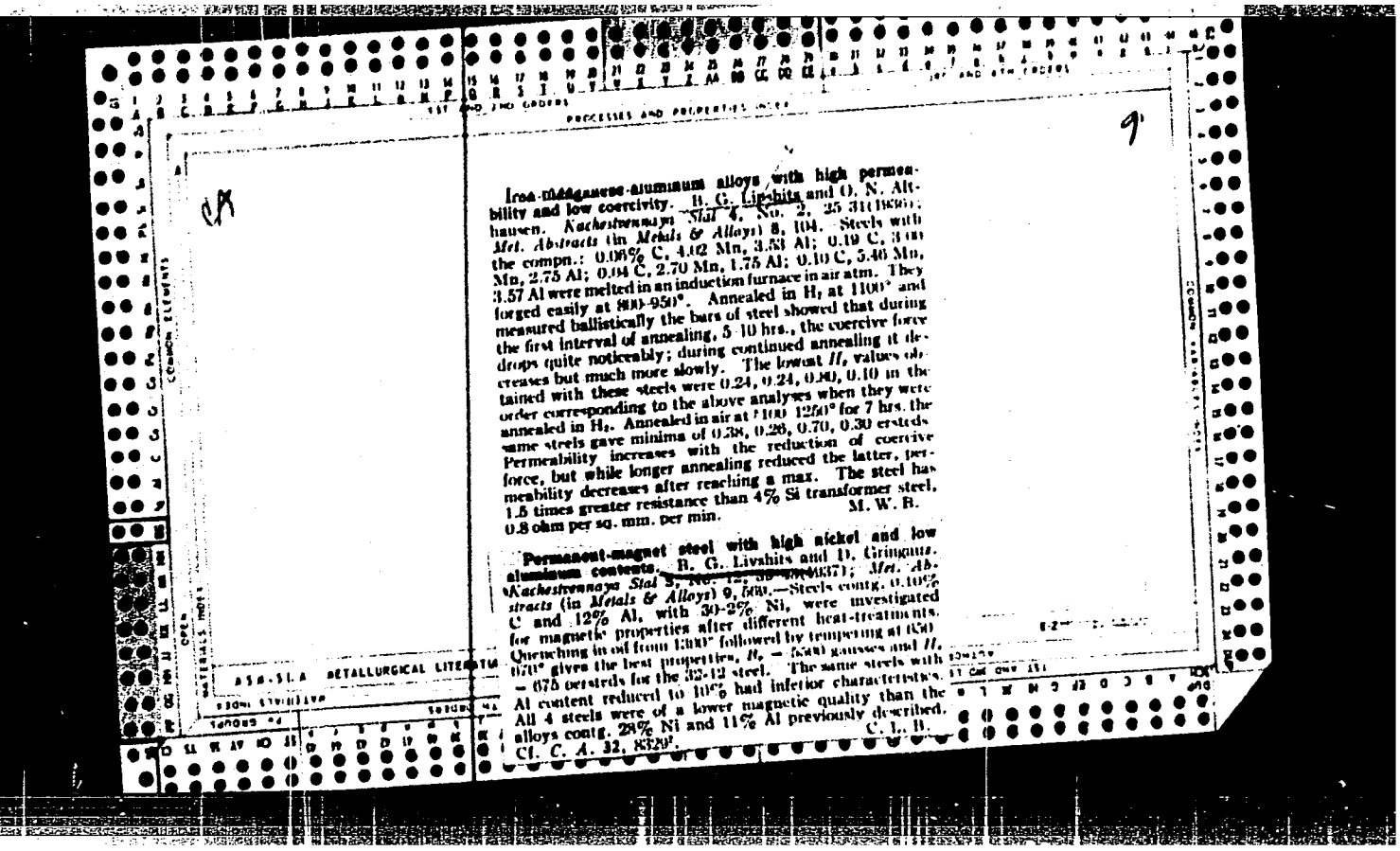
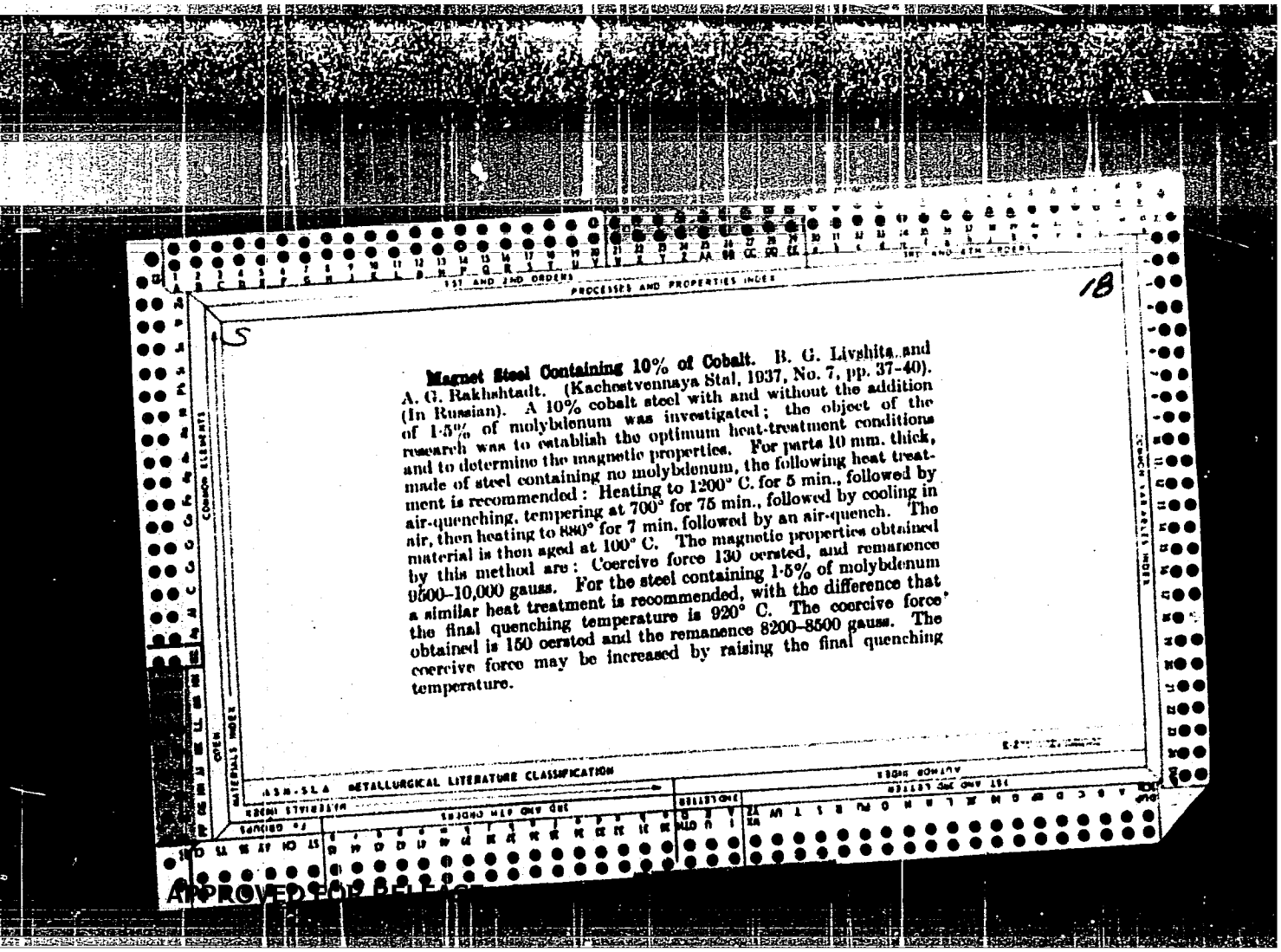


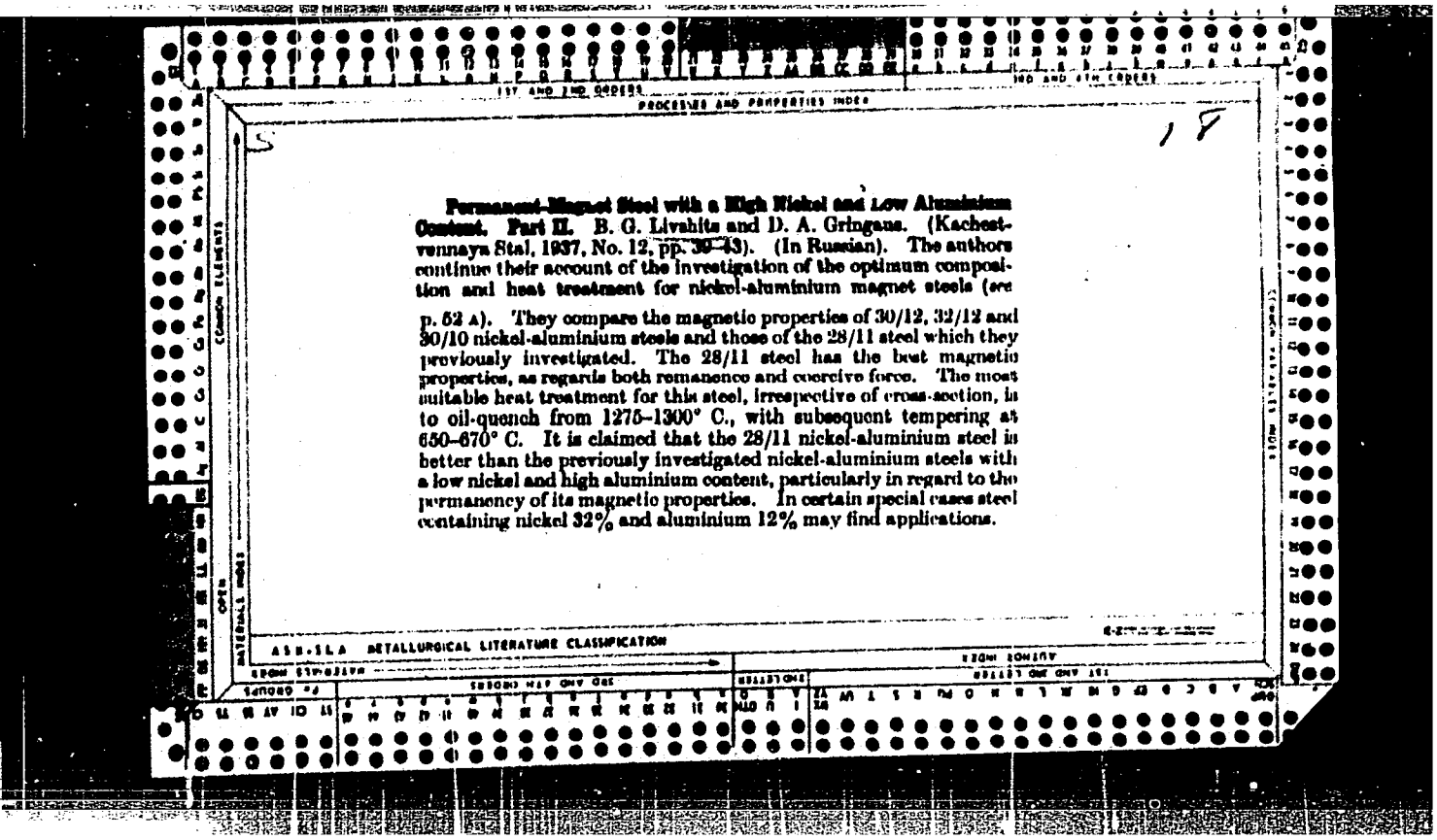
Iron-manganese-aluminum alloys with high permeability and low coercivity. B. G. Livshits and O. N. Altshausen. *Kachestvennaya Stal* 4, No. 2, 25-31(1936); *Met. Abstracts* (in *Metals & Alloys*) 8, 104. Steels with the compn.: 0.06% C, 4.02 Mn, 3.53 Al; 0.19 C, 3.40 Mn, 2.75 Al; 0.04 C, 2.70 Mn, 1.75 Al; 0.10 C, 5.46 Mn, 3.57 Al were melted in an induction furnace in air atm. They forged easily at 800-950°. Annealed in H_2 at 1100° and measured ballistically the bars of steel showed that during the first interval of annealing, 5-10 hrs., the coercive force drops quite noticeably; during continued annealing it decreases but much more slowly. The *lowest H*, values obtained with these steels were 0.24, 0.24, 0.80, 0.10 in the order corresponding to the above analyses when they were annealed in H_2. Annealed in air at 1100-1250° for 7 hrs. the same steels gave minima of 0.38, 0.26, 0.70, 0.30 oersteds. Permeability increases with the reduction of coercive force, but while longer annealing reduced the latter, permeability decreases after reaching a max. The steel has 1.5 times greater resistance than 4% Si transformer steel, 0.8 ohm per sq. mm. per min. M. W. B.

