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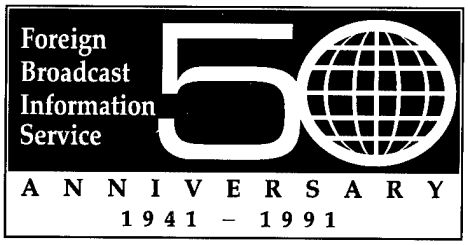

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Glow Around Meteorological Rockets MR-2

917F0097A Tomsk OPTIKA ATMOSFERY in Russian No 9, Sep 90 pp 946-953

[Article by Yu.Ye. Belikov, Institute of Applied Geophysics imeni Academician Ye.K. Fedorov, USSR State Committee on Hydrometeorology, Moscow]

UDC 551.510:629.783

[Abstract] The data on glow around meteorological rockets are analyzed, such a glow having been recorded on board the MR-12 rocket along its descending trajectory. Two spectroradiometers SR-184 and SR-185 with a 3° field-of-view angle each were mounted inside the rocket head, for measurement of radiation emission and scattering in the upper atmosphere. Their optical axes were oriented along the rocket's axis of rotation (SR-185) and at a 55° angle to it (SR-184), the optical axis of the SR-184 sweeping a cone with a 110° aperture angle due to rotation of the rocket. The glow intensity was measured in four narrow-band spectral channels of the the SR-184 (369 nm, 457 nm, 530 nm, 576 nm) and of the SR-185 (391.4 nm, 427.8 nm, 530 nm, 557.7 nm). The altitudinal profiles of its intensity plotted on the basis of the readings reveal their dependence not only on the angle between the direction of viewing and the direction of rocket flight but also on the angle between the direction of rocket flight and the rocket's axis of rotation. Single peaks at 100-110 km altitude were recorded during the night flight (Z-50 launch), evidently associated with radiation emission by gaseous combustion products from the rocket during their interaction with atomic oxygen in the atmosphere. These and also second peaks at 80-90 km altitude were recorded during the day flights (Z-44,45 and V-53,60 launches), evidently associated with scattering of sunlight by atmospheric aerosol. The observed indicatrix effect confirms the existence of this second component in day-time near-rocket glow. Its variations are caused by different behavior of different aerosol size fractions and its amplification or attenuation also depends largely on the direction of rocket flight, whether toward or away from the sun. Figures 3; tables 2; references 9.

Stability of Uniform Gyroscope Rotation in Cardan's Suspension in Central Newtonian Force Field

917F0083A Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA TVERDOGO TELA in Russian No 5, Sep-Oct 90 pp 3-8

[Article by S.A. Belikov, Leningrad]

UDC 531.383

[Abstract] Rotational motion of a heavy dynamically symmetric but unbalanced gyroscope in a Cardan suspension in a central Newtonian force field is analyzed, taking into account the masses of both outer and inner rings. The two rings are assumed to be solid bodies rotating in perfectly smooth bearings about mutually perpendicular axes, the axis of rotation of each coinciding with one of its principal axes of inertia and the axis of rotation of the outer ring (frame) remaining stationary. The wheel is assumed to rotate about the axis of its dynamic symmetry, this axis coinciding with another principal axis of inertia of the inner wheel and thus also being perpendicular its axis of rotation. All three axes of rotation intersect at the fixed point of the wheel. The center of mass of the outer ring (frame) is assumed to lie on its stationary axis of rotation, this axis being also perpendicular to the line which the intersection point O of all three axes with the center point S of the force field, while the center of mass of the "inner ring - wheel" system lies on the axis of symmetry of the wheel. The instantaneous positions of such a gyroscope relative to the stationary platform are defined in terms of three Euler angles representing rotation of the outer ring (frame), the inner ring, and the wheel respectively. The canonical equations of motion for this system in terms of the Hamiltonian function admit a particular solution describing steady rotations of the gyroscope. Stability analysis of these rotations reduces to stability analysis of the Hamiltonian function in their vicinity. Following a series expansion of the Hamiltonian function in a new system of normalized variables, first the necessary conditions and the the sufficient conditions for stability are established in terms of constraints on the coefficients in normal forms of the Hamiltonian function. Figures 1; references 12.

Model Problem of 3-Dimensional Two-Leg Walk Dynamics and Energetics

917F0083F Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA TVERDOGO TELA in Russian No 5, Sep-Oct 90 pp 42-50

[Article by V.V. Beletskiy, Moscow, and M.D. Golubitskaya, Sverdlovsk]

UDC 531.8

[Abstract] The dynamics and the energy characteristics of a two-leg walking mechanism are analyzed on the basis of a model which describes its walk in a three-dimensional system of coordinates. The mechanism is assumed to consist of a bar simulating the torso and two three-link legs hinged together at lower end of the torso. The legs are assumed to be weightless and the torso is treated as a "mathematical pendulum" in the form of a weightless beam carrying a point mass. The gait is characterized by two parameters: horizontal shift δ of the hinge point relative to the ground support point and vertical distance h from the hinge point to the ground surface, both parameters being positive quantities. Forward walk with a regular gait (arbitrary δ,h) without lateral movement during shifting of legs is considered. Continuous periodic transverse oscillations of the center of mass during walk in situ are portrayed in the phase

plane, the form of the phase portrait depending on the gait parameters δ,h, and shown to be independent of the forward motion. Analysis of the dynamics of such a walk is based on the equation of motion for the center of mass and the equation of force balance. The energy relations are established and the energy losses are calculated on the basis of the work functional, disregarding motion of the model relative to its center of mass. This functional has been evaluated numerically for various three-dimensional walk patterns and the results compared with earlier results pertaining to a model with plane motion only. The difference between the energy characteristics of the two becomes more pronounced as the center of mass is shifted to a lower position. Figures 7; references 8.

Perturbed Rotation of Solid Body Relative Fixed Point

917F0083C Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA TVERDOGO TELA in Russian No 5, Sep-Oct 90 pp 16-23

[Article by D.D. Leshchenko and S.N. Sallam, Odessa]

UDC 531.383

[Abstract] Rotation of a dynamically symmetric solid body relative to a fixed point by action of a restoring moment is analyzed, this moment depending on the nutation angle and on the perturbing moment. The analysis is based on the Euler equations of dynamics in projections on the body's principal axes of inertia for the case where $p^2+q^2 << r^2$, $Cr^2 >> k$, $|M_{1,2}| << k$, $M_3 \approx k$. These conditions correspond to: 1) a small angle between the vector of the body's angular velocity and the axis of its dynamic symmetry, 2) an angular velocity sufficiently high to make the kinetic energy of the body by far exceed its potential energy associated with the restoring moment, 3) a vector of the restoring moment nearly in line with one of the body's principal axes of inertia. It is further assumed that the perturbing moments are smaller than the restoring one. This system of equations is solved by the averaging method, after an appropriate change of variables and introduction of a small parameter. For a body off resonance the right-hand sides of the three equations are each independently averaged over the two fast variables (phases α and γ). For a body at resonance (single frequency) the fast variable α is before averaging replaced with a slow variable: linear combination of phases with integer-coefficients. As two special cases are considered Lagrange motion of a body under a small constant restoring moment which acts along the body's axis of symmetry and Lagrange motion of a body in the presence of dissipative moments exerted on it by the ambient medium. The authors than F.L. Chernousk and L.D. Akulenko for formulating the problem and for helpful discussions. Figures 1; references 15.

Dynamics of Solid Body in 'Sphere Inside Sphere' Float-Type Suspension

917F0083B Moscow IZVBESTIYA AKADEMII NAUK SSSR: MEKHANIKA TVERDOGO TELA in Russian No 5, Sep-Oct 90 pp 9-15

[Article by A.A. Lapin, M.A. Pavlovskiy, and Yu.V. Radysh, Moscow and Kiev]

UDC 531.38

[Abstract] A mechanical system consisting of a spherical homogeneous solid body immersed in an incompressible viscous fluid is considered, the fluid filling a spherical cavity in a solid carrier and the floating solid body being suspended by a central force of a magnitude linearly dependent on the distance from its center to the center of the cavity. Equilibrium of that body and its motion during transient flow of the fluid are analyzed for stability, assuming a small Reynolds number. No constraint is imposed on the Strouhal number, inasmuch as the characteristic time τ of body motion is within the same order of magnitude as the stabilization time of fluid flow ε^2/ν (ε- clearance between surface of suspended body and cavity wall, ν- kinematic viscosity of fluid). The principal vector and the moment of hydrodynamic forces acting on the body are calculated by solving a system of two simultaneous equations, a linearized equation of system dynamics and an equation of motion for the center of the body in suspension. The boundary conditions are adhesion of the fluid to the surface of the suspended solid body and to the solid cavity wall. The initial conditions are a finite body-cavity eccentricity and zero velocity of the fluid. Stability analysis of the equilibrium is performed with the aid of Laplace and inverse Laplace transformations, this method then being also applied to the case of several solid bodies rotating at a constant angular velocity each with an invariant locus of their axes of rotation. Figures 4; references 15.

Dependence of Float Oscillations in Nonhomogeneous Fluid on Shape of Float Surface

917F0083D Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA TVERDOGO TELA in Russian No 5, Sep-Oct 90 pp 24-31

[Article by L.D. Akulenko, S.A. Mikhaylov, and S.V. Nesterov, Moscow]

[Abstract] Free vertical oscillations of a body, a thin tall float, on the interface of two heavy ideal stably stratified fluids in the gravitational force field are analyzed for their dependence on the shape of the float surface. The analysis is based on treating this as an external problem of hydrodynamics, namely as wave motion of a two-layer composite fluid with an immersed solid body which moves in a given mode. An equation describing vertical oscillations of that body as a Newtonian motion is then

derived by solving the Volterra integrodifferential equation with slowly relaxing difference kernels for the corresponding Cauchy problem. These kernels cannot be described in an analytical form and are, therefore, evaluated approximately according to Simpson's rule. This mathematical model serves as basis for numerical solution, an analytical solution not being generally feasible for specific forms of the float surface. Five different floats are considered: 1) body with "infinitely large sag", 2) body of rhombic shape, 3) body with lenticular profile, 4) body with concave rhombic profile, 5) body with yacht-like profile. A numerical analysis of first- order accuracy has been performed with the aid of a Standard System 1055 digital computer by a method analogous to Euler's broken lines method, namely by numerical integration of ordinary differential equations. The results indicate that both the frequency of oscillations and the rate of their attenuation increase as the thickness-to-height ratio of the float is increased. The energy dissipation thus depends strongly on the float shape, a correlation existing between the float shape and the Volterra kernel. Oscillations of floats with an "infinitely large sag" and of floats of rhombic shape decay fastest.

Suboptimal Control of Electromechanical Manipulator With High Positioning Precision

917F0083E Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA TVERDOGO TELA in Russian No 5, Sep-Oct 90 pp 32-41

[Article by V.V. Avetisyan and N.N. Bolotnik, Moscow]

UDC 531.8

[Abstract] A two-link manipulator is considered, its perfectly rigid two bars being joined by a cylindrical hinge. The first bar is at its other end joined to a stationary base through another cylindrical hinge and the second bar has a gripper at its free other end. The axes of the two hinges are vertical so that each link rotates in a horizontal plane, driven independently by a vertical electric d.c. gear motor. The motor driving the first link is mounted on the same base and the motor driving the second link is mounted on the first link. The rotor axis of the second motor passes through its center of inertia and coincides with the axis of the cylindical hinge which joins the two links. Control of such a two-degrees-of-freedom manipulator for high-precision positioning within minimum positioning time is synthesized on the basis of two Lagrange equations describing the motion of its two links under action of electromagnetic torques and two Kirchhoff voltage equations for the two motor armature circuits respectively. The electrical time constants of the motor armatures are usually much shorter than the operating cycle of a transport manipulator and friction is assumed to be negligible. On this basis is first constructed an algorithm of optimal separate control of the two links, considering that the gear ratios of the speed reducers are high. An algorithm of suboptimal control is then constructed which combines initial optimum control with subsequent control by a linear regulator as the final manipulator position is approached. Such a control is demonstrated numerically for the arm of the Universal-5.02 industrial robot. Figures 9; references 10.

