List of exam questions for the educational program
8D07202 / 8D07203 - «Metallurgy of ferrous and non-ferrous metals»

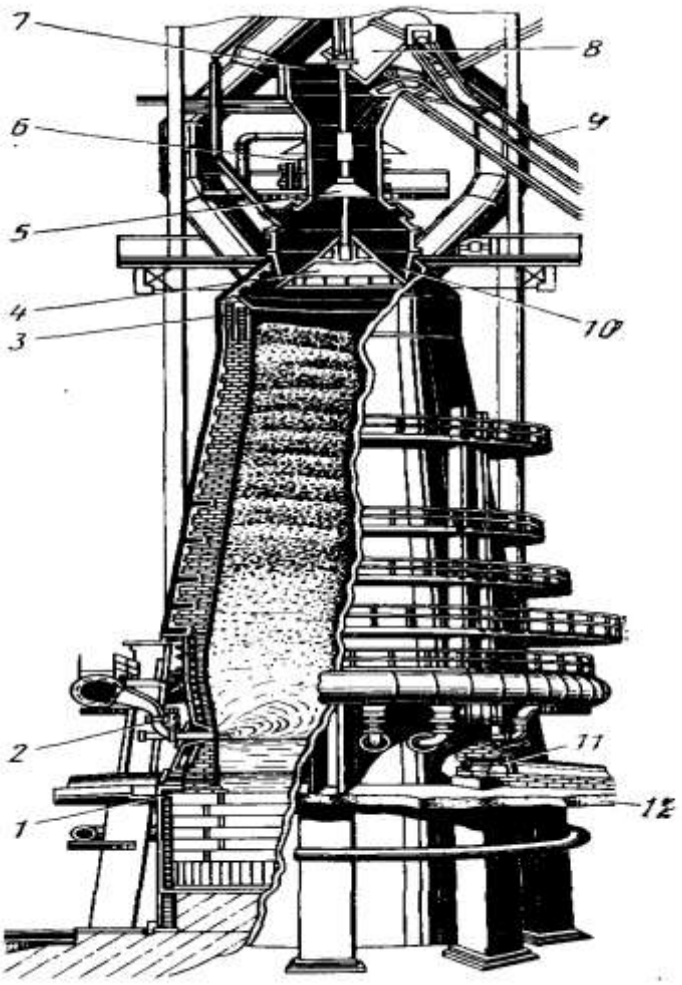
Module 1

1. Raw materials used in the blast furnace process.
2. Deposits and their main indicators.
3. Iron and its importance, place and contribution to human culture.
4. Coal coking processes and its importance.
5. Preparation of raw materials for metallurgical smelting.
6. Processes of crushing and grinding ore pieces.
7. Methods for obtaining concentrates.
8. Agglomerate production technology.
9. Processes of cutting ores and their necessity.
10. General characteristics of the cast iron production furnace.
11. Cast iron and its types.
12. Reduction of iron.
13. The Shape of the blast furnace and the characteristics of the processes taking place in it.
14. The process of obtaining steel from recyclable cast iron.
15. Metallurgical units in which steel smelting processes are carried out.
16. Kinetics of steel smelting processes.
17. VERTICON system scrap heater.
18. Methods of electric smelting of steel in arc furnaces.
19. Degassing of steel in a vacuum.
20. Physical and chemical state of melting.
21. Copper matte conversion.
22. Structure of solid and liquid ferroalloys and slags.
23. Physical and chemical bases of ferroalloy processes.
24. Magnesium production.
25. Metallurgy of aluminum.
26. The leading elements of ferroalloys.
27. Production of silicomanganese.
28. Production of carbonaceous ferrochrome.
29. Ferrotitanium production.
30. Silicon and silicon carbide.
31. Crystalline silicon smelting technology.
32. Properties of manganese and its compounds.
33. Technology of smelting high-carbon ferromanganese.
34. Metallurgy of lead.
35. Metallurgy of zinc.
36. Metallurgy of gold.
37. Metallurgy of krypton.
38. Minerals, ores and concentrates of manganese.
39. Ferrotungsten production.
40. Technology for the production of ferromolybdenum by the out-of-furnace silicoaluminothermic method.

41. Technology for the production of nitrided ferrovanadium.
42. Properties of molybdenum and its compounds.
43. Thermodynamics of titanium reduction reactions.
44. Theoretical foundations of silicon reduction by carbon.
45. Technology for smelting metallic manganese, low- and medium-carbon ferromanganese.
46. General requirements for the quality of ferroalloys.
47. Metallurgy of radon.
48. Classification of ferroalloy processes according to technological features.
49. Classification of ferroalloy processes according to the type of unit used.
50. Assortment of crystalline silicon and quality of charge materials.

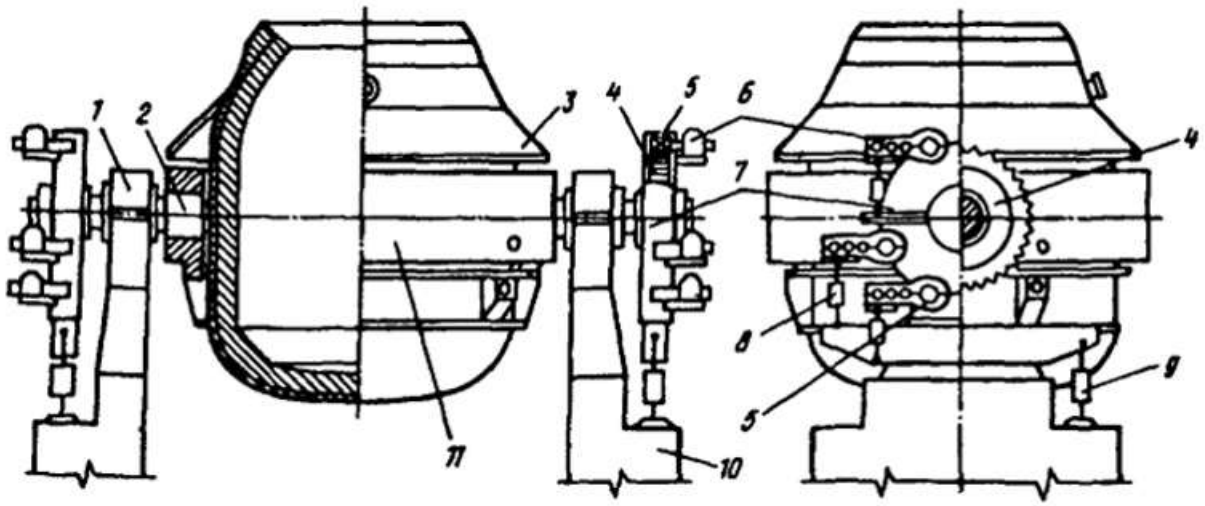
Module 2

1. Find the basicity of slag if CaO – 24.121%, MgO – 1.165%, SiO_2 – 27.246%, Al_2O_3 – 3.214%.
2. The composition of iron ore consists of 80% Fe_2O_3 and 10% SiO_2 determine the percentage of iron and silicon in the ore.
3. Write down the reactions of desulfurization and phosphorization process.
4. Record iron ore enterprises in our country.
5. The blast furnace gas contains 32% CO, 14% CO2, the rest is nitrogen (by volume). Determine the required amount of oxygen for combustion of 1000 m3 of gas.
6. Name the positions marked with numbers in the figure, their purpose, characteristics.



