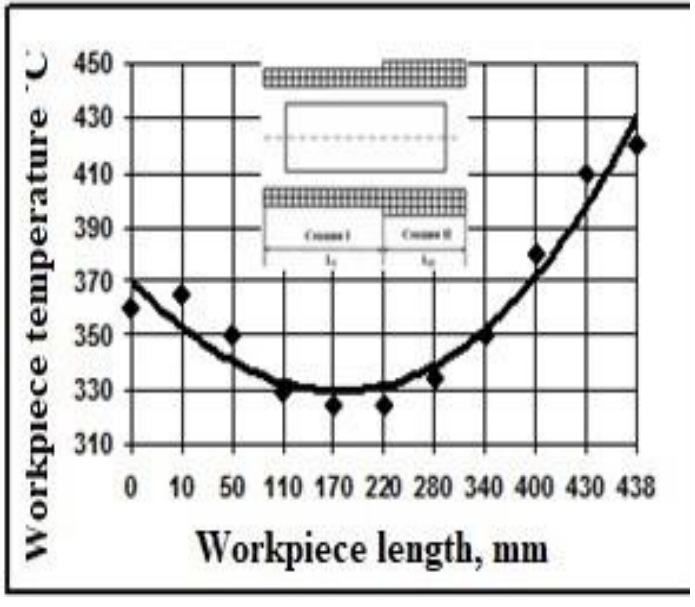
## Computer Research Results




Recess size x = 30 mm,
inductor length $L_i$ = 514 mm,
inductor current $I_i$ = 1850 A




Inductor Section Lengths
$L_I$ = 92 mm и $L_i$ = 422 mm,
inductor current $I_i$ = 1900 A

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## Characteristics of gradient heating options

| Energy characteristics | Option 1 | Option 2 |
|---|---|---|
| Active power of the system, kW | 143 | 136 |
| Power factor | 0,26 | 0,32 |
| Electrical efficiency | 0,85 | 0,86 |

Recess size x = 30 mm,
inductor length $L_i$ = 514 mm,
inductor current $I_i$ = 1850 A

Inductor Section Lengths
$L_l$ = 92 mm и $L_i$ = 422 mm,
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CONCLUSION

The developed automated calculation procedure allowsм

1) Reduce the complexity of entering the input data of the problem and reduce the total calculation time by 3 times.
2) Consider the possibility of implementing gradient heating with the required characteristics in one step and with less time.
3) Investigate induction plants in order to find an option to optimize the gradient heating process, which allows to reduce the energy consumption for heating workpieces.

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# Thank you for attention!

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