Ways to Improve Installation Mechanization Procedures in Machine Rooms of Nuclear Power Plants

917F0098B Moscow ENERGETICHESKOYE STROITELSTVO in Russian No 12, Dec 90 pp 37-39

[Article by E.I. Dzegilevich, engineer, and I.K. Babayev, engineer]

UDC 65.001.54+621.874+621.165.006.3

[Abstract] Installation of K-1000-60/1500-2 POAT KhTZ (Kharkov Turbine Manufacturing Plant) or K-100-60/3000 POT LMZ (Leningrad Metal Works) turbines in commercial nuclear power plants is analyzed from the standpoint of mechanization, two overhead traveling cranes (one 125/20 t and one 200/32 t for POAT KhTZ turbines, two 125/20 t for POT LMZ turbines) on the upper-level rails and one 15 t overhead traveling crane on the lower-level rails being used for this purpose. A drawback of this arrangement is that, after installation of the turbine, a 125/20 t crane has to be removed by means of an intricate rig and several metal structures inside the machine room have to be disassembled so as to provide space for the additional crossbeam needed for overhaul disassembly and reassembly of the generator stator. A study of this problem made at the Kharkov branch of the Planning and Surveying Scientific Research Institute of Power Equipment Installation has come up with the following remedies: 1) monoblock layout of 2) 36 m shorter machine room, 3) larger cranes for hoisting individual parts weighing up to 400 tons, 4) disposition of the turbogenerator parallel to the longer machine room walls, 5) transverse disposition of rails for lateral entry of wagons into the last bay in the machine room, 6) removal of installation-and-overhaul platform from the last bay. For hoisting generator stators weighing up to 400 t have been considered: 1),2) a 200 t gantry crane or overhead traveling crane with a special rig which adds overload capacity for hoisting a 400 t load once, 3) a set of special hydraulic hoists with 400 tons combined capacity, 4) a new gantry design for 400 tons capacity. One way to raise the load capacity of a 200 t overhead traveling crane is to fasten its crossbeam at one end directly to the block-and-tackle of its main hoist and at the other end to the rope of the 12.5 t extra windlass of the block-and tackle, windlass and pulley yokes fastened to the crane bridge. Another way is to hook the block-and- tackle (10 threads) of the main hoist to a 200 t hanger located at a certain distance from the carriage on the crane bridge. Based on a comparative analysis of these various mechanization schemes, it is both technically and economically most advantageous to have one 200 t overhead traveling crane with a special rig on the upper-level rails and two 15 t overhead traveling cranes on the lower-level rails. This scheme should be suitable for a 15 months-long operation. Figures 1.

Comparative Analysis of Theoretically and Experimentally Determined Dynamic Characteristics of Building Structures in Nuclear Power Plants With 440 MW Water-Cooled Water-Moderated Power Reactor

917F0098C Moscow ENERGETICHESKOYE STROITELSTVO in Russian No 12, Dec 90 pp 64-65

[Article by V.L. Mnatskanyan, candidate of technical sciences, and A.N. Mikaelyan, engineer]

UDC 624.012.8:621.3016.352

[Abstract] The earthquake resistance of building structures in nuclear power plants with a 440 MW water-cooled water-moderated reactor is evaluated by comparing vibration data obtained with a set of SM-3 seismographs and theoretical vibration data based on a simple approximation of intricate objects. Such an object is in this case the "machine room - electric mounting frame - reactor compartment tent" structure. For calculation of its vibration amplitudes and frequencies, this structure was treated as a three-dimensional statically indeterminate one mounted on an elastic base and consisting of elastically coupled frames (a plane three-span frame representing the tent) with a lumped mass each. Measurements were made in the Armyanskaya AES. In the first series of measurements were recorded vibrations of all three tent frame spans, some caused by earth microtremors and some caused by braking action on the overhead traveling cranes. In the second series of measurements were recorded only vibrations caused by braking action on the main crane and its carriage. The results validate the model of that structure, inasmuch as its neutral axis is elastic with a curvature which corresponds to flexural vibrations. The damping factor is 0.25 according to calculations and 0.265 on the basis of measurements, the difference thus being merely 6%. Figures 2; tables 1; references 2.

Composite Noncombustible Thermal Insulation Material Based on Foam Polystyrene

917F0098A Moscow ENERGETICHESKOYE STROITELSTVO in Russian No 12, Dec 90 pp 27-29

[Article by M.A. Sadovich, candidate of technical sciences, and V.G. Lempert, engineer]

UDC 699.86

[Abstract] A composite fire-resistant thermal insulation material consisting of cement and foam polystyrene has been developed by addition of three modifiers: urea-formaldehyde resin, disperse polyvinyl acetate, and sulfate soap. The amounts of these additives have been determined on the basis of density and strength requirements: 20 wt.% urea formaldehyde resin and 8 wt.% polyvinyl acetate 0.01 wt.% sulfate soap) referred to weight of cement. The technology of producing this material has been designed to ensure continuity of the

fire-resistant shell around around polystyrene grains throughout the entire volume and adequate adhesion of polystyrene grains to the cement-binder. It was tested in mixing with cement for both fire resistance and dependence of its density on the cement content, the latter being varied from 60 to 220 kg per 1 m^3 volume of polystyrene (water:cement ratio 1:4). Plates of this polystyrene-cement composite were then comprehensively tested for heat insulation and fire resistance, for moldability into of double-layer roof covering panels and triple-layer wall panels, and for damage-free transportability. The material, its density being 190 kg/m^3, was found to be suitable for such panels made now of materials weighing 50-100 kg/m^3 more. Special tests have also established that this material is adequate as heat retaining filler between sheets of steel in class G(4) or D(5) fire-resistant building panels. Replacement of the mineral heat retaining material now used with this new material is estimated to save at least 300,000 rubles per 100,000 m_2. Tables 2.

The Chernobyl Syndrome

917F0125B Moscow RABOCHAYA TRIBUNA in Russian 6 Feb 91 p 2

[Interview with N. Shteynberg, deputy chairman, USSR State Committee on Supervising Work Safety in Nuclear Power (USSR Gospromatomnadzor) by RABOCHAYA TRIBUNA correspondents Natalya Kozlova and Yuriy Rogozhin under the "Fact and Commentary" rubric: "The Chernobyl Syndrome"; first four paragraphs are italic RABOCHAYA TRIBUNA introduction]

[Text] According to data from the USSR State Committee on Supervising Work Safety in Nuclear Power, 14 nuclear power plants [AES] were in operation in our country during the past year. Forty-five units with different types of nuclear reactors operated at these plants. Water-moderated water-cooled [VVER]-type reactors, which are analogous to those used abroad, have become the most popular in recent years.

Over the course of the year there were 132 unscheduled reactor shutdowns at nuclear power plants.

The statistics may be summarized as per tables 1a and 1b.

Table 1a. Nos. of Units and Shutdowns at AES by Reactor Type

Nuclear Power Plant	No. Units	Shutdowns
VVER Reactors		
Balakovo	3	14
Zaporozhye	5	30
Kalinin	2	6
Kola	4	5
Novovoronezh	3	12
Rovno	3	17
Khmelnik	1	5
South Ukraine	3	21
RBMK Reactors		
Ignalina	2	5
Kursk	4	5
Leningrad	4	1
Smolensk	3	8
Chernobyl	3	5
Other Types of Reactors		
Beloyarsk	1	2
Bilibino	4	3

Table 1b. Reasons for the Unscheduled Shutdowns (%)

Unsatisfactory workmanship	24.5
Poor design	17
Personnel errors	31.5
Other and unexplained reasons	23

N. Shteynberg, deputy chairman of the USSR State Committee on Supervising Work Safety in Nuclear Power, responded to questions by our editorial staff.

Question: How has the quality of nuclear power plant operation in 1990 changed as compared with that in the preceding year?

Shteynberg: Unfortunately the number of unscheduled shutdowns increased by 17 percent. Another indicator—the average frequency of shutdowns per power plant unit—also worsened (3 in 1990 versus 2.6 in 1989).

Question: How can this be explained?

Shteynberg: Nuclear power generation cannot be isolated from everything else that is happening in our country: discipline is falling off, and the quality of equipment and spare parts shipped to AES is worsening. The constant changes in the system of managing the national economy is not having the best effect. Moreover, nuclear power generation has its own specific problems. What I have in mind is the antinuclear movement, which last year undertook active measures against personnel at several AES. In July a blockade of the Khmelnik AES was organized. Demonstrations conducted at the Balakovo and South Ukraine AES demanded they they be closed. The situation at the Ignalina AES has become acute.

People must understand that forcing of the intolerable situation around AES is having a very bad effect on personnel and hence on work safety.

Question: Tell us about the most serious incident at AES in the past year.

Shteynberg: Before answering your question I would like to mention that the seriousness of incidents at AES is estimated at a 7 on the international scale.

After estimates in accordance with this scale were made from 1 September to 31 December, most (56) of the 82 incidents at AES were classified as being at the zero level, that is, as not affecting AES safety; 24 were assessed as insignificant (level 1); and only 2 were classified as events with a medium degree of gravity (level 2). These are the ones I will tell you about.

On 8 September in the No. 1 unit at the Ignalina AES personnel errors led to the opening of the safety values of the reactor's primary loop. The steam released from the valves was absorbed by the localization system; therefore, no emission into the environment or irradiation of personnel occurred. The seriousness of the incident lay in its potential danger.

On 9 October the Zaporozhye AES was being refueled with nuclear fuel. Because of a malfunction of the fuel handling machine a fuel assembly with new fuel was damaged. Although there was no danger of radioactive contamination in the given case, the very fact of the malfunction of the fuel handling machine was justifiably assessed as being a rather serious event.

Question: Now answer a question that may be beyond the scope of our conversation. How are things regarding safety on the vessels in our nuclear fleet?

Shteynberg: Last year 11 ship nuclear power plants were in operation on six icebreakers and on one LASH ship. Overall this equipment operated with adequate reliability and did not create any serious problems with respect to meeting the navigation plan. But there were individual incidents, and they must be mentioned.

On the Sibir nuclear icebreaker there were seven cases of steam generator leaks. The commission of the USSR State Committee on Supervising Work Safety in Nuclear Power banned the operation of this icebreaker's nuclear power plant until the defective steam generator had been replaced. We also banned the operation of the port side nuclear reactor on the Arktik until the left reactor's core was replaced.

There were no other incidents on the nuclear fleet of importance from a safety standpoint.

Sentence in Roentgens

917F0125A Moscow RABOCHAYA TRIBUNA in Russian 30 Jan 91 p 3

[Article by Natalya Kozlova; first paragraph is boldface RABOCHAYA TRIBUNA introduction, and final two paragraphs are boldface RABOCHAYA TRIBUNA text headlined "In Place of a Postscript"]

[Text] The background changes, becoming stronger as the instrument rose higher and higher. This told the specialists one thing: they would have to look on all the floors. At first glance it was stupid work. There were many homes in the neighborhood. Who threw out the suspicious trash? The perimeter of the search on Severo-Dvinskaya Street in Moscow has narrowed. Time passes and the neighbors tell about how after having noticed the people with instruments who reappeared downstairs, their neighbor fled feverishly while still in his slippers—leaving for somewhere in his car. Without apparent enthusiasm, the militia regarded this and other facts. Only after a year do they "begin to act"...