General view of the blast furnace

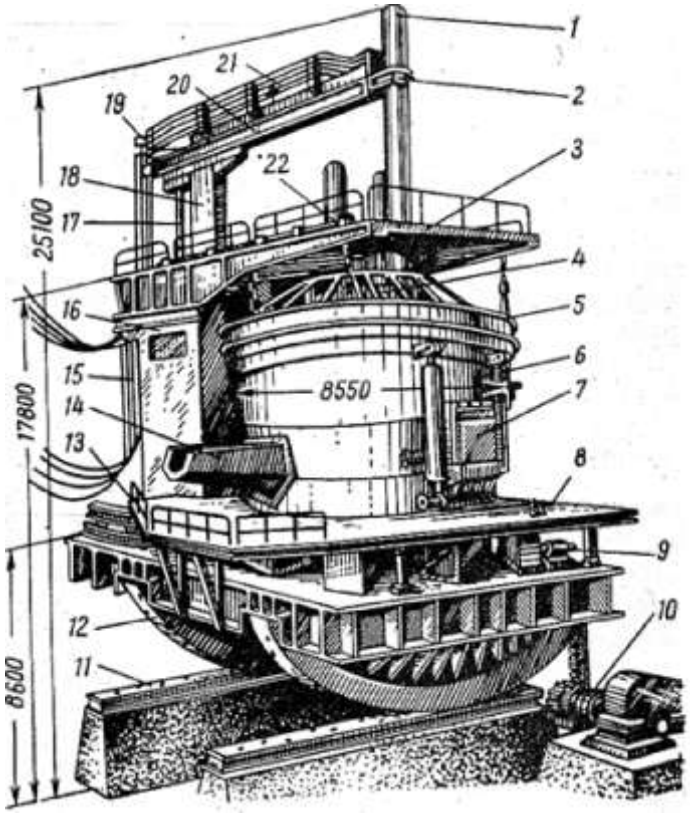
7. 5 g of a steel sample when burned in a stream of oxygen gave 0.1 g of carbon dioxide. The percentage of carbon contained in the steel.
8. Name the positions marked with numbers in the figure, their purpose, characteristics.



Oxygen converter

9. Calculate, on the basis of the molecular theory of slags, the activities of CaO and FeO in slags of the following composition, %: 28CaO; 15SiO2; 28FeO; 5Fe2O3; 5MgO; 2P2O5; 17MnO. To accept the existence of the following compounds in the slag: 4CaO · SiO2; CaO · Fe2O3; 4CaO · P2O5. All compounds are not dissociated. The content of MgO and MnO is calculated together with CaO.

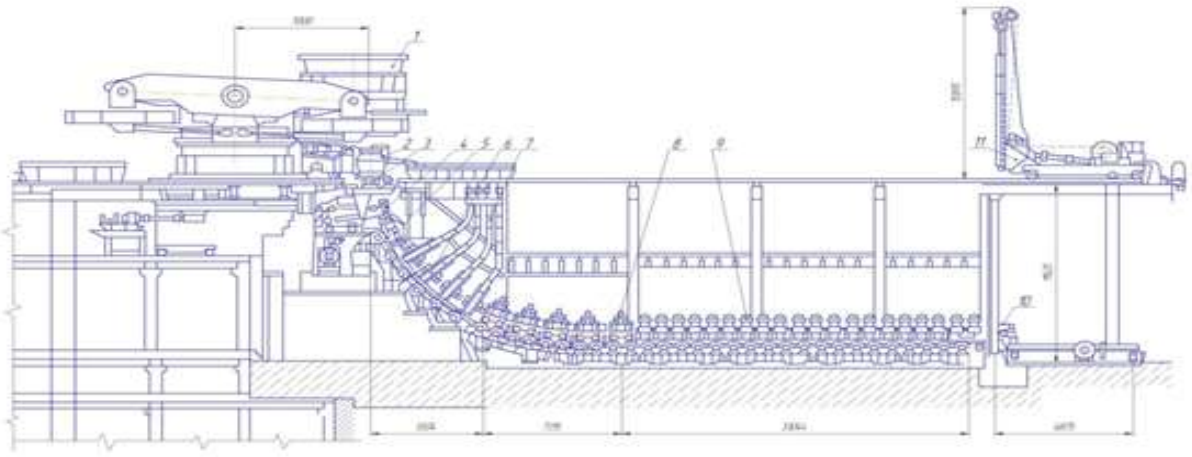
10. Name the positions marked with numbers in the figure, their purpose, characteristics.



Electric arc furnace ДСП-200

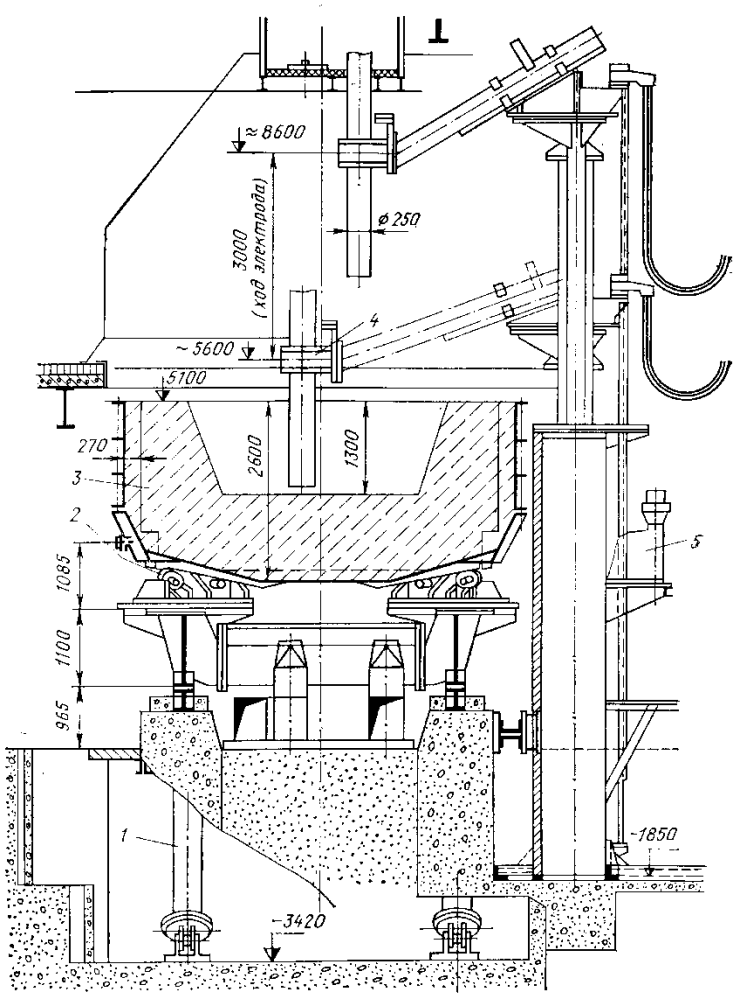
11. Considering the molten slag as a phase with a collective electronic system, calculate the activity of CaO and FeO in the slag melt of the following composition, %: 30CaO; 23SiO2; 25FeO; 6Fe2O3; 3MgO; 9P2O5; 4MnO at a temperature of 1580Cº.