Permanent-magnet steel with high nickel and low aluminum contents. B. G. Livshits and D. Gringuts. *Kachestvennaya Stal* 3, No. 12, [illegible](1937); *Met. Abstracts* (in *Metals & Alloys*) 9, [illegible].—Steels contg. 0.10% C and 12% Al, with 30-2% Ni, were investigated for magnetic properties after different heat-treatments. Quenching in oil from 1300° followed by tempering at 650-670° gives the best properties. H_c = [illegible] gausses and H_c = 675 oersteds for the 32-12 steel. The same steels with Al content reduced to 10% had inferior characteristics. All 4 steels were of a lower magnetic quality than the alloys contg. 28% Ni and 11% Al previously described. Cf. *C. A.* 32, 8529⁹. C. L. B.

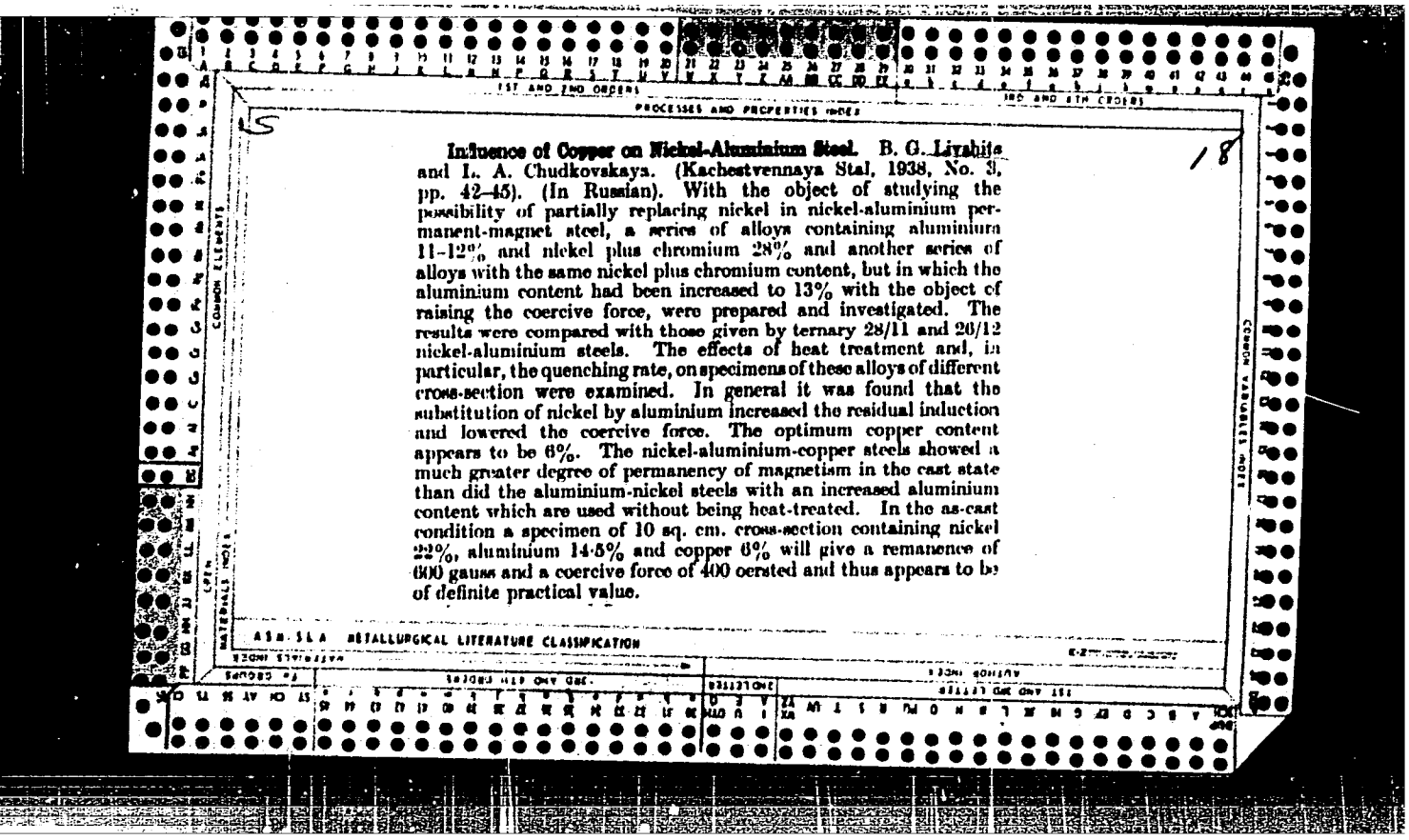


18

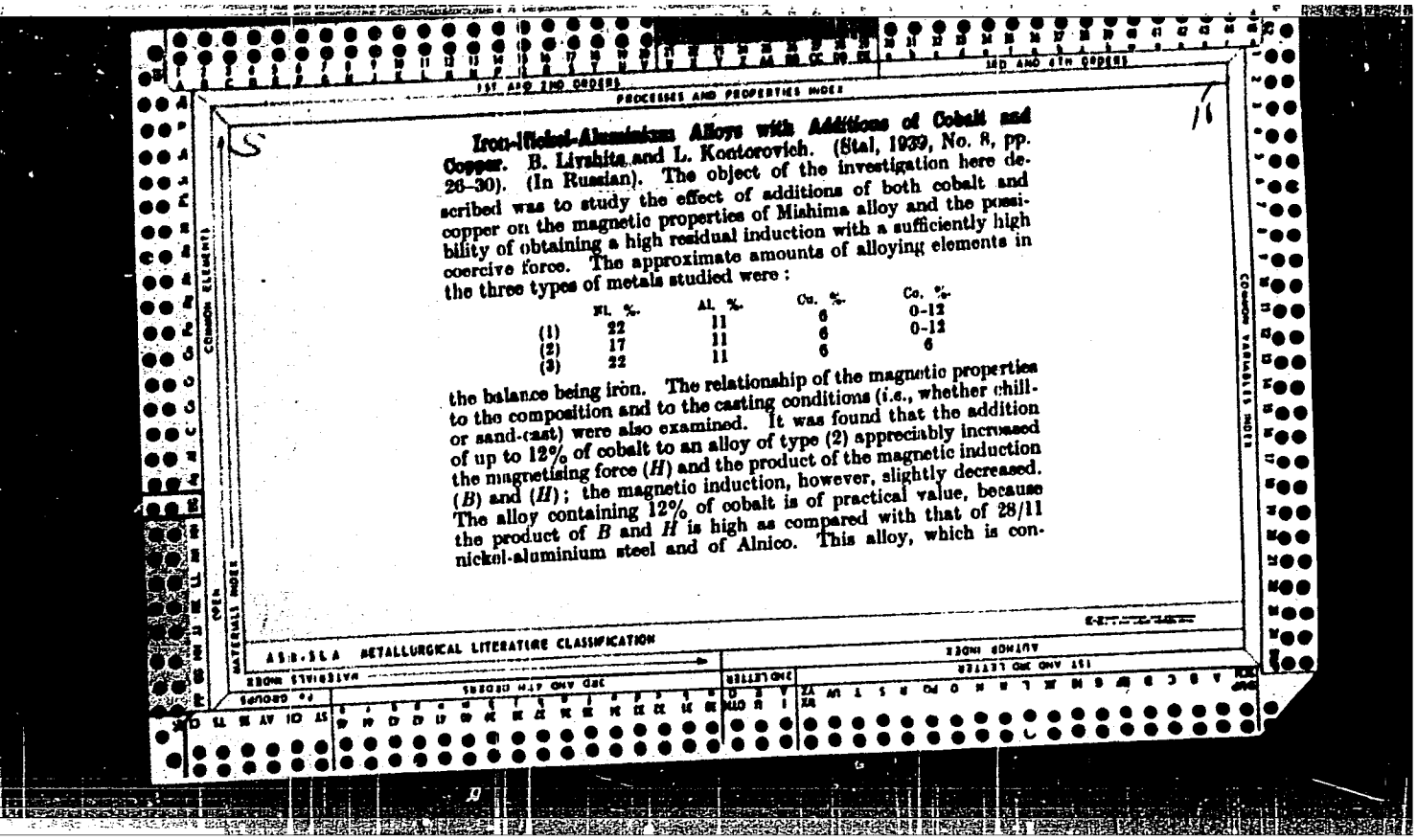
Magnet Steel Containing 10% of Cobalt. B. G. Livshits and A. G. Rakhshtadt. (Kachestvennaya Stal, 1937, No. 7, pp. 37-40). (In Russian). A 10% cobalt steel with and without the addition of 1·5% of molybdenum was investigated; the object of the research was to establish the optimum heat-treatment conditions and to determine the magnetic properties. For parts 10 mm. thick, made of steel containing no molybdenum, the following heat treatment is recommended: Heating to 1200° C. for 5 min., followed by air-quenching, tempering at 700° for 75 min., followed by cooling in air, then heating to 880° for 7 min. followed by an air-quench. The material is then aged at 100° C. The magnetic properties obtained by this method are: Coercive force 130 oersted, and remanence 9500–10,000 gauss. For the steel containing 1·5% of molybdenum a similar heat treatment is recommended, with the difference that the final quenching temperature is 920° C. The coercive force obtained is 150 oersted and the remanence 8200–8500 gauss. The coercive force may be increased by raising the final quenching temperature.



Permanent-Magnet Steel with a High Nickel and Low Aluminium Content. Part II. B. G. Livshits and D. A. Gringaus. (Kachestvennaya Stal, 1937, No. 12, pp. 39–43). (In Russian). The authors continue their account of the investigation of the optimum composition and heat treatment for nickel-aluminium magnet steels (see p. 52 A). They compare the magnetic properties of 30/12, 32/12 and 30/10 nickel-aluminium steels and those of the 28/11 steel which they previously investigated. The 28/11 steel has the best magnetic properties, as regards both remanence and coercive force. The most suitable heat treatment for this steel, irrespective of cross-section, is to oil-quench from 1275–1300° C., with subsequent tempering at 650–670° C. It is claimed that the 28/11 nickel-aluminium steel is better than the previously investigated nickel-aluminium steels with a low nickel and high aluminium content, particularly in regard to the permanency of its magnetic properties. In certain special cases steel containing nickel 32% and aluminium 12% may find applications.



Influence of Copper on Nickel-Aluminium Steel. B. G. Livshits and L. A. Chudkovskaya. (Kachestvennaya Stal, 1938, No. 3, pp. 42–45). (In Russian). With the object of studying the possibility of partially replacing nickel in nickel-aluminium permanent-magnet steel, a series of alloys containing aluminium 11–12% and nickel plus chromium 28% and another series of alloys with the same nickel plus chromium content, but in which the aluminium content had been increased to 13% with the object of raising the coercive force, were prepared and investigated. The results were compared with those given by ternary 28/11 and 20/12 nickel-aluminium steels. The effects of heat treatment and, in particular, the quenching rate, on specimens of these alloys of different cross-section were examined. In general it was found that the substitution of nickel by aluminium increased the residual induction and lowered the coercive force. The optimum copper content appears to be 6%. The nickel-aluminium-copper steels showed a much greater degree of permanency of magnetism in the cast state than did the aluminium-nickel steels with an increased aluminium content which are used without being heat-treated. In the as-cast condition a specimen of 10 sq. cm. cross-section containing nickel 22%, aluminium 14·5% and copper 6% will give a remanence of 600 gauss and a coercive force of 400 oersted and thus appears to be of definite practical value.