After the Chernobyl tragedy we began to speak seriously about radiation. The entire stream of "radioactive" news that came down on the unprepared people's heads spawned terror in some and calmed others, depending on who was speaking or writing about it. After limiting the purely geographical dangerous zone to the confines of the nuclear power plants, we still continue to live in certainty that if things are bad and dangerous, they are so somewhere alongside the reactors. Unfortunately, the situation today is far more serious...

The Rodon and Others

Radioactive wastes were buried near the city of Zagorska (which is near Moscow). That was in 1978. At the time hazardous cargo was transported from Moscow by a modest, unknown organization—the Rodon Scientific Production Association. At its request, the Rodon was helped by the central dispatching office Geologorazvedka [geological exploration] of the USSR Ministry of Geology. Its task was to come and check the routes of the vehicles transporting the radioactive wastes. It was handled by a special search team from the dispatching office that had instruments and transportation. According to the test results, the route with the wastes turned out to be "clean." Simply put, it had a normal radiation background. But as from a horn of plenty, the troubles came from where they were least expected. The instruments established an increase in radiation in the ravines, on the roadsides, and at the dumps. True, they were not the Rodon's affair.

No one is to blame. There are a host of industrial and scientific institutions that use instruments with radioactive components and produce wastes that are dangerous to human health. But the instruments get old and surrendering them for burial is a lot of trouble. You don't worry about radioactive wastes either. It is terrifying to think that, just because of our negligence, cities (both large and not so large) have turned into a zone that is hazardous to life. We are paying for our long-time habit of waving things off, saying "But it will all go away."

Scale for the City

The Moscow City Council knew that something incomprehensible was going on with radiation in the capital of our Motherland. They even issued a special resolution to monitor the contaminated sites. The planning operations began in 1982. They "took background readings" of the parks and squares, alleys, homes, and trash heaps. All together they compiled a very, very alarming map of

the city. The number of sections in need of decontamination quickly climbed into the several hundreds.

The scale of work for Moscow was initially selected as being 2 mil. This means that instrument readings were plotted on the map every 20 meters. The results turned out to be as unexpected as they were frightening. They began to switch to a 1 mil scale, i.e., to establish readings every 10 meters. When checking the children's institutions they switched to a 0.5 mil scale overall. And there was every basis for so doing. Did you know that for Moscow the normal background is 12 to 15 microroentgens per hour? In the children's area of the No. 1 departmental day nursery at the Atomic Energy Institute imeni Kurchatov the instruments established points with up to 612,000 μrad/h! This happened because it was built on an unmonitored site—and without a construction resolution from the sanitary and epidemiological station, which unfortunately is generally without any unpleasant consequences in Moscow.

"Background" of the School Bell

The former Central Geologic Dispatching Office is now the Geoekotsentr [Geoecocenter] in the concern Geologorazvedka. The Geoekotsentr is headed by Leonid Ivanovich Dmitrakov. The entire responsibility for finding and neutralizing radiation in Moscow lies on his shoulders—it lies on him and his colleagues.

And so it was. When 436 Moscow schools were checked, even the experienced specialists were beside themselves. Radiation sources were found in 302 of them. The sanitary service's directive that old instruments, pieces of iron of unknown origin, and the like be disposed of in a timely manner remains unfulfilled. I understand how wild it sounds, but to this day no one is rushing to remove the dangerous trash from the schools.

For today, the Geoekotsentr can, as they said quite recently, "report about what has been accomplished." The report will be a sad one, however. In Moscow they discovered about 600 radiation sources, 15 of which have not yet been neutralized. This figure, albeit low, is hardly reassuring. Indeed in a certain sense radiation is a bitter serpent. Every time one head is cut off, two grow in its place. The capital's Central Park of Culture and Rest imeni Gorkiy was also checked, and everything was normal. But a strong radiation source was found in a flower bed during a repeat examination. The answer was simple—fresh soil had been brought in. And therein lies the complexity of the search team members' work—sections of earth that are "clean" from a radiation standpoint are not constantly clean. Here is a typical situation: dozens of years ago trash, including radiation-emitting trash, was dumped in an outlying district of Moscow. Years later, a new microrayon in the process of its development ploughs up tons of earth around itself. And the old wastes, hazardous as before, end up on the surface.

Dumps may be termed unique recordholders. One of them has even "shone" from a helicopter.

The search for the owner of the trash with the roentgens led to the Ferrous Metal Plant in Podolsk. After breaking through the checkpoint, the specialists found four contaminated shops. The plant's entire territory turned out to be contaminated. Neutralizing the plant has already cost about 12 million rubles. But even that is just the beginning. The final total will stretch to about 40 million.

L. Dmitrakov believes that the main thing is to set up continual monitoring not only of Moscow but of all of the country's large industrial centers.

There is another opinion as well. To put it directly, there is the opposite opinion. Yu. Gusev, director of municipal services of the October Rayon Executive Committee [rayispolkom] does not worry about roentgens or other petty details. His plan is more serious—to surrender the premises of the Geoekotsentr to the cooperatives.

T-Shirt With a Surname

In the rest area in Mytishche near Moscow, the specialists on the search team followed the arrows on their instruments like police detectives following a dog. The radiation background grew before their eyes. The hiding place was located in a pipe that was reliable covered with lead slabs. But the radiation was so strong that it penetrated through this protection. Alongside it they found some rags that also had a "background." Among these was a child's t-shirt with the child's surname sewn in. And so the address of the home on Severo-Dvinskaya Street in Moscow resurfaced. The T-shirt belonged to the child of the apartment owner who, a year earlier, had run off in his slippers in view of the people with the instruments.

The instruments registered hundreds and thousands of microroentgens an hour in the bathroom and lavoratory and on the balcony. No matter how they tried, the examiners could not determine where the apartment owner obtained the radioactive substance. Only the measure of his punishment was known—4 years' deprivation of freedom. This riddle proved to be very expensive for us. More than 250,000 rubles was spent on the decontamination alone. And it still is not finished.

In Place of a Postscript

I am well aware of how thankless a task it is to frighten people in our so-frightening time. But this material was not prepared for the sake of sensationalism. The situation regarding radioactive contamination in Moscow and in the oblast as certainly in many other of our large and small cities is very, very bad. This is precisely why the work of the Geoekotsentr demands the most serious attention and support on a governmental level—and nothing less. Moreover, its activity must be extended to other cities in a timely manner. Radiation monitoring must be conducted constantly and according to a plan.

The people who try as hard and as much as they can to guard us from serious danger cannot depend on the mood of some executive of rayon rank or on his sympathies and ideas regarding the importance or needlessness of someone's work.

I pose the following question: Where will the money for all this come from? I am not the minister of finance. But he has not become Premier—he holds the reins in his hands. Indeed we are talking about people's health. And that is not a matter of trade.

Outlook for Buildup of Oil and Gas Reserves in Carpathian Oil and Gas Province

917F0076A Kiev NEFTYANAYA I GAZOVAYA PROMYSHLENNOST in Russian No 4, Oct-Dec 90 pp 2-5

[Article by B.I. Denega, Ukrainian Scientific Research Institute of Ore Mining, and Yu.Z. Krupskiy, Poltava Gravimetric Observatory "Zapukrgeologiya" (Reserve Buildup Geology)]

UDC 553.981/982.042(477)

[Abstract] The status of crude oil and natural gas exploration and production in the Carpathian Oil and Gas Province, in each of its four "oblasts" (Volyno-Podolskaya, Predkarpatskaya, Karpatskaya, Zakarpatskaya) and two "rayons" (Bilche-Volitskiy, Borislavsko-Pokutskiy), is surveyed on the basis of available seismographic and drilling data. The survey indicates that industrial reserves of hydrocarbons will increase, from newly discovered but not yet fully explored deposits in contiguous areas (Volyno-Podolskaya Upland strip, Skladchatyye Karpaty range, Zakarpatskiy Pass, underthrusts in Pokutsko-Bukovinskiye Karpaty range and in Skidovskaya belt, molasses in Samborskaya belt, deep embedded folds in Borislavsko- Pokutskaya belt, mesozoic formation in Bilche-Volitskaya belt), also from new stratigraphic and lithologic units. Figures 1; tables 1.

Development of Spiral Motion of Air Particles in Gromeka Sense by Action of Coriolis Inertia Force

917F0089C Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA in Russian No 6, Nov-Dec 90 pp 43-50

[Article by N.A. Slezkin]

UDC 551

[Abstract] Considering that the Bjerkness theorem does not address some aspects of vortical circulation of an ideal fluid inside a closed contour along which the velocity vector rotates, namely changes of this motion in time and its singularity produced by action of the Coriolis inertia force, this aspect is analyzed on the basis of the vector equation of motion of air particles relative to the moving Earth. Into account are taken rotation of the Earth at a constant angular velocity and acceleration of gravity g, assuming a constant viscosity of air but ignoring changes of its density ρ. The vortex singularity is stipulated in the simplest for $2\omega \times V = 0$. The system of partial differential equations generated by this vector equation becomes a lincar one by virtue of analogy to the theory of translatory motion of a uniformly rotating solid body in an ideal fluid medium, this theory stating that the translatory motion of such a body is stable when it rotates at an angular velocity congruent with its linear velocity. This system of equations is projected onto coordinate axes x_1, x_2, x_3 (x_1-axis vertical and positive upward at angle θ_0 to Earth's axis of rotation, x_2- axis tangential to meridian and positive northbound, x_3- axis tangent to parallel and positive westbound) rigidly pinned to the Earth. Together with the equation of incompressibility they form a closed system of four equations. The pressure function $P = -p/\rho - V^2/2 - gx_3$ is introduced into the $\delta P/\delta x$ terms of these equation and then eliminated from the system by use of the classical expression for vortex components i= 1,2,3. The simplest case $2\theta_i = +/-kV_i$ (i = 1,2,3 and k = constant multiplier) is then considered, namely spiral flow in the Gromeka sense (I.S. Gromeka, 1952). Further mathematical analysis leads to a system of two simultaneous partial differential equations for the flow function Ψ: $\delta^2\Psi/\delta x_1^2 + \delta^2\Psi/\delta x_3^2 + k^2\Psi = A$ and $\delta^2\Psi_2/\delta x_1^2 + \delta^2\Psi_2/\delta x_3^2 + k^2\Psi_2 = 0$ ($X_2 = \delta\Psi/\delta x_2$). Their solution will describe the development of relative spiral motion of particles of an incompressible fluid in the Gromeka sense. Because these equations do not contain derivatives with respect to the x_2 coordinate, the initial boundary of the vortical region can be stipulated only in the plane of a meridian and not arbitrarily. At altitudes above the highest mountains, the initial region of vortical motion can be a circular torus around the Earth. This case is further analyzed, assuming that the flow function in a meridian plane depends on the radius $r = [x_1^2 + (x_3 - h)^2]^{1/2}$ only (h- altitude of highest mountain peak) so that the equation for this function becomes $\delta^2\Psi/\delta r^2 + \delta\Psi/rdr + k^2\Psi = A$. References 2.