12. Name the positions marked with numbers in the figure, their purpose, characteristics.



Continuous casting machine

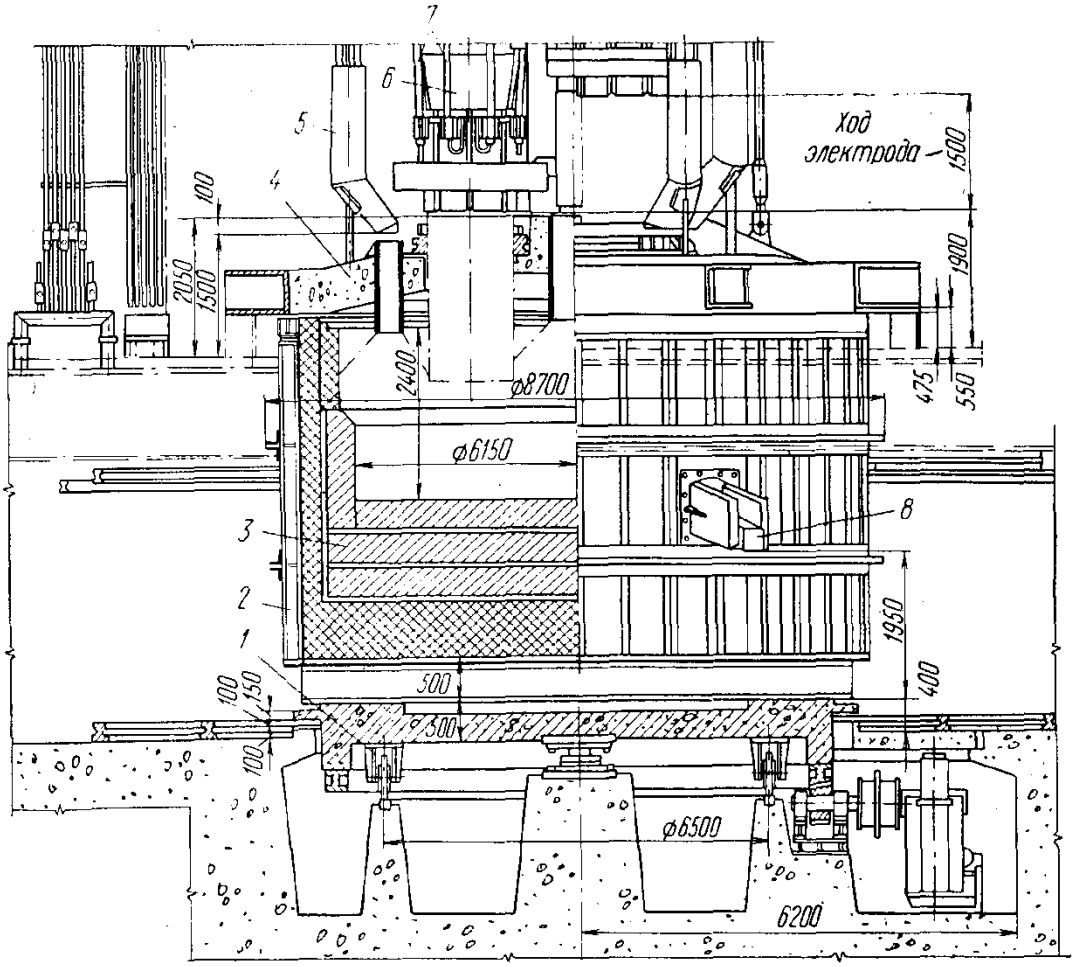
13. Calculate the activity of sulfur dissolved in molten iron of the following composition, %: 0.3C; 0.5Si; 2C2; 0.4Ti; 0.028S. System temperature 1600Cº.
14. Name the positions marked with numbers in the figure, their purpose, characteristics.



Refining furnace type RKO-3.5

15. Determine the duration of casting, if it is carried out on the continuous casting machine through a tundish. The height of the metal in the ladle is H = 0.5 m, the slag is Nsh = 50 mm, the diameter of the nozzle is d = 30 mm, all heats are G 300 t, the density of the slag is γsh = 3.5 t / m3.

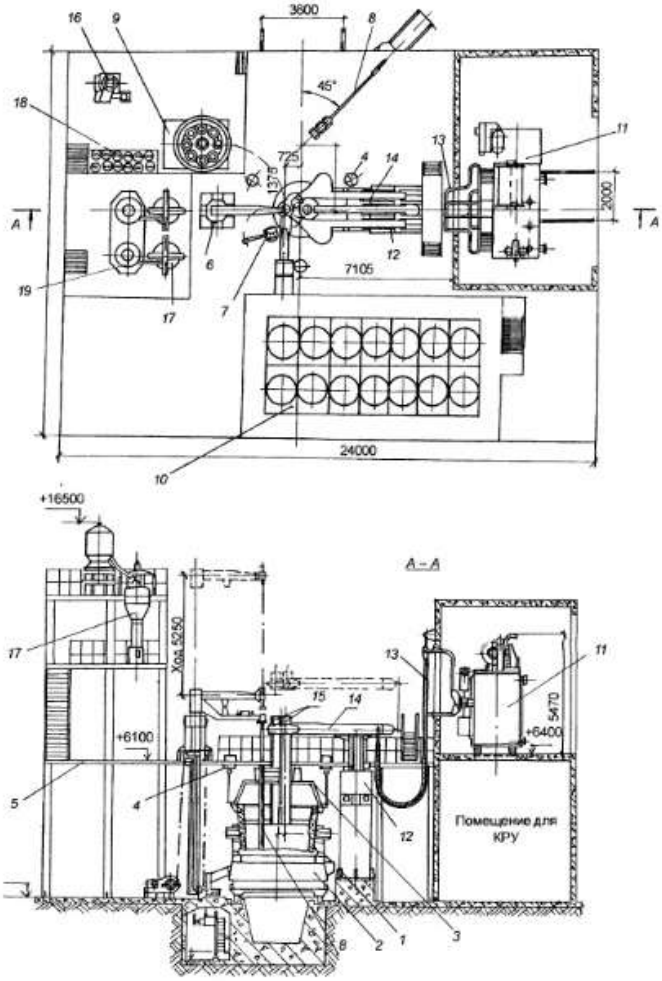
16. Name the positions marked with numbers in the figure, their purpose, characteristics.



Closed ore reduction furnace RKZ-16.5

17. Determine the productivity of the continuous casting machine during casting by the "melt to melt" method A and with pauses A1 for the following conditions: billet thickness a = 200 mm; workpiece width h = 1700 mm; K = 0.3; weight of liquid steel in a ladle P = 300 tons; number of heats in a series m = 20; the output of suitable ingots a1 = 0.95; the number of working days in a year n = 300; number of streams N = 2.

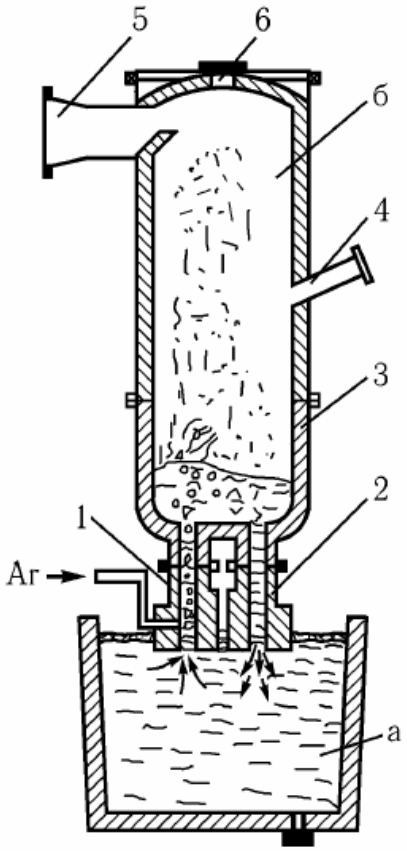
18. Name the positions marked with numbers in the figure, their purpose, characteristics.



Complex steel processing unit AKOS

19. The throughput capacity of the gas-cleaning tract of the converter with a capacity of 300 tons is 2.5 thousand nm3 / min of gas under normal conditions. Prove the possibility (impossibility) of increasing isp up to 5 m3 / t · min, assuming that all oxygen is consumed for the oxidation of carbon to CO.

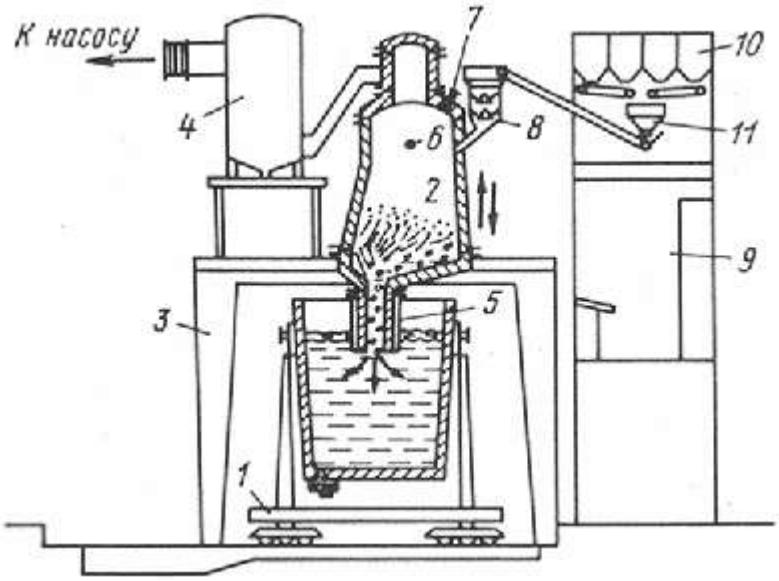
20. Name the positions marked with numbers in the figure, their purpose, characteristics.



Scheme of circulating evacuation of steel

21. It is required to obtain steel with a chromium content of 0.80-1.1%. Ferrochrome with a chromium content of 65% is used for alloying. The amount of residual chromium in the bath is 0.10%. The furnace charge is 100 tons. Chromium waste is 30%.