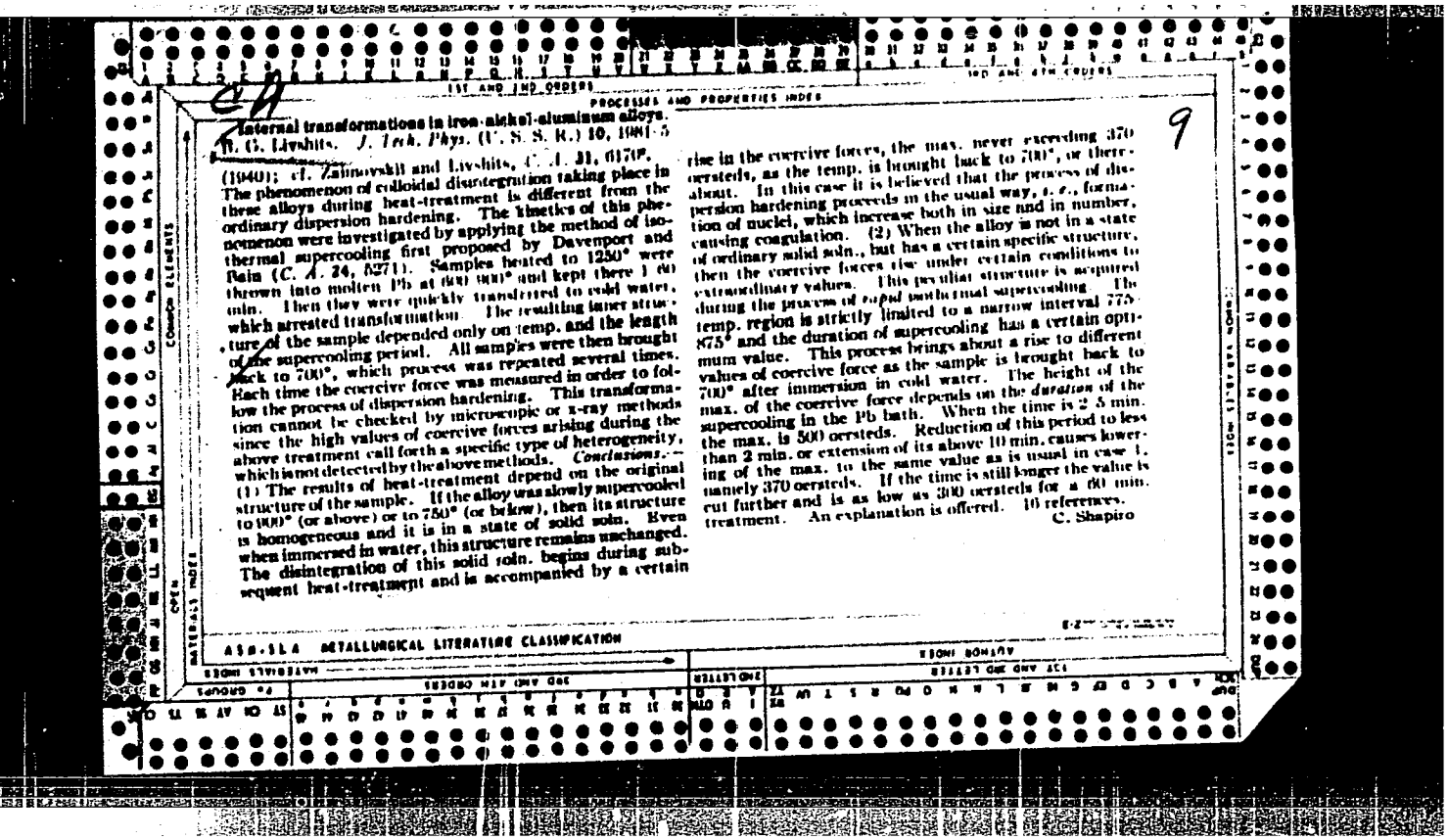


Iron-Nickel-Aluminium Alloys with Additions of Cobalt and Copper. B. Livshits and L. Kontorovich. (Stal, 1939, No. 8, pp. 26–30). (In Russian). The object of the investigation here described was to study the effect of additions of both cobalt and copper on the magnetic properties of Mishima alloy and the possibility of obtaining a high residual induction with a sufficiently high coercive force. The approximate amounts of alloying elements in the three types of metals studied were :

	Ni. %.	Al. %.	Cu. %.	Co. %.
(1)	22	11	6	0-12
(2)	17	11	6	0-12
(3)	22	11	6	6

the balance being iron. The relationship of the magnetic properties to the composition and to the casting conditions (*i.e.*, whether chill- or sand-cast) were also examined. It was found that the addition of up to 12% of cobalt to an alloy of type (2) appreciably increased the magnetising force (*H*) and the product of the magnetic induction (*B*) and (*H*); the magnetic induction, however, slightly decreased. The alloy containing 12% of cobalt is of practical value, because the product of *B* and *H* is high as compared with that of 28/11 nickel-aluminium steel and of Alnico. This alloy, which is con-

sidered to be the best among those studied, has a coercive force of 580–740, a remanence of 5420–6200, and $B \times H$ of 360–400 depending on the casting conditions. In alloys of type (1) the addition of up to 12% of cobalt increases the magnetising force and the product $B \times H$; the maximum magnetic induction is obtained with 6% of cobalt for small sections. An increase in the nickel content from 17% to 22% in an alloy of small section containing cobalt 12%, aluminium 11% and copper 6%, increases H and lowers B, the product $B \times H$ remaining constant. A similar increase of the nickel content in an alloy containing cobalt 6%, aluminium 11% and copper 6% increases H and the product $B \times H$, and slightly reduces E. Chill-cast Alnico in sections of 12 × 12 mm. and 20 × 20 mm. is superior to the 28/11 nickel-aluminium steel, whereas sand-cast Alnico in sections of 30 × 30 mm. is inferior to the 28/11 steel. The addition of copper to Alnico has no beneficial results.



PROCESSES AND PROPERTIES INDEX

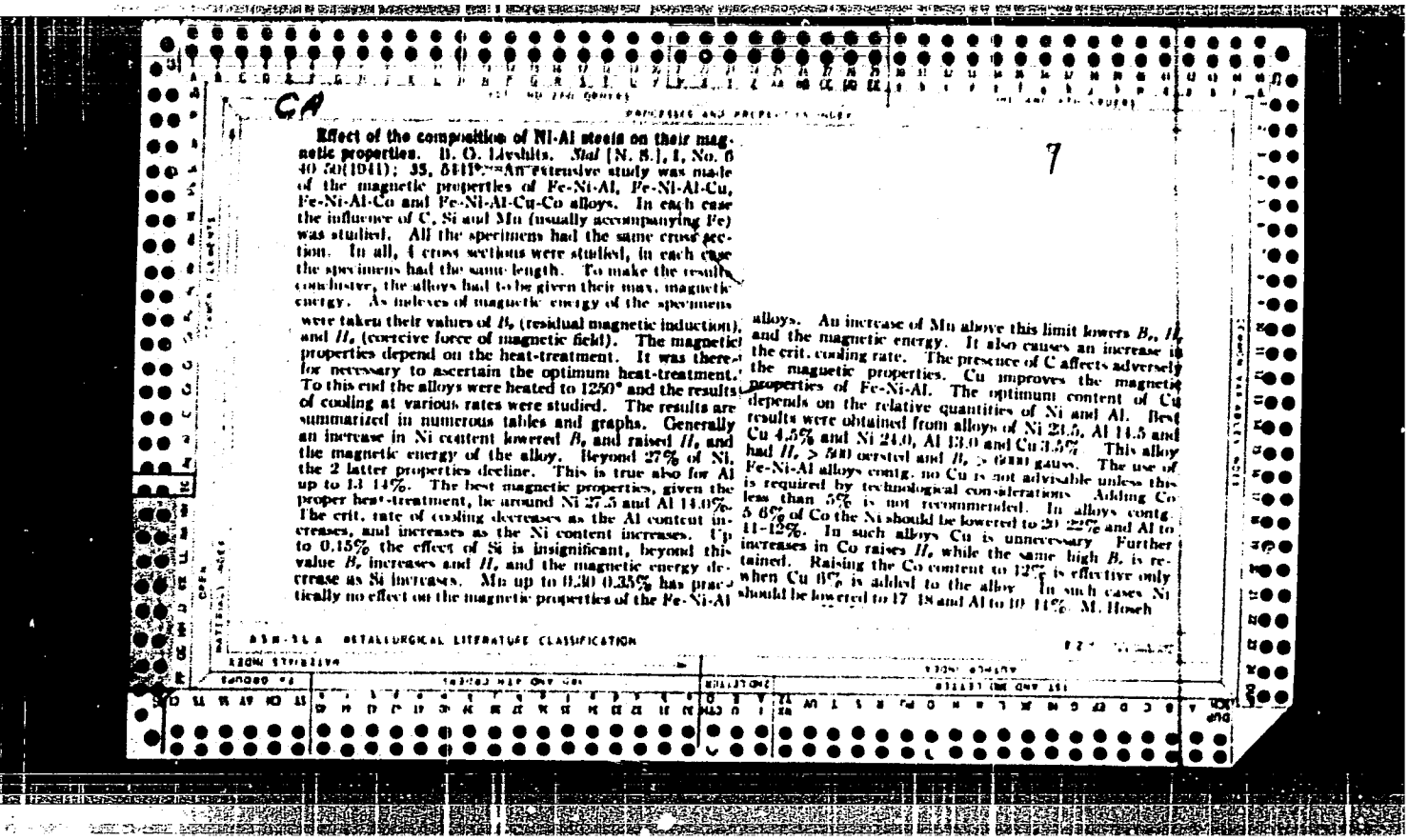
9

Internal transformations in iron-nickel-aluminum alloys.

B. G. Livshits. *J. Tech. Phys.* (U. S. S. R.) 10, 1081-5 (1940); cf. Zalmovskii and Livshits, *C. A.* 31, 6170⁸. The phenomenon of colloidal disintegration taking place in these alloys during heat-treatment is different from the ordinary dispersion hardening. The kinetics of this phenomenon were investigated by applying the method of isothermal supercooling first proposed by Davenport and Bain (*C. A.* 24, 5271). Samples heated to 1250° were thrown into molten Pb at 600-800° and kept there 1-60 min. Then they were quickly transferred to cold water, which arrested transformation. The resulting inner structure of the sample depended only on temp. and the length of the supercooling period. All samples were then brought back to 700°, which process was repeated several times. Each time the coercive force was measured in order to follow the process of dispersion hardening. This transformation cannot be checked by microscopic or x-ray methods since the high values of coercive forces arising during the above treatment call forth a specific type of heterogeneity, which is not detected by the above methods. *Conclusions.*—(1) The results of heat-treatment depend on the original structure of the sample. If the alloy was slowly supercooled to 800° (or above) or to 750° (or below), then its structure is homogeneous and it is in a state of solid soln. Even when immersed in water, this structure remains unchanged. The disintegration of this solid soln. begins during subsequent heat-treatment and is accompanied by a certain rise in the coercive forces, the max. never exceeding 370 oersteds, as the temp. is brought back to 700°, or thereabout. In this case it is believed that the process of dispersion hardening proceeds in the usual way, *i. e.*, formation of nuclei, which increase both in size and in number, causing coagulation. (2) When the alloy is not in a state of ordinary solid soln., but has a certain specific structure, then the coercive forces rise under certain conditions to extraordinary values. This peculiar structure is acquired during the process of *rapid* isothermal supercooling. The temp. region is strictly limited to a narrow interval 775-875° and the duration of supercooling has a certain optimum value. This process brings about a rise to different values of coercive force as the sample is brought back to 700° after immersion in cold water. The height of the max. of the coercive force depends on the *duration* of the supercooling in the Pb bath. When the time is 2.5 min. the max. is 500 oersteds. Reduction of this period to less than 2 min. or extension of its above 10 min. causes lowering of the max. to the same value as is usual in case 1, namely 370 oersteds. If the time is still longer the value is cut further and is as low as 300 oersteds for a 60 min. treatment. An explanation is offered. 10 references.

C. Shapiro

A 38-51 A METALLURGICAL LITERATURE CLASSIFICATION



CA

7

Effect of the composition of Ni-Al steels on their magnetic properties. H. O. Livshits. *Stal* [N. S.], 1, No. 6 40-50(1941); 35, 5411[illegible]. An extensive study was made of the magnetic properties of Fe-Ni-Al, Fe-Ni-Al-Cu, Fe-Ni-Al-Co and Fe-Ni-Al-Cu-Co alloys. In each case the influence of C, Si and Mn (usually accompanying Fe) was studied. All the specimens had the same cross section. In all, 4 cross sections were studied, in each case the specimens had the same length. To make the results conclusive, the alloys had to be given their max. magnetic energy. As indexes of magnetic energy of the specimens were taken their values of B_r (residual magnetic induction), and H_c (coercive force of magnetic field). The magnetic properties depend on the heat-treatment. It was therefor necessary to ascertain the optimum heat-treatment. To this end the alloys were heated to 1250° and the results of cooling at various rates were studied. The results are summarized in numerous tables and graphs. Generally an increase in Ni content lowered B_r and raised H_c, and the magnetic energy of the alloy. Beyond 27% of Ni, the 2 latter properties decline. This is true also for Al up to 13-14%. The best magnetic properties, given the proper heat-treatment, lie around Ni 27.5 and Al 14.0%. The crit. rate of cooling decreases as the Al content increases, and increases as the Ni content increases. Up to 0.15% the effect of Si is insignificant, beyond this value B_r increases and H_c and the magnetic energy decrease as Si increases. Mn up to 0.30-0.35% has practically no effect on the magnetic properties of the Fe-Ni-Al alloys. An increase of Mn above this limit lowers B_r, H_c and the magnetic energy. It also causes an increase in the crit. cooling rate. The presence of C affects adversely the magnetic properties. Cu improves the magnetic properties of Fe-Ni-Al. The optimum content of Cu depends on the relative quantities of Ni and Al. Best results were obtained from alloys of Ni 21.5, Al 14.5 and Cu 4.5% and Ni 24.0, Al 13.0 and Cu 3.5%. This alloy had $H_c > 500$ oersted and $B_r > 6000$ gauss. The use of Fe-Ni-Al alloys contg. no Cu is not advisable unless this is required by technological considerations. Adding Co less than 5% is not recommended. In alloys contg. 5-6% of Co the Ni should be lowered to 20-22% and Al to 11-12%. In such alloys Cu is unnecessary. Further increases in Co raises H_c while the same high B_r is retained. Raising the Co content to 12% is effective only when Cu 6% is added to the alloy. In such cases Ni should be lowered to 17-18 and Al to 10-11%. M. Hoseh

ASM-SLA METALLURGICAL LITERATURE CLASSIFICATION

2. Properties of Alloys

Met. Abs.
V 9.