Force Loads on Wedge Diffracting Shock Wave Generated by Strong Explosion

917F0089A Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA, SERIYA 1: MATEMATIKA I MEKHANIKA in Russian No 6, Nov-Dec 90 pp 19-23

[Article by A.G. Chernov]

UDC 533.6.011.51

[Abstract] Diffraction of a shock wave by a stationary wedge is considered, the shock wave having been generated by a strong plane explosion without back-pressure in a plane perpendicular to the plane of symmetry at some distance from the cutting edge, and the resulting pattern of gas flow is analyzed according to the Maccormack scheme with extraction of the reflected shock (R.W. Maccormack, AMERICAN INSTITUTE OF AERONAUTICS AND ASTRONAUTICS Paper No 65-354). On this basis are then calculated forces acting on the wedge, assuming regular interaction of that wedge and the incident shock wave. Propagation of the shock wave and the flow of gas behind it are described by Sedov's equations. The gas flow within the region ahead of the reflected shock front is supersonic relative to the latter until the shock wave has returned to its source. The flow pattern within this region can, therefore, be treated as one independent of the flow pattern within the region between the wedge nose and the reflected shock front. That flow pattern is a obviously a transient one and, accordingly, dependent on the initial conditions. These are stipulated on the premise that the diffractional flow pattern is established instantaneously, thus being determined solely by the velocity of the incoming shock wave at that instant of time and on the parameters of the gas in the immediate vicinity of the shock front and not depending on the derivatives of these quantities. Subsequent calculations involve solution of the two Euler equations of dynamics for a perfect thermally nonconducting gas and simulation of the Hugoniot conditions on the reflected shock front. Stability of the scheme is ensured by satisfying the Courant-Levi conditions. The wedge is fictitiously split two adjacent ones along the plane perpendicular to the plane of the incident shock wave, these "half"-wedges having generally unequal edge angles unless that plane is also the plane of symmetry. Numerical calculations were made for a wedge split into two with 70° and 50°, with a 0.9 value of the Çourant number. Figures 3; references 9.

Calculation of Interphase Force in Monodisperse Bubbling Medium With Nonuniform Bubble Distribution

917F0089B Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA, SERIYA 1: MATEMATIKA I MEKHANKA in Russian No 6, Nov-Dec 90 pp 23-28

[Article by V.Ye. Kroshilin]

UDC 532.529

[Abstract] Microstructural analysis of a monodisperse bubbling media with a nonuniform bubble distribution

in the form of chains or clusters rather than a regular or random one is considered, of concern being the interphase force in such a medium. This force is calculated by averaging the force on a particular bubble in a specific configuration of all other ones over all their positions. The bubbles are assumed to be spherical and to move at a constant velocity relative the carrier fluid regardless of their positions, a pair of bubbles one behind the other moving faster than a single bubble. The flow of the carrier phase is assumed to be a potential two-dimensional one, with the mean values of the fluid parameters being functions of the longitudinal coordinate only. With a certain form of the binary correlation function stipulated, calculations are made for an ideal incompressible fluid with a zero velocity potential φ around a spherical bubble and appropriate boundary conditions at the surface of a given bubble and at the surfaces of all others. The corresponding equation $\Delta\varphi = 0$ is solved by the method of successive approximations, the first approximation being $\varphi_1 = \Sigma\, \varphi_1$ over $i = 1,...,N$ (N- number of bubbles). The second approximation φ_2 being obtained from the requirement that $\varphi_1 + \varphi_2$ satisfy the equation and also the constraints at the boundary of the region occupied by the two-phase medium. The pressure is then determined from the Cauchy-Lagrange integral, whereupon an average force on a bubble is obtained which includes an Archimedes component. The equation of momentum for the bubble phase is now formulated as average force on a bubble equal zero, inasmuch as the mass of vapor is negligible. The equation of motion for the carrier phase is obtained by averaging the Cauchy-Lagrange integral over bubble positions for a point located in the liquid. The equation of continuity is formulated next, ignoring changes of true density of each phase and assuming that no phase transitions occur. This system of three equations is then analyzed for stability of its solution, considering that the system will be a hyperbolic or nonhyperbolic one depending on whether the first of two coefficients in the expression for the force is larger than or smaller than unity. References 8.

Numerical Simulation of Rebound of Porous Cylinder From Rigid Barrier

917F0088F Novosibirsk ZHURNAL PRIKLADNOY MEKHANIKI I TEKHNICHESKOY FIZIKI in Russian No 3, May-Jun 90 pp 100-104

[Article by S.P. Kiselev, V.M. Fomin, and Yu.A. Shitov, Novosibirsk]

UDC 539.3

[Abstract] Rebound of a porous cylindrical striker from a nondeformable barrier is analyzed on the basis of the Prandtl-Rice model describing complete inundation of pores at the shock front, the striker becoming a continuous medium behind the front of the plastic wave with all attendant flow singularities localized at that front. The five two-dimensional partial differential Prandtl-Reis equations together with the equation of state and equation of pressure, the latter involving the Grueneisen coefficient and supplemented with the partial differential equation for internal energy, form a closed system of eight equations. This complete system was solved numerically by the Wilkinson method. For analysis of shock wave propagation through a porous medium, the problem is treated as a one-dimensional problem of plane motion of a plunger approaching a barrier at a constant velocity before striking it. Figures 5; references 9.

Use of Scattered Light Method for Determining K_{III} Coefficient of Stress Intensity in Three-Dimensional Problems

917F0088J Novosibirsk ZHURNAL PRIKLADNOY MEKHANIKI I TEKHNICHESKOY FIZIKI in Russian No 3, May-Jun 90 pp 167-170

[Article by V.M. Tikhomirov and V.P. Tyrin, Novosibirsk]

UDC 620.171.5

[Abstract] An simple procedure for experimental determination of the stress intensity K_{III} ($N/mm^{3/2}$) during inspection of three-dimensional structural elements is described, this procedure involving measurement by the scattered light method and subsequent interpretation of the readings as in the method of plane photoelasticity. Inasmuch as the optical path difference between light rays due to a difference between quasi-principal stresses in a plane perpendicular to the direction of light rays is measured, most effective will be measurement with a polarized knife-blade light beam parallel to the plane of the crack so that it encounters no rotation of the principal axes and thus no change of orientation of the principal stresses as it passes above and below the crack without intersecting the crack mouth. A theoretical analysis based on the inspection geometry and the light interference pattern leads to an expression for the stress intensity coefficient in the form of a double series. Rounding of the crack tip is accounted for, approximately, by use of the expression for the shearing stress in an infinitely long axisymmetric body with a hyperbolic notch. By minimization of the functional F(r,p) (r- radius of nondefective body segment, p- load parameter) that expression for K_{III} is reduced to an explicit one involving radius r^* and load parameter p^* corresponding to the minimum of that functional. The procedure continues with transition from an axisymmetric body with a hyperbolic notch to the limiting cases of one with a circular circumferential notch and one with a sectoral radial notch. The procedure was tested on two corresponding models under torsion, a cylinder made of ED-16 epoxy compound with a circular notch around the entire circumference and a cylinder made of SKU-6 polyurethane with a radial notch along the entire lateral surface. Measurements were made with polarized light from an LG-75 He-Ne laser, a half-wave plate for rotating the plane of polarization, two cylindrical lenses and a diaphragm with a slit transforming the laser beam into a 0.5 mm thick and 37 mm knife-blade beam, and a photodetector for recording the interference patterns. Subsequent calculations based on the readings and the explicit

formula for each cylinder have yielded K^{III} values only slightly differing from theoretical values obtained by evaluation of the double series. Figures 2; tables 1; references 7.

Characteristics of Convergence of Rotating Cylindrical Shell

917F0088H Novosibirsk ZHURNAL PRIKLADNOY MEKHANIKI I TEKHNICHESKOY FIZIKI in Russian No 3, May-Jun 90 pp 110-112

[Article by S.M. Bakhrakh, N.P. Kovalev, V.A. Rayevskiy, Yu.M. Styazhkin, and T.A. Toropova, Moscow]

UDC 539.13

[Abstract] Inertial convergence of a compressible viscous cylindrical shell during its rotation is analyzed on the basis of the applicable system of three Landau-Lifshitz pertaining to mechanics of continuous media, the inside surface of such a shell ceasing to move inward as it reaches a certain limiting distance r_{min} from its axis of symmetry which depends on the viscosity of the shell material as well as on geometric and kinematic parameters. Thermal conductivity and second viscosity are ignored, such an approximation being valid for condensed media. That system of equations was solved numerically by the method of finite differences with separation of physical processes. On each step of integration with respect to time the solution of the problem proceeded in two stages: the subsystem describing motion of a nonrotating shell and then being evaluated the terms with angular velocity. The method was tested on two problems with known analytical solution, namely on a rotating cylindrical shell of an ideal fluid and on a nonrotating cylindrical shell of a viscous fluid. The results agreed within 1%. The method was then applied to inertial convergence of a cylindrical shell with given initial inside radius and thickness, using the Mie-Grueneisen equation of state and with zero stresses $\sigma_{rr} = \sigma_{r\varphi} = 0$ stipulated at both inside and outside surfaces. Figures 2; tables 1; references 7.

Quick Estimation of 'Tracktron' Accelerator Parameters

917F0088G Novosibirsk ZHURNAL PRIKLADNOY MEKHANIKI I TEKHNICHESKOY FIZIKI in Russian No 3, May-Jun 90 pp 104-110

[Article by A.P. Kuznetsov, Moscow]

UDC 533.95:538.4

[Abstract] A method is proposed for quickly estimating the performance characteristics of a "tracktron" accelerator, an ultrahigh-current electromagnetic macroparticle accelerator for applications such as controlled thermonuclear fusion, and particularly of its discharge ciruit. The method derives from the Lagrangian characterizing an ideal such device in generalized coordinates q_1 (trajectory of accelerated body) and q_2 (charge on energy storing capacitor). Inasmuch as the equations of motion based on this Lagrangian cannot be solved analytically and require a numerical solution, another equation of "motion" is considered: $Ld^2q_2/dt^2 + (dL/dt)(dq_2/dt) + q_2/C = 0$, where $L = L_0 + kq_1$ is the accelerator inductance and C is the storage capacitance. The three time- variable coefficients in this equation (L, dL/dt, C) are replaced with constant ones, namely their averages over the acceleration time t*, the latter ones then appearing in the equation $d^2q/dt^2 + 2n(dq/dt)/(n+2)t^* + 2q/(L_0C(n+2)) = 0$ ($nL_0 = \Delta L$ denoting the increment of inductance during acceleration time t*) which yields an expression for direct calculation of the accelerator efficiency and also an expression for the dependence of the natural frequency of the storage circuit on the accelerator parameters. The expression for the acceleration time $t^* = 2x^*/V^* = 2nL_0/kV^*$ (x*- length of acceleration path, V*- equivalent mean velocity) is sufficiently accurate for n= 2,...,4. It indicates a decrease of the acceleration efficiency as n exceeds 2, a further boost of final velocity requiring a longer acceleration path. The feasibility of and the requirements for a multistage "tracktron" accelerator, each stage operating independently, are examined by application of this quick estimation method. This is done first without any constraints, then taking into account constraints imposed by mechanical and thermal characteristics of the electrode material, finally also taking into account the ohmic electrical resistance of the accelerator channel. Figures 1; tables 2; references 6.

