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the concentrations of the atoms in the x- y- and z-positions (Fig. 1), the following holds: $c = c_x + c_y + c_z$ (1). c denotes the total concentration. In the state of equilibrium, these quantities are functions of the deformation and temperature, in the non-equilibrium state they are independent variables satisfying (1). The free energy of the unit volume of a weak solution in equilibrium is known to be

$$F = F_1 + kTN_0 c \ln(c/e) + c\psi + {}^1/_2 c^2 \Phi, \qquad (2)$$

Here, F_1 denotes the free energy of the pure solvent, $ktN_0 c\ln(c/e)$, the free energy due to the rearrangement of identical particles of the dissolved substance, ψ and Φ characterize the interaction of the dissolved particles and their interaction with the particles of the solvent. N_0 is the number of dissolved particles per unit volume. F_1, ψ and Φ are functions of the deformation tensor and of temperature. The non-equilibrium free energy F_k for a single crystal has the form

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$$F_K = F_1 + kTN_0[c_x \ln(c_x/e) + c_y \ln(c_y/e) + c_z \ln(c_z/e)] + c_x\psi_1 + c_y\psi_2 + c_z\psi_3 + \\ + {}^1/_2 c_x^2\psi_{11} + {}^1/_2 c_y^2\psi_{22} + {}^1/_2 c_z^2\psi_{33} + c_x c_y\psi_{12} + c_x c_z\psi_{13} + c_y c_z\psi_{23}, \quad (A)$$

for which form

$$F_K = {}^1/_2 C_{11}(\varepsilon_{xx}^2 + \varepsilon_{yy}^2 + \varepsilon_{zz}^2) + C_{12}(\varepsilon_{xx}\varepsilon_{yy} + \varepsilon_{xx}\varepsilon_{zz} + \varepsilon_{yy}\varepsilon_{zz}) + \\ + {}^1/_2 C_{44}(\varepsilon_{xy}^2 + \varepsilon_{xz}^2 + \varepsilon_{yz}^2) + c\psi_0 + \lambda_1 c\varepsilon_{ll} + \\ + kTN_0[c_x \ln(c_x/e) + c_y \ln(c_y/e) + c_z \ln(c_z/e)] + \\ + \lambda_2(c_x\varepsilon_{xx} + c_y\varepsilon_{yy} + c_z\varepsilon_{zz}) + {}^1/_2(c_x^2 + c_y^2 + c_z^2)\psi_{11} + (c_x c_y + c_x c_z + c_y c_z)\psi_{12}, \quad (3)$$

is found which is invariant with respect to the rotation by a multiple of $\pi/2$. Subsequently, for the non-equilibrium free energy F_n of a polycrystal the expression

$$F_n = {}^1/_2 K\varepsilon_{ll}^2 + \mu(\varepsilon_{xx}^2 + \varepsilon_{yy}^2 + \varepsilon_{zz}^2 - {}^1/_3\varepsilon_{ll}^2) + \\ + kTN_0[c_x^* \ln(c_x^*/e) + c_y^* \ln(c_y^*/e) + c_z^* \ln(c_z^*/e)] + \\ + (\beta_0 + \beta_1\varepsilon_{ll})c + \beta_2(c_x^*\varepsilon_{xx} + c_y^*\varepsilon_{yy} + c_z^*\varepsilon_{zz}) + {}^1/_2\beta_3(c_x^{*2} + c_y^{*2} + c_z^{*2}) + \\ + \beta_4(c_x^* c_y^* + c_x^* c_z^* + c_y^* c_z^*), \quad (4)$$

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is obtained. Here, K denotes the modulus of compression and μ the shearing modulus. The constants β_i and ψ_0, λ_1, λ_2, ψ_{11}, ψ_{12} are experimentally determined. If $\bar{c}_x$, $\bar{c}_y$ and $\bar{c}_z$ denote the equilibrium values of c_x, c_y and c_z, determined from the equation $\partial Fk/\partial c_i = 0$, equation

$$\bar{c}_x = \alpha c, \quad \bar{c}_y = \beta c, \quad \bar{c}_z = \gamma c;$$
$$\alpha = \frac{1}{1 + \exp[\omega(\varepsilon_{xx} - \varepsilon_{yy})] + \exp[\omega(\varepsilon_{xx} - \varepsilon_{zz})]};$$
$$\beta = \frac{1}{1 + \exp[\omega(\varepsilon_{yy} - \varepsilon_{xx})] + \exp[\omega(\varepsilon_{yy} - \varepsilon_{zz})]}; \qquad (5)$$
$$\omega = \frac{\lambda_1}{kTN_0}.$$

is obtained from (3) and (1). The strain in a single crystal under tensile stress is also found from (3):