Structure Transformations in Copper Nickel Iron Alloys. [illegible] and A. G. Rakhshtadt (*Zhur. Tekhnich. Fiziki (J. Tech. Phys.)*, 1941, 11, 1098–1105; *C. Abs.*, 1942, 36, 1001). [In Russian.] The alloy containing copper 60, iron 20, and nickel 20% (cf. Neumann *et al.*, *Met. Ab.*, 1937, 4, 331) was studied, particularly in respect of its electromagnetic properties. The changes in electric resistivity and magnetic properties on heat treatment can be explained only by solution and the formation of a superstructure. On annealing a supersaturated solid solution there occurs a decomposition into phases of indefinite composition, but possessing a superstructure. A rather considerable increase in H (magnetic intensity) during the annealing process is connected with coagulation of the decomposition phases and their approach to equilibrium. Work causes a decomposition of the superstructure of the alloy, having a heterogeneous structure: large strains of low grade, of form which are oriented in the direction of the rolling, and small strains of high grade, of form which are not oriented and which neutralize the influence of the large strains, thus lowering the value of H and the relation of the residual induction to magnetic saturation. A second annealing after work leads to a return of these, *i.e.*, to the removal of the small strains. Heat treatment to 1050° C. has the sole purpose of changing all compounds into a solid solution; the first annealing causes formation of a two phase structure, with the participating phases having an intermediate composition and a definite direction of orientation; work done on this alloy destroys their super structure and prevents them; the final annealing removes the small strains, leaving the large ones, which retain their orientation, so that the residual induction is above the direction of rolling is close to maximum saturation.

LIVSHITS, Boris Grigor'evich.

Physical characteristics of alloys; textbook. 2. pere. izd. Moskva, Gos. nauchno-tekhn. izd-vo lit-ry po chernoi i tsvetnoi metallurgii, 1946. 320 p.

TA490.L5 1946

CA

High-cobalt alloys for permanent magnets. B. G. Livshits and A. B. Lapuk. *Stal* 6, 584-91(1940).—The results of a study on the magnetic properties of Co (12-18%) alloys are reported. M. Hosch

The phenomenon of colloidal decomposition of solid solutions in high coercivity alloys. B. G. Livshits. *Izvest. Sektora Fiz.-Khim. Anal., Inst. Obshchei i Neorg. Khim., Akad. Nauk S.S.S.R.* 16, No. 2, 148-60(1948). —A no. of high coercivity alloys are classified on the basis of their structure transformation which is responsible for an increase in their coercive force. The 1st group comprises steels hardened to martensite. In the 2nd group dispersion-hardened steels belong. This group comprises 2 subgroups. To the 1st subgroup belong Fe-Mo, Fe-Co-Mo, Fe-Co-W, and similar steels in which high coercivity is obtained by hardening with complete supersaturation of the solid soln. followed by a temper which causes a sepn. of a dispersed excess phase. As a rule the sepd. out phase is of a chem. compn. the lattice of which differs greatly from the lattice of the solvent phase. To the 2nd subgroup belong alloys of the Cu-Fe-Ni, Cu-Co-Ni, and Fe-Ni-Al types. When the solid soln. of these alloys decomp. 2 phases differing from one another and from the original solid soln. are sepd. out. The spacial lattices of the original solid soln. and of the 2 products are crystallographically identical. The 3rd group comprises alloys of systems capable of forming continuous series of solid solns., e.g., Fe-Pd, Fe-Pt, Co-Pt, etc. Because of their cost, these alloys have no practical application. Their high coercive force is attributed to their superstructural transformation. M. Hosch

LIVSHITS, B. G.

"Reversion Phenomenon in Aging Technical Iron," Zhur. Tekh. Fiz., 16, No.11, 1946.

LIVSHITS, B. G.

PA 69T83

USSR/Metals Mar/Apr 1948
Alloys, Ferrous
Deformation

"Plastic Deformation of Alloys With High Coercive Powers," B. G. Livshits, Inst of Steel imeni Stalin, 5 pp

"Iz Ak Nauk SSSR, Ser Fiz" Vol XII, No 2

General account of these alloys and their properties. Present-day physics does not as yet provide a satisfactory explanation of various effects. Illustrated by diagrams.

69T83

LIVSHITS, B.G.

Livshits, B.G. and Tsuprun, L.I. "Research on the phenomenon of aging low-carbon steel," report (Mosk. in-t stali im. Stalina) 26, 1948, p. 208-42

SO: U-2888, Letopis Zhurnal'nykh Statey, No. 1, 1949

LIVSHITS, B. G. 62/49T95

USSR/Metals Aug 49
Steel
Coercivity

"The Coercive Force of Tempered Steel ShKh15," B. K. Vaynshteyn, B. G. Livshits, 11 pp

"Zhur Tekh Fiz" Vol XIX, No 8 - p. 971

Established for ShKh15 that intensive increase in martensite needles after dissolving of carbides does not influence the coercivity and electrical resistance, and that residual austenite is the main factor in varying the magnetic properties. Maximum coercivity is attained for 11% austenite content.

62/49T95

LIVSHITS, B. G.

Livshits, B. G. and Fomin, G. N. - "Aging of sheet steel for deep drawing", Sbornik (Mosk. in-t stali im Stalina), 27, 1949, p. 86-111, - Bibliog: 5 items.

SO: U-3042, 11 March 53, (Letopis 'Zhurnal 'nykh Statey, No. 8, 1949).

LIVSHITS, B. G.

USSR/Engineering - Thermomagnetic Effect Feb 50
Carbides, Analysis

"Employment of Thermomagnetic Method in Carbide Analysis," B. G. Livshits, K. V. Popov, Moscow Inst of Steel imeni I. V. Stalin, 4 pp

"Zavod Lab" Vol XVI, No 2

Introduces new method for thermomagnetic analysis of isolated carbides, used for investigating carbide phases of chromium steels, which permits, to a certain extent, compensation for deficiency in chemical and X-ray investigations. Investigated thermomagnetic properties of carbides

159T20

USSR/Engineering - Thermomagnetic Effect Feb 50
(Contd)

isolated from steels with chromium contents up to 4.34%. Analysis revealed carbide phases present in chromium steels after holding at supercritical temperature. This was impossible by any other method.

159T20

LIVSHITS, B. G.

USSR/Metals - Alloys
Metallography

May 50

"Metallographic Analysis of Ferroalloys and Alloy Steels With the Aid of Thermal Coloration," S. S. Gorelik, B. G. Livshits, Moscow Steel Inst imeni I. V. Stalin, 3 pp

"Zavod Lab" Vol XVI, No 5

Describes method of thermal coloration in application to ferroalloys and alloy steels based on intensive oxidation of metals at high temperatures with formation of oxide films which are usually detected on metals as temper colors. Intensity of forming and thickening of films and, consequently, coloring depends on dissociation elasticity of oxide of given metal or compound and on rate of oxygen diffusion into metal through film and diffusion of metal atoms to film surface.

PA 160T74

LIVSHITZ, B. G. and POPOV, K. V.

"Modifications in the Phase Diagram of the System Fe-Cr-C," Dokl. AN SSSR, 60, No.4, 1950.

Evaluation B-62231

Livshits, B. G.

52

"An More Accurate Determination of the Equilibrium Diagram of the System Iron-Chromium-Carbon. B. G. Livshits and K. V. Popov (*Doklady Akad. Nauk S.S.S.R.*, 1950, 70, (4), 633–635).—[In Russian]. The equilibrium diagram of the Fe-Cr-C system has been more accurately determined. Chem. and X-ray methods were applied to the carbides separated from the steels by an electrolytic method. The steels were melted in an induction furnace and annealed at 700° C.; those with high Cr content were very slowly cooled, especially in the region 600°–400° C. An isothermal cross-section of the diagram below the critical temp. is given.—Z. S. B.

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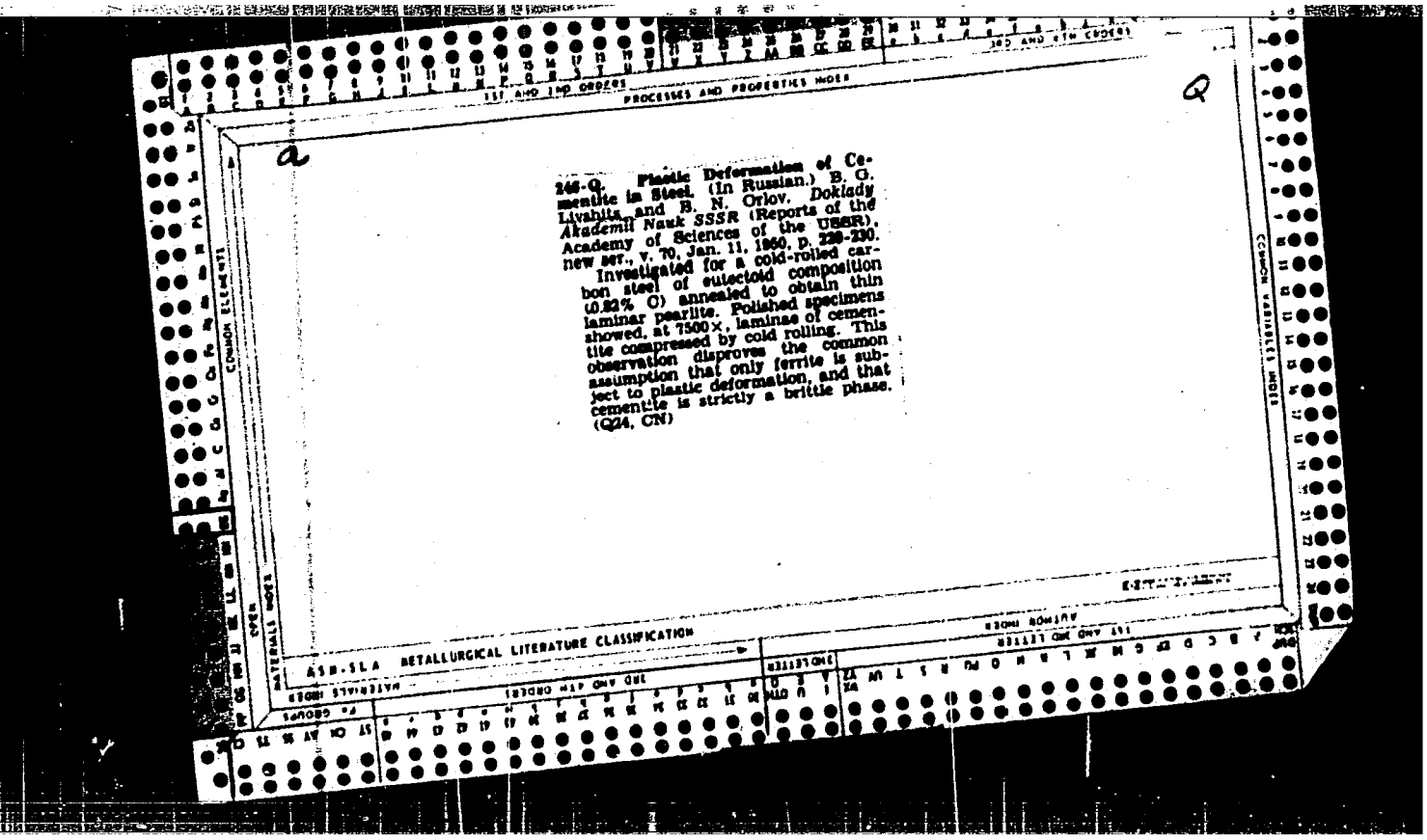


246-Q. Plastic Deformation of Cementite in Steel. (In Russian.) B. G. Livshits and B. N. Orlov. *Doklady Akademii Nauk SSSR* (Reports of the Academy of Sciences of the USSR), new ser., v. 70, Jan. 11, 1950, p. 229-230.

