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UP-TO-DATE VIBROSCREENS OF RIVS SCIENTIFIC AND PRODUCTION CORPORATION

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There is the great demand for different types of the screens in many industrial branches. More than 300 enterprises and firms produce the screens outside CIS including 90 big firms: 32 — in the USA, 16 — in the Great Britain, 11 — in FRG, 6 — in Japan. Examination of the Russian and foreign patents shows the increasing interest in perfecting of the screens, in designing of the new models of the last ones.

The main tendencies of perfecting of the screens are directed to:

- increase of efficiency of screening;
- increase of reliability and durability of operation;
- expansion of the sphere of application and technological possibilities.

For all this the main attention is paid to increase of efficiency of screening.

"NPO "RIVS" traditionally makes efforts to perfecting of construction and to increase of technological parameters of the screens used in the crushing and comminuting chains. The screens process the big volumes of the materials at the beginning of technological process. They are demanded high efficiency of screening, high reliability and durability. In the case of operation of the crushers jointly with the low efficient classifying equipment the circulating load in the crushing cycle increases. It negatively affects the parameters of operation of the most expensive crushers and parameters of the cycle "crushing-comminuting" as a whole. There are two ways in increase of efficiency of screening: extensive — with increase of the area of the sieve surface and intensive — with increase of the amplitude of vibration of the screen and decrease of the angle of the screen incline. The second way is reached by means of application of the self-balanced screens with the two self-synchronized vibrators instead of traditional inertia screens with the only vibrator.

Application of the screens with increased area of the sieving surface is the most justified at the enterprises, where the project scheme permits to install the screens without significant volumes of construction works. For example, application of the screens GST-81R (fig. 1), manufactured by "NPO "RIVS" instead of the screens GST-71, at Satpaevsky CP (concentration plant) of the corporation "Kazakhmys" (Kazakhstan) has permitted to increase annual productivity of the factory from 3 to 5 million tons without replacement of the crushing equipment. But installation of equipment of the large dimensions is impossible in the most cases. So, it is necessary to work up the more effective apparatus with the same dimensions. The screen GST-72S-RIF (fig. 2),

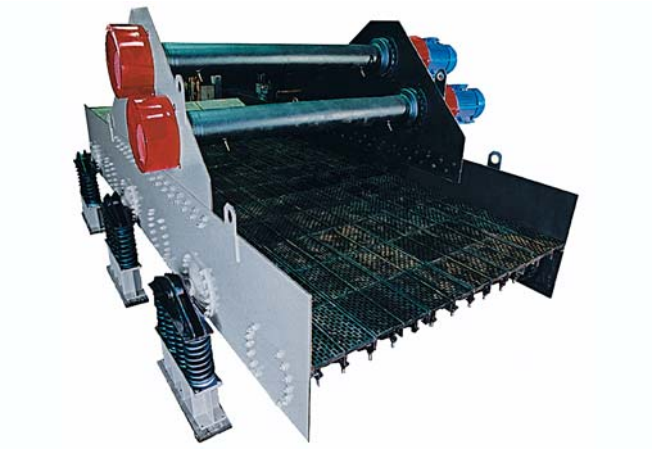

Fig. 1. Screen GST-81R

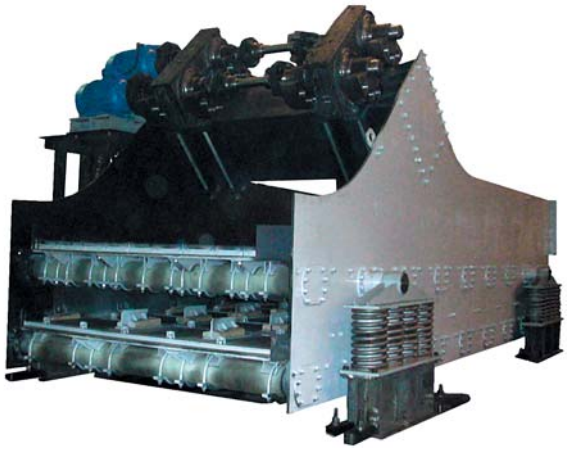

Fig. 2. Screen GST-72S-RIF

designed by "NPO "RIVS" to order of GMK "Noril'sky nickel", is the example of the new approach to the task. The new screen is destined to replace the screens GIST-72 operated at the combine earlier.

Comparative technical parameters of the screens GST-72S-RIF and GIST-72 are given in the table 1.