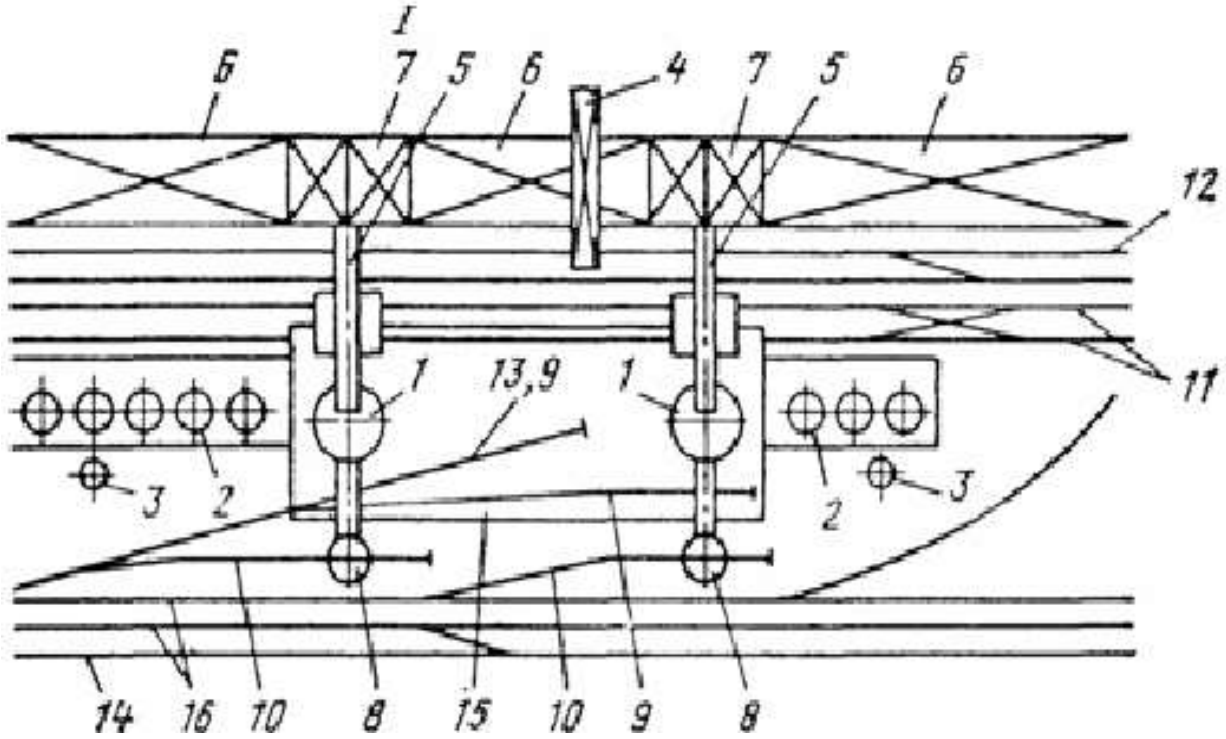
22. Name the positions marked with numbers in the figure, their purpose, characteristics.



Scheme of batch vacuuming of steel

23. Determine the annual productivity of the converter with a charge of 300 tons, with a melting time t = 50 min, the output of suitable ingots from the metal charge a = 0.9; the number of working days in a year is n = 300.

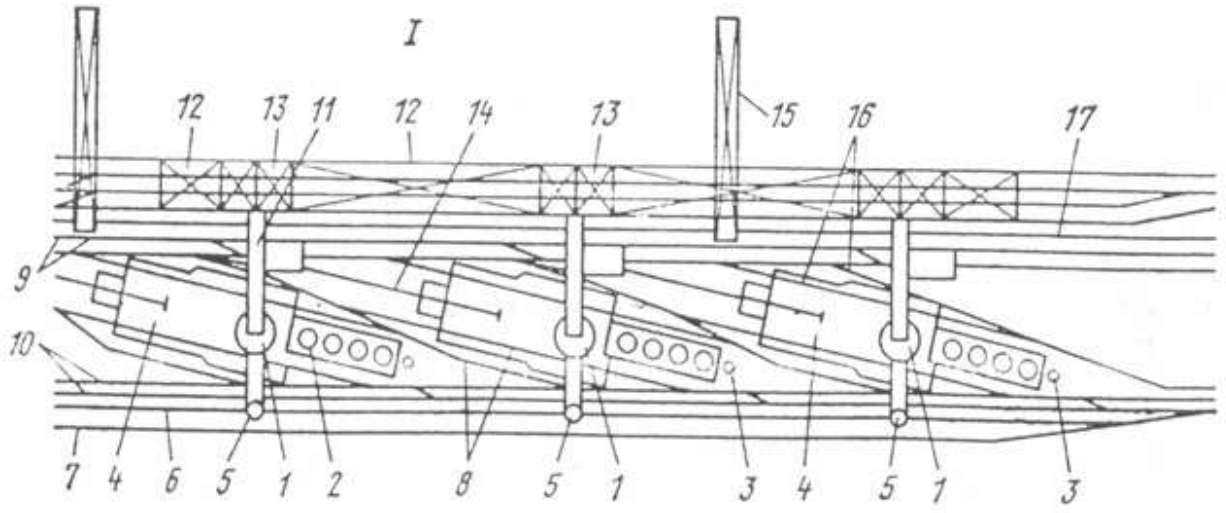
24. Name the positions marked with numbers in the figure, their purpose, characteristics.



Blast-furnace shop plan with block arrangement of furnaces (I - ore yard)

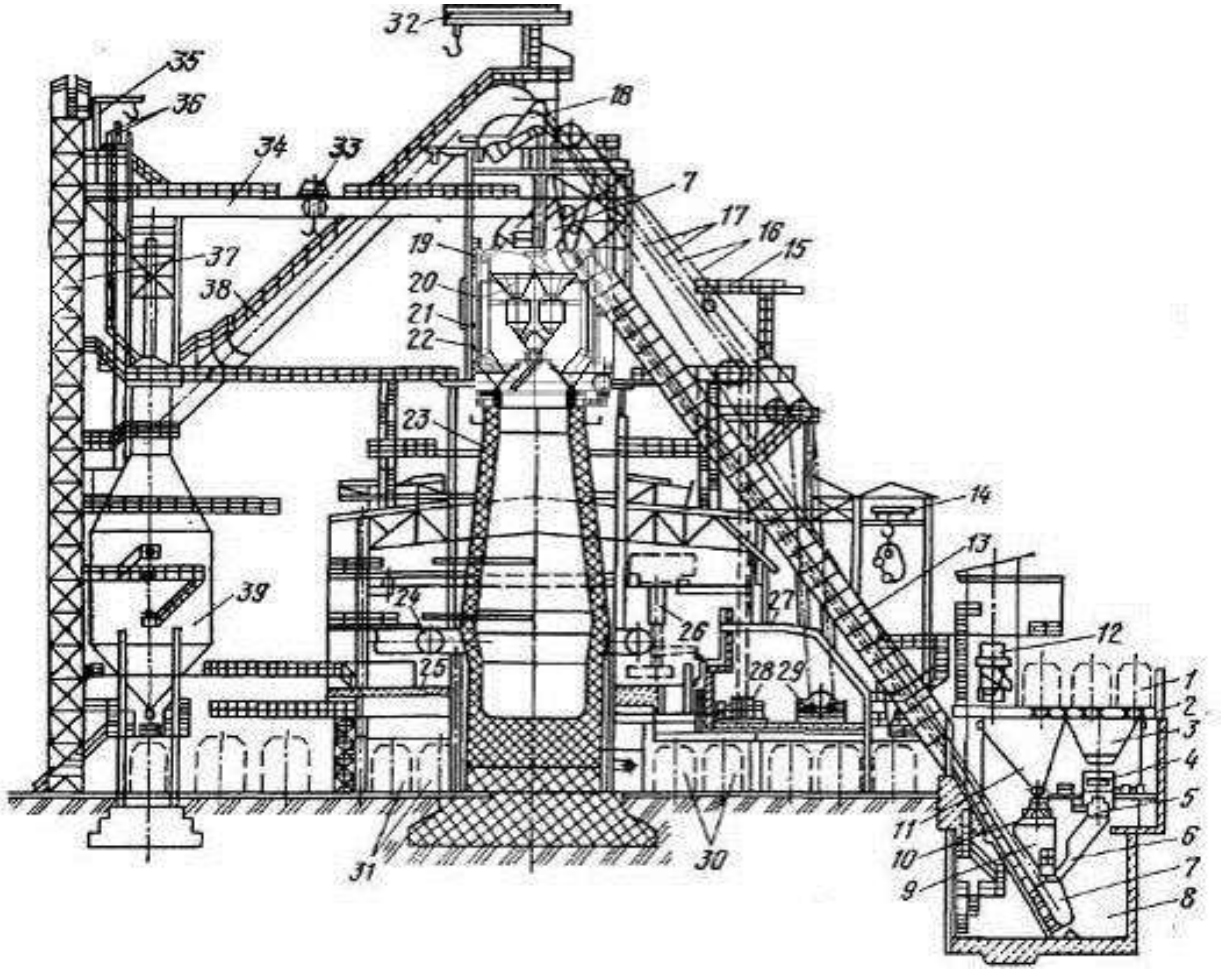
25. Determine the annual productivity of the continuous casting machine, if the duration of the casting cycle of one heat is τcycle = 60 min; the actual number of days of operation of the continuous casting machine in a year n = 330; coefficient of using the operating time of the continuous casting machine K = 0.8; coefficient of yield of suitable metal B = 0.95; the mass of liquid metal in the ladle is Q = 300 tons.