Investigated for a cold-rolled carbon steel of eutectoid composition (0.82% C) annealed to obtain thin laminar pearlite. Polished specimens showed, at 7500×, laminae of cementite compressed by cold rolling. This observation disproves the common assumption that only ferrite is subject to plastic deformation, and that cementite is strictly a brittle phase. (Q24, CN)

Livshits, B. G.

62

Electrical resistance of Ni$_3$Fe alloys containing molybdenum. B. G. Livshits and M. P. Ravdel' (*Dokl. Akad. Nauk. SSSR*, 1953, 93, 1033–1035).—Addition of Mo to Ni$_3$Fe reduces the linear increase in its specific conductivity κ with % reduction in area, normally observed, and at >1% Mo there is actually a decrease. An alloy with 5% Mo shows a max. κ at 450°, whereas pure Ni$_3$Fe has a min. κ at this temp. The dilatometric curve for Ni$_3$Fe with 5% Mo does not show the sudden increase (followed by later decrease) of volume at 550° shown by pure material, but simply a change to a lower coeff. of expansion; the curve for alloy with 1% Mo shows the first effect at 550°, the second at ~650°. The interpretation is that Mo eliminates the ordered structure of Ni$_3$Fe at low temp. and replaces it by segregation of Mo and Fe.

R. C. MURRAY.

(1)

LIVSHITS, B. G.

USSR/Solid State Physics - Phase Transformations in Solids, E-5

Abst Journal: Referat Zhur - Fizika, No 12, 1956, 34732

Author: Livshits, B. G., L'vov, V. S.

Institution: Moscow Institute of Steel USSR

Title: Investigation of the Mechanism of Aging of High-Coercivity Iron-Nickel-Aluminum Alloy

Original Periodical: Fiz. metallov i metallovedeniye, 1955, 1, No 3, 455-458

Abstract: An alloy containing 27% nickel, 15% aluminum, and the remainder iron was investigated. The method of 2-step working, imitating continuous cooling from a high temperature, was used: the homogeneous alloy was cooled from 1,250 to 800 or 850°, was soaked for a certain time (from one minute to 10 hours), and the resultant heterogeneous state was fixed by hardening. The coercivity and the temperature coefficient of the electric resistivity of monolithic specimens was measured at various stages of the heat treatment. The NiAl phase was separated chemically, and in it the contents of iron was determined and the coercivity, the saturation magnetic, and the temperature coefficient of electric resistivity were measured. The separated NiAl phase was furthermore subjected to heat treatment: slow heating to 100-700°,

USSR/Solid State Physics - Phase Transformations in Solids, E-5

Abst Journal: Referat Zhur - Fizika, No 12, 1956, 34732

Author: Livshits, B. G., L'vov, V. S.

Institution: Moscow Institute of Steel USSR

Title: Investigation of the Mechanism of Aging of High-Coercivity Iron-Nickel-Aluminum Alloy

Original Periodical: Fiz. metallov i metallovedeniye, 1955, 1, No 3, 455-458

Abstract: after which the magnetic saturation and the coercivity were measured. It was found that the supercooled solid solution of iron, nickel and aluminum alloy breaks up at 800-850° into an iron phase and a nickel-aluminum phase, containing iron. At a lower temperature (700°), there is a further decomposition of the nickel-aluminum phase with a separation of iron from it.

2 of 2

Livshits, B. G.

Phase condition, magnetic properties, and mechanism of aging of iron-nickel-aluminum alloys. B. G. Livshits and V. S. L'vov. *Sbornik Moskov. Inst. Stali* 33, 75-95 (1955); *Referat. Zhur., Met.* 1956, No. 6692.—Fe alloys contg. (1) Ni 26.85 and Al 15.32%, and (2) Ni 27.80 and Al 15.50% are characterized by abnormal aging. They acquire the highest coercivity (600 oersteds) after uninterrupted cooling from the temp. of single-phase state down to room temp. at a crit. rate. Chem., x-ray, electron-microscopic, and magnetic-phase studies were made. Supercooling from the single-phase state from 1250 to 800-850° and aging at this temp., followed by tempering at 700° for 1-80 min. resulted in a coercivity of 610 oersteds. The disintegration at 800-850°, that resulted in max. coercivity creates a highly dispersed and strained state after a one-minute exposure. An increase of the exposure time caused coagulation of the disintegrated phases. Alexis N. Pescoff

LIVSHITS, B. G., and L'VOV, V. S., (Moscow)

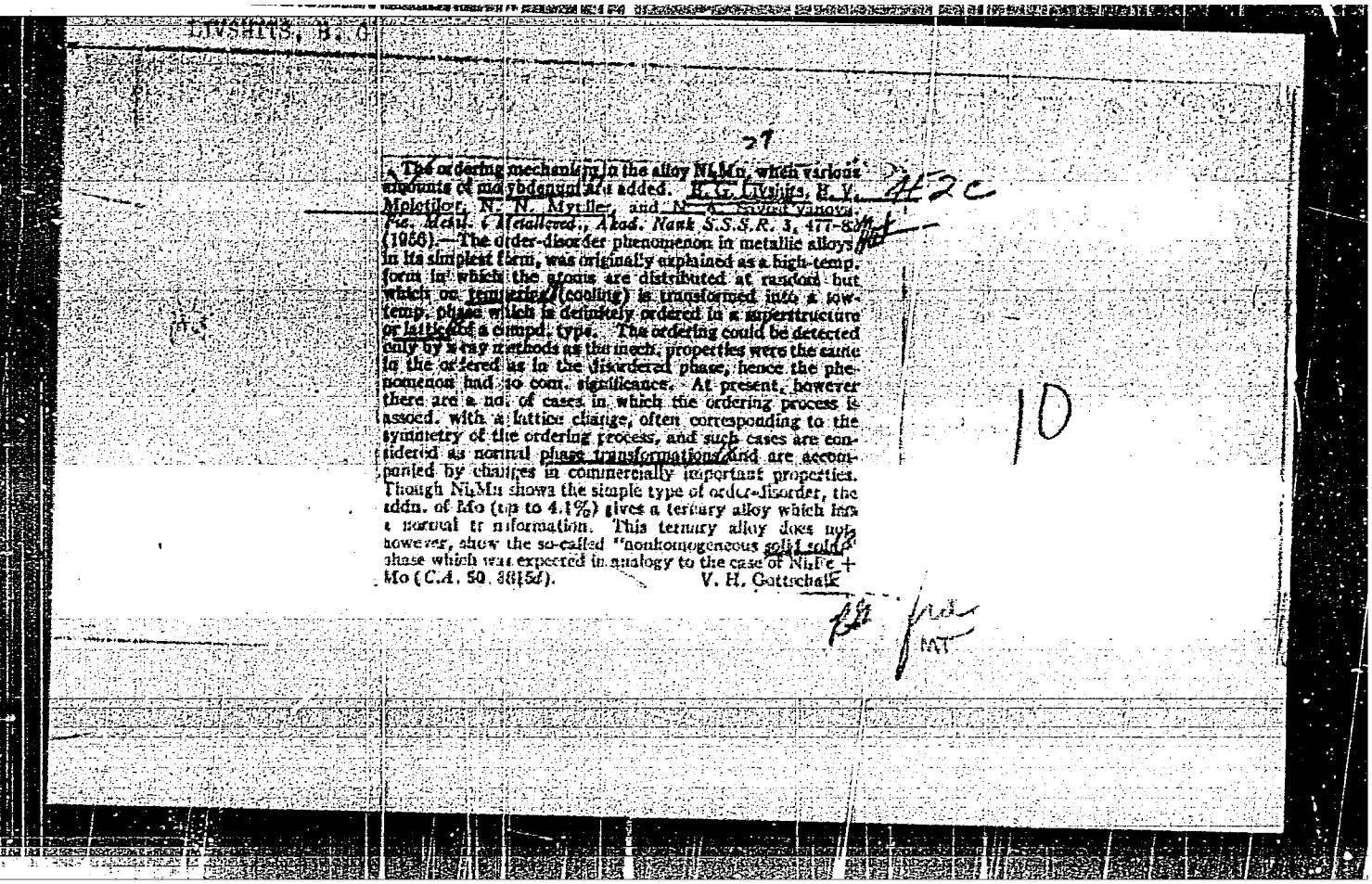
"The Constitution of the Alloys Fe-Ni-Al in their High Coercive State," a paper submitted at the International Conference on Physics of Magnetic Phenomena, Sverdlovsk 23-31 May 56.

LIVSHITS, B. G., and MELOTILOV, B. V. (Moscow)

"The Magnetic Investigation of the Ordering of the Alloys," paper presented at the International Conference on Physics of Magnetic Phenomena, Sverdlovsk, USSR, 23-31 May 1956

LIVSHITS, Boris Grigor'yevich, professor, doktor tekhnicheskikh nauk; KOMOCHKIY, Ye.I., professor, doktor fiziko-matematicheskikh nauk, retsenzent; RAKHSHTADT, A.G., dotsent, kandidat tekhnicheskikh nauk, redaktor; MODEL', B.I., tekhnicheskiy redaktor

[Physical properties of metals and alloys] Fizicheskie svoistva metallov i splavov. Moskva, Gos. nauchno-tekhn. izd-vo mashinostroit. lit-ry, 1956. 352 p. (MLRA 10:2)
(Alloys) (Metals)



LIVSHITS, B. G.

27

The ordering mechanism in the alloy Ni_4Mn, which various amounts of molybdenum are added. B. G. Livshits, B. V. Moletilov, N. N. Myuller, and N. K. Savel'yanova. *Fiz. Metall. i Metalloved., Akad. Nauk S.S.S.R.* 3, 477-80 (1956).—The order-disorder phenomenon in metallic alloys in its simplest form, was originally explained as a high-temp. form in which the atoms are distributed at random but which on tempering (cooling) is transformed into a low-temp. phase which is definitely ordered in a superstructure or lattice of a cmpd. type. The ordering could be detected only by x-ray methods as the mech. properties were the same in the ordered as in the disordered phase, hence the phenomenon had no com. significance. At present, however there are a no. of cases in which the ordering process is assocd. with a lattice change, often corresponding to the symmetry of the ordering process, and such cases are considered as normal phase transformations and are accompanied by changes in commercially important properties. Though Ni_4Mn shows the simple type of order-disorder, the addn. of Mo (up to 4.1%) gives a ternary alloy which has a normal transformation. This ternary alloy does not however, show the so-called "nonhomogeneous solid solns" phase which was expected in analogy to the case of Ni_4Fe + Mo (*C.A.* 50, 8815*d*). V. H. Gottschalk

1. Antimony-cobalt systems--Electrical properties--Thermal effects
2. Antimony-cobalt systems--Thermodynamic properties 3. Antimony-cobalt systems--Metallurgical analysis 4. Antimony-cobalt systems--X-ray analysis
5. Antimony-cobalt systems--Chemical analysis

137-58-4-8094

Translation from: Referativnyy zhurnal, Metallurgiya, 1958, Nr 4, p 247 (USSR)

AUTHORS: Livshits, B.G., Ravdel', M.P.

TITLE: The Effect of Molybdenum on Order/Disorder Transitions in Permalloy (Vliyaniye molibdena na uporyadocheniye permalloya)

PERIODICAL: Sb. tr. Tsentr. n.-i. in-t chernoy metallurgii, 1956, Nr 15, pp 53-67

ABSTRACT: Resistance (R) measurements and dilatometric investigations were employed to determine the effect of heat treatment and work hardening on the properties of Fe-Ni-Mo alloys of constant Ni contents (about 80%) and various Mo contents (0-6%), also the kinetics of structural transformations in alloys. The R of a hardened specimen of Ni_3Fe alloy (0% Mo) after heating and slow cooling in the temperature interval of order/disorder transition declines by 17.5% due to ordering. Addition of up to 1% Mo diminishes this effect, and when more than 1% is added, its sign is reversed. In an alloy with 5% Mo, the increase in R attains 5%. On work-hardening, contrariwise, the R of alloys with 5-6% Mo diminishes by 13%, and the R of the ordered Ni_3Fe alloy (OA) increases by 36%. Dilatometric investigation of isothermic

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137-58-4-8094

The Effect of Molybdenum on Order/Disorder Transitions in Permalloy

tempering of a hardened specimen of Ni_3Fe shows the reduction in volume common in OA. Under the same conditions of tempering, an alloy having 5% Mo showed the opposite, viz., an increase in volume. In cold-drawn specimens of Ni_3Fe, quenched from 300-600°C, the R drops rapidly with time until equilibrium is attained. In Fe-Ni-Mo alloys, R increases in the same manner at all tempering temperatures. The greatest change in R in both cases is that occurring at 400-500°. Heat treatment in the 300-600° interval does not affect the microstructure of the alloy. The anomalous change in the properties of Fe-Ni alloys when >1% Mo is added is explained by the appearance of a K phase which may perhaps owe its existence to the fact that the Mo and Fe atoms form complexes as a result of the appearance of chemical bonding forces between the different atoms. These complexes are the reason for the supplementary scattering of electrons and consequently the increase in R. An alloy containing 1% Mo is midway between OA and alloys with a K phase.