Replacement of the screens GIST-72 by the screens GST-72S-RIF has permitted to use the single technological chain instead of thy two parallel ones used earlier.

It has to be noted that in the both above mentioned cases working up of the new equipment has been accompanied by solution of additional questions. The last ones do not arise in creating of the screens less than 10 m^2 and with relatively small amplitude on vibration of the box. Today it has appeared the standard constructive and program-apparatus complexes. They allow to calculate construction of the screens at the projection stage, to forecast technologic parameters of operation of the screens with the high degree of reliability and with sufficient trustworthiness. Constructors works for creating of vibration screen include certainly the following stages: calculation of stability of the self-synchronization [1, 2], analysis of vibration moving of material along the sieve, determination of the frequency and the form of vibrations, strains and deformations of the elements of construction of the box. Equally with its own soft-wares used for specific calculations (self-synchronization, vibration moving) the corporation uses the universal commercial soft-wares for analysis of the strained-deformed state of the construction [3] and for determination of dynamical parameters. They realizes numerical solution of the tasks of elasticity theory by means of the method of the final elements.

Dimensions, type and parameters of the sieving surface are determined proceeding from *technologic requirements* to constructed machine. In the case of application of the sieves with the stiffness influencing on the screening (rubber and polyurethane sieves) it is necessary to analyze the strained-deformed state of the sieves.

Comparative technical parameters of the screens GST-72S-RIF and GIST-72

Parameters	GST-72S-RIF	GIST-72
Dimensions of the sieving surface, mm	6000×2500	6000×2500
The number of the layers of the sieves, pieces	2	2
Sizes of the holes in the sieves, mm		
upper	25	30
lower	2	2
Angle of incline of the sieving surface, degree	2.5	2.5
Amplitude of vibration, mm	7–10	6–8
Maximum coarseness of initial feeding product, mm	120	120
Real productivity, t/h	650*	350
Power of electric drive, kW	2×22	2×22
Mass of the screen with the drive and frame, tons	17.3	15
Efficiency of screening of the sieves, %		
upper	86	73
lower	87	54
Inter-repair cycle, months	3**	2**

*Maximum productivity of the screens is limited by productivity of the crusher KMD-2200T
**Inter-repair cycle is determined by the life of the sieve surfaces

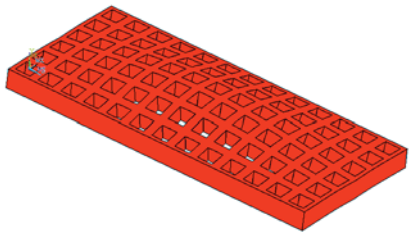

Fig. 3. Form of the rubber sieve in the moment of the maximum displacement of its contour

Above mentioned task — dynamical analysis of the construction of the super-elastic material — is one of the most difficult in simulation. Calculating methods and programs directed to analyze of the quick-passing non-linear processes are used for achievement of the aim. Fig. 3 shows the polyurethane sieve. The form of the sieve has been obtained by the direct integration of the equations of movement of its final-element model. It has been supposed that the sieve is pre-stretched, periodical movement of the contour is described by the target function of the time. The program complex LS-DYNA has been used for calculation.

The calculations allow determine influence of the form of the holes, thickness of the sieve surface, preliminary tension properties of the material, amplitude and frequency of vibration on the firmness and dynamical parameters of the sieving surface. Definition of the rational form of the sieve vibration ensuring the efficient screening is the next stage. The vibrations may be rectilinear, circular, elliptical depending on accepted kinematic scheme of the