26. Name the positions marked with numbers in the figure, their purpose, characteristics.



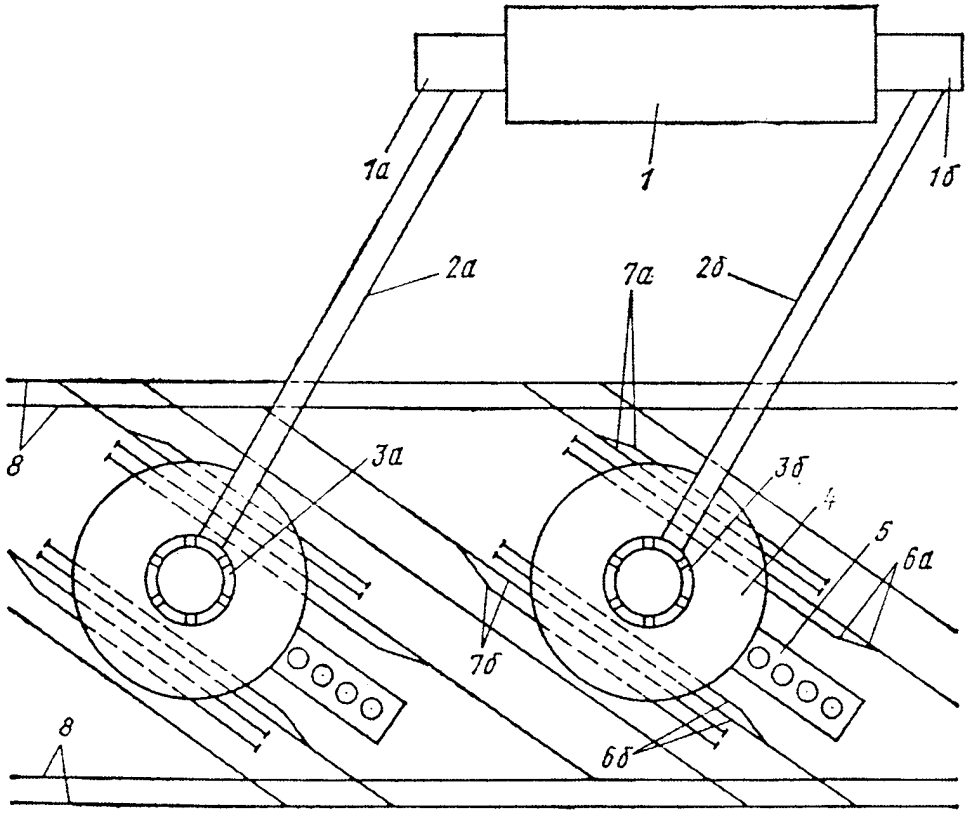
Blast furnace shop plan with an island arrangement of furnaces and a skip top lift (I - ore yard)

27. Determine the consumption of hematite ore containing 56% Fe per 1 ton of cast iron composition [C] = 4%; [Si] = 0.8%; [Mn] = 0.7%; [S] = 0.04%; [P] = 0.2%.
28. Name the positions marked with numbers in the figure, their purpose, characteristics.



Blast-furnace shop section

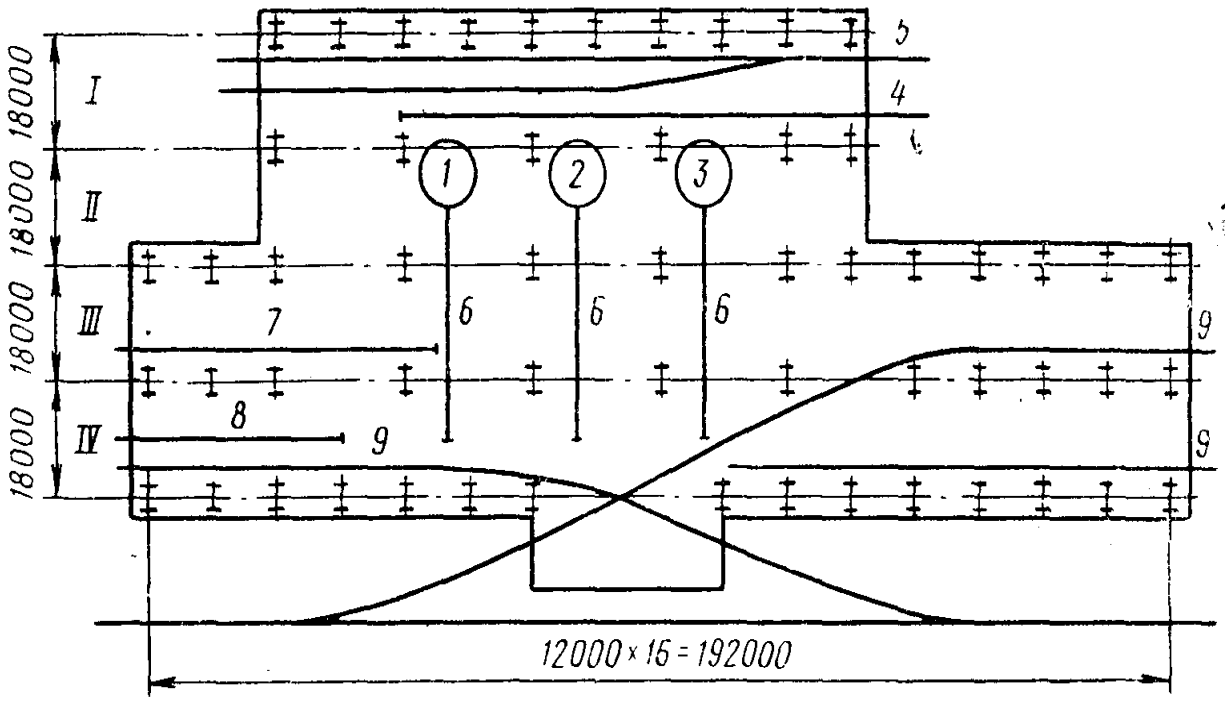
29. Lime composition: CaO = 91%; SiO2 = 3%. Determine Φ to obtain the basicity of the slag, equal to 3
30. Name the positions marked with numbers in the figure, their purpose, characteristics.