1. Iron-molybdenum-nickel alloys--Phase studies 2. Iron-molybdenum -nickel alloys--Phase transitions--Effects of molybdenum 3. Iron-molybdenum -nickel alloys--Properties--Effects of heat treatment 4. Iron-molybdenum -nickel alloys--Properties--Hardening effects

Ye. V.

Card 2/2

LIVSHITS, B.G.

137-1957-12-24904

Translation from: Referativnyy zhurnal, Metallurgiya, 1957, Nr 12, p 279 (USSR)

AUTHORS: Krasnopevtseva, T. V., Livshits, B. G.

TITLE: The Effect of Vanadium on the $\gamma \rightarrow \alpha$ Transformation in Fe-Co-V Alloys (Vliyaniye vanadiya na $\gamma \rightarrow \alpha$ prevrashcheniye v zhelezokobal'tvanadiyevykh splavakh)

PERIODICAL: Sb. tr. Tsentr. n.-i. in-t chernoy metallurgii, 1956, Nr 15, pp 68-85

ABSTRACT: The effect of V on the $\gamma \rightarrow \alpha$ transformation (T) was studied under continuous cooling of the gamma phase, as well as under isothermal conditions. The investigation was carried out on alloys with 0, 2, 4, 6, 8, 10, and 12 percent V content, all alloys having a constant content of 51 percent Co. All measurements were performed on Akulov's anisometer. Measurements of coercive force were also performed and the microstructure of the alloys was studied. Increasing the V content from 0 to 12 percent causes the temperature, which corresponds to the beginning of the $\gamma \rightarrow \alpha$ transformation, to vary from 925° to 525°. In alloys with 2 percent V or less the $\gamma \rightarrow \alpha$ occurs purely by diffusion. An analogous process takes place also in an alloy

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137-1957-12-24904

The Effect of Vanadium on the $\gamma \rightarrow \alpha$ Transformation in Fe-Co-V (cont.)

containing 12 percent V; in this process also no martensite T was detected. In super-cooling the γ phase of alloys containing 4 - 10 percent V, as well as during isothermal exposure of these alloys, the decomposition process also occurs by diffusion; however, when alloys containing 6 - 10 percent V are cooled at a rate of 5 - 6 deg/min the process of the $\gamma \rightarrow \alpha$ T assumes a non-diffusive martensite character. At identical cooling rates the $\gamma \rightarrow \alpha$ T in a 4 percent V alloy is of intermediate nature, but changes to a martensite nature when the cooling rate is increased. From the results obtained it is concluded that both the kinetics and the mechanism of T in a super-cooled gamma phase of the alloys investigated may be interpreted by means of the usual theory of decomposition and martensitic transformation.

P. S.

1. Iron-cobalt-vanadium alloys - Transformations - Effects of vanadium

Card 2/2

LIVSHITS, B. G.

Translation from: Referativnyy zhurnal, Metallurgiya, 1958, Nr 1, p 244 (USSR)

AUTHORS; Livshits, B.G., Rayevskaya, M.N.

TITLE: Malleable Magnetically Retentive Alloys Based on Iron-nickel-aluminum (Deformiruyemyye magnitotverdyye splavy na zhelezonikel' alyuminiyevoy osnove)

PERIODICAL: Sb. tr. Tsentr. n.-i. in-t chernoy metallurgii, 1956, Nr 15, pp 360-396

ABSTRACT: In an effort to discover inexpensive malleable alloys for permanent magnets having high magnetic qualities, the following alloys with reduced Al content were melted in an induction furnace, rolled into foil 1.5-10 mm in thickness, and studied. Ni 15-30, Al 0-15, and also an alloy with 15-25 Ni and 5-10 Al, with supplementary alloying by Nb, Zr, Ti, Va, and B. It was found that alloys containing not over 9 percent Al are capable of deformation in the 1200-850° C interval. Ti and Nb increase the coercive force of Ni-Al-Fe alloys up to 550 Oe with a B_s=5000 gauss (Ti). These alloys may be machined by hard alloy cutters. In the highly coercive state the alloy consists of finely dispersed β and β' phases, the β phase being in the form

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Malleable Magnetically Retentive Alloys Based on Iron-Nickel-Aluminum

of isolated particles in the β' phase. An alloy containing added Nb also contains a third phase, Fe_2Nb. In alloys containing Ti, the latter is completely dissolved, and no titanides are formed. Bibliography: 10 references. Ya.P.

1. Permanent magnets--Determination 2. Iron nickel aluminum alloys--Applications

Card 2/2

SOV/137-58-10-21512

Translation from: Referativnyy zhurnal, Metallurgiya, 1958, Nr 10, p 150 (USSR)

AUTHORS: Livshits, B. G., Ibragimov, Sh. Sh., Avraamov, Yu. S., Konev, Yu. K.

TITLE: Theory of Phase Transformations in Nichrome and Nimonic (Teoriya fazovykh prevrashcheniy v nikhrome i nimonike)

PERIODICAL: V sb.: Issled. po zharoprochn. splavam. Vol 2. Moscow, AN SSSR, 1957, pp 171-180

ABSTRACT: The fact that electrical resistivity (ER), heat capacity (HC), and certain other properties of nimonic and nichrome alloys are functions of temperature indicates that a K-state exists in these alloys. In nichrome specimens which have been quench-hardened at a temperature of 770°C, the K-state appears as a result of heating to 400-460°. Heating the alloy to 460-560° causes it to revert into a statically disordered solid-solution state. The formation of the K-state is accompanied by changes in the microstructure of the alloys, apparently as a result of deformations, i. e., according to X-ray data the alloys retain their single-phase character. A change in microhardness analogous to a change in the ER

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Theory of Phase Transformations in Nichrome and Nimonic

is observed. In the case of nimonic two processes take place: 1) Segregation of a $Ni_3(Ti, Al)$ phase from the solid solution at temperatures of 850-750°, and 2) the appearance of a K-state at temperatures below 500-600°. Despite the high magnifications employed (10-12,000 x), electron-microscope studies of the structure of nimonic which had been tempered at 500-600° failed to reveal any decomposition of the solid solution, even though the physical properties of the alloy had changed considerably in the process. The K-state was also studied by the method of measuring the internal friction of alloys with the aid of a vacuum relaxator. On the strength of these data it may be concluded that Ni and Cr participate in the formation of the K-state in nichrome, whereas in the case of nimonic Ni, Cr, Ti, and Al are the participating elements.

1. Chrome-nickel alloys---Phase studies

P. S.

Card 2/2

18 (7)

SOV/112-59-1-120

Translation from: Referativnyy zhurnal. Elektrotekhnika, 1959, Nr 1, p 11 (USSR)

AUTHOR: Avraamov, Yu. S., and Livshits, B. G.

TITLE: Investigation of Nimonick Alloy by Methods of Internal Friction, Electrical Resistance, and Dilatometric Analysis

PERIODICAL: V sb.: Issled. po zharoprochn. splavam, Vol 2, M., AS USSR, 1957, pp 198-210

ABSTRACT: In the nimonick alloy (21% Cr, 2.48% Ti, 0.67% Al, the rest Ni), the transmutation passes two phases: disintegration and "predisintegration." The former has a character of dispersional solidification, while the predisintegration is actually a formation of segregated Cr and Ti atoms. The disintegration takes place at 700-800°C; the K state (anomalous increase in electrical resistance when tempering after a hardening) is formed at 500-650°C. Both processes are entirely independent of each other. Bibliography: 12 items.

O.B.O

Card 1/1

Livshits, B.G.

AUTHOR: Ivanushkina, A.Z. and Livshits, B.G.

TITLE: Alloying of 36% invar enables one to change its properties by hardening and tempering. (Legirovanie 36-protsentnogo invara pozvolyaet izmenyat' ego svoystva putem zakalki i otpuska.)

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PERIODICAL: "Fizika Metallov i Metallovedenie", (Physics of Metals and Metallurgy), 1957, Vol.IV, No.1 (10), pp.184-185 (U.S.S.R.)

ABSTRACT: The authors show that the K-state can be obtained by alloying of a single-phase alloy which without alloying has no ordered state or phase transformations. As such an alloy invar (36% Ni, rest Fe) was chosen and in Fig. 1 the change of the electric resistance after tempering from various temperatures of hardened invar containing 8% Mo is given. Thus, it is shown that a K-state can be obtained in order as well as disorder solutions by introducing small quantities of a third component. One graph, 1 German and 1 Russian reference.

Recd. July 24, 1956.

LIVSHITS, B.G.

USSR/Solid State Physics - Phase Transformation in Solid Bodies E-5

Abs Jour : Ref Zhur - Fizika, No 1, 1958, 998

Author : Ibragimov, Sh.Sh., Livshits, B.G.

Inst : Moscow Institute of Steel.

Title : Change in Properties and Structure in Solid Solutions With a Nickel Base.

Orig Pub : Fiz. metallov i metallovedeniye, 1957, 4, No 2, 315-318

Abstract : An investigation was made of the influence of heat treatment and cold deformation on the electric resistivity, linear dimensions, microhardness, and microstructure of alloys Ni-21.4 Cr and 57.4 Ni-16.55 Cr-Fe (in percent). When heating hardened alloys Ni-Cr, the electric resistivity of the specimens in a region of 420 -- 530° is intensele increased, starting with 530° it gradually diminishes to a minimum and after 750° it again starts increasing.

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USSR/Solid State Physics - Phase Transformation in Solid Bodies E-5

Abs Jour : Ref Zhur - Fizika, No 1, 1958, 998

of the process of formation of unordered portions. Also observed is a change in the microstructure of the alloys as a result of slow cooling.

Card 3/3

IVANUSHKINA, A.Z.; LIVSHITS, B.G.

Investigating properties and structure of invar alloys with additions of molybdenum, chromium and niobium. Fiz. met. i metalloved. 5 no. 3:527-535 '57. (MIRA 11:7)

1. Institut pretsizionnykh splavov TSentral'nogo nauchno-issledovatel'skogo instituta chernoy metallurgii.
(Nickel steel--Analysis)
(Metallography)

LIVSHITS, B. G.

AUTHOR: Livshits, B. G. 48-9-3/26

TITLE: Note on the Modification of the Structure and the Properties of Solid Nickel Solutions on a Heat Treatment (Izmeneniye stroyeniya i svoystv nikelevykh tverdykh rastvorov pri termicheskoy obrabotke).

PERIODICAL: Izvestiya AN SSSR Seriya Fizicheskaya, 1957, Vol. 21, Nr 9, pp. 1225-1231 (USSR).

ABSTRACT: In this paper a new structural state (phase modification of a homogeneous solid solution), which was given by Thomas, H. (ZS.Physik, 129, 219, 1951) the denomination "K - state", in Chromium-Nickel, Mo-permalloy, and in alloyed molybdenium was investigated by means of measuring the electric resistance, its dilatation, strength and magnetic saturation. These investigations produced consistent results. Thermodynamic problems and the causes leading to the formation of the K - state were not studied. The characteristic features of the K - state are summed up as follows:
1) the kinetics of the formation of the K - state show that this state comes into existence by diffusion, in the same way as ordering or the normal aging process. 2) Within the solid solution the process takes place without the formation of a second phase with a lattice differing from that of the original lattice of the solution.

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LIVSHITS, B. G.

AUTHORS: Livshits, B. G., and L'vov, V. S. 48-9-4/26

TITLE: Note on the Structure of Fe-Ni-Al-Alloys in a Highly Coercitive State (Stroyeniye Fe-Ni-Al-Splavov v ikh vysokokoertsitivnom sostoyanii).

PERIODICAL: Izvestiya AN SSSR Seriya Fizicheskaya, 1957, Vol. 21, Nr 9, pp. 1232-1232 (USSR.).

