28899
S/129/61/000/010/001/012
E193/E480

188200

AUTHORS: Oding, I.A., Corresponding Member AS USSR, Lozinskiy, M.G., Doctor of Technical Sciences, Antipova, Ye.I., Engineer and Stepanov, V.N., Engineer

TITLE: A study of the mechanism of fracture of austenitic steel in short-time service at 1100°C

PERIODICAL: Metallovedeniye i termicheskaya obrabotka metallov, no.10, 1961, 10-13 + 4 plates

TEXT: Results are reported of short time (3 to 30 minutes) constant-load and time-to-rupture tests, carried out at 1100°C on austenitic steels ЭХ18Н9 (EKh18N9) (0.07% C, 18% Cr, 9% Ni, 1.56% Mn, 0.31% Si) and 4Х14Н14В2М (4Kh14N14V2M) (0.45% C, 14% Cr, 15% Ni, 2.3% W, 0.6% Mn and 0.34% Si). The test pieces were preliminarily heat treated by heating for two hours at 1100°C in evacuated quartz ampules followed by oil quenching. One face of each heat treated specimen was polished and etched to reveal the microstructure and test pieces with an average grain-size of 30 to 60 (EKh18N9) or 100 to 130 microns (4Kh14N14V2M) were selected. During the tests (carried out in vacuum) the etched side of the test piece, marked by a series of equi-distant

Card 1/3

was also supported by the results of bending and fatigue tests. The strength decreased with increasing length and diameter. This effect is attributed to various structural defects, defects formed during the handling of specimens and surface defects associated with the action of the surrounding atmosphere. Whiskers whose diameter exceeded 10 μ had a mosaic structure and their strength was very low. The axes of copper whiskers coincided with the [100], [110] and [111] crystal axis; the cross-section of whiskers with a [111] and [100] orientation was hexagonal and square, respectively.
There are 7 figures and 21 references: 1 Soviet and 20 non-Soviet. The four latest English-language references quoted are: Ref. 16 - Cabrera, N. - Cambridge Conference on Whiskers and Thin Films Abstract in Nature, Vol. 102, 1958; Ref. 18 - W.W. Webb and M. Stern - Journ. Appl. Phys., Vol.30, 1958; Ref. 19 - S.S. Brenner - Journ. Appl. Phys., Vol.30,1959; Ref. 21 - P.B. Price - Philos. Mag., V. 5, 1960.

ASSOCIATION: Institut metallurgii AN SSSR (Institute of Metallurgy of the AS USSR)

APPROVED FOR RELEASE: 06/23/11: CIA-RDP86-00513R001237800041-6

diffraction. In Fig. 4, the tensile stress (σ, kg/mm^2) is plotted against elongation (ε) of a) iron whiskers, 5.3 μ in diameter and, b) copper whiskers, 2.5 μ in diameter. The effect of size is illustrated in Fig. 5, where UTS (σ, kg/mm^2) of copper whiskers is plotted against diameter (d, mm, diagram a) and length (L, mm, diagram б), the diameter in the latter case being 6 - 7 μ. Similarly, the UTS (kg/mm^2) of large iron whiskers is plotted against their diameter (μ) in Fig. 7. Finally, the effect of crystal orientation on the strength of copper whiskers is illustrated in Fig. 7, where UTS (σ, kg/mm^2) is plotted against whisker diameter (μ), the continuous curve relating to whiskers whose axes coincide with the [111] crystal axis and the broken curve showing the average UTS of whiskers with axes in the [100] and [110] directions. In fatigue tests some of the specimens subjected to stresses of 60 - 120 kg/mm^2 remained unbroken after ten million cycles. The results confirmed that the tensile strength of whiskers approached the theoretical strength of metals; this conclusion

26796
S/129/61/000/009/004/006
E193/E380

18 9500

AUTHORS: Oding, I.A., Corresponding Member of the AS USSR and Kop'yev, I.M., Engineer

TITLE: Mechanical Properties of Metal Whiskers

PERIODICAL: Metallovedeniye i termicheskaya obrabotka metallov, 1961, No. 9, pp. 44 - 49

TEXT: Although the mechanical properties of metal whiskers have been extensively studied, the causes of their high strength are not yet properly understood, mainly because of difficulties in applying statistical methods of analysis to the relatively small number of experimental results obtained on whiskers grown and tested under a large variety of conditions. Hence, the present investigation, whose object was to study the mechanical properties of iron and copper whiskers, produced by hydrogen reduction of CuCl and $FeCl_2$. A large variety of forms was produced, including bent, twisted, conical and branched-out crystals. Only straight whiskers (3 - 10 mm long) with uniform surface reflectivity were used in bending, tensile and fatigue tests; the copper whiskers were also examined by X-ray

ODING, I.A.; KOP'YEV, I.M.

Properties of strength and plasticity of filiform crystals. Trudy Inst. met. no.8:254-258 '61. (MIRA 14:10)
(Metal crystals)

APPROVED FOR RELEASE: 06/23/11: CIA-RDP86-00513R001237800041-6

24187

Mechanism of growth of whisker S/129/61/000/007/001/016
E021/E135

At low degrees of supersaturation no growth was observed, but on increasing T_1 and T_2, thin crystals were found, 2-10 μ in diameter and 0.1-0.4 mm long. All mechanisms of growth are based on the development of helical dislocations. Many attempts to show dislocations in whiskers have been made. Emission microscope studies by E. Müller (Ref.16: Journ. Appl. Physics, V.30, No.11, 1959) on iron whiskers have confirmed the presence of pairs of helical dislocations with opposite signs.
There are 3 figures and 16 references: 1 German and 15 English. The four most recent English language references read as follows:
Ref.8: S.S. Brenner, Acta Metalurgica, V.7, No.10, 1959.
Ref.10: as above.
Ref.15: J.D. Eshelby, Growth and Perfection of Crystals. (John Willey Sons, Ins. New York, 1959).
Ref.16: as above.

ASSOCIATION: Institut metallurgii AN SSSR
(Institute of Metallurgy, AS USSR)

Card 3/4

APPROVED FOR RELEASE: 06/23/11: CIA-RDP86-00513R001237800041-6

24187
S/129/61/000/007/001/016
E021/E135

Mechanism of growth of whisker ....

with the surface of a larger crystal, the formation of helical dislocations was possible, leading to the growth of the crystal in thickness. S.S. Brenner and G.W. Sears put forward a third mechanism for the growth of whiskers from the gaseous phase (Ref.5: Acta Metalurgica, V.4, No.3, 1956) which is also based on helical dislocations. It was proposed that atoms would precipitate on the steps of a helical dislocation when a surface containing such imperfections was exposed to a supersaturated gaseous medium. This mechanism is only observed with high degrees of super-saturation as in the reduction of halide salts. For several metals, a basal mechanism of growth has been observed in such reductions. The rate of growth of silver whiskers from silver chloride can be calculated approximately, and results have given good agreement with experimental data. W.I. Allen and W.W. Webb (Ref.10: Acta Metalurgica, V.7, No.9, 1959) proposed that copper whiskers formed from copper chloride grow both at the base and at the top. The present authors have carried out some tests on the growth of copper whiskers from CuCl. The apparatus used is shown in Fig.3 (where: 1 - heater, 2 - thermocouple, 3 - quartz tube). The salt was vapourised at temperature T_1 and reduced at temperature T_2.

Card 2/4

18 9500

24187
S/129/61/000/007/001/016
E021/E135

AUTHORS: Oding, I.A., Corresponding Member, AS USSR, and
Kop'yev, I.M., Engineer

TITLE: Mechanism of growth of whisker crystals

PERIODICAL: Metallovedeniye i termicheskaya obrabotka metallov, 1961, No.7, pp. 2-7

TEXT: The hypotheses put forward in the last few years to explain the growth of "whiskers" are reviewed. It was first proposed by G.W. Sears (Ref.1: Acta Metalurgica, V.3 No.4, 1955) that in the condensation of mercury to form a whisker, the whisker inherited the helical dislocations of the surface on which it was growing. A calculation using thermodynamics showed that this gave a rate of growth several times too low. When it was assumed that the atoms striking the side of the whisker could diffuse to the top and take part in growth, calculation showed that this gave results which were observed in practice. In work with potassium chloride whiskers in aqueous solutions, a second hypothesis was put forward by I.B. Newkirk and G.W. Sears (Ref.3: Acta Metalurgica, V.3, No.2, 1955) which proposed that when small particles were in collision

APPROVED FOR RELEASE: 06/23/11: CIA-RDP86-00513R001237800041-6

30900

Increasing the ....

S/180/61/000/005/010/018
E073/E335

Ref. 3 - E.N. Andrade, D.A. Aboav - Proc. Roy. Soc., A, 1957, v. 240, no. 122, p. 304; Ref. 6 - R. Maddin, N.K. Chan - Progr. Metal Phys., 1954, v. 5, p. 53; Ref. 10 - D. McLean - J. Inst. Metals, 1952, v. 81, p. 133; Ref. 11 - J.J. Weertman - J. Appl. Phys., 1957, v. 28, no. 10.