Irrotational Flow of Ideal Fluid Past Rotating Plate

917F0088C Novosibirsk ZHURNAL PRIKLADNOY MEKHANIKI I TEKHNICHESKOY FIZIKI in Russian No 3, May-Jun 90 pp 71-72

[Article by V.S. Sadovskiy, Moscow]

UDC 532.5

[Abstract] The problem of irrotational flow of an ideal incompressible fluid past a rotating plate is formulated in dimensionless variables, the coordinates normalized to the half-chord of the plate and the dependent variables normalized to the velocity of quiescent flow. The flow potential is defined as $\varphi = \varphi_1 + \varphi_2$, where $\varphi_1 = \omega[-(1/4)e^{-2\xi}\sin 2\eta + x_0e^{-\xi}\sin\eta]$ and φ_2 is the real part of the complex velocity potential $w_2(z) = -z\cos\alpha - i(z^2-1)^{1/2})$plate at an α angle of attack. It is noteworthy that the tangential velocity u(z) does not generally satisfy the Chaplygin-Joukowsky condition. The suction forces are calculated on the basis of the Cauchy-Lagrange integral. The aerodynamic lift and drag coefficients are calculated tin terms of apparent masses for the constant velocity of the oncoming stream and the angular velocity of the plate respectively. The results are not influenced by a shift of the point of rotation point in the direction normal to the plate. Figures 1; references 1.

Theory of Deep Dynamic Stall at Airfoil

917F0088D Novosibirsk ZHURNAL PRIKLADNOY MEKHANIKI I TEKHNICHESKOY FIZIKI in Russian No 3, May-Jun 90 pp 72-78

[Article by G.I. Taganov (deceased), Moscow]

UDC 532.5

[Abstract] The surprising results of experiments on dynamic stall at airfoils with the angle of attack changing at a constant rate (J. AMERICAN INSTITUTE OF AERONAUTICS AND ASTRONAUTICS: M.S. Francis and J.E. Keese, Vol 23 No 11, 1985; Paper No 0008 by G.M. Graham and J.H. Strickland; Paper No 0117 by E.J. Jumper, S.J. Shreck, and R.L. Dimmick) are explained on the basis of a theoretical model, namely separation flow past a plate with an infinitely long span moving forward in an incompressible fluid medium at a constant linear velocity while its angle of attack varies at a constant rate relative to a point of that plate at some fixed distance from its center. The aerodynamic load on such a plate is first calculated for the simplest case of a zero lift force and a drag force with zero inertial component, this condition corresponding to a 90° angle of attack. The results of calculations are shown to be consistent with the experimental data on the NASA 0015 profile at a Reynolds number $N_{Re} = 10^5$. Also the results of subsequent calculations for a 45° angle of attack are shown to be consistent with the corresponding experimental data. The analysis is extended by considering the model of deep dynamic stall, shown to be consistent with experimental data on the NASA 0012 profile at a Reynolds number of the order of 10^6 (W. Johnson, AEROSPACE ENGINEERING No 5, 1987) down to small angles of attack. The hysteresis in the aerodynamic characteristics, particularly in the dependence of the lift coefficient c_y on the angle of attack α, and the periodic variation of the angle of attack α as a sinusoidal function of its rate of change $\alpha = \alpha_0 + \alpha_1 \sin(d\alpha/dt)t$ within the range of small angles ($\alpha_0 = \alpha_1 = 10°$) are interpreted in terms of that model. Both dissipative and inertial components of the drag coefficient c_x as well as the lift coefficient and the amplitude of its hysteresis loop are, however, calculated by replacing that sinusoidal dependence with a dependence covering the entire $0 < \alpha < 20°$ range and consisting of two segments: a linear one which corresponds to a constant rate of change of α and one which corresponds to a zero rate of change of α (steady flow). Figures 3; references 9.

Wave Flow of Film of Conducting Viscous Liquid in Transverse Magnetic Field

917F0088E Novosibirsk ZHURNAL PRIKLADNOY MEKHANIKI I TEKHNICHESKOY FIZIKI in Russian No 3, May-Jun 90 pp 96-100

[Article by Yu.N. Gordeyev and V.V. Murzenko, Moscow]

UDC 537.84

[Abstract] The general vector equations of magnetohydrodynamics in the noninductive approximation for small values of the magnetic Reynolds number $N_{Re,m}$ are applied to plane flow of a film of an electrically conducting incompressible viscous liquid on a solid surface in crossed transverse electric and magnetic fields with $N_{Re,m} << 1$. The boundary conditions are zero velocity at the solid surface (adhesion) and a free surface with surface tension under a gage pressure. Plane flow in constant crossed fields is considered, the film thickness varying both in the direction of flow and in time: $y = h(x,t)$. The equations are reduced to a system of dimensionless variational ones in perturbations of variables, with the Hartmann number, the Weber number, and the Reynolds number as parameters. The system is reduced to a single equation, a closed one in the long-wave approximation, and this equation is rewritten as a differential one which has periodic steady-state solutions describing solitary and periodic surface perturbation waves. It is in this form a generalization of the Korteveg-deVries equation. Figures 1; references 11.

Flow of Plane Shock Wave Past Boundary Layer of Low-Density Gas at Rigid Wall

917F0088A Novosibirsk ZHURNAL PRIKLADNOY MEKHANIKI I TEKHNICHESKOY FIZIKI in Russian No 3, May-Jun 90 pp 15-23

[Article by B.I. Zaslavskiy, S.Yu. Morozkin, A.A. Prokofyev, and V.R. Shlegel, Mendeleyevo]

UDC 533.6.011.72

[Abstract] Interaction of a plane shock wave and a boundary layer of low-density gas at a rigid surface reflecting the shock wave was studied in an experiment covering wide ranges of shock wave intensity, shock wave incidence angle, and gas density. Theoretical analysis of this process is based on the model of an infinitely long plane shock wave entering at a given velocity V_1 a half-space occupied by a gas, this gas in its quiescent initial state being characterized by density ρ_0 and speed of sound c_0 at temperature T_0 and pressure p_0. The region behind the shock front is characterized by pressure $p_1 > p_0$ and velocity of particles q_1. The processes in time $t > 0$ until and after the shock wave strikes the solid surface behind the gas layer are analyzed by taking into account not only the acoustic perturbation at the surface and the rarefaction wave in the gas layer as well as in the shock wave but also the vortex generated by interaction of the shock wave and the gas layer in accordance with the Bjerknes circulation theorem. Tests were performed in a single-stage horizontal shock tube with a rectangular 85x125 mm^2 channel and two diaphragms splitting it into three compartments. The target was an 85 mm wide and 200 mm long plate with the front edge tapered into a wedge facing the shock wave, its inclination being varied and thus the angle of grazing incidence of the shock wave. Its active upper surface was

covered with a layer of gas lighter than air by blowing that gas under a soap film, first a layer of N_2-He mixture and then a layer of N_2-Ar mixture. The ratio of each mixture was varied, for simulating the density of hot air and the speed of sound in it over the 500-2700°C range. Pressure drops were measured with a set of four piezoelectric transducers, two time- interval meters, and two oscillographs. Interaction of the shock wave and rigid surfaces was monitored by the schlieren method, using a high-speed photographic camera with a flash-lamp. Flow patterns were recorded thermographically. Figures 7; references 16.

Residual Structural Stresses in Reinforced Shells of Revolution

917F0088I Novosibirsk ZHURNAL PRIKLADNOY MEKHANIKI I TEKHNICHESKOY FIZIKI in Russian No 3, May-Jun 90 pp 153-159

[Article by A.G. Kozyuk and G.I. Starostin, Krasnoyarsk]

UDC 539.373:624.074:678.067

[Abstract] Residual stresses and strains in reinforced shells of revolution produced by winding or pressure forming are calculated, of special concern being residual structural stresses. The shell fabrication processes is defined as a sequence of four operations: formation of a shell blank by winding or forming unidirectionally reinforced layers on a mandrel - heating the shell blank with mandrel up to the binder polymerization temperature - cooling the finished shell with mandrel to room temperature - removal of the mandrel. Calculation of residual stresses is based on four premises: 1) structural stresses produced in the composite material during elastic transition of the binder relax completely, owing to ductility of the not yet cured binder, so that binder can be treated as an ideal fluid during the first two operations and as a Duhamel-Neumann solid body during the last two operations while the armature obeys the Duhamel-Neumann law during all operations; 2) polymerization of the binder involves an instantaneous change of its properties during its phase transition from liquid to solid; 3) in a thin-walled shell the temperature distribution over its thickness remains uniform during all operations, stresses in the armature caused by filtration of the binder and progression of the polymerization front being negligible; 4) both armature and uncured binder are in a plane state of stress and are ideally joined together. The general expressions for residual stresses derived on this basis are applied to shells of revolution with armature layers stacked pairwise symmetrically with respect to the median surface. Such shells are assumed to be in an axisymmetric zero-moment state and in a frictionless contact with both the mandrel and the forming tool, also to comply with Kirchhhoff-Love hypotheses. Two such shells are considered, a glass-plastic one formed on a paraboloidal mandrel under a uniform pressure with six pairs of unidirectional armature layers and a circular cylindrical one formed by wet winding of K-115/110 glass tape on a steel mandrel. Residual displacements and structural stresses in the first one and residual deflections of the median surface of the second one, dependent on the winding tension, have been calculated according to this scheme. Figures 2; references 9.

Solution to Problem of Flow of Ideal Fluid in Vicinity of Tips and Wings

917F0088B Novosibirsk ZHURNAL PRIKLADNOY MEKHANIKI I TEKHNICHESKOY FIZIKI in Russian No 3, May-Jun 90 pp 60-65

[Article by A.V. Voyevodin and G.G. Sudakov, Zhukovskiy]

UDC 532.5

[Abstract] The problem of nonvortical flow of an ideal fluid past the apex of a cone or the corner of a wing is formulated in a Cartesian system of coordinates and solved for boundary conditions of an impermeable body surface. The flow potential must satisfy the three-dimensional Laplace equation, corresponding to self-similar flow, and is sought in the form $\Phi = Cx^n\varphi(y/x,z/x,\theta)$ (x-axis coincident with axis of symmetry, z-axis in plane of wing or in any plane of cone perpendicular to axis of symmetry, y-axis perpendicular to both, φ-dimensionless function, C- dimensional constant). The problem is solved by numerical solution of the integral equation, by the method of "vortex frames" for a wing corner and by the method of panels for the apex of a circular cone. In the first case the flow potential is treated as the potential of a double layer. In the second case the problem is also solved analytically by reduction to an ordinary differential equation in spherical coordinates. It is noteworthy that nontrivial solutions exist only for certain values of exponent n, so that also an eigenvalue problem is involved here. Figures 5; references 7.