Blast-furnace shop plan with conveyor top lift and bucket cleaning of slag

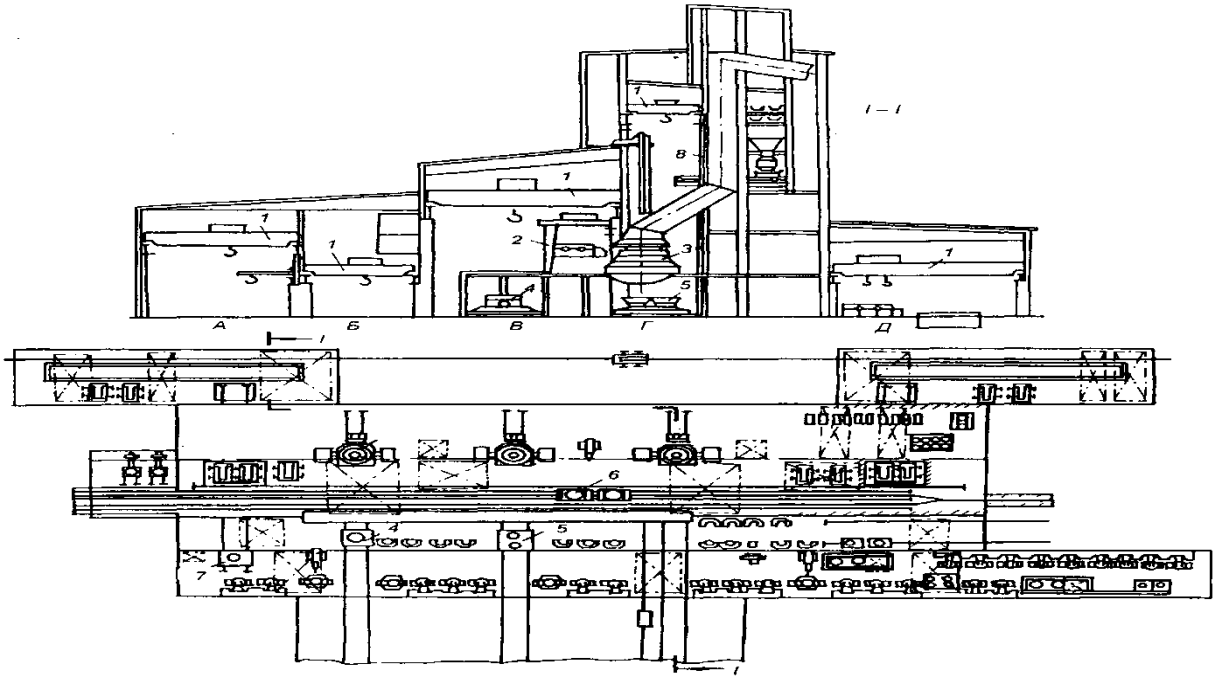
31. Determine the lime consumption for smelting for the following conditions: converter capacity 270 t; B = 3; cast iron / scrap ratio - 70/30; liquid yield - 90%. The silicon content in cast iron is 0.7%, in scrap - 0.2% when using lime of the following composition: a) CaO = 92%; SiO2 = 4%; b) CaO = 88%; SiO2 = 2%. Which lime is more effective?

32. Name the positions marked with numbers in the figure, their purpose, characteristics.



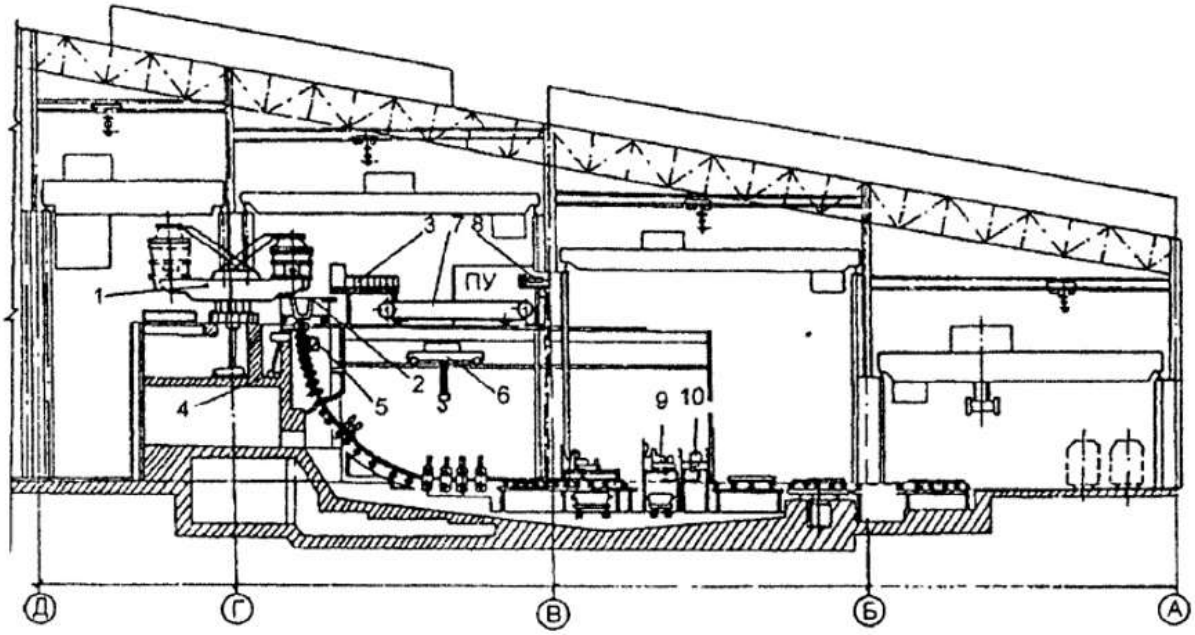
Scheme of the classical system of work and cargo flows of the oxygen-converter shop

33. Determine the chemical composition and amount of lime and gases obtained during the complete decomposition of 100 kg of limestone of the following composition: $CaCO_3$ = 98.5%; SiO_2 = 1.0%; Al_2O_3 = 0.3%; Fe_2O_3 = 0.2%.
34. Name the positions marked with numbers in the figure, their purpose, characteristics.



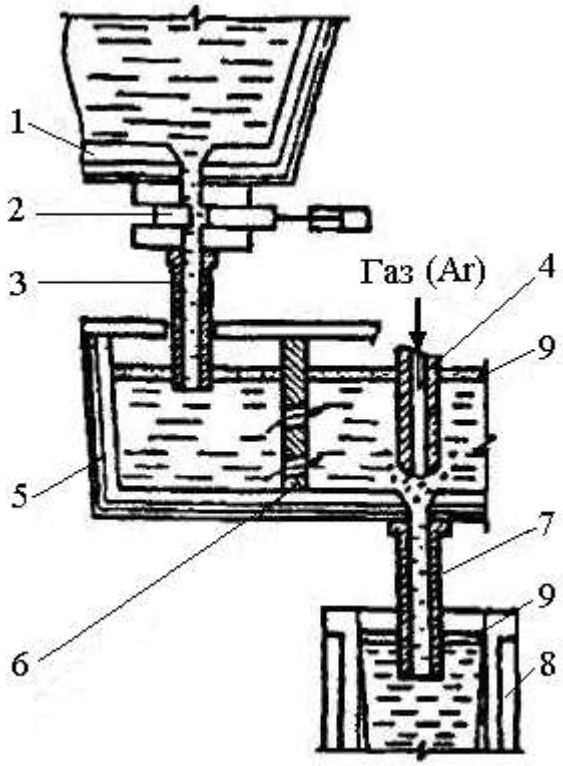
Converter shop plan and section

35. Determine the consumption of limestone for slagging ash 1 kg of coke. Limestone composition: CaO = 52%; SiO2 = 1.5%. Ash content in coke - 13.23%. Ash contains: 39.5% SiO2; 3.65% CaO. Slag basicity 1.2.
36. Write down the brand and composition of gadfield steel.
37. Limestone contains, %: 54.0 CaO; 0.56 MgO; 1.36 (SiO2 + Al2O3). Determine the fluxing ability of limestone and its consumption for slagging waste rock of ore containing, % 14.8 (SiO2 + Al2O3) and 4.6 (CaO + MgO), if it is required to obtain slag with basicity B = 1.05 in a blast furnace
38. Name the positions marked with numbers in the figure, their purpose, characteristics.