SUBMITTED: January 5, 1961

APPROVED FOR RELEASE: 06/23/11: CIA-RDP86-00513R001237800041-6

strength was tested at the same temperature. It was found that the specimens which were preliminarily deformed by 0.3 and 1% showed an increase in the 100-hour strength from 82 to 92 kg/mm^2. There appear to be certain optimum temperatures and degrees of deformation which ensure the greatest increase in service life. At a load of 85 kg/mm^2 a 30-40-fold increase in the service life was obtained. It was found that with increasing degrees of deformation from 0.3 to 10% the effect of strengthening increased at first (at 0.3 and 1.0% deformation) and then dropped appreciably (at degrees of deformation of 2 - 10%). A change in the annealing temperature will also reduce the effect of strengthening. The optimum for this alloy is a deformation of 0.3 to 1.0% at 600 °C. The increase in strength is attributed to the formation of Cottrell clouds. There are 2 figures and 12 references: 3 Soviet-bloc and 9 non-Soviet-bloc. The four latest English-language references mentioned in the text are:

APPROVED FOR RELEASE: 06/23/11: CIA-RDP86-00513R001237800041-6

specimens were subjected to standard creep tests. The creep rate decreased by a factor of 20 to 25; the decrease in the creep speed indicates that, after mechanical-heat treatment, the movement of dislocations is impeded. The authors of this paper aimed at studying the possibility of increasing the long-run strength of steel by producing polygonal structures by mechanical-heat treatment. The principle consists of producing dislocations of a certain density by plastic deformation and then, by subsequent heat-treatment, to allow diffusion of the dislocations into rows which are more favourable from the energy point of view (sub-grain boundaries). Preliminary deformation was produced not by creep but by active stretching at the test temperature. 5 mm dia. 15 mm gauge lengths of Ni-Cr alloy specimens were preliminarily soaked at 1 050 °C for 2 hours and air-cooled. Following that, the specimens were stretched at a rate of 2.5 mm/min at 600 °C (considerably below the recrystallization temperature) to produce deformations of 0.3, 1.0, 2.0, 5.0 and 10%. After stretching, the specimens were held for 100 hours at 600 °C and then their long-run

30900
S/180/61/000/005/010/018
E073/E335

1.1700

AUTHORS: Oding, I.A. and Fridman, Z.G. (Moscow)

TITLE: Increasing the heat-resistance of alloys by the method of mechanical-heat treatment

PERIODICAL: Akademiya nauk SSSR. Izvestiya. Otdeleniye tekhnicheskikh nauk. Metallurgiya i toplivo. no. 5, 1961, pp. 75 - 77

TEXT: Of the known mechanisms of strengthening of metals during plastic deformation, polygonization is particularly important. V.S. Ivanova (Ref. 12 - On the role of dislocations in creep. Izd-vo AN SSSR, 1956) has shown experimentally the possibility of reducing the speed of creep by an appropriate method of polygonization of iron and of austenitic steels. Ivanova obtained polygonal structures by applying mechanical-heat treatment: during creep tests a residual deformation was obtained which equalled some critical value and, following that, the specimen was relieved of the load and maintained at the test temperature for 24 hours, as a result of which polygonization developed in the metal. Following that, the

Card 1/4

APPROVED FOR RELEASE: 06/23/11: CIA-RDP86-00513R001237800041-6

ODING, I.A.; GEMINOV, V.N.

Professor A.H.Cotrell's lectures. Metalloved. i term. obr. met. no.5:46-49 My '61. (MIRA 14:5)
(Dislocations in metals)

ODING, I.A.; GUREVICH, S.Ye.

Effect of work hardening on the cyclic strength at stress concentrations. Trudy Sem.po kach.poverkh. no.5:32-38 '61. (MIRA 15:10)

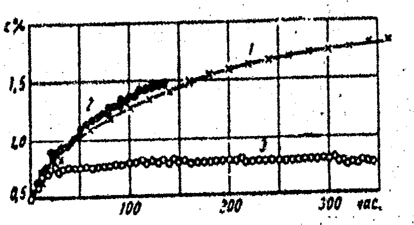
(Surface hardening)

S/129/61/000/001/001/013
E111/E135

Polygonization in Metals

authors concluding that substantial improvements are possible.

Fig.8



There are 8 figures and 56 references: 8 Soviet and 48 non-Soviet.

ASSOCIATION: Institut metallurgii AN SSSR
(Institute of Metallurgy, AS USSR)

Card 4/4

APPROVED FOR RELEASE: 06/23/11: CIA-RDP86-00513R001237800041-6

S/129/61/000/001/001/013
E111/E135

Polygonization in Metals

found to be facilitated by increasing purity (Fig.7 shows polygonal structure in ferrite grains). Figs 5 and 6 (both quoted from Kochendörfer and Ewertz, 'Archiv Eisenhüttenwesen', Vol.30, No.7, 1959) show the temperature-deformation-grain area-grain-number relations. The rate of polygonization is determined by dislocation effects which are themselves subject to various influences (Ref.34). Polygonization occurs in creep (e.g. Refs 13-15, 35-37) and this effect has been studied (Refs 38-49), it being shown (Ref.25) that with a suitable method of polygonization of iron and austenitic steels, creep rate can be greatly reduced. Fig.8 shows the creep curves for Armco iron, $\sigma = 8.5$ kg/mm^2, T = 450 °C: (curve 1 - normalised state, $v_p = 1.1 \cdot 10^{-4}$%/h; curve 2 - load relieved and furnace switched off; curve 3 - after mechanical working combined with heat treatment, $v_p = 4.5 \cdot 10^{-5}$%/h). The authors discuss such methods. Polygonization in metals subjected to deformation and heat treatment and during crystallization is also considered. The survey concludes with a section on the influence of polygonization on mechanical properties, the

Card 3/4

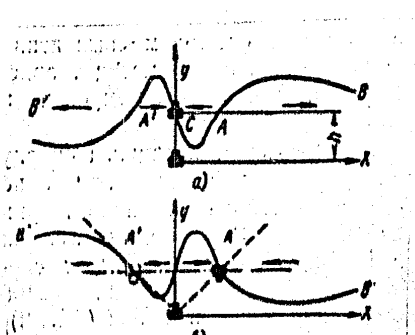
APPROVED FOR RELEASE: 06/23/11: CIA-RDP86-00513R001237800041-6

S/129/61/000/001/001/013
E111/E135

Polygonization in Metals

The authors consider the interaction of two parallel dislocations (Fig.3) and then that of many such dislocations from the aspect of polygonization. They then discuss polygonization in extension. The distortion of slip lines in extension of a crystal is shown schematically in Fig.4. Here temperature plays a major part. Polygonization in metals with various degrees of purity has been

Fig. 3



Card 2/4

APPROVED FOR RELEASE: 06/23/11: CIA-RDP86-00513R001237800041-6

S/129/61/000/001/001/013
E111/E135

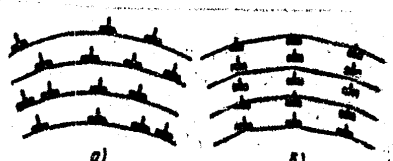
AUTHORS: Oding, I.A., Corresponding Member, AS USSR,
Zubarev, P.V., Engineer, and Fridman, Z.G., Engineer

TITLE: Polygonization in Metals

PERIODICAL: Metallovedeniye i termicheskaya obrabotka metallov, 1961, No. 1, pp. 2-10

TEXT: Polygonization is the formation in the grain of subgrains with their own orientations. The authors discuss this phenomenon which was first observed in 1932 (Ref.1) and the similar effect called "recrystallization in situ" (Refs 2-5). The paper is mainly a critical literature survey. The authors maintain that polygonization can be correctly explained only on the basis of dislocation theory, as shown schematically in Fig.2.

Fig. 2



Card 1/4

APPROVED FOR RELEASE: 06/23/11: CIA-RDP86-00513R001237800041-6

ODING, I. A.

"Influence of Flow Boundaries During Critical Stress"

Paper presented at Conference on Dimensioning and Strength Calculation, Budapest, 24-28 Oct 61

APPROVED FOR RELEASE: 06/23/11: CIA-RDP86-00513R001237800041-6

ODING, I. A.

"The Role of the Yield Limit as a Strength Criterion." Report submitted for the Conference on Design and Strength Analysis, Hungarian Acad. Sci, Oct. 1961

APPROVED FOR RELEASE: 06/23/11: CIA-RDP86-00513R001237800041-6

Name : ODING, I.A.

Title : Corresponding Member of the USSR Academy of Sciences. Deputy Director of the Institute of Metallurgy im. A. A. Baykiev.

Remarks : I. ODING is the author of an article entitled "The Ideal Metal", which refers to super-strong metal already obtained in minute quantities and able to withstand pressures of up to 1,400 kgs. per one square millimeter. The Institute is striving to make longer wires from such metal (at least 100 mm) and sheets of foil.

Source : N: Izv. #232, 29 Sep. 1961, p. 4, c. 3, top.

34 10

APPROVED FOR RELEASE: 06/23/11: CIA-RDP86-00513R001237800041-6

S/030/60/000/012/010/018
B004/B056

AUTHOR: Oding, I. A., Corresponding Member AS USSR

TITLE: International Symposium of the Fatigue Strength of Large Size Machine Units

PERIODICAL: Vestnik Akademii nauk SSSR, 1960, 30, No. 12, p. 91

TEXT: The International Symposium of the Fatigue Strength of Large Size Machine Units took place at Prague from September 9 to 10, 1960. The lectures dealt with problems of fatigue destruction, the action of metallurgical and technical factors, and the size and shape upon strength. A comprehensive report was delivered on each of the problems. The discussion was synchronously translated into five languages. A new metallurgical plant at Ostrava and the Scientific Research Institute of Welding in Bratislava were inspected. At the close of the symposium, the Anniversary Medal of the Higher Polytechnic College, Prague, was awarded, among other persons, to the Soviet research scientists Ye. P. Unksov and I. A. Oding.

Card 1/1

(Ref. 5), that for small samples a slight deformation resistance exists in the surface layer, which leads to an additional increase of the fatigue limit for small samples. In contrast to N. N. Davidenkov (Ref.4), A. Wells (Ref. 6), and Ye. M. Shevandin (Ref. 7), the author is of the opinion that the elastic energy of the sample is not suitable for defining the type of the scale factor. In the author's opinion, an explanation of the type of scale factor by microcracks according to V. V. Lavrov (Ref. 8) is not suitable either, since microcracks which effectively reduce the strength, do not occur in most metals used in machine construction. Since many influences affect the scale factor, systematic experiments must be conducted in the author's opinion in order to solve the scale factor problem, and laboratories would have to participate where comparison tests can be conducted on large and small samples. There are 8 references: 5 Soviet, 2 US, and 1 German.