Plane Problem of Penetration of Thin Elastic Cylindrical Shells Into Compressible Fluid

917F0087G Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 26 No 9, Sep 90 pp 66-75

[V.D. Kubenko, Institute of Mechanics, UkSSR Academy of Sciences, and V.V. Gavrilenko, Kiev Institute of Automobile Roads]

UDC 536.6.013.42

[Abstract] Plunging of a thin elastic cylindrical shells into a compressible fluid is treated as a plane problem of penetration from free fall. An infinitely long horizontal circular cylindrical shell is considered which, upon moving vertically downward, reaches the free surface of a weightless barotropic ideally compressible fluid at time $t = 0$ with a velocity $v_0 = 0$ and then proceeds to penetrate

deeper. The problem is formulated in a stationary Cartesian system of coordinates Oxyz with the origin O on the quiescent fluid surface (Ox- horizontal axis on fluid surface perpendicular to cylinder orientation, Oy- horizontal axis on fluid surface parallel to cylinder orientation, Oz- vertical axis with positive direction downward into the fluid and passing through a point O' on cylinder axis always at right angles as the latter moves down, θ- polar angle of declination to the wetting line). The problem is formulated as a linear one, which imposes constraints on the penetration velocity v_0 (t) to remain lower than the speed of sound c in the fluid and on the penetration depth z* to remain smaller than the mean shell radius R. Motion of the perturbed fluid is described by the applicable wave equation for the wave potential φ. The wetted shell surface is assumed to be impermeable. The problem is solved for a moving free fluid surface, with the boundary condition of a constant and specifically zero pressure on it outside the cylinder so that $\delta gf/\delta z|_{z-0} = 0$ there. The rise of the fluid along the penetrating lateral shell surface is first ignored and then taken into account. The problem is also solved for a quiescent free fluid surface, with the initial condition of a constant and specifically zero pressure on it so that $\delta\varphi/\delta z|_{t=0} = 0$ when the surface is constrained by a "rigid" shield or $\delta\varphi/\delta z|_{t=0} = -w(t,\theta)$ when the surface is constrained by a "deformable" shield. Motion of the shell in the fluid proceeds according to Newton's second law and its attendant deformation is assumed to follow the dynamics of thin elastic shells based on Kirchhoff-Love hypotheses. Solution of all four boundary-value problems requires prior solution of two auxiliary problems. The first one is to determine the relation between the strain rate V(t,θ) of the fluid surface and the hydrodynamic pressure p(t,θ) on that surface, which is done by expansion of both into Fourier series. The second one is to determine the dependence of displacements $u_x(t,\theta)$ and $w_z(t,\theta)$ of points of the median shell surface, also of their vertical velocity dw/dt(t,θ) on the pressure p(t,θ), which is also done by expansion of all into Fourier series. A subsequent Laplace transformation of all series and of the wave equation, followed by application of the convolution theorem for two originals and then another round of Fourier series expansions, leads to an infinite system of linear Volterra integral equations of the second kind for the coefficients p_n (t) in the time ingrals representing displacements u_n (t), W_n (t) and velocity dw/dt_n(t). This system was for each problem solved numerically on a finite time interval T, the latter having been subdivided into equal parts. Figures 4; references 7.

Supercritical Strains in Flexible Multilayer Shells of Revolution under Compound Load

197F0087F Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 26 No 9, Sep 90 pp 60-66

[Article by N.N. Kryukov and T.V. Krizhanovskaya, Institute of Mechanics, UkSSR Academy of Sciences, Kiev]

UDC 539.3

[Abstract] Supercritical as well as subcritical strains in flexible multilayer shells of revolution under a compound force load or force and heat load are calculated on the basis of a system of eight homogeneous nonlinear ordinary differential equations describing the state of stress and strain in the geometrically nonlinear formulation of the problem. Structures consisting of coaxial wound multilayer shells in tandem are considered, the material of each shell being an elastic and orthotropic one which satisfies the generalized Hooke's law and the Duhamel-Neumann hypothesis. Its elastic and thermophysical properties do not vary in the axial direction, but the thickness of the layer generally does. Every point of the shell lies in a plane of symmetry parallel to the coordinate plane. The layers, rigidly joined to one another, react compatibly to the load without sliding and separation. The method of solving that system of equations for such a structure is based on simultaneous linearization and orthogonalization. It has been solved numerically for a structure consisting of a conical shell and a cylindrical shell on both sides of a paraboloid of revolution under combined internal pressure and axial compression. also for a conical bimetal shell of uniform thickness under a normal surface load in a uniform temperature field. Figures 4; references 10.

Some Effective Solutions to Problem of Metal Sliding in Layer

917F0087H Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 26 No 9, Sep 90 pp 75-82

[Article by L.A. Tolokonnikov and V.B. Penkov, Tula Polytechnic Institute]

UDC 539.374

[Abstract] Flow of a metal in a thin plane fluid layer is considered as a problem of the metal machining process. Its solution is based on both Prandtl and Kiyko theories (I.I. Kiyko, NAUCHNYYE TRUDY INSTITUTA MEKHANIKI, Moscow State University 1976). The latter identifies three range of motion: 1) sliding with surface friction subject to Coulomb's law; 2) slowing down under maximum shearing stress, equal to yield point; 3) stagnation region moving as solid body with linear distribution of surface forces. The hypothesis of incompressibility applies to the fluid in the form $u_{,x} + v_{,y} = 0$ within a layer of constant thickness h. The fluid is assumed to be a linear viscous one, thus to differ from the Saint Venant model by retaining a constant viscosity. The equations of metal flow are accordingly rewritten in a form reducible to Cauchy-Riemann conditions for flow between smooth plates. Complex potentials can in this case be effectively used for solution of given boundary-value problems, whereupon the solutions can be used as first-order approximations of the perturbation theory with respect to the parameter f/h (f- friction coefficient) for problems of flow between rough surfaces. Flow between smooth surfaces is analyzed, following solution

of two one-dimensional problems. The first one, of parallel flow, simplifies considerably and is solved directly by two successive integration with respect to the transverse coordinate. The second one, of centrisymmetric flow with closed current lines, is solved by solving the applicable system of Navier-Stokes equations in polar coordinates. In conclusion is examined conformal motion of the region containing metal, such a motion being one during which the deformable boundary of this region always belongs in the family of curves obtained by mapping the given mapping $z = \omega(\xi,a_1,...a_n)$ (a_k- mapping parameter.) Figures 1; tables 1; references 9.

Optimum Pulsed Space Trajectories of Material Particle in Two-Body Field

917K0087I Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 26 No 9, Sep 90 pp 102-109

[Article by V.I. Gulyayev, A.B. Vasilyev, and V.L. Koshkin, Kiev Institute of Construction Engineering]

UDC 531.01:521.1

[Abstract] Optimum programming of pulsed space trajectories for a material particle in a two-body field in a stationary sidereal planetocentric system of coordinates is considered, for transition of that particle from a circular limit trajectory around the attracting first body to a circular limit trajectory around an attracting second body which revolves around the first one along an also circular trajectory. Positions of the material particle are defined by the real anomaly read from the ascending node. For a material particle with zero mass, transition from one limit trajectory to the other in a sequence of discrete active movements caused by successive velocity pulses is approximated with a sequence of discrete passive movements by action of gravitational forces only. The optimization problem is to determine the number, directions, and magnitudes of those velocity pulses applied to the material particle and controlling its motion, also the instants of time of their application. The problem is regularized with respect to the center of one of the attracting bodies, in two steps: renormalization from real time to a fictitious time with the aid of the Sundman time transformation $ds = dt/r$ and change from Cartesian coordinates to Kustaanheimo-Stiefel variables $x^* = Lu$, $V^* = 2Lu'/r$. It is subsequently solved by the numerical method the authors had developed for optimization of pulsed transitions between noncoplanar elliptical orbits (KOSMICHESKIYE ISSLEDOVANIYA Vol 26 No 4, 1988). Optimum three-pulse trajectories have thus been constructed for a material particle moving in the direction opposite to motion of the second body around the first. Perturbation of the field of the first body by the second body was first ignored during the Hohmann transition to the orbit of the second body and then taken into account during the final segment of transition to the material particle to the limit trajectory around the second body. It was taken into account by involving another problem, namely mininmizing the deviation of the end point from the a'priori stipulated destination point on that limit trajectory. Figures 4; references 11.

Free Vibrations of Long Cylindrical Shells With Initial Twist

917F0087E Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 26 No 9, Sep 90 pp 54-60

[Article by S.N. Kukudzhanov, Tbilisi Institute of Mathematics, GSSR Academy of Sciences]

UDC 539.3

[Abstract] Free vibrations of long cylindrical shells with initial twist are considered, expressions being derived for the natural frequencies and particularly the lowest ones depending on the initial twist. The general expressions, derived from the resolvent equation for radial displacement (deflection) of such a shell, are applied to "beam" vibrations with $n = 1$. These expressions yield in turn expressions for critical torques which are identical to the Timoshenko formula for sufficiently long shells and to the Timoshenko-Greenhill formula for shells on hinge supports with a twist angle equal to $m\pi R/L$ (R- radius, L-length, $m = 1$). The expressions are then appropriately modified for $n \geq 2$. Figures 4; references 6.

Natural Vibrations of Mechanical System Consisting of Ribbed Cylindrical Shell, Frame, and Attached Mass

917F0087D Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 26 No 9, Sep 90 pp 43-50

[Article by V.G. Palamarchuk, Institute of Mechanics, UkSSR Academy of Sciences, Kiev]

UDC 539.3

[Abstract] Natural vibrations of a thin closed right circular cylindrical shell reinforced by a regular array of stringers and hoops are analyzed, this shell carrying a square frame inside in a plane perpendicular to the shell axis. This frame is rigidly attached to four stringers 90° apart, to one at each corner, and in turn carries a mass in its center (on the shell axis) held in place by four identical compression-extension coil springs seated pairwise in the middle of opposite frame bars. The material of the shell is assumed to be elastic and isotropic. Its state of stress and strain conforms to the Kirchhoff-Love hypothesis. All stringers and hoops are treated as discrete one-dimensional elements, so joined to the shell as to ensure equal deflections along the contact line. They are assumed to both bend and twist during vibration of the structure, while the frame inside vibrates only flexurally in its plane. The springs are assumed to be massless and to remain within Hooke's law, while the attached mass in the center vibrates in the plane of the frame along the two orthogonal spring axes. Inasmuch as the shell is much stiffer in the tangential planes than in the a radial

directions, its inertia in tangential planes can be ignored. The natural modes and frequencies of this structure are calculated on the basis of the linear theory and the Hamilton-Ostrogradskiy principle, this principle yielding a Lagrange equation of the second kind which reduces to an infinite system of ordinary differential equation in the sought components of the deflection functions. The equation of compatibility with respect to strains is put in the form del del $\varphi = -(E/r)(\delta^2 w/\delta x^2$ where deflection w satisfies the conditions of hinge support. The method of calculation is demonstrated on a numerical example. Figures 6; references 5.

Forced Axisymmetric Vibrations of Electrically Excited Hollow Piezoceramic Sphere

917F0087B Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 26 No 9, Sep 90 pp 16-21

[Article by I.A. Loza and N.A. Shulga, Institute of Mechanics, UkSSR Academy of Sciences, Kiev]

UDC 539.3:534.1

[Abstract] Forced axisymmetric vibrations of a radially polarized and electrically excited hollow piezoceramic sphere are analyzed, specifically its coupled electroelastic vibrations (second class) rather than pure elastic vibrations (first class). The analysis is based on a system of three partial differential equations describing both elastic and electromagnetic steady-state axisymmetric processes in the quasi-static approximation, in the absence of external charges and currents as well as of body forces. These equations involve both radial and circumferential components of the stress tensor and the displacement vector, the radial component of the electric induction vector, and the electric potential. The parameters of this system are components of the dielectric permittivity tensor, of the elastic constants tensor, and of the piezoelectric constants tensor, also density of the material and frequency of vibrations. It is solved for given boundary conditions regarding radial and axisymmetric stresses and the electric potential at both surfaces. The solution is sought in series of Legendre polynomials $x_n P_j(\cos)e^{i\omega t}$ ($j = 0,...,\infty$, $n = 0,...,\infty$) by reduction to a system of six recurrence relations, these then being reduced to a system of six algebraic equations. This method is applied to a piezoceramic hollow sphere with both surfaces covered by split electrodes and thus excitable into axisymmetric vibrations. Excitation by a harmonic potential with a 180° phase difference between upper and lower hemispheres is considered, assuming zero stresses at both surfaces. Numerical calculations have been made for such a hollow sphere made of a specific piezoceramic material. The resonance frequencies were obtained from the dependence of normalized natural frequencies on the index of the Legendre polynomial. The amplitude-frequency characteristic of forced electroelastic vibrations was calculated for various amplitudes of the electric potential. The distribution of vibration amplitudes over the wall thickness of the sphere was calculated first for thick spheres, with the normal component of electric induction almost linearly distributed over the thickness, then for thin spheres with the electrostatic potential distribution analogous to that on a plane capacitor and with uniform distributions of displacements over the thickness. Figures 4; references 7.