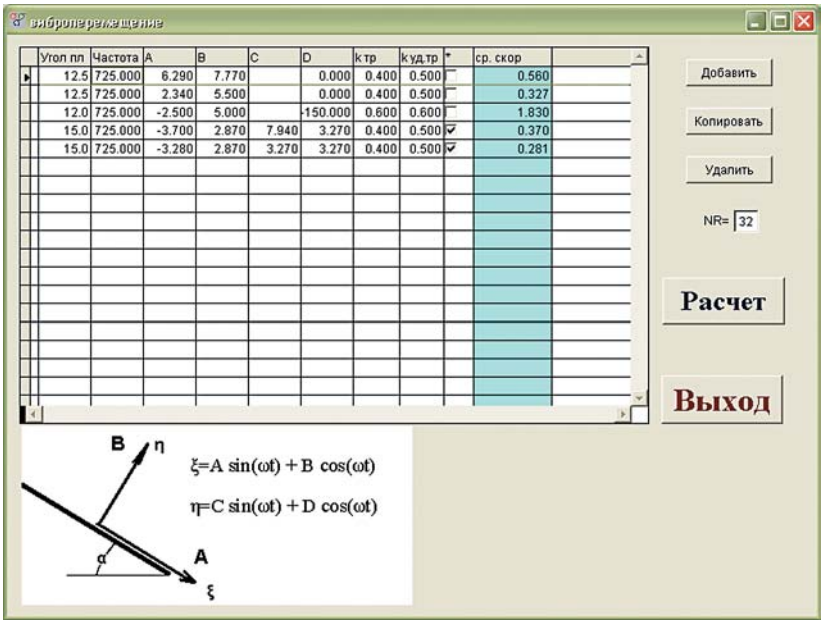

Fig. 4. Interface of the program of vibration motion of material point

screen. NPO has worked up the model of motion of the material point relative to the surface accomplishing harmonic oscillations in accordance with the common enough law (fig. 4). The model is used for definition of velocity of material motion.

Designing of the box and drive, corresponding to determined earlier kinematic parameters, has begun after definition of required parameters of oscillation of the working body. After selection of constructive scheme it is constructed its kinematic model. The model may be used for achievement of distribution of the mass and parameters of the drive answering the purpose. The purpose is reached by operational changes of constructive parameters. For example, the program ADAMS is the suitable means. It permits to build the kinematic scheme of the screen on the base of 3D-constructive working drawings, to carry out numerical integration of the equations of motion of the box in automatic regime and to obtain the trajectory of motion of selected points of its construction (fig. 5).

Analysis of the own frequencies and forms of the screen box oscillation and control of strength of its elements are the next stages. The calculations are carried out by means of traditional final-element solution of the task about forced harmonic vibration of elastic construction by the method of decomposition of the own forms and frequencies [4, 5]. Advantages of the numerical simulation in comparison with the simplified "manual" calculation consist in the fact that the number the dangerous (lowest) forms of oscillations can not be obtained in simplified calculations.

The constructive changes ensuring the proper protection against the resonance and firmness of the construction are made in accordance with results of analysis of parameters of the box.

Of course, it has to be made some assumptions and simplifications in drawing up of the calculation scheme of the screen [6]. First of all it is supposed that all joints of construction elements are perfected, i. e. the contacting surfaces of the flange junctions are deformed equally without loss of the contact and without slipping. The welded seams are assumed as equally strength and so on. Value of the "attached mass", i. e. the mass of the screened product, that is considered as hard-attached to the sieve, is assumed proceeding from the some approximate conceptions. So, the model can not be considered as absolutely identical to the real construction.

The proper construction of the model for obtain of the adequate results of calculations requires the complete of statistical data about the real parameters of operation of the real constructions of the

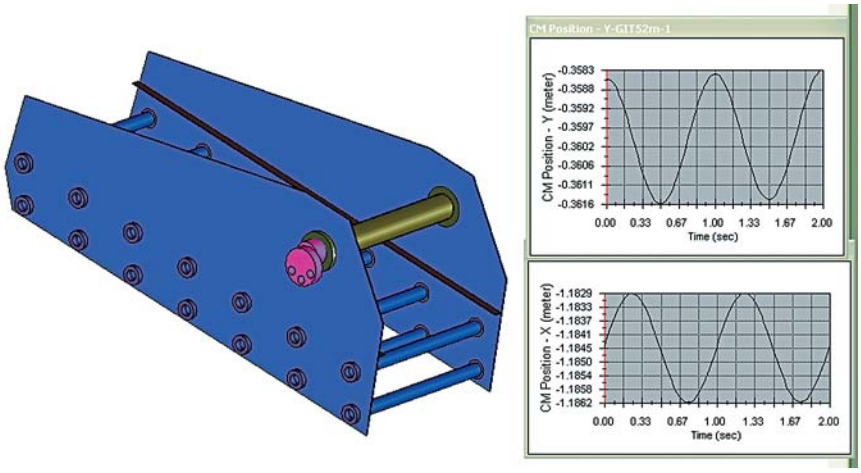

Fig. 5. Example of calculation of trajectory of motion of the points of the sieve of the screen