ASSOCIATION: Institut metallurgii Akademii nauk SSSR (Institute of Metallurgy of the Academy of Sciences USSR)

APPROVED FOR RELEASE: 06/23/11: CIA-RDP86-00513R001237800041-6

S/032/60/026/009/008/018
B015/B058

AUTHOR: Oding, I. A.

TITLE: The Nature of the Scale Factor at Cyclic Loads

PERIODICAL: Zavodskaya laboratoriya, 1960, Vol. 26, No. 9, pp. 1106 - 1107

TEXT: The influence of the sample dimensions on the metal strength is influenced by various factors depending on the test conditions. In the present paper, the author discusses the factors which may be considered to effect a reduction of the cyclic strength at an increase of diameter and thickness of the samples. In a previous paper (Ref. 3), five factors were already mentioned by the author, which were used for specifying the scale factor, i.e., the metal quality, the tension gradient, the heterogeneity of tensions and mechanical properties in the microvolumes of the metal, the technique of sample preparation and the total influence of the cyclic tenacity and size of the metal granulation. In the present case, these factors must also be considered apart from the tension gradient, and it must be added in view of the statements by Hollomon

Card 1/2

APPROVED FOR RELEASE: 06/23/11: CIA-RDP86-00513R001237800041-6

ODING, I.A.; GEMINOV, V.N.

Mechanism of metal recovery during creep at high temperature. Issl. po zharopr. splav. 6:89-94 '60.
(Creep of metals) (MIRA 13:9)

ODING, I.A.; BURDUKSKIY, V.V.

Effect of variable loading stress on the durable strength of steel. Issl. po zharopr. splav. 6:77-88 '60. (MIRA 13:9)
(Steel--Fatigue) (Creep of metals)

APPROVED FOR RELEASE: 06/23/11: CIA-RDP86-00513R001237800041-6

28364
S/124/61/000/007/044/044
A052/A101

Modification of some physical properties ...

causes a sharper decrease of plasticity of microsamples and an increase of yield characteristics. Dynamical method of measurement was employed when studying temperature relations and changes of E and internal friction. For iron the peak of internal friction was detected at 110°C, whereby the decrement of damping max δ decreased by 38% by the end of the first stage of creep, in the stage of the steady creep max δ underwent no changes. No maximum of decrement δ was observed with chrome-nickel alloy, however in the first stage δ decreased rather considerably (approximately by 50%). In the case of iron E changed slightly, whereas in the case of chrome-nickel alloy it changed considerably, passing through the maximum. In connection with the deduced laws of changes of internal friction at creep, conclusions are made on the decrease of density of dislocations, prepared for motion, at the first stage of creep, its constancy at the second stage, and on a continuous increase in the number of such dislocations in the process of accelerated creep. In the authors' opinion the results of the investigation confirm experimentally the main principles of the structural theory of creep, as to the laws of changes in the density of dislocations with stages of creep. There are 14 references.

L. Getsov

[Abstracter's note: Complete translation]

Card 2/2

APPROVED FOR RELEASE: 06/23/11: CIA-RDP86-00513R001237800041-6

28364 S/124/61/000/007/044/044
A052/A101

10 7300

AUTHORS: Oding, I. A., Gordiyenko, L. K.

TITLE: Modification of some physical properties of metals in the process of creep at high temperatures

PERIODICAL: Referativnyy zhurnal, Mekhanika, no. 7, 1961, 61, abstract 7V528 (V sb. "Issled. po zharoprochn. splavam. T. 6", Moscow, AN SSSR, 1960, 3-16)

TEXT: The work investigates the modifications of microhardness, electric conductivity, mechanical characteristics, internal friction and modulus of elasticity E in the process of creep tests at various stresses and temperatures up to 750°C. The tests refer to commercial iron, ЭИ-257, ЭИ-395, ЭИ-432, ЭИ-437Б, ЭИ-598 (EI-257, EI-395, EI-432, EI-437B, EI-598) alloys and chrome-nickel alloy. In the case when no structural conversions affecting micro-hardness are present, substantial changes of microhardness take place in the first and third stages of creep: in the first stage the microhardness decreases, in the third it increases. Plasticity is most sensitive to changes in the process of creep. The increase of residual stress with an increased creep strain

Card 1/2

86060

S/180/60/000/005/001/033
E073/E135

Certain Relations Governing Long-Life Strength

experimentally. Therefore, a very simple method is proposed of determining the coefficient of reserve working ability of the metal K_c, which can be expressed as the reserve service life for a given stress and can also provide a possibility of calculating the strength reserve from the reserve of service life. Structures in which the metal has an equal proneness to damage will possess equal strength reserve values. The distance between the lines of equal proneness to damage from the failure lines will differ for various metals, depending on the intensity of accumulation of damage. The proneness to damage of the metal can be expressed as the ratio of the past service time at a given stress to its service life until failure at the same stress. The here proposed method is more justified than the current method of calculating the coefficient of strength reserve, which is based on a constant stress reserve for any given service life. There are 3 figures and 9 references: 8 Soviet and 1 English.

SUBMITTED: July 6, 1960

Card 4/4

86060

S/180/60/000/005/001/033
E073/E135

Certain Relations Governing Long-Life Strength

If the work of a single dislocation is expressed by r, a stress σ will produce $e^{\beta\sigma}$ dislocations in the avalanche. The total number of avalanches required for the metal to fail will be

$$t = \frac{C}{kr\,\exp(\beta\sigma)} \qquad (8)$$

At present no data are available which would permit establishing accurately the work until failure C during creep. However, it is shown in the paper that, assuming that the work until failure is a constant value, the line of equal damage of a given alloy is equidistant to the line of failure. Experimental results reproduced in the graph, Fig.3, for several steels and some other alloys indicate that in all cases the lines of proneness to damage are parallel to the lines of failure. Thereby, as the proneness to damage the authors assume that point on the creep curve which corresponds to the beginning of the third section, 18 the section of the curve with increasing creep speed. The theoretically established fact that all the lines of proneness to damage are parallel to the failure lines have been confirmed
Card 3/4

86060

S/180/60/000/005/001/033
E073/E135

Certain Relations Governing Long-Life Strength

plasticity resource, the plastic properties of the metal can be better utilised and, consequently, higher creep speeds and higher rated stresses are permissible. However, calculations of the strength reserve on the basis of ε_r are difficult in cases in which the metal under consideration has a low plasticity resource. In this case the variance in experimental data makes accurate calculation difficult and prone to dangerous errors. In this paper another criterion is proposed for establishing the reserve strength of machine parts operating at elevated temperatures. The basic idea consists in selecting as the strength criterion the work required for failure C, assuming that it is a constant value and does not depend on the magnitude of the applied stress. Depending on the magnitude of stress and the duration of stress application, various degrees of damage may occur; if the same work C' is spent, the same degree of damage will be achieved for a given metal with various stresses and service durations. Then, the reserve strength until failure C will equal

$$K_c = \frac{C}{C'} \tag{4}$$

Card 2/4

86060

S/180/60/000/005/001/033
E073/E135

10.9210

AUTHORS: Ivanova, V.S., Oding, I.A., and Fridman, Z.G. (Moscow)

TITLE: Certain Relations Governing Long-Life Strength 26

PERIODICAL: Izvestiya Akademii nauk SSSR, Otdeleniye tekhnicheskikh nauk, Metallurgiya i toplivo, 1960, No.5, pp.33-37

TEXT: In earlier work of the authors and their team (Refs 1-5) a new criterion of high temperature strength was established, namely, the "plasticity resource" ε_r, determined as the time to failure t_1 for a given constant stress σ_1 and an average creep speed V_1

$$\varepsilon_r = V_1 T_1 \quad (2)$$

Assuming that for a given component during service life t_s, total deformation ε_{tot} is permissible and the plasticity resource is ε_r, the remaining reserve plasticity resource will be

$$K_\varepsilon = \frac{\varepsilon_r}{\varepsilon_{tot}} \quad (3)$$

By carrying out the strength calculations on the basis of the

Card 1/4

80197
S/129/60/000/04/005/020
E073/E535

Deformation and Failure in the Case of Thermal Fatigue

if a component is produced from material with a high thermal conductivity and the value of the criterion Bi is low, appearance of fractures in the case of cyclic heating and cooling is to be anticipated on the ribs. However, if the component is produced from material with a low thermal conductivity, the cracks will appear on the flat part of the component. Some of the results obtained for the tested materials are given in the paper. There are 3 figures, 1 table and 4 references, 2 of which are Soviet and 2 German.