Predicting Strength of Ternary Fibrous Composite Materials

917F0087A Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 26 No 9, Sep 90 pp 10-16

[Article by B.P. Maslov, A.Kh. Melikbekyan, and S.N. Bugay, Special Design and Manufacturing Engineering Office, UkSSR Academy of Sciences, Kiev, and Voronezh Institute of Machine Construction]

UDC 539.3

[Abstract] A composite material is considered which consists of an isotropic matrix with anisotropic unidirectionally oriented continuous reinforcing fibers and isotropic spheroidal inclusions, the latter randomly distributed over the volume or in a plane perpendicular to the fibers. The problem of predicting its macrostructural strength is solved on the basis of microstructural analysis, by first averaging the physical law of elasticity over a macrovolume containing all three components and then applying it also to a separate microvolume containing the matrix with inclusions only. Within this microvolume the inclusions are regarded as another reinforcing component. The equation of balance is then solved with the aid of Green's function, considering a microvolume in a state of elastic equilibrium with random ergodic stress, strain, and modulus of elasticity distributions. The strength criteria obtained on this basis are applied to optimization of the reinforcement for maximum load capacity of a composite material by use of high-modulus fibers, as demonstrated on a numerical example. Figures 4; references 6.

Action of Moving Load on Ribbed Cylindrical Shell With Elastic Filler

917F0087C Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 26 No 9, Sep 90 pp 22-29

[Article by V.I. Pozhuyev, Zaporozhye Industrial Institute]

UDC 539.3

[Abstract] The problem of moving loads is solved for an infinitely long cylindrical shell reinforced with stringers on the outside surface and containing an elastic sluggish filler. Motion of the shell under such a load is described by the classical system of three equations based on the Kirchhoff-Love hypothesis. Motion of the stringers is described by the equations of elastic deflection in the theory of beams, only the stringers being assumed to carry the load. The behavior of the filler is described by

the vector equation of dynamics in the theory of elasticity. The boundary conditions for the filler are: stresses $\sigma rx = \sigma_{r\theta} = 0$, $\sigma_{rr} = -p_c$ (p_c- reaction force exerted by filler on shell), and radial displacements $u_r = w$ at its outside surface in sliding contact with the shell and stresses $\sigma = \sigma_{r\theta} = \sigma_{rr} = 0$ at its free inside surface. The solution to the steady-state problem with constant load speed c is sought in the moving system of cylindrical $r,\theta,\eta = (x- ct)/a$ coordinates. It is solved with the aid of a Fourier transformation with respect to the η-variable and expansion of the sought quantities into Fourier series with respect to the θ-variable. The circumferential distribution of deflections in the $\eta = 0$ cross-section and the distribution of contact pressure at the shell-filler interface have been calculated for a specific shell, with not only the number of stringers and their cross-section varied but also the ratio of filler stiffness to stringer stiffness. The computer time was shortened appreciably by a reverse sequence of operations, namely expansion into Fourier series first and Fourier transformation afterwards with summation thus preceding integration. Figures 2; references 5.

Experimental Study of Cylindrical Shells for Load Capacity under External Pressure

917F0086H Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 26 No 8, Aug 90 pp 114-117

[Article by Ye.F. Prokopalo, Dnepropetrovsk University]

UDC 539.3

[Abstract] An experimental study of smooth cylindrical shells was made for a determination of their load capacity under lateral external pressure. The shells were spot-welded tubes made from foil of cold-rolled Cr18Ni9 stainless steel, this steel having a modulus of elasticity $E = 2.1x10^5$ MPa and a yield strength $\sigma_{0.2} = 840$ MPa. All shells had an R = 4.3 cm radius and an h = 0.09 mm wall thickness. Six lots of shells were tested, their ratio of gage length to radius being L/R = 1.0, 1,5, 2.0, 2.5, 3.0, 4.0 respectively. In the first part of the experiment six shells of each lot were tested for stability loss up to failure. For this test a shell was supported in a manner approximating hinge support and closed at each end by a cylindrical plug, a steel rod inserted tightly between the plugs taking up the axial load when lateral external load was applied by evacuation of the shell cavity through a hole in one plug. In the second part of the experiment four shells of each lot were tested for the "load - volumetric strain" relation. For this test a shell with both plugs was placed vertically inside a chamber and connected to a standpipe under a water tank. It was first completely filled with water, which drove the air out through a vent hole. The latter was then hermetically closed with another plug. As the shell was subsequently loaded laterally from outside, water was flowing out of the cavity through the standpipe back to the tank. The experimental data yield critical loads only 10-18% lower than does Papkovich's formula $p_{cr} = 0.92E(R/L)(h/R)^{5/2}$. They also indicate a further increasing load capacity of beyond the stability loss, accompanied by increasing shape distortion and volume reduction, up to a critical level prior to failure by flattening. Figures 2; references 1.

Load Capacity and Behavior of Shells With Linearly Distributed Masses Under External Pressure Pulse

917F0086I Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 26 No 8, Aug 90 pp 117-120

[Article by O.M. Dubovik, Dnepropetrovsk University]

UDC 539.3

[Abstract] An experimental study of thin circular cylindrical shells carrying masses linearly distributed along their generatrices was made, for a determination of their load capacity under an external pressure pulse. The shells were spot-welded tubes made of Cr18Ni9 stainless steel foil, this steel having a modulus of elasticity $E = 2x10^5$ MPa and a yield strength $\sigma_{0.2} = 800$ MPa. The shells were 0.187 mm thick and 114 mm long with a 57 mm radius. The linear masses they carried were segments of Cr19Ni9 wire spot-welded to the inside surface into a symmetric pattern of reinforcing stringers. The wire gage was changed from shell to shell, for simulation of the inertia characteristics of such a burden. Identical smooth shells without stringers were also tested, for comparison. The shells were loaded dynamically inside an electromagnetic inductor through the coil of which a capacitor battery was discharged in pulses of 90 μs duration, such a discharge producing a radial pressure shock on the shell. These tests have yielded data on the behavior of such shells under such loading conditions, particularly pertaining to the modes of stability loss and the critical load depending on the number of wire stringers and on their size. The critical loads differ from theoretical ones based on the theory of orthotropic structures and thus indicate limits of its applicability. The data should be useful in the design of shells for given stiffness with minimum mass. Figures 3; references 4.

Design of Systems of Connected Coaxial Cylindrical Shells

917F0086G Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 26 No 8, Aug 90 pp 106-109

[Article by V.I. Demura, Kiev University]

UDC 539.3

[Abstract] An analytical design method for structures which consisting of connected coaxial circular cylindrical shells with hinge-support end constraints is outlined in a general terms applicable to any geometrical configuration, any mechanical characteristics, and any force field. The directrix of such a structure is portrayed as a family of m circular arcs and of each j-th cylindrical

element is described by the equation of the engineering theory of shells. The general solution to the homogeneous problem and the particular solutions to a nonhomogeneous problem are all expressed in Vlasov's stress functions F_0,F_1. The calculation, including also the temperature field, have been programmed in Analitik-79 language. They are demonstrated on two examples. The first example is a structure consisting of two coaxial thin circular cylindrical shells with uniform wall thickness each, one inside the other, joined by two plates in their diametral planes. The structure is under a pressure load: $p = -p_0 \sin(\pi r/L)\xi$ on the outer shell and $-p = p_0 \sin(\pi r/L)\xi$ on the inner one. The plate material is assumed to have a modulus of elasticity much lower than that of the isotropic shell material with a 0.3 Poisson ratio. Calculations were made by subdividing both shells into equal numbers of identical arcuate segments: (four $\pi/2$ segments, eight $\pi/4$ segments, sixteen 16 $\pi/8$ segments, etc). The second example is the same structure with a third such shell inside, similarly joined and under analogous load conditions. Figures 5; references 5.

Regular and Random Surface Waves in Fluid under Limited Excitation of Cylindrical Tank Into Vibrations

917F0086F Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 26 No 8, Aug 90 pp 85-93

[Article by T.S. Krasnopolskaya and A.Yu. Shvets, Institute of Mechanics, UkSSR Academy of Sciences, Kiev]

UDC 532.595:534.1

[Abstract] Free oscillations of the free surface of a fluid inside a rigid tank excited into horizontal vibrations is analyzed in the case of limited excitation power. A cylindrical tank on wheels under its flat rigid bottom is put in horizontal reciprocating motion by an electric motor driving it through a slider-crank mechanism. The fluid is assumed to be nonviscous and incompressible. The resulting oscillations of the free fluid surface are described following solution of the boundary-value problem for its velocity potential. The kinetic energy T is calculated in accordance with Dirichlet's principle and the potential energy V calculated as work against d'Alembert's forces, the Lagrangian L = T- V then yielding an equation for the angular coordinate of the motor shaft. Assuming then that the steady-state motor speed is close to the fundamental natural frequency of the free fluid surface, a closed system of Lagrange equations is obtained which describes the coupling between vibrations of the free fluid surface and rotation of the motor shaft. An asymptotic solution of this system of equations yields either limit cycles or random attractors. This system of equations contains six parameters which, together with the initial conditions, determine the steady-state behavior of the mechanical system. The asymptotic phase trajectories, calculated numerically by the Runge-Kutta method with fourth-order precision, indicate three possible steady-state modes: 1) motor shaft rotating at constant speed, free fluid surface oscillating at constant frequency with constant amplitude; 2) motor shaft rotating at periodically modulated speed, free fluid surface oscillating at modulated frequency with modulated amplitude; 3) speed of motor shaft as well as frequency and amplitude of oscillations of the free fluid surface varying randomly in time, transition to this random mode occurring according to Feygenbaum's scenario. Figures 5; references 12.

Electroelastic Vibrations of Conical Elements

917F0086E Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 26 No 8, Aug 90 pp 53-59

[Article by A.M. Bolkisev, Institute of Mechanics, UkSSR Academy of Sciences, Kiev]

UDC 539.3:534.133

[Abstract] Forced electroelastic vibrations of conical piezoelectric shells with arbitrary apex half-angle γ are analyzed by application of the Hamilton-Ostrogradskiy variational principle and the method of finite elements to this problem of electroelasticity in spatial formulation. The physical relations are combined with the Cauchy relations and the gradient equation for the electric potential so that all relations which do not follow from the stationarity of the functional become lumped into two equations: for components of the stress tensor $\sigma_{ij} = c_{ijkl}u_{k,l} + e_{mij}\varphi_{,m}$ and for components of the electric induction vector $D_n = e_{nkl}u_{k,l} - \varepsilon_{mn}\varphi_{,m}$ ($u_{k,l}$- components of displacement vector, c_{ijkl}- components of modulus of elasticity tensor, φ- electric potential, e_{mij}- components of piezoelectric coefficients tensor, ε_{mn}- components of dielectric permittivity tensor, i,j,k,l,m = 1,2,3). The conditions within the shell volume and at its boundary surfaces are then established for zero first variation of that functional. Bare surfaces and surfaces covered with metal electrodes are considered. In accordance with standard procedure, tensor notation is changed to matrix notation, volume and surface integrals are replaced with sums of finite- element volume and surface integrals, and distributions of unknown functions are described with approximating functions. A resolvent system of equations is obtained by introduction of four-dimensional displacement (generalized), stress, and strain vectors, also a load vector, a square density matrix, and a square matrix of physical properties $(c,e^T,e,-\varepsilon)$. Using a grid of first-order triangular finite elements, the frequencies of the first four resonances were calculated as functions of the apex half-angle γ for cones made of TsTS-19 piezoceramic. The piezoelectric coupling in the first mode was found to increase to a maximum in a $\gamma \approx 20°$ cone, to become much weaker in $\gamma > 30°$ cones, and to vanish in a $\gamma = 90°$ disk. The frequencies of the higher resonances were found to decrease monotonically to some constant level, the frequency of the fourth ceasing to depend on the apex half-angle above 60° already. Figures 3; references 11.