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$$= \frac{\partial F_x}{\partial \varepsilon_{xx}} = C_{12}\varepsilon_{ii} + (C_{11} - C_{12})\varepsilon_{xx} + \lambda_1 c + \lambda_2 c_x =$$

$$\left(C_{11} - \frac{2C_{12}^2}{C_{11} + C_{12}}\right)\varepsilon_{xx} + \frac{(C_{11} - C_{12})\lambda_1 - C_{12}\lambda_2}{C_{11} + C_{12}} +$$

$$+ \lambda_2 \frac{C_{11} + 2C_{12}}{C_{11} + C_{12}} c_x. \qquad (6)$$

The following is obtained for the relaxation-elasticity modulus:

$$\overline{E}_{100} = \frac{\partial \sigma_{xx}}{\partial \varepsilon_{xx}} = E_{100} + \lambda_2 \frac{C_{11} + 2C_{12}}{C_{11} + C_{12}} \frac{\partial \alpha}{\partial \varepsilon_{xx}} c, \qquad (7)$$

where $E_{100} = C_{11} - 2C_{12}^2(C_{11} + C_{12})^{-1}$. From (7) and (5(it may be seen that the relaxation modulus decreases with increasing concentration and increases with increasing strain, thus, approaching its maximum E_{100}. Thus, a strong dependence between E_{100} and the concentration occurs, e.g.,

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E_{100} is reduced in α-iron at 0.01 wt% carbon by 4.5 %. The function between modulus of elasticity and concentration at tensile stress in the direction x is due to the transition of the carbon atoms from the y- and z-positions into x-positions, which causes a further elongation in the direction x. This becomes obvious by the reduction of the modulus of elasticity. At quick deformation, when the carbon atoms have no opportunity of changing their positions, the modulus of elasticity is independent of concentration. The modulus of universal compression is independent of concentration, since at universal compression, the x-, y-, and z-positions do change in the same sense. In polycrystalline material, usually the conditions

$$|\omega(\varepsilon_{xx} - {}^1/_3\,\varepsilon_{ll})| \ll 1, \quad |\omega(\varepsilon_{yy} - {}^1/_3\,\varepsilon_{ll})| \ll 1, \quad |\omega(\varepsilon_{zz} - {}^1/_3\,\varepsilon_{ll})| \ll 1. \quad (\bar{B})$$

are satisfied. Thus, it is possible to determine the free energy of a polycrystal in equilibrium state from (4) and (5):

$$\bar{F}_n = {}^1/_2\,K\varepsilon_{ll}^2 + (\mu - \beta_2^2 c/6kTN_0)(\varepsilon_{lk}^2 - {}^1/_3\,\varepsilon_{ll}^2) + kTN_0 c \ln(c/e) + \\ + (\beta_0 - kTN_0 \ln 3)c + (\beta_1 + {}^1/_3\,\beta)c\varepsilon_{ll} + (\beta_3 + 2\beta_4)c^2, \quad (8)$$

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The characteristics of the thermodynamics... B104/B207

It follows herefrom that the redistribution of the atoms entails in this case a reduction of the modulus of shear while the compression modulus is practically independent of concentration. It is briefly indicated (Ref. 4 being mentioned (L. D. Landau, E. M. Lifshits, Mekhanika sploshnykh sred, 1953)) that the concentration increases in proportion with $1/r^6$ on approaching a spherical inclusion. There are 3 figures and 4 references: 2 Soviet-bloc and 2 non-Soviet-bloc.

ASSOCIATION: Institut metallofiziki Tsentral'nogo nauchno-issledovatel'skogo instituta chernoy metallurgii im. I. P. Bardina (Institute of Metal Physics of the Central Scientific Research Institute of Iron Metallurgy imeni I. P. Bardin)

PRESENTED: January 3, 1961, by G. V. Kurdyumov, Academician

SUBMITTED: December 27, 1960

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FASTOV, N.S.