ASSOCIATION: TsNIITMASh

Card 4/4

80197

S/129/60/000/04/005/020
E073/E535

Deformation and Failure in the Case of Thermal Fatigue

to that shown in Fig 1b. In the second case the temperature of the surface of the component will be basically equal and accordingly the temperature stresses will be equal throughout the surface and, therefore, the above formula does not allow any conclusion on the likely location of the crack formation. The authors of this paper investigated rectangular prism specimens made of the alloys EI765, EI607 and EI612 (materials used for gas turbines). These specimens were heated in the furnace to a temperature of 800°C throughout and were then quenched in oil at 40°C. All the specimens showed thermal fatigue cracks at the surfaces of edges and not at the ribs of the prisms. In the most intensively cooled parts of the prism (ribs) the increased ductility proved to have a positive influence on the resistance to crack formation. Apparently cracks on ribs of prisms made of refractory metals of low thermal conductivity will only form if, due to the presence of stress concentrators, the local temperature stresses exceed the stresses of the basic metal. Thus,

Card 3/4

80197
S/129/60/000/04/005/020
E073/E535

Deformation and Failure in the Case of Thermal Fatigue

that the heat exchange criterion Bi = $(\alpha/\lambda)R$ has a low value. In this equation α is the coefficient of heat release, λ the coefficient of heat transfer and R is a characteristic dimension of the component. The character of the temperature field after a certain time from the beginning of the cooling process is illustrated by Fig 1a; materials with a high coefficient of heat conductivity have a low value of the criterion Bi. If the heat exchange proceeds in accordance with the boundary conditions of the third type, the temperature of the surface of a rib will be lower than the temperature in the centre and, therefore, the highest stresses will occur at the surface of the rib, which explains the crack formation in ribs. If the criterion Bi is sufficiently large (heat exchange proceeds in accordance with boundary conditions of the first type or conditions approaching it), the temperature of the entire surface will very rapidly become equal to the temperature of the cooling medium and the temperature field will correspond

Card 2/4

80197
S/129/60/000/04/005/020
E073/E535

18.8100

AUTHORS: Oding, I.A., Corresponding Member of the Academy of Sciences USSR and Kostochkin, Yu.V., Engineer

TITLE: Deformation and Failure in the Case of Thermal Fatigue

PERIODICAL: Metallovedeniye i termicheskaya obrabotka metallov, 1960, No 4, pp 26-29 (USSR)

ABSTRACT: The resistance to crack formation depends on the strength, ductility, thermal conductivity, the coefficient of thermal expansion and a number of other characteristics. The authors considered the temperature field in a cross-section of a rectangular prism during the process of colling. It is thereby assumed that during the first instant the temperature is equal along the entire cross-section and that the temperature of the surrounding medium remains constant throughout the entire process of cooling. The interaction between the surface of the body and the surrounding medium will proceed according to the laws of convective heat exchange, which corresponds to third order boundary conditions (Ref 1) provided

Card 1/4

S/180/60/000/03/001/030
E193/E383

The Process of Fracture of Metals as a Result of the Interaction Between Dislocations

fracture, the arrangement shown in Figure 3 corresponding to either brittle fracture or to fracture preceded by a small degree of plastic deformation. He shows, also, that the width of dislocation can be a factor determining the brittle or ductile nature of fracture of metals. Lastly, the present author discusses the mechanism of propagation of cracks, rejects the hypothesis that growth of a micro-crack is caused by stress concentration at its ends and postulates that line dislocations formed at the ends of microcracks in a way illustrated schematically in Figure 4 interact with the already existing dislocations and cause growth and propagation of the cracks.
There are 4 figures, 3 tables and 10 references, 7 of which are Soviet, 2 English and 1 German.

SUBMITTED: February 12, 1960

Card 4/4

S/180/60/000/03/001/030
E193/E383

The Process of Fracture of Metals as a Result of the Interaction Between Dislocations

dislocations, which gives the maximum specific energy of elastic deformation, is shown in Figure 2; lastly, a grouping of dislocations, which leads to stress concentration at the leading dislocation, is shown in Figure 3. A term "critical arrangements of dislocations" is ascribed by the present author to these arrangements, which either cause a stress concentration (Figure 3) or increase the stress, owing to the superimposition of two fields of forces (Figures 1,2) to a value sufficiently high to cause fracture of the metal. The magnitude of stress, necessary to start the formation of a crack, can be assessed with the aid of the criterion which determines the state of saturation of a micro- or ultramicro-volume with the energy of elastic deformation; according to the present author, the limiting value of the specific elastic deformation is equal to the latent heat of melting. In the third chapter of the present paper, the author discusses the conditions leading to the formation of the critical arrangement of dislocations and concludes that the arrangements shown in Figures 1 and 2 correspond to ductile

VC

S/180/60/000/03/001/030
E193/E383

The Process of Fracture of Metals as a Result of the Interaction Between Dislocations

are reproduced in Table 1, showing the values of A_{xx}, A_{yy} and A_{xy} (given in this order in each set of three figures) for points whose coordinates (in b) are given at the right side (y) and at the bottom (x) of the table. Having calculated D for various metals, the author shows that the stresses at certain points of the field may reach values as high as 450 kg/mm^2 for aluminium, 850 kg/mm^2 for copper and 1 350 kg/mm^2 for iron. Stresses of this magnitude present in the vicinity of dislocations cannot but affect the strength of the metal in the macroscopic scale, particularly when, owing to a high concentration of dislocation, conditions are created under which there is a possibility of interaction between the fields of forces of neighbouring dislocations. In the next chapter, several cases of interaction between dislocations are discussed. Figure 1 shows an arrangement of two dislocations which gives the maximum value of stress; an arrangement of

Card2/4

S/180/60/000/03/001/030
E193/E383

AUTHOR: Oding, I.A. (Moscow)

TITLE: The Process of Fracture of Metals as a Result of the Interaction Between Dislocations

PERIODICAL: Izvestiya Akademii nauk SSSR, Otdeleniye tekhnicheskikh nauk, Metallurgiya i toplivo, 1960, Nr 3, pp 3 - 16 (USSR)

ABSTRACT: The author of the present paper starts his theoretical analysis of the part played by dislocations in fracture of metals by discussing the fields of forces surrounding each dislocation. The field of forces, or rather stresses, around a line dislocation is described by a set of equations given at the foot of p 3 (if the coordinates x and y are measured in multiples of the Burger's vector b , then the coefficients A_{xx}, A_{yy} and A_{xy} will be expressed in dimensionless units and the dimension of D will be kg/mm^2; D is constant for each metal and its magnitude depends on the shear modulus G and poisson ratio μ). The equations are approximate only and do not describe stresses in the centre of a dislocation; they are applicable to points whose distance from the centre of a dislocation is not less than 1.5 b . The results of calculations based on these equations

Card1/4

68590

S/180/60/000/01/014/027
E193/E135

Failure of Metals due to Thermal Fatigue

There are 3 figures, 4 tables and 5 Soviet references.

SUBMITTED: October 6, 1959

Card 7/7

68690
S/180/60/000/01/014/027
E193/E135

Failure of Metals due to Thermal Fatigue

ε = 3%; n = 0. The results of creep tests for steel EI-612, tested at 650 °C under σ = 22.3 kg/mm², are presented in the same manner in Fig 3, curves 1-5 corresponding to: 1 - blade I5; τ = 203 h; ε = 2.5%; n = 6200; 2 - blade I1; τ = 209 h; ε = 1.94%; n = 5722; 3 - blade I14; τ = 856 h; ε = 1.44%; n = 1420; 4 - blade I15; τ = 942 h; ε = 1.47%; n = 710; 5 - blade I17; τ = 1091 h; ε = 1.4%; n = 0. The creep curves, reproduced in Figs 2 and 3, show that the larger the number of temperature reversals, the faster was the rate of deformation in creep and the higher the total elongation of the specimen. This was obviously due to the fact that fracture of blades, subjected to preliminary cyclic temperature reversals, took place across a smaller (on the account of cracks) effective cross-section area and, therefore, under a higher effective stress. It was concluded that the harmful effect of thermal fatigue is best assessed by conducting creep tests on specimens subjected to cyclic temperature variations, closely resembling those that occur under the actual operating conditions.

Card 6/7

68690
S/180/60/000/01/014/027
E193/E135

Failure of Metals due to Thermal Fatigue

boundaries in the direction perpendicular to the axis of the blade (and to the applied stress), until the load bearing cross section was reduced to about 50% of the original area, at which moment the specimen broke, the fracture taking place by intra-crystalline shear along a plane inclined at 45° to the horizontal. (In the case of blades that had not been subjected to preliminary, cyclic temperature variations, fracture under these conditions occurred instantaneously and was of the inter-crystalline nature). The creep curves (elongation ε, %, versus time τ, h) obtained in the course of the next series of experiments are given in Figs 2 and 3. Fig 2 shows the results for the EI-765 alloy, tested at 750 °C under σ = 22.3 kg/mm^2, the other conditions (for curves 1-5) being: 1 - blade E16; τ (time-to-rupture) = 276 h; ε (at the moment of fracture) = 6.45%; number of preliminary temperature reversals, n = 6200; 2 - blade E17; τ = 306 h; ε = 4.55%; n = 5817; 3 - blade E2; τ = 605 h; ε = 4.2%; n = 3580; 4 - blade E1; τ = 912 h; ε = 3.95%; n = 2315; 5 - blade E21; τ = 1520 h;

Card 5/7

68690
S/180/60/000/01/014/027
E193/E135

Failure of Metals due to Thermal Fatigue

fatigue cannot be assessed by the method employed. Consequently, actual turbine blades were used in the next series of experiments; these were also alternately heated and cooled in a stream of hot gas and cold air, after which they were subjected to creep tests in a manner described by the present author in Ref 5. The results of the time-to-rupture tests are given in Fig 1, where time-to-rupture (τ, h) for alloy EI-765, tested at 750 °C (continuous curves), and steel EI-612, tested at 650 °C (broken curves) is plotted against the number, n, of temperature reversals; the stress, σ, (kg/mm^2) applied during the creep test being given by each curve. It will be seen that with increasing n the creep resistance of the alloys (as indicated by the time-to-rupture) decreased, the rate of this decrease slowing down with both increasing n and increasing magnitude of the applied stress, σ. Macro- and micro-analysis of the fracture revealed that the failure had occurred not instantaneously, but progressively. A surface crack was first formed which then propagated along the grain