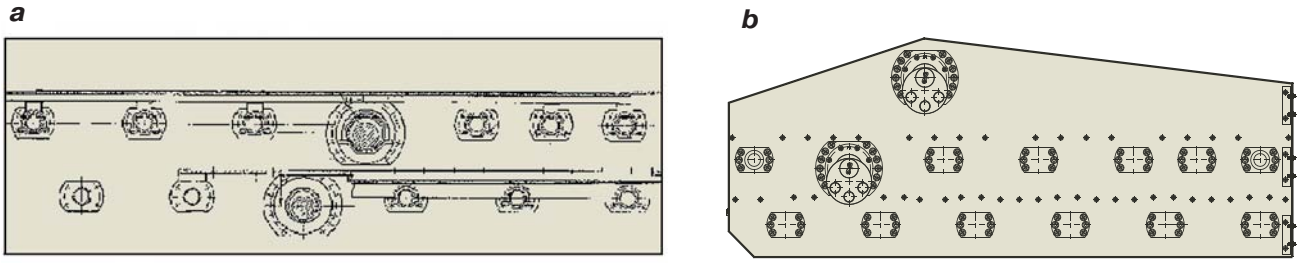

Fig. 6. Arranging schemes of the screen GST-52MU:
a — initial, *b* — corrected

screens, embodied in the metal. With that end in view it is carried out the complex of the measurements of parameters of the screens in the course of the factory testing. NPO "RIVS" has bought the modern measuring technique (vibrometers, tensor-measuring stations) for the factory testing. It is possible to say today that constructed models ensure the precision sufficient for engineering calculations. After obtaining of sufficient volume of statistical data further works for correction of the calculations will permit to forecast exactly the parameters of operation of the screens (both for average and for different specific working conditions).

Undoubtedly, the mathematical simulation is carried out under supposition of the ideal making and quality of the units of construction of the screen, lack of the latent defects in the machine parts (defects of rolling and so on). So, the quality of the final products depends not only on the quality of projection but on the level of responsibility of the workers in the course of producing and operation of the screens. Increase of technological parameters may be reached by increase of the loads on the screens. But it requires to take into account some factors that may be insignificant in calculations of the less power-loaded apparatus. So, it is necessary to increase significantly requirements to quality of the used materials and to keep technological regimes of producing. The screen GST-52MU made by NPO "RIVS" for Uchalinsky GOK may be the example of increase of importance of the factors that were not taken into account earlier. The screen is exploited for three years with the high technological parameters and reliability. But increase of content of the moist clay admixtures in initial material in the spring-autumn period leads to adhere of the moist small pieces to the lower transport chute. It displaces the centre of gravity of the screen and breaks synchronization of the vibrators. It is necessary to exploit the screen with the lower productivity in this period. After detailed analysis it has been built the mathematical model of the screen, and the arranging scheme (location of the vibrators) has been changed. Fig.6 shows initial and corrected arranging schemes of the screen GST-52.

The screen GST-72S-RIF mounted at GMK "Noril'sky nickel" is the example of necessity to increase the demands of quality of the used materials. The screen primarily has been made with application of the modern methods of calculation and projection. Its construction had had the sufficient safety margin and reserve adjusting of the own frequencies of vibration of the box. The results of the tensor-metric measurements were within the limits of permissible values. But the defect of the rolling sheet, not revealed in the course of the entrance control, and un-sufficient perfecting of technology of mounting have led to appearance of the crack in the rolling sheet of the box after 8 months of the operation. Hardness of construction of the box has been increased on the base of analysis of the mathematical model for elimination analogous breakages in future. Fig. 7 shows the forms of the own oscillations of initial and corrected model of the box of

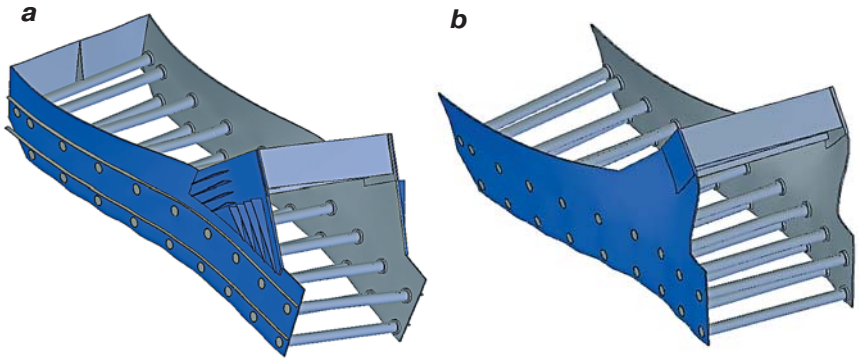

Fig. 7. Lowest form of the own oscillations of initial (*a*) and corrected (*b*) models of the box of the screen GST-72

the screen. The under-vibrator beam was put out of action because of unqualitative welding technology and subsequent thermal treatment at the same screen. The causes of the breakages have been eliminated, and today the screens operate without censures.