Stability of Nonideal Ribbed Spherical Belt

917F0086D Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 26 No 8, Aug 90 pp 43-46

[Article by G.D. Gavrilenko and A.S. Sitnik, Institute of Mechanics, UkSSR Academy of Sciences, Kiev]

UDC 539.3

[Abstract] A ribbed spherical shell with axisymmetric shape imperfections between two parallel planes equidistant from the equatorial plane, a spherical belt resting on a horizontal base, is analyzed is for stability under a pressure load. The belt material is characterized by its modulus of elasticity and Poisson ratio. The belt geometry is characterized by thickness of the shell, cross-sectional area, moment of inertia, and static moment of the stringers. Subcritical strains and stresses, related through the Lamé constants, are calculated by solving a system of two linear equations of balance in longitudinal and radial displacement. These equations are solved by the numerical method of finite differences, for boundary conditions of zero circumferential as well as longitudinal and radial displacement and a zero rotation angle at the base. The critical load is then calculated by solving a system of three equations of neutral equilibrium. With changes of curvature, changes of angles of rotation, and strains in the perturbed state having been expressed in terms of all three displacements, these equations are solved following an expansion of each displacement into a single infinite trigonometric series. The equations of stability then become ordinary differential ones which, upon conversion to finite differences, reduce to a system of algebraic ones for numerical calculation of the critical load. Figures 2; references 1.

Radial Electroelastic Vibrations of Hollow Piezoceramic Sphere

917F0086B Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 26 No 8, Aug 90 pp 20-25

[Article by N.A, Shulga, Institute of Mechanics, UkSSR Academy of Sciences, Kiev]

UDC 534.1:537.228

[Abstract] Nonaxisymmetric radial harmonic vibrations of a radially polarized hollow piezoceramic sphere are analyzed on the basis of two partial differential equations of electroelasticity involving radial displacement u_r, radial and angular mechanical stress tensor components σ_{rr}, $\sigma_{\alpha\alpha}$ ($\sigma_{\alpha\alpha} = \sigma_{\beta\beta}$), and radial electric induction D_r. Implicitly is also involved the electric potential $\varphi(r,t)$, inasmuch as both stress components and the induction are related to it as well as to the displacement. Following space integration of $\delta D_r/\delta r$, which yields $D_r = (R/r)^2)D_0(t)(c_a\ \varepsilon_0)^{1/2}$ (c_a- elastic constant of sphere at constant electric field intensity, ε_0 dielectric constant of vacuum, inside radius of sphere R- h, outside radius of sphere R+ h), those two partial differential equations are transformed into two ordinary differential ones in time and the latter are solved then in power series. As a specific case is considered a spherical shell with metal electrodes covering both outside and inside surfaces. Its resonance frequencies are determined from the frequency equation, for calculating the efficiency of energy conversion at these frequencies are also needed its antiresonance frequencies. The latter are found to be natural frequencies of a spherical shell with bare surfaces. While the lower resonance frequencies are readily calculated, calculation of the higher ones requires a computer. References 6.

Dynamics of Shell Structures under Impulsive Loads: Survey

917F0086A Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 26 No 8, Aug 90 pp 3-20

[Article by P.Z. Lugovoy, Institute of Geophysics, UkSSR Academy of Sciences, Kiev]

UDC 531/539

[Abstract] Theoretical research done since 1979 on the dynamics of shell structures under impulsive loads is systematically surveyed, beginning with smooth shells followed by shells with holes or inclusions and shells reinforced by stiffener ribs. Methods of design and performance analysis covering all basic shell types (cylindrical, conical, spherical) and the entire gamut of dynamic loads, including hydrodynamic and acoustic ones, are identified by author and publication. Special attention is paid to thin-walled shells. Solution of coupled problems for hydroelastic shell-fluid systems and of corresponding initial-value boundary-value problems of is another concern. The survey covers also experimental research, particularly design of shock tubes for shell testing and tests actually performed. References 202.

Solving Problem of Propagation of Elastic Waves Through Cylinder With Fluid

917F0086C Kiev PRIKLADNAYA MEKHANIKA in Russian VOl 26 No 8, Aug 90 pp 25-29

[Article by G.L. Komissarova, Institute of Mechanics, UkSSR Academy of Sciences]

UDC 534.1:534.232

[Abstract] Propagation of axisymmetric normal waves through a waveguide consisting of a hollow elastic cylinder and an ideal compressible fluid inside is analyzed in terms of longitudinal and radial displacement vector components u_z and u_r, assuming that the outside surface of the cylinder is stress-free while its entire inside surface is in contact with the fluid. Solution of this problem involves the velocity potential φ of the fluid and two mechanical stress tensor components σ_{rr}, σ_{rz}. The corresponding set of five boundary conditions ($\sigma_{rr}(z,t) = \sigma_{rz}(z,t) = 0$ at the outside surface, $\sigma_{rr}(z,t) = i\omega\rho_0\omega(z,t)$ at the inside surface, and $\delta u_z/\delta t = -\delta\varphi/\delta r$

at the inside surface, ρ_0- density of fluid, ω- frequency of wave) yields a dispersion relation in the form $[va]_{ij}[v] = 0$ relating the dimensionless vibration frequency γ_2 to the propagation constant ζ. Two partial systems are considered next: an empty hollow cylinder and a rigid cylinder full of fluid, only the dispersion equation for the hollow one having complex roots. For plotting the complex dispersion branches in the static γ_2-ζ plane one needs to know the complex roots in that plane. They are found with the aid of the known solution to the static problem for a hollow cylinder in terms of propagation constants. These constants are large arguments of modified Bessel functions I_0,I_1,K_0,K_1 and thus readily evaluated by asymptotic expansion of the latter. Figures 2; tables 2; references 5.

Profiled Keyless Couplings with Equiaxial Contour: Their Advantages, Drawbacks, Applications, and Installation Procedure

917F0079C Moscow VESTNIK MASHINOSTROYENIYA in Russian No 11, Nov 90 pp 43-50

[Article by A.I. Timchenko, candidate of technical sciences, Moscow Institute of Machine Tool construction]

UDC 621.824.42.002.2

[Abstract] Profiled keyless couplings with equiaxial equilateral curvilinear contours described by the equations $X = (R - e\cos N\varphi)\cos\varphi - Ne\sin N\varphi \, N\varphi \sin\varphi$, $Y = (R - e\cos N\varphi)\sin\varphi + Ne\sin N\varphi \cos\varphi$, and $\theta = \varphi + \tan^{-1}[(Ne\cos N\varphi)/R + e\sin\varphi)]$ (φ- central angle, R- radius of pitch circle, $2e = R_a - R_d$, R_c- radius of addendum circle, R_d- radius of dedendum circle, N- number of sides (arcs) of equilateral polygon, θ- polar angle) have higher fatigue strength, higher efficiency, and smaller mass-to-load ratio (especially when joining hollow shafts). Those with triangular contours, moreover, feature automatic centering under load attended, when $e = R/32$, by self-stopping of the gear hub against the shaft shoulder and consequent elimination of axial play. The manufacture of these couplings involves a simpler technology and a shorter machining time, it therefore costing less to produce them. They can also be readily coated with an antifriction material, which will lengthen their life. They are most effectively used for torque transmission, in planetary gear trains as sun wheel, in chucks for clamping, and in tail spindles for centering. The geometrical and mechanical design of these couplings, with continuous contour lines (RK, K) or with corners cut flat (K_c) must comply with specified allowances and fits. Experience has shown that the best way to introduce such couplings into manufacture of metal cutting machine tools is to do it in two stages, first individually in pilot units for experimental validation of their high performance characteristics and then on a full-scale production basis for eventual confirmation of their technological feasibility. Figures 3; tables 2; references 5.

Evaluation of Lubricating Characteristics of Transmission Oils from Accelerated Gear Transmission Tests

917F0079 Moscow VESTNIK MASHINOSTROYENIYA in Russian No 11, Nov 90 pp 26-28

[Article by L.A. Kiselev, candidate of technical sciences, State Union Scientific Research Institute of Tractors]

UDC 621.833

[Abstract] A new procedure has been developed for qualitative classification of automotive transmission oils and quantitative evaluation of their lubrication characteristics on the basis of accelerated 200 h gear tests, the purpose of lubricating gears is to minimize wear and pitting under constant and peak stresses. The procedure is demonstrated on testing the "second gear" transmission (driver with 30 teeth, driven gear with 48 teeth, all teeth 28 mm wide and 9.0 mm high, length of contact path 7.5 mm, pressure angle 20°) of the DT-75M tractor in the special LT-6M stand. Nine grades of transmission oils have been evaluated by this method and are, in accordance with applicable norms, recommended as follows: 1) new TEp-15, TSp-10EFO,and TAP-15V with LZ-23K additive for mechanical gear transmissions only; 2) MGT and experimental MGT-40, MGYe-68V of higher purity for hydraulic transmissions with shifting under load; 3) old TEp-15, M-8A, and TAP-15V with OTP additive unsatisfactory. Tables 2.

Energy Saving Electromechanical Stand for Comprehensive Testing Mechanical Helicopter Transmission

917F0079B Moscow VESTNIK MASHINOSTROYENIYA in Russian No 11, Nov 90 pp 31-34

[Article by S.A. Golubtsov and Yu.M. Goreglyad, V.I. Novikov, candidate of technical sciences, and G.P. Smirnov, Moscow Helicopter Manufacturing Plant imeni M.L. Milya, G.M. Ivanov, doctor of technical sciences, All-Union Scientific Research Institute of Electric Drives, Moscow]

UDC 621.85:629.735.45

[Abstract] An electromechanical stand for testing the mechanical transmission of a medium-size helicopter (main speed reducer - intermediate speed reducer - tail speed reducer; two connecting shafts, one tail shaft; overrunning clutches, disk clutches, spline couplings), its compact two-tier structure having been designed for convenient assembly as well as for easy mounting and energy-efficient testing of such transmissions. The kinematic system includes two 350 kW 0-2800 rpm wound-rotor induction motors, one induction generator, and five synchronous a.c. generators. The motors drive the main speed reducer of the tested transmission, each being coupled to one of its input shafts through a speed booster and the torque sensor of a dynamometer. The generators, electrically loading both main and tail speed reducers, are coupled through a distributing gear set to the output shafts of these reducers. All motors and generators are connected to an autonomous 6 kV network. Each of the two motors is energized by a synchronous generator and each of these two machines receives its field excitation from a 400 V network through a 0.4/6 kV transformer and a static (thyristor) current converter, a third such transformer-converter set delivering excitation to the parallel-connected fields of the five synchronous machines which load the speed reducers. The speeds of the three induction machines are regulated by static (thyristor) a.c. frequency converters, each of them connected to the 400 V network through a 0.4/6 kV transformer. This arrangement provides separate loading of the speed reducers, with torque regulation and with small consumption of electric energy. Figures 4; tables 1.

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