ABSTRACT: The paper is a short abstract from the lecture, the basic contents of which have been published in FMM, 1, 455 (1955) and more detailed in Sbornik Trudov MIS, 33, page 75, 1955. The solid Fe-Ni-Al solution is decomposed into a Fe - phase and a Ni-Al - phase at high temperature (at annealing and at aging as well). This leads to a coherent combination between the components of the structure, independent of the degree of pulverization. An anomaleous process of aging is characteristic for these alloys. The anomaly consists in the fact, that the maximum coercitive force is not obtained from an ordinary hardening by means of annealing, but is the result from a continuous cooling starting from high temperatures (from a one phase state) with a critical velocity. The continuous cooling can be replaced with the same result by the keeping of a undercooled high-temperature solution,

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48-9-4/26

Note on the Structure of Fe-Ni-Al-Alloys in a Highly Coercitive State.

first at 800 - 850°C and then at 650 - 700°C. At these temperatures the decomposition takes place in two steps: Fe-phase and Ni-Al-phase. The first decomposition is proved with the help of a microscope, the additional one by a phase analysis (chemical and X-ray) of the isolated Ni-Al-phase, which is separated from the alloy electrochemically after different heat treatments. The decomposition is also proved by measurements of electrical, magnetical and other properties of the monolyt samples. It can be assumed, that the maximum increase of the coercitive force is caused by an increased isolation of particles of α-iron on the additional decomposition of the phases (which have been obtained at the first decomposition of the undercooled solid solution).

ASSOCIATION: Moscow Institute for Steel imeni I. V. Stalin (Moskovskiy institut stali imeni I. V. Stalina).

AVAILABLE: Library of Congress.

Card 2/2

LIVSHITS, B. G.

AUTHORS: Livshits, B. G., and Molotilov, B. V. 48-9-5/26

TITLE: Note on Magnetic Investigations of the Ordering of Alloys on the Basis of Ni_3Mn (Magnitnoye issledovaniye uporyadocheniya splavov na osnove Ni_3Mn).

PERIODICAL: Izvestiya AN SSSR Seriya Fizicheskaya, 1957, Vol. 21, Nr 9, pp. 1233-1233 (USSR.).

ABSTRACT: The purpose of this paper was to clarify the influence of Mo on the ordering process of the Ni_3Mn solution. Alloys of Ni_3Mn without molybdenium and such with a molybdenum content up to 4% were investigated. First the kinetics of the phase transformation at various temperatures were studied by means of measuring the electric resistance and then this process was analyzed exactly with the thermomagnetic method in the anisometer of Akulov. Moreover, the elastic properties and the structure of the alloys was investigated. It appeared, that the various stages of ordering are accompanied by a process of formation and growth of the crystal nuclei of the ordered solution and a gradual disappearance of the disordered phase. The introduction of molybdenum into Ni_3Mn slows down the ordering and diminishes the degree of the possible ordering. This decrease is not proportional to the

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Note on Magnetic Investigations of the Ordering of Alloys on the Basis of Ni_3Mn. 48-9-5/26

dilution of Ni_3Mn by molybdenum. The decrease of the extreme order apparently is not only due to a distortion of the stoechiometrical composition, but also to a basic modification of the interatomic combination. The ability of the solid solution for ordering is kept at an introduction of at least 4,1% of molybdenum and no transition to the inhomogenuous solid solution takes place (K - state). The kinetics of the ordering of Ni_3Mn compounds are identical wether alloyed with molybdenum or not. The basic contents of the lecture have been published together with Myuller, N. N. and Savost'yanova in FMM, 3, 477 (1956).

ASSOCIATION: Moscow Institute for Steel imeni I. V. Stalin (Moskovskiy institut stali imeni I. V. Stalina).

AVAILABLE: Library of Congress.

Card 2/2

LIVSHITS, B.G.

137-58-3-5865

Translation from: Referativnyy zhurnal, Metallurgiya, 1958, Nr 3, p 200 (USSR)

AUTHORS: Livshits, B.G., Ibragimov, Sh. Sh.

TITLE: Investigation of Structural Transformations and Properties of Nichrome Alloys(Issledovaniye strukturnykh prevrashcheniy i svoystv nikhromovykh splavov)

PERIODICAL: Sb. Mosk. in-t stali, 1957, Vol 36, pp 75-102

ABSTRACT: The nature and mechanism of the K-state was studied on alloys Kh20N80 and Kh15N60, which were obtained industrially in the form of a wire 3.5 mm in diameter. Specimens encased in ampoules containing Na to ensure an oxygen-free atmosphere were maintained for 5 hours in a silit-resistor furnace at a temperature of 1200°C, after which they were cooled to 1100° within one hour, maintained at that temperature for one hour, and then were either quenched in water or allowed to cool at a specified rate. At temperatures below 400° the heat treatment was performed in sealed Cu cartridges. At higher temperatures the samples were maintained either in a Sn bath, or in quartz ampoules. Temperatures were measured by means of a Pt-Pt-Rh thermocouple. In order to study the effect of deformation on the

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Investigation of Structural Transformations (cont.)

properties of alloys, the specimens were subjected to reduction amounting to 98 percent. The effect of various heat treatment procedures and of cold deformation on the properties of alloys, as well as the kinetics of transformation, were studied by means of measuring microhardness and electrical resistivity; the latter was measured by a null method on a potentiometer bridge. In addition, the σ_b and δ were measured and microstructural analysis and dilatometric studies were performed on a Chevenard dilatometer under conditions of continuous heating and cooling. It is shown that common aging with carbide separation occurs in the alloys investigated together with intraphase transformations in which no separation occurs and which are accompanied by changes in microstructure, increases in microhardness and in electrical resistivity, and decreases in the permanent solid-solution lattice. In the case of the Kh20N60 alloy, both these processes are separated. Activation energies of the intraphase transformation process were calculated from changes in electrical resistivity, and were found to be 43,300 cal/g-atom for the Kh20N80 alloy, and 66,800 cal/g-atom for the Kh15N60 alloy. If the Kh20N80 alloy contains 0.07 percent of C, the activation energy increases to a value of 55,600 cal/g-atom. It is postulated that regions enriched with Cr are formed within the lattice of the solid solution as a result of the intraphase transformations.

Card 2/2

V. R.

137-58-6-11802

Translation from: Referativnyy zhurnal, Metallurgiya, 1958, Nr 6, p 86 (USSR)

AUTHORS: Livshits, B.G., Shishko, L.A., Lakhman, N.G.

TITLE: The Quality of Steel Smelted in a Recirculation Oven (Kachestvo stali, vyplavlennoy v retsirkulyatsionnoy pechi)

PERIODICAL: Sb. Mosk. in-t stali, 1957, Nr 37, pp 395-418

ABSTRACT: An investigation is made of the quality of St 28 steel made in experimental heats and of St 3, 30, 40, 45, and Armco steels made in a recirculation oven using air with up to 50-80% O_2, not preheated. The steel of the test heats corresponded in quality to the GOST (All-Union State Standards) and was distinguished from open-hearth steel by higher homogeneity, superiority of mechanical and physical properties along the length of the ingot, low [P] (which was 0.004-0.008% in Armco steel), but elevated [O]. The test steel differed little from open-hearth steel in [N] and [H]. Bibliography: 1 reference.

A.Sh.

1. Steel--Production 2. Steel--Test results
3. Furances--Effectiveness

Card 1/1

69187

SOV/137-59-12-27205

Translation from: Referativnyy zhurnal, Metallurgiya, 1959, Nr 12, pp 205 - 206 (USSR)

18.1250 18.7100

AUTHORS: Livshits, B.G., Kossakovskaya, N.N., Ibragimov, Sh.Sh., Avraamov, Yu.S.

TITLE: Investigation Into Phase and Structure Transformations of "EI437" Alloy

PERIODICAL: Tr. Sektsii metalloved. i term. obrabotki metallov, Tsentr. pravl. Nauchno-tekhn. o-va mashinostroit. prom-sti, 1958, Nr 1, pp 140 - 154

ABSTRACT: The authors carried out investigations of "EI437" alloy subjected to various types of heat treatment and having the following composition (in %): C 0.05, Si 0.43, Mn 0.24, S 0.003, P 0.005, Ce 0.02, Cr 20.55, Ti 2.44, Al 0.79, Cu 0.004, Fe 0.56; the remainder was Ni. Electric resistance was measured on "UPN3/2" and "UTV-2" machines during the heating process and at room temperatures; measurements were made on a capacity dilatometer; the temperature dependence of heat capacity was determined by the Sykes (Sayks) method; the phase composition of electrolytically separated deposits was determined by the roentgenographical, microscopical and electron-microscopical methods. Moreover, endurance tests were performed. Heat treatment of specimens consisted of quenching with subsequent controlled cooling-off at various rates. Highest

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Investigation Into Phase and Structure Transformations of "EI437" Alloy

hardness values were obtained if the cooling rate was 160 degrees/hour, corresponding to a sufficiently complete isolation of the separating phases and to not too excessive a coagulation. The electron-microscopical investigations showed that the separation and coagulation of the strengthening γ'-phase was more intensive during continuous cooling-off from high temperatures than during tempering of a supercooled solution; the particle dimensions depended on the cooling rate. In slow cooling a hexagonal phase was revealed together with the γ'-phase. Measurement of the temperature dependence of specific heat capacity and measurements of electric resistance and dilatometrical data, showed that two processes took place: namely, within the 700 - 900°C temperature range, a process connected with the formation of a phase in the solid solution, and a process of developing a K-state below 700°C; whose thermal effect was equal to 1.35 cal/g. The first process shifted the maximum of the K-state formation slightly towards the lower temperature side. It is assumed that the origination of the K-state is due to the formation of Guinier-Preston type zones in areas with increased concentration of alloying elements; it is characterized by the occurrence of a specific micro-relief. There are 12 bibliographical titles.

V.R.

SOV/137-59-1-1097

Translation from: Referativnyy zhurnal. Metallurgiya, 1959, Nr 1, p 149 (USSR)

AUTHORS: Van'-Zhun', Livshits, B.G.

TITLE: The K-state and the Phenomenon of Recovery Upon Aging (K-sostoyaniye i yavleniye vozvrata pri starenii)

PERIODICAL: Nauchn. dokl. vyssh. shkoly. Metallurgiya, 1958, Nr 1, pp 169-174

ABSTRACT: The authors studied aging in the 300 - 900°C temperature range of the Fe-Ni-Nb alloy after quenching in water from 1150°. Upon aging in a low temperature range (300 - 600°) the electrical resistivity and hardness increase, while the saturation magnetization decreases, which indicates the appearance of a K-state. In the high temperature range the changes of the properties exhibit a reverse character indicating an aging process accompanied by the separation of a second phase, which fact is verified by metallographic analysis. The activation energy of the low-temperature process is ~40,000 cal/g-atom, that of the high-temperature process is ~71,000 cal/g-atom, i.e., both are diffusion processes. The authors also examined the phenomenon of the recovery of properties

Card 1/2

The K-state and the Phenomenon of Recovery Upon Aging

after aging with a short (5-sec) heating to 700°. A complete recovery of the properties is detected only prior to the separation of a second phase. Both processes examined develop independently and can proceed simultaneously.

L. V.

AUTHORS: Yeliseyev, S. A., Livshits, B. G. SOV/163-58-1-32/53

TITLE: The Comparison Between the K-State and the "Increasing Diffusion" in Some Iron Alloys (Sravneniye k-sostoyaniya i "voskhodyashchey diffuzii" v nekotorykh zheleznykh splavakh)

PERIODICAL: Nauchnyye doklady vysshey shkoly. Metallurgiya, 1958, Nr 1, pp 175-181 (USSR)

ABSTRACT: The effects K-state and "increasing diffusion" are two phenomena occurring in the steel melt.
The formation of the K-state in iron alloys is characteristic of the increase in the electric resistance and the simultaneous increase in the hardness of the alloys.
The "increasing diffusion" effect is also characterized by an increasing hardness and a decreasing electric resistance in the alloys.
The two effects K-state and "increasing diffusion" were investigated and the differences were explained.
In alloys in which no K-state occurs after annealing and hardening such an effect does not occur after deformation.
There are 4 figures, 2 tables, and 11 references, 6 of which are Soviet.