Section ECCS with a linear arrangement of machines

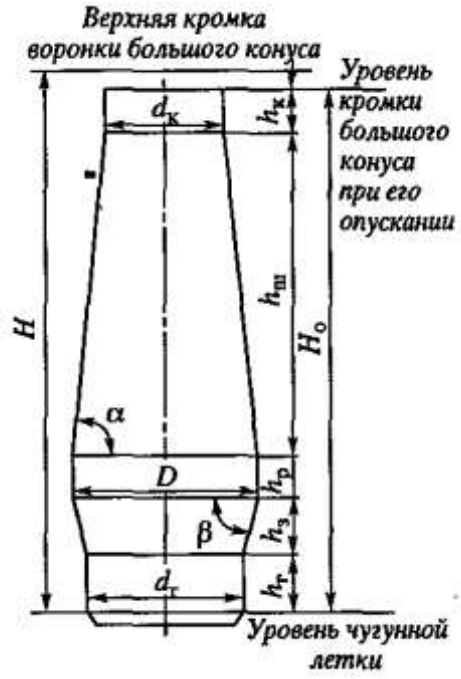
39. Two ores (A) and (B) are given. Determine the percentage of iron-containing minerals in each ore, if, according to chemical analysis, ore (A) contains Fetot = 46.0%, FeO = 13.0%, in ore (B): Fetot = 50.4%, FeO = 23, 0%
40. Name the positions marked with numbers in the figure, their purpose, characteristics.



Steel guiding system from steel ladle to mold

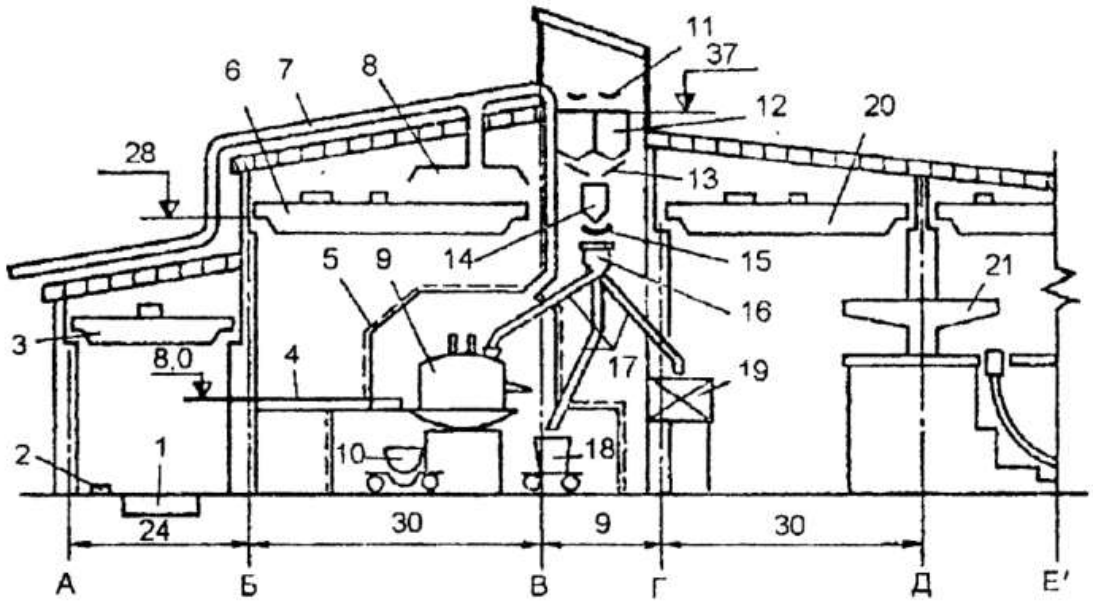
41. Converter capacity G = 370 t, casting cycle t = 72 min, mass velocity Q = 2.8 t / min m per strand, maximum slab width B = 2200 mm, CCM metallurgical length Ll = 19 m (radial CCM R = 12 m). Determine the optimal ingot thickness and linear casting speed.

42. Name the positions marked with numbers in the figure, their purpose, characteristics.



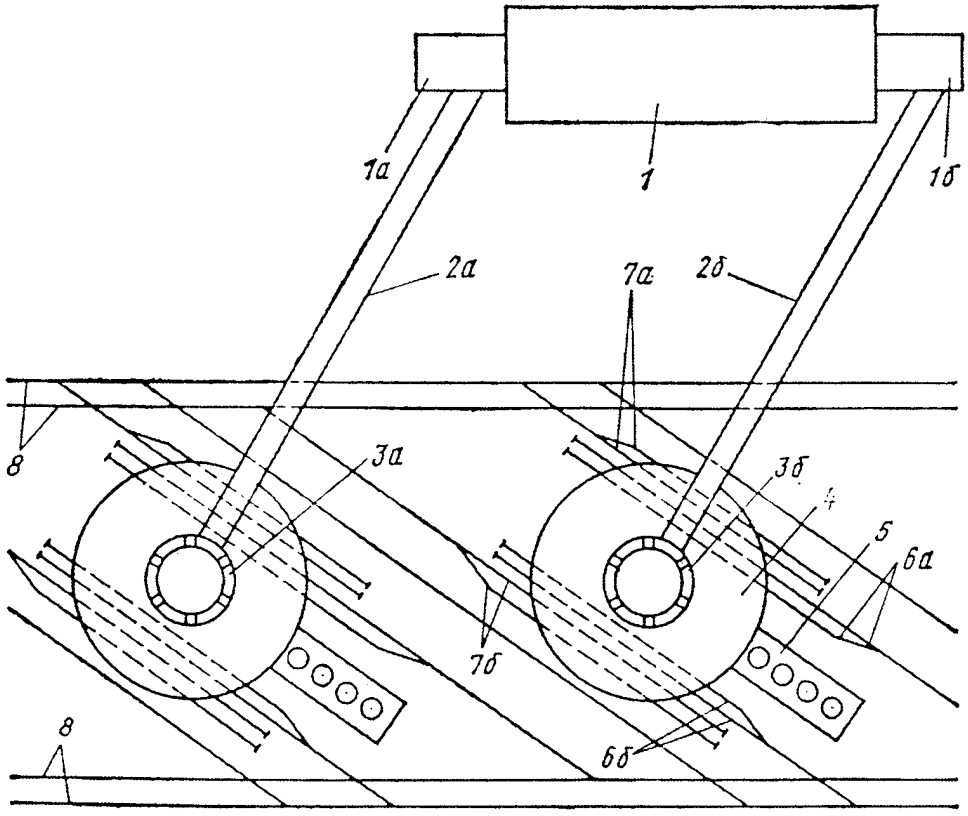
Blast furnace profile

43. Calculate the speed of the sintering carriage on the AKM-192 sintering machine with its capacity equal to 240 t / h. It is known that the height of the sintered layer is 0.5 m, and the bulk density of the charge is 2.1 t / m3 and the yield is 0.9.
44. Name the positions marked with numbers in the figure, their purpose, characteristics.