Thorough analysis of analogous breakages and registration of the last ones in the course of designing of the new screens permits to solve successfully the tasks of increase of efficiency and reliability of the screens of the types GST and GIT.

Today NPO "RIVS" offers to the customers the worked up models of the screens tested in the course of operation. Besides, NPO "RIVS" can to work out the screens adapted to classification of the materials with non-standards coarseness and humidity, non-traditional loading and unloading, non-standard width and for especially difficult working conditions.

It has to be said apart about sieving surfaces.

Sieves are the main element of the screen. Efficiency of screening depends greatly on construction of the sieves. Economic factor plays significant part: the sieves are the most wearing and often replaceable elements of the screen.

Thus, life of the most popular today steel net of the low carbonaceous steel for screening of the ores does not exceed few days. The main advantage of the steel net is the big "living section". In combination with relative cheapness it stipulates the wide application of the steel nets. Shortcomings of the last ones are evident: short life and obstruction of the sieves with the screened material, especially in the case of presence of the clayey admixtures in the material.

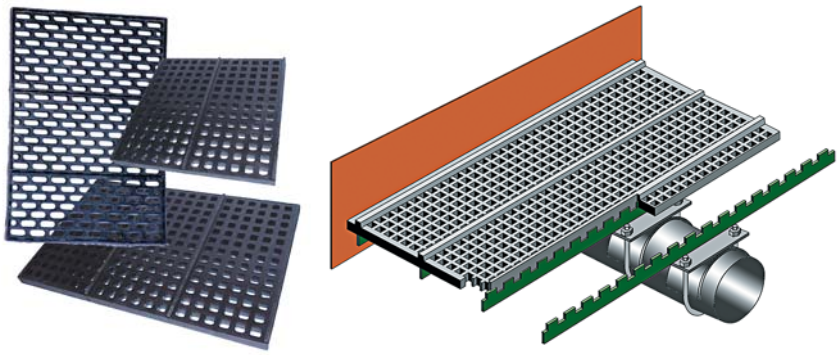

Fig. 8. Sieves "ESALH" and scheme of mounting of the last ones

So, the main direction of perfecting of the sieving surfaces is application of the rubber and polyurethane sieves.

The rubber sieves have the smaller living section than the metal ones, but they have the following advantages:

- high were resistance and consequently the longer (few times) period of life;
- ability for self-cleaning stipulated by elasticity of the rubber threads "equalizing" living section of the metal nets in the course of operation;
- lower level of the noise in the course of operation;
- lower operational costs owing to decrease of the work inputs and idle time of the screens because of the more rare replacement of the sieves.

Many firms produce the rubber sieves today. Every firm uses its own sort of rubber and its design of the under-sieve devices for fastening of the last ones.

The firm "RIVS" produces the rubber sieves of the type "ESALH" with the holes of the different sizes, un-reinforced, single-layer, of the rubber with use of the natural caoutchouc. The sieves are characterized by the quick-removing, fastening at the special under-sieves devices without the fastening bolts, brads and cramps. The cards with the sizes 500x500, 500x250, 500x750 mm may be installed at the any standard Russian screens. After negligible adjusting of the under-sieve devices the cards may be installed at the foreign screens too. The sieves "ESALH" and the scheme of installation of the last ones are shown at the fig. 8. The sieves have shown high efficiency. For example, the sieves with the holes 25x25 mm (screen GST-52MU) mounted at Uchalinsky GOK have been exploited for one year. They have sieved 1 million tons of the ore, i. e. 130 thousand tons per 1 m^2 of the sieving surface. The rubber sieves designed by NPO "RIVS" have the high wear resistance. They are poorly subjected to obstruction with the screening material. They are easily changeable.

Positive results of exploiting of the sieves have been obtained at Noril'sky concentration factory (the screen GST-72), at Alexandrinsky mining-ore company (the screen Nordberg), at Uchalinsky GOK (GST-52), at "Apatite" JSC (GIST-72), at Aksusky ferroalloy plant and others.

Fig. 9 shows technological parameters of operation of the screen GIST-72, equipped with the rubber sieve with the holes 25x25 mm, mounted in the building of screening at ANOF-3, and analogous screen with the steel sieve with the round holes 28 mm diameter.