Card 4/7

68690

S/180/60/000/01/014/027
E193/E135

Failure of Metals due to Thermal Fatigue

various numbers of reversals, were tested for tensile and impact strength; the results of these tests are given in Tables 1-4. The results of short-time, tensile tests for the EI-765 alloy are given in Table 1 under the following headings: number of the specimen; number of the 750-70-750 °C cycles; tensile test temperature, °C; 0.2% proof stress, $\sigma_{0.2}$, kg/mm²; U.T.S., σ_B, kg/mm²; elongation, δ, %; reduction of area, ψ, %. The results of the impact strength tests for the same alloy are given in Table 2, showing: number of the specimen; number of 750-70-750 °C cycles; impact testing temperature, °C; impact strength, a_k, kgm/cm². The results of the short-time tensile tests and impact strength tests for steel EI-612 are presented in the same manner in Tables 3 and 4, respectively. Analysis of these tables showed that, taking into account the scatter of the results (characteristic for thermal fatigue tests), the mechanical properties of the specimen were hardly affected by the variation of the number of temperature reversals, thus indicating that the extent of the damage due to thermal

Card 3/7

68690

S/180/60/000/01/014/027
E193/E135

Failure of Metals due to Thermal Fatigue

broadening of the grain boundaries which can be considered as the first stage of the formation of cracks. Even in these cases, it is still necessary to evaluate the extent of the damage so as to be able to assess the suitability (or otherwise) of the part for further service. The object of the present investigation was to find a convenient method of checking the effect of thermal fatigue on the resistance of metals to deformation; the EI-765 nickel/chromium alloy and the EI-612 austenitic steel were selected as the experimental materials, both these alloys being used in the manufacture of gas turbine blades. Standard, cylindrical, tensile test pieces and impact strength test bars were used in the first series of experiments, which consisted in heating the specimens in a stream of gas at 750 °C and cooling them by a stream of air at 70 °C which corresponded very closely to the thermal conditions under which the turbine blades operate in service. A maximum of 6000 reversals was applied and even then no cracks could be detected in the investigated specimens. The test pieces, subjected to

Card 2/7

66690

18.9550
18.8200

S/180/60/000/01/014/027
E193/E135

AUTHORS: Kostochkin, Yu.V., and Oding, I.A. (Moscow)

TITLE: Failure of Metals due to Thermal Fatigue

PERIODICAL: Izvestiya Akademii nauk SSSR, Otdeleniye tekhnicheskikh nauk, Metallurgiya i toplivo, 1960, Nr 1, pp 101-104 (USSR)

ABSTRACT: If a metal part of a rest piece is subjected to cyclic temperature variations, its mechanical strength diminishes owing to the formation of a network of surface cracks. The laboratory investigations of thermal fatigue are, in most cases (Refs 1-3) conducted under rather severe conditions. The test pieces are heated in a furnace or by an electric current and cooled by a stream of cold air or by quenching in water, while the number of reversals often exceeds that likely to occur under actual service conditions; as a result, easily discernible surface cracks are formed which considerably reduce the strength and plasticity of the test pieces. The temperature variations under the actual service conditions are less drastic, so that in many cases only micro-cracks are formed, which are not easy to detect; more often, the only result of the cyclic temperature variations is

Card 1/7

PHASE I BOOK EXPLOITATION SOV/4502

Akademiya nauk SSSR. Nauchnyy sovet po probleme zharoprochnykh splavov

Issledovaniya po zharoprochnym splavam, tom 6 (Investigations of Heat-Resistant Alloys, Vol. 6) Moscow, 1960. 319 p. Errata slip inserted. 3,000 copies printed.

Sponsoring Agency: Akademiya nauk SSSR. Institut metallurgii imeni A. A. Baykova. Nauchnyy sovet po probleme zharoprochnykh splavov.

Editorial Board: I. P. Bardin (Deceased) Academician, G. V. Kurdyumov, N. V. Ageyev, Corresponding Member, Academy of Sciences USSR (Resp. Ed.), I. A. Oding, I. M. Pavlov, and I. F. Zudin, Candidate of Technical Sciences; Ed. of Publishing House: V. A. Klimov; Tech. Ed.: S. G. Tikhomirova.

PURPOSE: This book is intended for research workers in the field of physics of metals and for metallurgists, particularly those working on heat-resistant alloys.

COVERAGE: This collection of 45 articles deals with various problems in the production of heat-resistant alloys. Special attention is paid to the mechanisms of deformation of such metals as aluminum, copper, iron, and nickel. Various defects and failures of metals are analyzed, and means for increasing the heat resistance and plasticity are described. Among the special problems discussed are: electrolytic conductivity of iron-aluminum alloys in the solid state; the mobility of atoms in nickel-iron alloys, depending upon defects of their crystalline structure; the kinetics of change in isolated pores; the irreversible thermal transformation of solid bodies, etc. No personalities are mentioned. References follow each article.

3/

Oding, I.A.

PHASE I BOOK EXPLOITATION SOV/4375

Akademiya nauk SSSR. Institut metallurgii imeni A.A. Baykova

Ustalost' metallov; materialy soveshchaniya po ustalosti metallov 22-24 sentyabrya 1958 g. (Fatigue of Metals; Materials of the Conference on Fatigue of Metals, September 22-24, 1958) Moscow, 1960. 157 p. 3,500 copies printed.

Resp. Ed.: I.A. Oding, Corresponding Member, Academy of Sciences USSR; Ed. of Publishing House: A.N. Chernov; Tech. Ed.: I.N. Dorokhina.

PURPOSE: This collection of articles is intended for mechanical engineers, metallurgists, and scientific research workers.

COVERAGE: The collection contains discussions relating to fatigue failure of metals, fatigue in finished parts, and methods for testing endurance. Included are a critical review of existing theories on metal fatigue, some data on physical regularity patterns, and features of steel failure caused by fatigue. Possibilities for applying a new criterion to the notch sensitivity of metals and high-strength steels are investigated. The mechanism of failure due to corrosion fatigue of metals is discussed along with pertinent experimental data. Also presented are the results of testing the fatigue strength of such metal parts as large-size plates and various parts of machines used in the petroleum industry. Problems involved in testing metals for fatigue are examined. No personalities are mentioned. Each article is accompanied by bibliographic references, most of which are Soviet.

AVAILABLE: Library of Congress (TA460.A377)

Card 4/4

VK/wrc/mas
11-9-60

ODING, I.A.

APPROVED FOR RELEASE: 06/23/11: CIA-RDP86-00513R001237800041-6

ODING, I. A.

report presented at the 1st All-Union Congress of Theoretical and Applied Mechanics, Moscow, 27 Jan - 3 Feb '60.

134. A. A. Ilyushin (Moscow): Problems of the theory of plasticity under combined loading.

135. V. K. Kabulov (Tashkent): Elastic-plastic vibrations of rods of non-circular cross section.

136. V. S. Kalinin (Leningrad): The forced non-linear flexural vibrations of a homogeneous prismatic rod and a very long rectangular plate.

137. S. Kaliski (Warsaw): On a method of solving the equations of motion for an infinite anisotropic medium in the presence of a magnetic field.

138. S. N. Kan, F. A. Shkolni (Kharkov): An engineering method for the design of open prismatic shells.

139. I. I. Kandaurov (Leningrad): The distribution of vertical compressive stresses and strains in foundations in homogeneous or stratified soils.

140. B. Ya. Kantor (Kharkov): Bending of cantilever plates of variable stiffness.

141. K. S. Karapetian (Erevan): The effect of aging and anisotropy on the creep of concrete.

142. L. M. Kachanov (Leningrad): On the time of rupture in creep.

143. L. M. Kachanov (Leningrad): On some variational principles and methods in the theory of plasticity.

144. K. A. Kerimov (Baku): A procedure of determining an impact tension diagram for large deformations.

145. K. A. Kilchevskii (Kiev): Some generalizations of the formulation of elastostatic and elasto-dynamic contact problems and methods for their solution.

146. A. Kh. Kim (Minsk): The flow of a visco-plastic medium in a cone.

147. L. A. Kitovas (Leningrad): On the elastic equilibrium of thin, infinite orthotropic plates.

148. K. V. Kovalev (Kharkov): Models of the influence surfaces for the intensity of the bending moment in thin plates and shells.

149. A. D. Kovalenko (Kiev): Shallow shells of revolution of variable thickness in a three-dimensional temperature field.

150. M. Kanarov (Sofia): Dynamic stability of cylindrical and spherical shells.

151. M. Komarov (Sofia): The influence of initial imperfections of shape on the stability of thin elastic cylindrical sandwich shells under axial compression.

152. W. T. Koiter (Delft): Elastic stability and post-buckling behavior.

153. A. S. Kondratev (Kuibishev), Yu. P. Burkov (Orenburg): The effect of support elasticity on the natural vibrations of rods.

154. I. M. Kopev, I. A. Oding (Moscow): Strength and plasticity of "whiskers".

155. B. G. Korenev (Moscow): The design of flexible plates and beams on elastic foundation.

156. M. S. Kornishin (Kazan): Bending of rectangular shallow shells with elastic ribs.

157. M. S. Kornishin (Kazan): On the solution of the nonlinear algebraic equations of shell theory.

158. V. G. Korotkin, D. M. Tartakovskii (Leningrad): The one-dimensional problem of the consolidation of a sediment layer with variable specific weight and variable water permeability.

159. A. S. Kosmodamianskii (Saratov): The elastic equilibrium of anisotropic plate with a finite number of elliptical holes.

160. Yu. I. Kosterin (Iaroslavl), I. V. Kragelskii (Moscow): Rheological phenomena in dry friction.

161. Yu. V. Krotov (Stalinsk): Lateral stability of coupled arches with double curvature.

162. A. I. Kuznetsov (Leningrad): On the theory of plane plastic stress.

163. V. N. Kukudzhanov, L. V. Nikitin (Moscow): Propagation of elastic, visco-plastic waves in bars.

164. V. D. Kupradze (Tbilisi): The investigation of contact problems in the theory of elasticity by the method of singular integral equations.