High-temperature branch of the internal friction background. Dokl. AN SSSR 138 no.5:1069-1072 Je '61. (MIRA 14:6)

1. Institut metallovedeniya i fiziki metallov TSentral'nogo nauchno-issledovatel'skogo instituta chernoy metallurgii im. I.P.Bardina. Predstavleno akademikom G.V.Kurdyumovym.
(Deformations (Mechanics)) (Torsion) (Friction)

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FASTOV, N.S., kand.fiziko-matematicheskikh nauk

Thermodynamics of irreversible processes of deformation and its application to viscous flow in solids. Probl.metalloved.i fiz. met. no.7:117-133 '62. (MIRA 15:5)
(Creep of metals) (Internal friction)

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FASTOV, N.S., kand.fiziko-matematicheskikh nauk

Some peculiarities of the thermodynamics of deformed solid solutions. Probl.metalloved.i fiz.met. no.7:134-155 '62. (MIRA 15:5)

(Intermetallic compounds—Thermal properties) (Diffusion)

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EWT(m)/EWP(w)/EWA(d)/EWP(t)/EWP(b) ASD(f)-2/AFWL/AFETR/SSD/ESD(t)
AR4046543 S/0058/64/000/008/E036/E036

SOURCE: Ref. zh. Fizika, Abs. 8E270

AUTHOR: Fastov, N. S. (Deceased)

TITLE: Viscous friction equations at high stresses

CITED SOURCE: Sb. Relaksatsi. yavleniya v met. i splavakh. M. Metallurgizdat, 1963, 31-32

TOPIC TAGS: stress analysis, viscous friction, shear stress, creep, relaxation time

TRANSLATION: It is proposed that at a constant stress s_{ik} the medium behaves like a Maxwellian body. Recognizing that in accordance [illegible] the microscopic theory of stationary creep its velocity is [illegible] s_{ik} by a hyperbolic-sine relat[illegible] the relaxat[illegible]

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ACCESSION NR: AR4046543

time τ of s_{ik} is determined as

$$\tau = \frac{s_{ik}}{2\mu A \sinh(\gamma s_{ik}/kT)},$$

[illegible] -- shear modulus, T -- absolute temperature, k -- Boltzmann constant, and A, γ -- parameters of the material. N. Malinin.

SUB CODE: SS ENCL: 00

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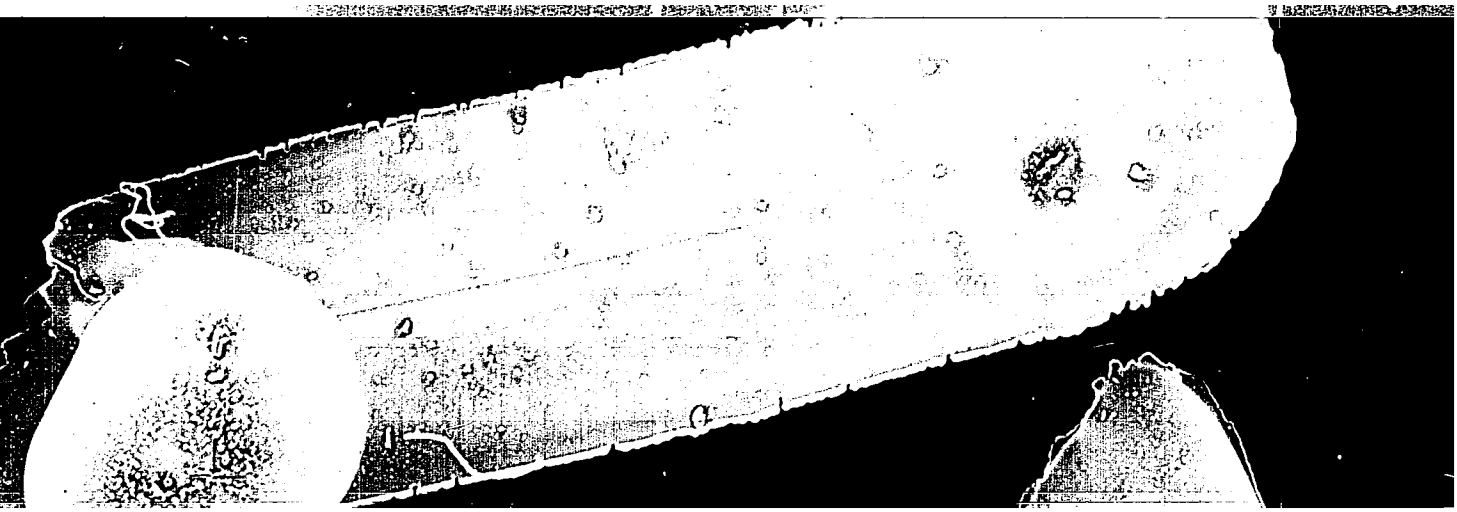