Cross section of an electric arc furnace

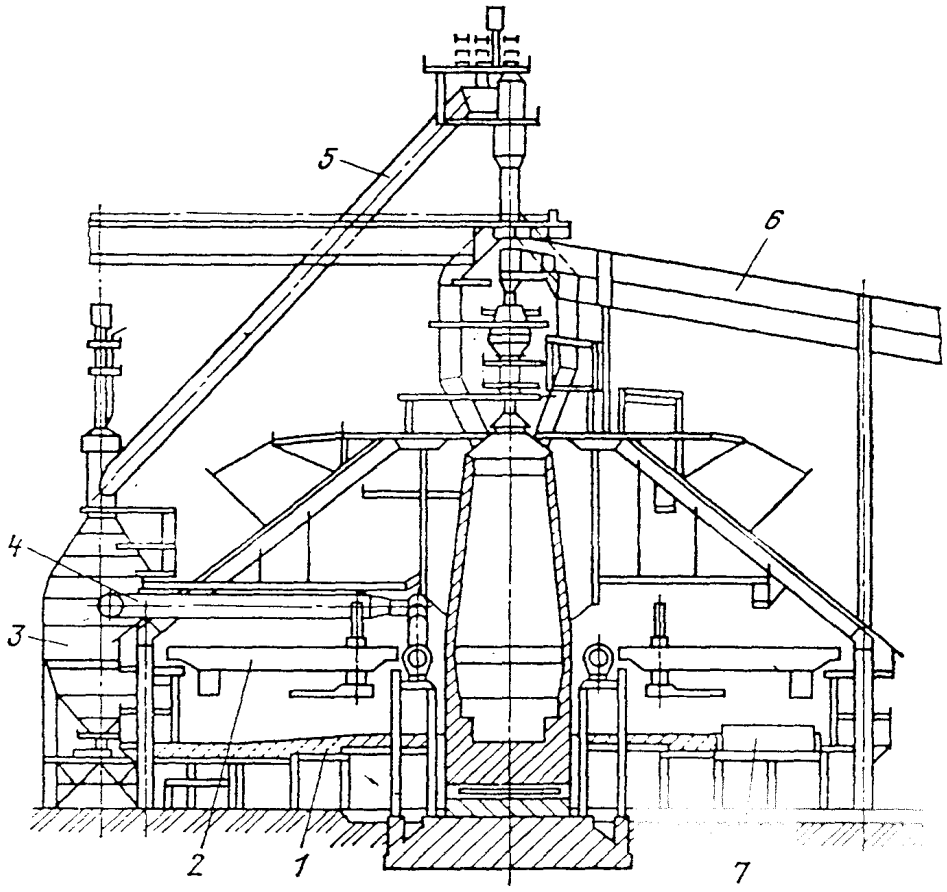
45. Calculate the productivity of the AKM-250 machine, if the height of the sintered layer is 0.45 m, the bulk density of the charge is 1.9 t / m3, the yield is 0.8, and the speed of the bogies is 2.1 m / min
46. Name the positions marked with numbers in the figure, their purpose, characteristics.



Blast-furnace shop plan with conveyor top lift and bucket cleaning of slag

47. The iron content in the ore is 31.5%, in the concentrate 51.2%, and in the tailings 12.1%. Calculate the enrichment rates.

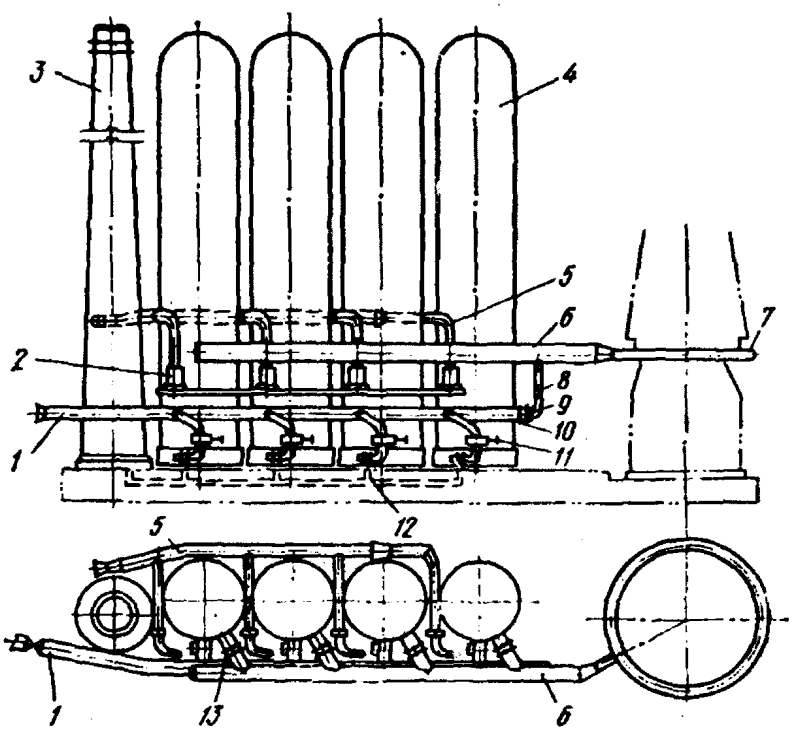
48. Name the positions marked with numbers in the figure, their purpose, characteristics.



Cross section of a circular blast furnace casting yard

49. Determine the amount of synthetic slag required to reduce the sulfur content in the metal by 0.01% when processing liquid steel with a mass of Gzh = 160 tons after deoxidation. The Mn content at the outlet was [Mn] b = 0.07. Deoxidizers were introduced into the metal in accordance with the specified steel grade 10sp. The sulfur content in the synthetic slag [S] is taken equal to 0.15%. $S_н$ = 0.04%.

50. Name the positions marked with numbers in the figure, their purpose, characteristics.



Air heaters block. Air heaters layout

Module 3

1. Steel vacuuming technology.
2. Increasing the durability of the lining of steel filling buckets.
3. Finishing of steel at the ladle furnace installation.
4. The process is carried out in two-bathroom furnaces.
5. Induction furnaces.
6. The behavior of manganese in steelmaking baths.
7. Melting equipment of special electrometallurgy workshops.
8. The main reactions in the chipboard bath.
9. Converter processes with bottom blast feed.
10. Electric arc single-electrode direct current steelmaking furnaces.
11. Chipboard with a scrap shaft heater.
12. Open jet steel casting technology.
13. Electron beam installations.
14. Converter processes with top blast feed.
15. The processes occurring in the cast steel.
16. Melting technology in smelting units in steel production.
17. VERTICON system scrap heater.
18. Out-of-furnace treatment and steel casting.
19. Technologies for the production of special steel.
20. Technological properties of minerals.
21. Processes for preparing minerals for beneficiation.
22. Apparatus for the preparation of minerals for beneficiation.
23. Processes for the processing and beneficiation of minerals.
24. Apparatus for processing and enrichment of minerals.

25. Auxiliary processes and apparatuses for mineral processing.
26. The structure and development trends of steel production.
27. High electric arc furnace technology.
28. Achievements and prospects for the development of out-of-furnace steel processing.
29. The main methods of surface hardening of steel products
30. Models of non-ferrous metal deposits in Kazakhstan.
31. Microstructures of aluminum and its alloys.
32. Combined metallurgical processes.
33. Statistical methods for managing the quality of metallurgical products.
34. Scientific and technological developments in metallurgy.
35. New metallurgical technologies.
36. Characteristics and composition of the casting and rolling complex.
37. Combined processes, prospects for the development of mini-metallurgical plants.
38. The main directions of restructuring of the metallurgical industry.
39. Innovative technologies in the production of cast iron.
40. Innovative technologies in steel production.
41. Research in the field of preparation of materials for blast-furnace smelting.
42. Detection of sulfur inclusions in steels.
43. Alloys with special physical properties.
44. Basic research methods in steelmaking.
45. Determination of the grain size of metals and alloys
46. Refining of non-ferrous metals.
47. Hydrometallurgical processes for the production of non-ferrous metals.
48. Electrochemical processes for the production of non-ferrous metals
49. Secondary non-ferrous metallurgy. Preparatory and basic processes.
50. Basic and auxiliary materials and processes of non-ferrous metallurgy.

List of recommended literature for exam preparation

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13. А.Б. Байбатша. Модели месторождений цветных металлов. Монография - Алматы, КазНТУ. 2012.– 264 с.
14. Минаев А.А. Совмещенные металлургические процессы. – Донецк: Технопарк ДонГТУ УНИТЕХ, 2008. – 552 с.
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Essay Topics

1. Actual problems of the development of metallurgical science in Kazakhstan.
2. Step into the wonderful world of metallurgy.
3. The choice of the profession of a metallurgist and the formation of personality.
4. What competencies should a modern metallurgist have?
5. Metallurgical professions of the future.
6. Metallurgy as a science and links with other scientific fields.
7. Kazakhstan Metallurgy Center.

8. Metals as a strategic material for national security.
9. World production and consumption of metals and alloys.
10. Young scientist-metallurgist. Inside view.
11. Metallurgy of the world.
12. Digital metallurgy of the future.
13. New materials as an alternative to metals and alloys.
14. The importance of metallurgy in human life.
15. Consumption of metals and trends in the search for alternative materials.
16. Problems of depletion of iron ore.
17. Problems of weapons disposal. What does metallurgical science have to offer?
18. Development of ethnic jewelry craftsmanship in Kazakhstan.
19. Technologies of the future in metallurgy.
20. Non-ferrous metals as an element of political blackmail.
21. Effect of dispersion on the properties of a substance.
22. Metals in our lives.