165. N. V. Lazovskaia (Moscow): The investigation of the deformations of drains on models by the X-ray method.

166. A. Langenbach (Berlin): Application of the non-linear variational principle to some problems of the theory of elastic-plastic strains.

167. M. M. Levi (Moscow): The investigation of rheological properties of gelatin solutions.

APPROVED FOR RELEASE: 06/23/11: CIA-RDP86-00513R001237800041-6

ODING, I.A.; GUREVICH, S.Ye., kand. tekhn. nauk

Investigating notch sensitivity of some steels under cyclic lead.
Vest. mash. 39 no.1:30-35 Ja '59. (MIRA 12:1)

1.Chlen-korrespondent AN SSSR (for Oding).
(Steel--Testing)

SOV/32-25-7-29/50

Testing of Turbine Vanes in the Gas Current at Varying Temperatures

temperature variation periods; durability, however, decreases. There are 4 figures and 1 table.

ASSOCIATION: Tsentral'nyy nauchno-issledovatel'skiy institut tekhnologii i mashinostroyeniya (Central Scientific Research Institute of Technology and Machine Construction)

Card 2/2

SOV/32-25-7-29/50

25(6)

AUTHORS: Oding, I. A., Kostochkin, Yu. V.

TITLE: Testing of Turbine Vanes in the Gas Current at Varying Temperatures (Ispytaniye turbinnykh lopatok v gazovom potoke peremennoy temperatury)

PERIODICAL: Zavodskaya laboratoriya, 1959, Vol 25, Nr 7, pp 863-865 (USSR)

ABSTRACT: A special method and arrangement UPT for testing turbine vanes and samples at varying temperatures of the gas current were worked out. The device (Fig 1) is, in principle, a gas turbine where hot gas enters on the one hand and air on the other. Four samples can be tested at the same time; hot gas and air flow around them alternately. The automatic shift from gas to air current is carried out by a servomotor PR-1. Turbine vanes (Fig 3) were tested on a nickel basis EI 765 while the temperature was reduced from 750 to 70° and again increased to 750°. The temperature of the sample was measured by thermocouples. In the course of the test the samples were extended by rotation; the rotor showed a rate of 7500 rpm, and a tensile stress of 28 kg/mm^2 was obtained. The testing results obtained (Table) show that the samples showed no surface cracks at 5500 rpm

The Importance of Surface Layers in Slow Ruptures of Metals at Creeping Conditions

obtained are given. It was found that in the case of a reduction of the thickness of the samples the plasticity and working time of the samples are considerably influenced by (I), i.e. reduced. It is not advisable to use thin samples (thickness: 1 mm and below) in durability and creeping tests because reduced results will be obtained. There are 5 figures, 1 table and 2 references.

ASSOCIATION: Institut metallurgii imeni A. A. Baykova Akademii nauk SSSR (Institute of Metallurgy imeni A. A. Baykov of the Academy of Sciences, USSR)

25(6) SOV/32-25-3-27/62

AUTHORS: Oding, I. A., Fridman, Z. G.

TITLE: The Importance of Surface Layers in Slow Ruptures of Metals at Creeping Conditions (Rol' poverkhnostnykh sloyev pri dlitel'nom razrushenii metallov v usloviyakh polzuchesti)

PERIODICAL: Zavodskaya laboratoriya, 1959, Vol 25, Nr 3, pp 329-332 (USSR)

ABSTRACT: The fact that plastic deformations take place under other energy conditions in the surface layer than in lower layers is of especial importance for durability tests of heat-resistant metals. In metal working under creeping conditions the influence of the surface layer depends mainly on the scale-factor (I) in the case of small-dimensional samples. The influence of (I) on samples with a thickness of <5 mm has so far not been examined systematically. In the case under discussion flat samples (Fig 1) of annealed, soft steel containing carbon (C - 0.15%, Mn - 0.39%, Si - 0.02%, S - 0.03%, P - 0.02%) were investigated. The thickness of the samples was changed from 0.15 to 2.0 mm and the creeping tests were carried out at 450^0 and stresses of 22 to 27 kg/mm^2. The creeping curves (Fig 2) and indices (Table)

Card 1/2

67832

SOV/180-59-6-8/31

Variation of the Mechanical Properties and Microstructure of Metals during Creep

There are 12 figures and 19 references, of which 15 are Soviet and 4 English.

SUBMITTED: June 5, 1959

Card 12/12

67832
SOV/180-59-6-8/31

Variations of the Mechanical Properties and Microstructure of Metals during Creep

primary creep stage, plays the decisive part in the process of creep of this metal. 3) It has been demonstrated that the structural defects formed in the early stages of creep can be revealed by means of room temperature tensile tests, conducted on test pieces cut out from the creep specimens and followed by examination of their microstructure. 4) The fact that the accumulation of the structural defects begins already in the primary creep stage, has been proved. 5) It has been demonstrated that the disc-shaped micro-pores, formed in the metal in the planes perpendicular to the direction of applied stress, constitute the potential nuclei of rupture of metal in creep; micro-pores of this description, present in the commercial grade iron tested in creep for 1000 hours (400 °C, σ = 13 kg/mm^2) and then subjected to a room temperature tensile test, are illustrated in Fig 12 (X 2000) showing: (a) a micro-pore at the grain boundary; (b) a micro-pore in the interior of a grain; (6) a micro-pore, revealed after the tensile test.

Card 11/12

67832
SOV/180-59-6-8/31

Variation of the Mechanical Properties and Microstructure of Metals during Creep

phase is precipitated at the grain boundaries, and the formation of the grain-boundary defects is intensified (Fig 11a). In this stage of creep, nuclei of inter-crystalline cracks are formed, which are revealed after subjecting the specimen to a tensile test (Fig 11b). Metallographic examination of specimens of the Ni-Cr alloy, tested in creep under higher applied stresses, yielded similar results. Detailed analysis of their experimental data, correlated with the theoretical considerations, led the authors to several conclusions.
1) The results obtained in the course of the present investigation have revealed a close relationship between the variation of the mechanical properties of a metal during creep and the density of dislocations in this metal, and confirmed the basic postulates of the structural theory of creep regarding the laws which govern the variation of the density of the "ready to move" dislocations during various stages of creep.
2) It has been established that intergranular plasticity, developed in the commercial-grade iron during the

Card 10/12

67832
SOV/180-59-6-8/31

Variation of the Mechanical Properties and Microstructure of Metals during Creep

amount of twinning. The large grains break up during creep, and after 600 hours at 750 °C under σ = 14 kg/mm^2 the structure becomes more uniform (Fig 10a); in the case of this alloy, the formation of defects during all stages of creep is most pronounced at the grain boundaries and is shown up by broadening of the grain boundaries, as indicated by arrows in Fig 10a. The presence of these grain-boundary defects is clearly demonstrated by the appearance of the microstructure after the tensile test (Fig 10b) which shows, also, that this effect is most pronounced in the layers which, in the as-quenched specimen, consisted of the small grains, the boundaries between grains formed as the result of breaking up of the large grains being apparently more resistant to deformation. Thus, even after creep test, followed by a tensile test, the alloy still preserves its "fibrous" structure, the alternative layers being characterized by the presence or absence of the grain-boundary defects. In the specimen subjected to creep at 750 °C for 1000 hours (σ = 14 kg/mm^2), the secondary

Card 9/12

4

67832

SOV/180-59-6-8/31

Variation of the Mechanical Properties and Microstructure of Metals during Creep

situated at, or near the grain boundaries) had appeared in the material. When the microstructure of a specimen (tested at 400 °C under 13 kg/mm^2) which had entered the secondary creep stage (1000 hrs) was examined, these defects were visible even before subjecting the specimen to the room temperature tensile test (Fig 8a); however, the tensile test revealed a large number of "new" micro-pores which in this case were present also in the interior of the grains (Fig 8b). The results of the metallographic examination of the Ni-Cr specimens are reproduced in Figs 9-11. This alloy, in the air-quenched condition, constitutes a partially decomposed γ solid solution, with some of the precipitated particles of titanium carbo-nitrides clearly visible in the interior of the grains (Figs 9a and b). In the main, however, the α'-phase is in the state of fine dispersion and is not resolved even at the magnification of 2000; the characteristic features of the alloy in the as-quenched condition are the presence of alternate layers of small and large grains (fibrous structure), and a certain

Card 8/12

67832
SOV/180-59-6-8/31

Variation of the Mechanical Properties and Microstructure of Metals during Creep

microstructure of the investigated materials before creep tests, immediately after the creep tests, and after the tensile tests, was studied. Fig 6 shows the structure of iron in the normalized condition (a) and after a room temperature tensile test (b); in the latter case, the grains became elongated in the direction of the applied stress. (It should be noted here that all microphotographs in the present paper are reproduced in such a way that the long side is parallel to the direction of the applied stress). Fig 7 shows the microstructure of an iron specimen (a) tested in creep (400°C, σ = 13 kg/mm^2) for 200 hours, and (b) subsequently subjected to a tensile test at room temperature. It will be seen that when the creep test had been interrupted during the primary stage, no structural changes could be observed in the specimens (Fig 7a); however, when the structure of this specimen was examined after subjecting it to a tensile test at room temperature (Fig 7b) it became evident that already in the primary creep stage, permanent structural defects (in the form of micro-pores