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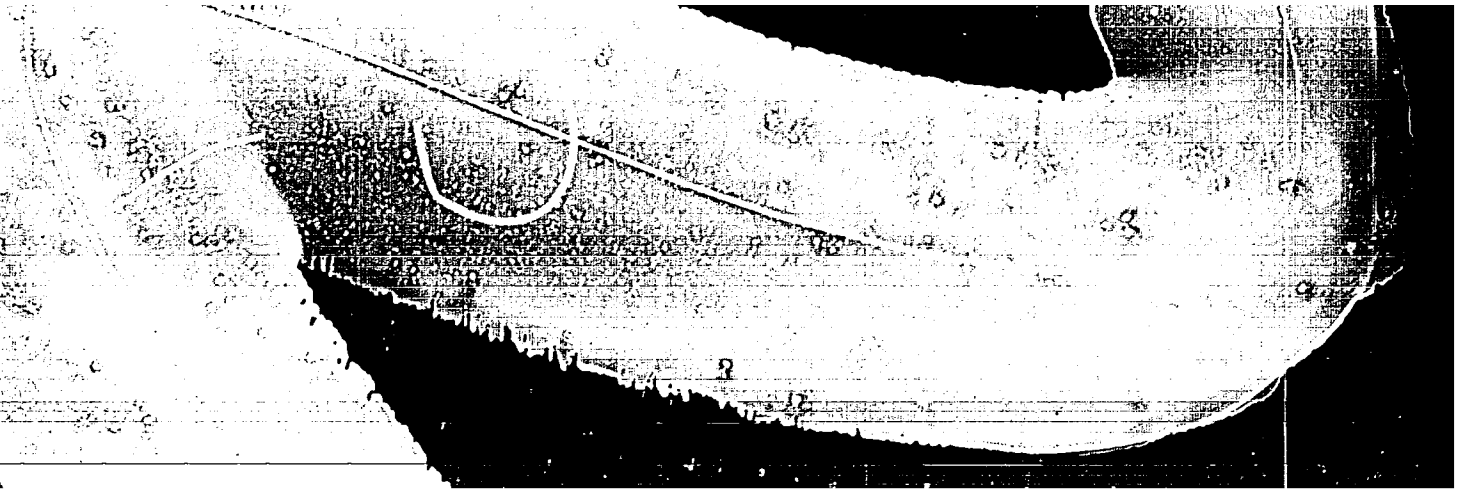