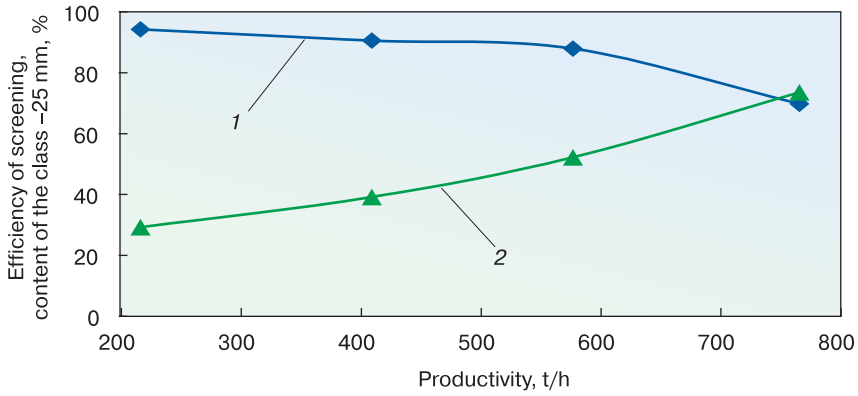

Fig. 9. Dependence of technological parameters of screening (%) by the class –25 mm on the load (rubber sieve with the holes 25x25 mm):
1 — efficiency of screening
2 — content of the class –25 mm in the above-sieve product

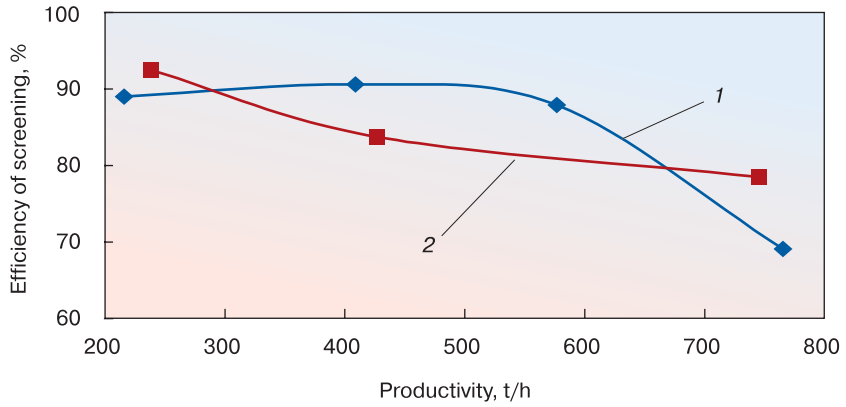

Fig. 10. Dependence of efficiency of screening by the class –25 mm on the load:
1 — rubber sieve, hole 25x25 mm
2 — metal sieve, hole 28 mm diameter

Brought data shows that application of the rubber sieving surfaces ensures the higher efficiency of screening in the working diapason of loading. Consequently it permits to decrease circulating load. It has to be noted that before putting into operation of the rubber sieves at ANOF-3 the screens GIST-72 were equipped with the springy bearings instead of the rubber shock-absorbers. It has led to additional positive effect even in the case of application of the metal sieves.

Of course, introducing of the rubber sieves in the large scale needs the adjusted control of quality of the rubber mixture and regime of the sieves vulcanization. Besides, it needs the further perfecting of construction, first of all — of the under-sieve devices. The sieve sags often upon influence of the high specific loads. The sag is stipulated by residual deformation of the rubber. Sometime it is observed bending of the bearing racks under big load. For elimination of above mentioned effects in operation of the sieves under increased specific load and for screening of the materials with the large coarseness construction of the under-sieve devices has been changed. It has been reinforced the main bearing racks and introduced additional transversal sieve bearings. It has permitted to increase significantly stability of parameters of screening.

Besides, it is produced the sieves for screening of the more coarse materials. The holes of the sieves are round and square. Its sizes vary from 40 to 60 mm. The sieves are thicker and in comparison with the sieves "ESALH" they are fastened by another way.

Thus, today NPO "RIVS" has all necessary possibilities for increase of technological parameters of screening of the different materials in different conditions. Produced by the corporation the dimensional range of the screens of the different types (including equipped with the rubber sieves ESALH) permits to select the standard solutions in the most cases. If the standard version does not comply with requirements of the customer, the corporation can produce the special version of the screen on the base of existing ones. The new screen will have all necessary parameters.

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