Card 7/12

early stage of creep (primary stage and the beginning of the secondary stage); as in iron, elongation decreased and U.T.S. increased, but in contrast to iron, the proportional limit increased. The creep curves of the Ni-Cr alloy, tested at 750 °C under the applied stress of 14, 18, and 20 kg/mm^2, are reproduced in Fig 5b. In Fig 5a, the properties (σ_s, σ_{nu}, δ) of the Ni-Cr alloy tested in creep at 750 °C for 600 hr, are plotted against the stress, σ_n, applied in the creep test. (The values of these properties at $\sigma_n = 0$ correspond to the original properties of the alloy). It will be seen that although the properties of the metal before and after the creep tests were different, the magnitude of this difference was hardly affected by the magnitude of the stress applied in the creep tests. This is attributed to the fact that in this case, the duration of the primary creep stage (which determines the magnitude of the change in the mechanical properties of the alloy) was practically unaffected by the variation of the applied stress. In the next series of experiments, the

67832

SOV/180-59-6-8/31

Variation of the Mechanical Properties and Microstructure of Metals during Creep

It will be seen that with increasing magnitude of the applied stress, the duration of the primary creep stage increased from 50 to 350 hrs, the total deformation (ε) increasing from 0.04 to 1.08%. Fig 3b shows how the various mechanical properties of the material (measured after 1000 hr creep) varied with the variation of the applied stress, $\sigma_{п}$ (the values at $\sigma_{п} = 0$ correspond to the properties of iron before the creep test). It will be seen that U.T.S. of the material was not affected by increasing the applied stress from 8 to 13 kg/mm^2; however, with increasing $\sigma_{п}$ (and therefore with increasing degree of total deformation), δ decreased and σ^{H}_{S} and σ^{B}_{S} increased. The creep curve of the Ni-Cr alloy, tested at 750 °C under $\sigma = 14$ kg/mm^2, shown in Fig 4 (bottom curve), is characterized by a very short primary stage and by a relatively short (300 hr) secondary stage. The effect of the duration of creep on elongation (δ), U.T.S. ($\sigma_{в}$), and proportional limit ($\sigma_{пц}$) is also illustrated in Fig 4. In this case too, the mechanical properties changed mainly in the

Card 5/12

of creep. Similar, although more pronounced, results were obtained when a slightly higher stress of 13 kg/mm2 was used in the creep tests. In this case, the increase in the yield points after the primary creep stage amounted to approximately 5 kg/mm2, while δ_g increased from 2.6 to 4.0%; since, in this case, the total plastic deformation at the end of the primary stage was three times larger than that in the case of the specimen tested under 12 kg/mm2, the object of the next series of experiments was to compare the mechanical properties of specimens tested in creep under various applied stresses and consequently, characterized by different degree of total deformation at the end of the primary creep stage. To this end, four iron specimens were tested at 400 °C under 8, 10, 12, and 13 kg/mm2, the duration of each test being 1000 hrs. The obtained creep curves are reproduced in Fig 3a, where elongation (ε, %) is plotted against time (τ, hours); the broken line connects the points at which the primary creep stage ended; the applied stress, σ, is indicated by each creep curve.

67832

SOV/180-59-6-8/31

Variation of the Mechanical Properties and Microstructure of Metals during Creep

each creep test and after the tensile tests was examined, longitudinal microsections having been used for this purpose. The results of the first series of experiments are reproduced in Fig 2, where all the mechanical properties, listed above, are plotted against the duration (τ, hours) of creep of iron at 400 °C under the applied stress of 12 kg/mm²; the bottom, $\varepsilon = f(\tau)$ curve is the creep curve of this material obtained under these conditions. It will be seen that most marked changes of the mechanical properties were observed in the material which had just entered the secondary creep stage (the duration of the primary stage being approximately 250 hr); at this point, a sharp decrease in the plasticity of iron, as characterized by δ, occurred, as well as an increase in the yield points and in the value of δ_S. In the initial stages of the secondary creep stage, δ slightly increased and σ_S^H, σ_S^B, and δ_S slightly decreased, after which all these properties remained virtually constant: practically no change in the U.T.S. was observed either in the primary or in the secondary stages

Card 3/12

4

67832

Variation of the Mechanical Properties and Microstructure of Metals during Creep SOV/180-59-6-8/31

iron, and at 750 °C in the case of the Ni-Cr alloy. The effect of creep on the mechanical properties of these alloys was studied by so-called "micro-mechanical" method which consisted in conducting mechanical (tensile) tests on small specimens cut out from the creep test pieces in the manner shown in Fig 1a; the shape and dimensions (mm) of the micro-specimens are shown in Fig 1б. In order to remove the residual stresses due to the machining operation, the iron micro-specimens were annealed for 10 hours at 400 °C; in the case of the Ni-Cr alloy this treatment was found to be unnecessary. The rate of strain of 0.5 mm/min was employed in all tensile tests. From the stress-strain diagram, the following properties were determined:

σ_b - U.T.S. (kg/mm2); σ_S^H and σ_S^B - lower and upper yield points, respectively (kg/mm2); δ_S - relative length of the plastic region of the stress-strain diagram (%); δ - elongation (%); $\sigma_{пц}$ - proportional limit (kg/mm2). At the same time the microstructure of the alloys after

Card 2/12

18.9200
18.8200

67832
SOV/180-59-6-8/31

AUTHORS: Gordiyenko, L.K., and Oding, I.A. (Moscow)

TITLE: Variation of the Mechanical Properties and Microstructure of Metals during Creep

PERIODICAL: Izvestiya Akademii nauk SSSR, Otdeleniye tekhnicheskikh nauk, Metallurgiya i toplivo, 1959, Nr 6, pp 52-65 (USSR)

ABSTRACT: The study of the variation of the structure-sensitive, mechanical and physical properties of metals during creep, was undertaken by the present authors in the belief that valuable information on the mechanism of creep can be obtained in this manner. The results of the investigation of the variation of microhardness and electrical conductivity have been reported elsewhere (Refs 1, 2); in the present paper an account is given of experiments in which the variation of [illegible] properties and microstructure was studied. [illegible] entirely different type were used as the experimental materials; commercial grade iron (0.045% C, 0.07% Si, 0.33% Mn, 0.035% S, 0.02% P, 0.04% Ni, 0.05% Cu), normalized at 950 °C; and air-quenched from 1050 °C Ni-Cr alloy containing 69.6% Ni, 14.8% Cr, titanium and carbon; the creep tests were carried out at 400 °C in the case of

Card 1/12

APPROVED FOR RELEASE: 06/23/11: CIA-RDP86-00513R001237800041-6

ODING, I.A.; GEMINOV, V.N.

New method of extrapolating data from short-time tests for durable stength and long terms of service. Issl.po zharopr. splav. 4:287-297 '59. (MIRA 13:5)
(Metals--Testing)

67281

SOV/180-59-4-12/48

On the Accuracy of Parametric Relations in Endurance Strength

parametric relation at present. There are 4 references, 2 of which are Soviet, 1 German and 1 English.

SUBMITTED: April 6, 1959

Card 3/3

67281

SOV/180-59-4-12/48

On the Accuracy of Parametric Relations in Endurance Strength

slopes obey certain laws. For an extrapolation to service lives of 100000 hours the range between 100 and 1000 hours has been recommended as a starting base. The stress plot for the same material has different slopes at different temperatures. The lines have no common intersection point. The widely used power law is untrue and impractical. The relation of the logarithm of service life against the temperature is linear. Theoretically, the plot should be drawn against the reciprocal of temperature. In practice, the relative temperature interval is not large and the manner of plotting unimportant. Seven general parametric relations are considered. Of these, the most accurate are those of Manson and Hafferd and of Zhurkov. Every three-dimensional parametric relation hitherto adopted rests on the assumption of the uniformity of the stress and temperature relation throughout the range of investigation. This assumption is untrue and large errors are caused in extrapolation. The authors advise against the use of any

Card 2/3

18.8200

67281

SOV/180-59-4-12/48

AUTHORS: Geminov, V.N. and Oding, I.A. (Moscow)

TITLE: On the Accuracy of Parametric Relations in Endurance Strength

PERIODICAL: Izvestiya Akademii nauk SSSR, Otdeleniye tekhnicheskikh nauk, Metallurgiya i toplivo, 1959, Nr 4, pp 73-76 (USSR)

ABSTRACT: The relation between the service life, the stress and the temperature is the parametric relation considered. Most test data are obtained at constant temperature (service life-stress relation) or at constant stress (service life-temperature relation). The full parametric relation can be checked only against these experimentally obtained partial relations. The stress relation (at constant temperature) has been shown by the present authors (Doklady AN SSSR, 1958, Vol 122, Nr 2) to yield in semi-logarithmic coordinates an S shaped curve. The first shallow range reaches from several minutes to several dozens of hours and its general laws are unknown. The second (steep) and third (shallow) regions can, in practice, be replaced by straight lines (plotting stress against the logarithm of service life). The change from the second to the third ranges and the ratio of the

Card 1/3

ODING, I.A.; IVANOVA, V.S.; LIBEROV, Yu.P.

Role of the interface surface on the gradual failure in metals. Issl.po zharopr.splav. 4:3-12 '59.
(MIRA 13:5)
(Crystal lattices) (Metallography)

SOV/129-59-4-1/17

Determination of the Characteristics of Deformation from Creep and Stress Relaxation Curves

et alii (Ref 3) for the steel 30 KhMA tested at 500°C were used. Results of comparative creep and relaxation tests were considered in an earlier work of one of the authors (Ref 4), in which good agreement was found to exist between the experimental results and those calculated on the basis of Eqs (3) and (4). There are 8 figures and 4 Soviet references.