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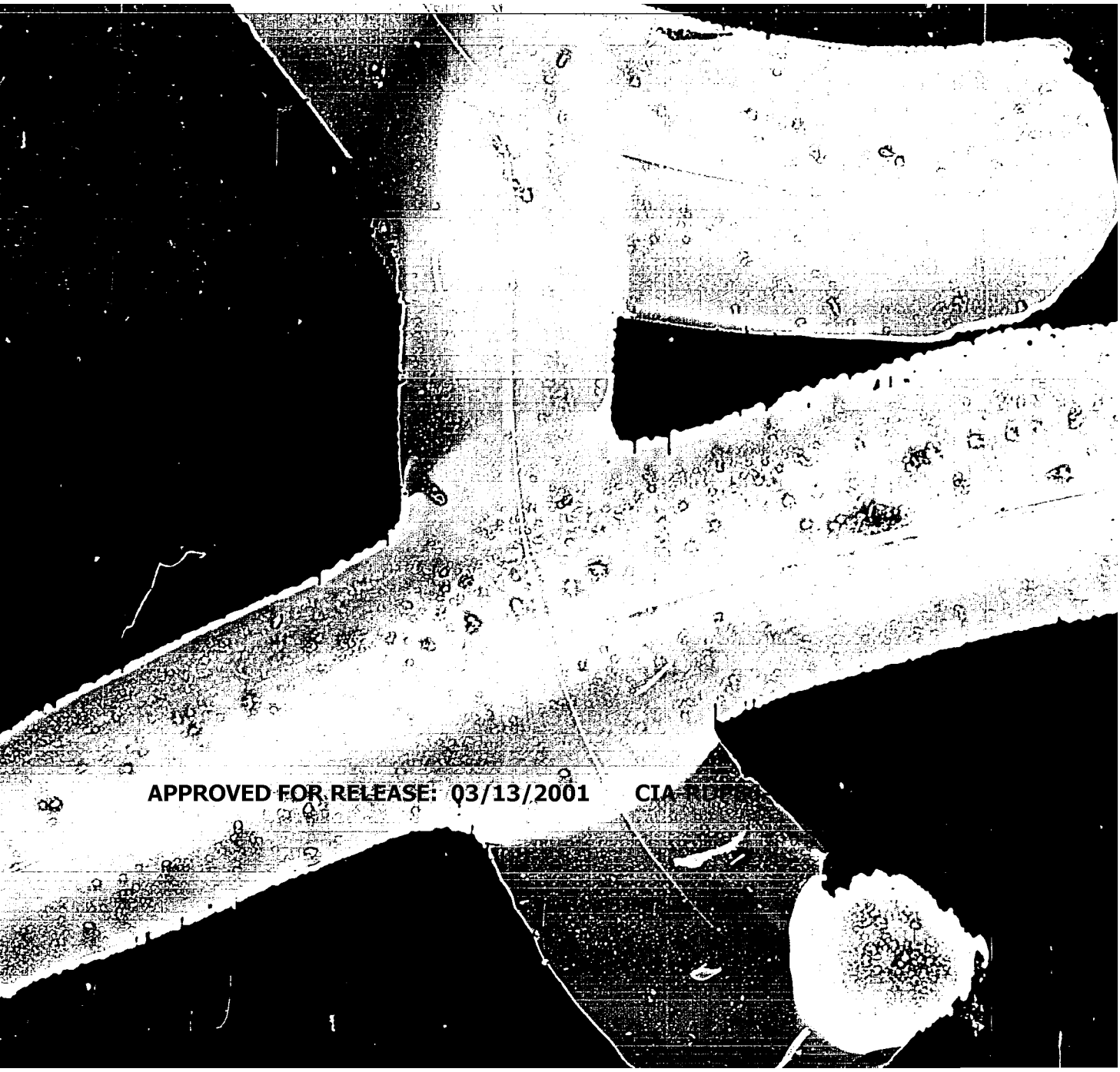

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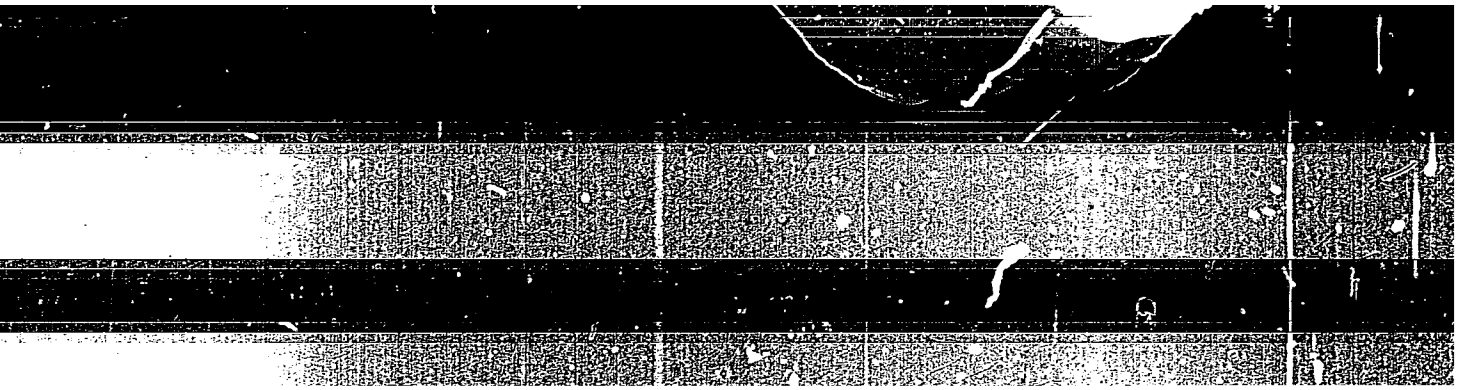

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Splice For End of
Reel # 124
Fast, A., in 24 70
End of Reel

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END
OF
SPLICE

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