ASSOCIATION: Institut Metallurgii AN SSSR imeni A.A. Baykova (Institute of Metallurgy, Ac.Sc. USSR, imeni A.A. Baykov)

Card 5/5

loading. In this paper the technique is described of determining characteristics of deformation on the basis of creep curves as well as on the basis of relaxation curves, and also a technique of plotting calculated creep and relaxation curves on the basis of known deformation characteristics. A simple method is described which permits determining, with an accuracy adequate for practical purposes, the deformation characteristics on the basis of creep curves as well as on the basis of relaxation curves. Characteristics derived from creep tests can be applied for plotting relaxation curves and vice versa, and also for plotting similar curves for other stress values. The here-described technique was applied and verified for commercial iron at 280°C and for the steel EI-257 at 600°C. The creep and relaxation tests were carried out in accordance with a method described in earlier work of one of the authors (Ref 2). For verifying the derived equations (3) and (4) and the here proposed technique on cylindrical specimens, the creep and relaxation curves published by Danilovskaya when the decrease in the transverse cross sections and the formation of internal defects do not play an appreciable role. Therefore the condition for attenuated creep will be $\varphi(\varepsilon_x, t) = 0$.

By integrating Eq (1) for this condition the following equation is obtained for attenuated creep:

$$\varepsilon_x = \varepsilon_1 (1 + m \alpha t)^{b/\alpha} .$$

The relaxation equation can be written thus:

$$t = \frac{1}{L} \int_{\alpha M \varepsilon_1}^{\alpha M \varepsilon_x} x^{\alpha/b - 1} e^x dx, \qquad (4)$$

where $L = mb (\alpha M \varepsilon_1)^{\alpha/b} e^{\alpha M \varepsilon_1}$, (5)

and M = E/100, E being the modulus of elasticity. In creep or relaxation tests, only two coefficients, α and M, are determined, which can be referred to as the characteristics of deformation since they represent the behaviour of the material under various conditions of

APPROVED FOR RELEASE: 06/23/11: CIA-RDP86-00513R001237800041-6

Determination of the Characteristics of Deformation from Creep and Stress Relaxation Curves

of the sudden plastic deformation in the following equation:

$$\varepsilon = 0.1\, e^{-b(c-\sigma)} \qquad (2)$$

The coefficient b characterises the distribution of the dislocations as a function of the activation stresses; the function $\varphi(\varepsilon_x, t)$ determines the conditions of operation of a given specimen or component. If various relations of the variation in the function $\varphi(\varepsilon_x, t)$ as a function of the deformation and time are given, it is possible to obtain from Eq (1) the deformation equations for various methods of testing (creep, relaxation, tension etc.). Thereby the type of a given function is determined directly from the conditions of loading of a given specimen or component. In this paper the authors investigate only equations of attenuated creep and relaxation. One of the conditions of attenuated creep is that the stresses applied to the specimens are maintained constant. In ordinary creep tests it can be assumed that the stress will be maintained constant only at relatively small values of stress and deformations

SOV/129-59-4-1/17

AUTHORS: Corresponding Member Ac.Sc. USSR I.A. Oding, Candidate of Technical Sciences G.F. Lepin

TITLE: Determination of the Characteristics of Deformation from Creep and Stress Relaxation Curves (Opredeleniye kharakteristik deformatsii po krivym polzuchesti i relaksatsii napryazheniy)

PERIODICAL: Metallovedeniye i Termicheskaya Obrabotka Metallov, 1959, Nr 4, pp 2-8 (USSR)

ABSTRACT: On the basis of present-day concepts of the dislocation theory on the character of processes taking place in polycrystalline materials during deformation, G.F. Lepin (Ref 1) arrived at the following general differential equation for deformation:

$$d\varepsilon_x/dt = mb\varepsilon_1^{\alpha/b}\ \varepsilon_x^{1-\alpha/b}\ e^{-\alpha\varphi(\varepsilon_x, t)} \quad (1)$$

where ε_x is deformation in % during the time t; ε_1 is sudden deformation during loading or heating; α is a coefficient characterising the "fluctuation" property of the given material; m is the proportionality coefficient; b is the coefficient of the dependence on the stresses

GUDTSOV, Nikolay Timofeyevich; BANNYKH, Oleg Aleksandrovich; ZUDIN, Ivan Feofanovich; ODING, I.A., otv.red.; ZOLOTOV, P.F., red. izd-va; RYLINA, Yu.V., tekhn.red.

[Alloying heat-resistant α-iron base steel] K voprosu o legirovanii teploustoichivoi stali na osnove α-zheleza. Moskva, Izd-vo Akad.nauk SSSR, 1959. 66 p. (MIRA 12:10)

1. Chlen-korrespondent AN SSSR (for Oding).
(Heat-resistant alloys--Metallurgy)

ODING, I. A.

"The Role of Interfaces on Creep Rupture,"

report to be submitted for the seminar on the Atomic Mechanisms of Fracture, to be held at Swampscott (Boston area) Massachusetts, 12-14 April 1959.

USSR Acad. Sci.

18(3) PHASE I BOOK EXPLOITATION SOV/2203

Tsentral'nyy nauchno-issledovatel'skiy institut tekhnologii i mashinostroyeniya

Struktura i svoystva zharoprochnykh materialov; [sbornik] (Structure and Properties of Heat-resisting Materials; Collection of Articles) Moscow, Mashgiz, 1959. (Series: Its: [Trudy] kn. 93) Errata slip inserted. 4,000 copies printed.

Additional Sponsoring Agencies: USSR. Gosudarstvennaya planovaya komissiya and Glavnoye upravleniye nauchno-issledovatel'skikh i proyektnykh organizatsiy.

Ed.: L.N. Petropavlovskaya, Candidate of Technical Sciences; Ed. of Publishing House: N.A. Ivanova; Tech. Ed.: A. F. Uvarova; Managing Ed. for Literature on Metal Working and Tool Making: R. D. Beyzel'man.

PURPOSE: This book is intended for workers of scientific research institutes and for engineering staffs of plant laboratories of the boiler and turbine industries and power stations. It may also be useful to staff members of higher educational institutions studying problems of physical metallurgy.

COVERAGE: This collection of articles describes results of work done at TsNIITMASh on the strength of materials used constantly at high temperatures in power plants. The articles deal with problems of heat resistance, alloying, and the production and heat treatment of heat-resistant steels. The evaluation of properties of industrial materials used under high and ultra-high pressures is given, and modern testing methods are discussed. No personalities are mentioned. References follow several of the articles.

TABLE OF CONTENTS:

APPROVED FOR RELEASE: 06/23/11: CIA-RDP86-00513R001237800041-6

APPROVED FOR RELEASE: 06/23/11: CIA-RDP86-00513R001237800041-6

Gurevich. There are approximately 400 references.

TABLE OF CONTENTS:

18(7) PHASE I BOOK EXPLOITATION SOV/2836

Oding, Ivan Avgustovich, Vera Semenovna Ivanova, Vladislav Vasil'yevich Burdukskiy, and Vladimir Nikolayevich Geminov

Teoriya polzuchesti i dlitel'noy prochnosti metallov (Theory of Creep and Long-Time Strength of Metals) Moscow, Metallurgizdat, 1959. 488 p. Errata slip inserted. 3,000 copies printed.

Sponsoring Agency: Akademiya nauk SSSR. Nauchnoy i tekhnicheskoy informatsii. Otdel tekhnicheskoy informatsii.

Ed. (Title page): I.A. Oding, Corresponding Member, USSR Academy of Sciences; Ed. (Inside book): G.V. Popova; Ed. of Publishing House: Ye.N. Berlin; Tech. Ed.: Ye. B. Vaynshteyn.

PURPOSE: This book is intended for scientific and engineering workers in the field of heat-resistant metals and alloys. It may also be useful to students at higher metallurgical and machine-building institutions.

Card 1/7

Studies (Cont.)

SOV/3355

AVAILABLE: Library of Congress

Card 12/12

VK/os
4/12/60

APPROVED FOR RELEASE: 06/23/11: CIA-RDP86-00513R001237800041-6

Studies (Cont.) SOV/3355

Card 10/12

Studies (Cont.) SOV/3355

Card 9/12

APPROVED FOR RELEASE: 06/23/11: CIA-RDP86-00513R001237800041-6

APPROVED FOR RELEASE: 06/23/11: CIA-RDP86-00513R001237800041-6

Studies (Cont.) SOV/3355

Card 5/12

APPROVED FOR RELEASE: 06/23/11: CIA-RDP86-00513R001237800041-6

Studies (Cont.) SOV/3355

Card 3/12

Studies (Cont.) SOV/3355

of specific materials. Various phenomena occurring under specified conditions are studied and reported on. For details, see Table of Contents. The articles are accompanied by a number of references, both Soviet and non-Soviet.

TABLE OF CONTENTS:

APPROVED FOR RELEASE: 06/23/11: CIA-RDP86-00513R001237800041-6

ODING, I.A.

18(7) P. 2-19 PHASE I BOOK EXPLOITATION SOV/3355

Akademiya nauk SSSR. Institut metallurgii. Nauchnyy sovet po probleme zharoprochnykh splavov

Issledovaniya po zharoprochnym splavam, t. IV (Studies on Heat-resistant Alloys, vol. 4), Moscow, Izd-vo AN SSSR, 1959. 400 p. Errata slip inserted. 2,200 copies printed.

Ed. of Publishing House: V. A. Klimov; Tech. Ed.: A. P. Guseva; Editorial Board: I. P. Bardin, Academician; G. V. Kurdyumov, Academician; N. V. Ageyev; Corresponding Member, USSR Academy of Sciences; I. A. Oding, I. M. Pavlov, and I. F. Zudin, Candidate of Technical Sciences.

PURPOSE: This book is intended for metallurgists concerned with the structural metallurgy of alloys.

COVERAGE: This is a collection of specialized studies of various problems in the structural metallurgy of heat-resistant alloys. Some are concerned with theoretical principles, some with descriptions of new equipment and methods, others with properties

Card 1/12

APPROVED FOR RELEASE: 06/23/11: CIA-RDP86-00513R001237800041-6

Theory of Dislocations (Cont.) SOV/2575

Card 3/5

APPROVED FOR RELEASE: 06/23/11: CIA-RDP86-00513R001237800041-6