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SOV/163-58-1-32/53

The Comparison Between the K-State and the "Increasing Diffusion" in Some Iron Alloys

ASSOCIATION: Moskovskiy institut stali (Moscow Steel Institute)

SUBMITTED: October 1, 1957

Card 2/2

AUTHORS: Livshits, B. G., Makhukov, N. G. SOV/163-58-2-43/46

TITLE: Investigating the Hardening of the Cold-Deformed Alloy K4CNKhM. (Issledovaniye otpuska kholodnodeformirovannogo splava K4CNKhM)

PERIODICAL: Nauchnyye doklady vysshey shkoly. Metallurgiya, 1958, Nr 2, pp. 239-242 (USSR)

ABSTRACT: To investigate the micro structure of the cold-deformed alloys with 0,05% carbon after the hardening to 600°C the alloy K4CNKhM was used. The influence of the temperature of hardening on the extent of internal friction in the alloys of the type K4CNKhM was investigated. In the curves plotted a maximum jump may be found at 300-350°C. This maximum is dependent on the relative mixing of the carbon and the atoms of molybdenum and tungsten. The extent of the maximum increases with the increase of the carbon concentration and the extent of deformation. The separation of molybdenum and tungsten formed decreases this maximum in the hardening after cold treatment. The investigations showed that in the alloys of the type K4CNKhM in the case of a hardening after riveting processes take place which are analogous to the processes occurring in the alloys Ni-Cr, Fe-Al, Fe-Si, Fe-Ni-Mo, and which are analogous to the process of natural aging in

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Investigating the Hardening of the Cold-Deformed Alloy K4CNKhM SOV/163-58-2-43/46

aluminium alloys. In the investigations of the internal friction carbon occurs as indicator in the formation of the K-state of the alloys. There are 4 figures, 1 table, and 11 references, 10 of which are Soviet.

ASSOCIATION: Moskovskiy institut stali (Moscow Institute of Steel)
Institut pretsizionnykh splavov TsNIIChM (Institute of Precision Alloys of the TsNIIChM)

SUBMITTED: November 25, 1957

Card 2/2

AUTHORS: Livshits, B. G., Myuller, N. N. SOV/163- 58-3-33/49

TITLE: The Investigation of the Phase Equilibrium in the System Cobalt - Chromium - Aluminum (Issledovaniye fazovogo ravnovesiya v sisteme kobal't - khrom - alyuminiy)

PERIODICAL: Nauchnyye doklady vysshey shkoly. Metallurgiya, 1958, Nr 3, pp 201 - 206 (USSR)

ABSTRACT: In the present paper the diagram of the phase equilibrium in the system Co-Cr-Al was determined. Within the range of concentration of the triangle Co-Cr-Al the ranges of the $\alpha+\theta$ -phase were investigated based on the results obtained; this was done by constructing the three isothermal sections at 1250°, 1000° and 800°. Furthermore the phase equilibrium at 1250°, 1000° and 800° C was investigated. The samples investigated were maintained at the respective temperatures for 1, 5, 16 and 128 hours. The investigations were carried out by micro-structural analyses and x-ray structural analyses, as well as by determining their microhardness. All alloys investigated may be divided into two groups:

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The Investigation of the Phase Equilibrium in the System Cobalt - Chromium - Aluminum SOV/163-58-3-33/49

in homogeneous and heterogeneous alloys. The latter have two and three phases. The results obtained made possible the determination of the limiting phase ranges in the investigation of the temperatures for the cobalt corners of the diagram Co-Cr-Al. When the temperature is decreased from 1250° to 1000°C the phase range α+θ widens with an increase of the aluminum content, the mono-phase range of ϵ decreases with an increase of the chromium content, and the phase range of ε is larger at 1250° than at 1000°. There are 1 figure, 1 table, and 4 references, 1 of which is Soviet.

ASSOCIATION: Moskovskiy institut stali (Moscow Steel Institute)

SUBMITTED: October 1, 1957

Card 2/2

LIVSHITS, B. G. and VAN ZHUN'

"Research on the Effect of Recovery of Characteristics by Aging of Alloys on Foundation of Iron"

Moscow Institute of Steel and Peking Inst. Ferrous Metallurgy

Acta Metallurgica Sinica, Vol 3, No 2, June 1958, p 128

78-3-3-26/47

AUTHORS: Livshits, B. G. , Khorin, Ya. D.

TITLE: Investigations of the Diagram of the Phase Equilibrium in the System Co-Cr-Ti (Issledovaniye diagrammy fazovogo ravnovesiya sistemy Co-Cr-Ti)

PERIODICAL: Zhurnal Neorganicheskoy Khimii, 1958, Vol. 3, Nr 3, pp. 685-693 (USSR)

ABSTRACT: In this work the diagram for the phase equilibrium in the system Co-Cr-Ti with a chromium content of up to 55 % and a titanium content of up to 45 % was investigated. The alloys were produced of purest electrolytically produced chromium, pulverulent titanium and cobalt in a crucible tungsten furnace of the type TBB-2 in a vacuum and argon atmosphere. In the phase-equilirbium diagram of the system Co-Cr the boundary between the solid solution of chromium in cobalt and the σ-phase were determined. It is only in the alloys with 36 - 37 % that a smaller quantity of the σ-phase occurs. The experiments showed that the σ-phase in the system Co-Cr directly forms from the liquid melt. The phase-equilibrium diagram of the system Co-CoTi was also

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Investigations of the Diagram of the Phase Equilibrium in the System Co-Cr-Ti

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constructed. The microstructure and X-ray analyses showed that the Co-Ti alloys with a Ti-content of up to 7 - 8 % consist of the ε-phase. (Solid solution of titanium in hexagonal cobalt). The X-ray investigations with 28,30 % and 32 % titanium showed that the compound Co_2Ti possesses an hexagonal modification. The phase-equilibrium diagram of the system Cr-Ti is characterized by its solid solution of titanium in chromium and the compound Cr_2Ti. By isothermal sections at 750, 900 and 1050°C the authors constructed the boundary of the phase regions in the ternary diagrams of the phase equilibrium of the system Co-Cr-Ti with a chromium content of up to 55 % and a titanium content of up to 45 %. In the investigated parts of the phase equilibrium diagram of the system Co-Cr-Ti the following phases occur:

1) The phase of the solid solution of chromium and titanium in cobalt.
2) The σ-phase with a maximum quantity of titanium (10-15%). on addition of titanium no marked modification of the hard-ness of this phase occurs.
3) The phase of the compound $(Co, Cr)_2Ti$
4) The phase of the compound CoTi. This phase dissolves in itself 1,5 - 2 % chromium.

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Investigations of the Diagram of the Phase Equilibrium in the System Co-Cr-Ti

78-3 3-26/47

5) The chemical compound with approximately the following composition: Co_4Cr_2Ti. There are 5 figures, 2 tables, and 9 references, 2 of which are Soviet.

ASSOCIATION: Moskovskiy institut stali im. I. V. Stalina
(Moscow Institut for Steel imeni I. V. Stalin)

SUBMITTED: June 25, 1957

Card 3/3

18(7)

AUTHORS: Livshits, B. G., Makhukov, N. G.

SOV/163-58-4-28/47

TITLE: Kinetics and Mechanism of Structural Change in Annealing a Cold-Worked Alloy of the K40NKhM-Type (Kinetika i mekhanizm strukturnogo prevrashcheniya pri otpuske kholodnodeformirovannogo splava tipa K40NKhM)

PERIODICAL: Nauchnyye doklady vysshey shkoly, Metallurgiya, 1958, Nr 4, pp 169-173 (USSR)

ABSTRACT: Examination of spring alloys of the K40NKhM type with a Co-Cr-Ni-Fe basis permitted (Ref 1) an analogy between the processes taking place during the heat treatment of these austenitic alloys and those occurring during the heat treatment of other one-phase alloys such as Ni-Cr, Fe-Al, Fe-Si, Fe-Ni-Mo. A maximum is observed at 400-500° on the hardness, elastic limit, and electric resistance curves of cold-worked alloys of the K40NKhM type as functions of the annealing temperature. The electric resistance curve of the alloys has a maximum also after hardening with annealing. The chief results of the examination of kinetics of the annealing process are given. The occurrence of maxima on the kinetic curves points to processes in the alloy that - at

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isothermal retardation - are opposite as to their influence on properties. In the opinion of the authors, the formation of the K-state leads to an increase of hardness. The electric resistance increases due to a reduction of mobility of the electrons (Refs 6, 7). The forming zones have dimensions in the order of magnitude of the free path of electrons, increasing their straying. A partial softening of the alloy at isothermal retardation is connected with the course of the recovery process after cold hardening. This is confirmed by the dilatometric curves at isothermal retardation, and by the curves of the actual elongation factor and relative elongation. It is shown that in a hardened (not cold hardened) alloy with the structure of a more or less homogenous solid solution only one process takes place in heating (formation of the K-state occurs up to 550°, and a gradual destruction of the same at a temperature between 550 and 650°). The second process (the recovery) is missing. It is shown that cold hardening greatly reduces the elastic modulus (in the given case by 20 %), and therefore the interatomic binding powers too. Subsequent annealing at

different temperatures (for 4 hours) increases the elastic modulus. This is connected with the formation of the zone of Gin'ye-Preston's type (K-state). There are 5 figures and 11 references, 4 of which are Soviet.

ASSOCIATION: Moskovskiy institut stali (Moscow Steel Institute)
Institut pretsizionnykh splavov TsNIIChM (Institute of Refined Alloys of the Central Scientific Research Institute of Ferrous Metallurgy)

SUBMITTED: December 28, 1957

SOV/126-6-1-15/33

AUTHORS: Avraamov, Yu. S., Belyakov, L. N. and Livshits, B. G.

TITLE: Internal Friction Peaks in Ni-Cr Base Solid Solutions (Piki vnutrennego treniya v tverdykh rastvorakh na baze nikel'-khroma)

PERIODICAL: Fizika Metallov i Metallovedeniye, 1958, Vol 6, Nr 1, pp 116-121 (USSR)

ABSTRACT: The alloys used were 20% Cr, 0.05% C, balance Ni, and 20% Cr, 2.48% Ti, 0.68% Al, 0.03% C, balance Ni (nichrome and nimonic respectively). Torsional oscillations in vacuc, using an apparatus not described, were employed. Fig.1 shows the effect of variable grain size (produced by quenching from various temperatures) on the internal friction-temperature curve for nimonic (up to 750°C); two peaks are found, at 150 (A) and 650-660°C (E) respectively. The latter is caused by grain boundary displacement. Fig.2 gives similar curves for nimonic of low and high carbon contents, the latter after quenching and ageing. Fig.3 shows the same for nimonic containing varying amounts of Ti. From these results it is concluded that the A peak is related to the presence of Ti, as no deformation is

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Internal Friction Peaks in Ni-Cr base solid solutions

involved, and the peak rises with Ti content. The exact shape of the peak is affected by ageing at 520°C, and completely removed by ageing at 575°C for eight hours. Fig.4 illustrates the results of applying various heat-treatments to the alloy. The effects are related to the formation of a K-state in the α' solid solution. The fact that the A peak tends to split into two separate peaks, which behave differently, is not, however, discussed.
There are 4 figures and 8 references, 5 of which are Soviet, 3 English.

ASSOCIATION: Moskovskiy institut stali (Moscow Steel Institute)

SUBMITTED: October 22, 1956

Card 2/2

1. Nickel alloys--Physical properties 2. Nickel alloys--Mechanical properties 3. Grains (Metallurgy)--Metallurgical effects 4. Titanium--Metallurgical effects

SOV/126-6-4-12/34

AUTHOR: Yelisеyev, S.A., Livshits, B.G.

TITLE: Investigation of Phase Transformations in Certain Iron-Base Alloys (Issledovaniye fazovykh prevrashcheniy v nekotorykh zheleznykh splavakh)

PERIODICAL: Fizika Metallov i Metallovedeniye, 1958, Vol 6, Nr 4, pp 657-661 (USSR)

ABSTRACT: There are large numbers of alloys which, in spite of the fact that according to metallographic evidence they consist (within a wide temperature interval) of one phase only, may, in this temperature range, undergo transformations accompanied by changes of their various properties. Alloys of the composition corresponding to the formulae Ni_3Mn (Ref.1), Ni_3Fe (Ref.2) and many others, undergo a disorder-order transformation. Alloys of the "Nichrome" type containing 20-30% Cr (Ref.3,4,8), the iron-base alloys with 36% Ni and 1-8% Mo and certain other materials are characterised by a structural condition, stable at low temperatures and referred to as the K-state. The disorder-order

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Investigation of Phase Transformations in Certain Iron-Base Alloys

transformations are accompanied by a decrease of the electrical resistivity of the alloy, while a transformation from the normal to the K-state results in an increase of this property. In both cases hardness is increased and some other properties are also affected. For obvious reasons, freedom from transformations of this type is very important in the case of single-phase alloys used for the preparation of wire strain-gauges, and the object of the present investigation was to ascertain whether such transformations occur in certain iron-base alloys. The main alloying constituent of the 5 investigated alloys was vanadium (8-14%). Alloys No.3 and 4 contained in addition 2.15 and 2.9% molybdenum, while alloy No.5 contained 1.15% aluminium. The carbon content of the alloys, whose complete chemical analysis is given on p 658, did not exceed 0.035%. High purity metals were used for the preparation of the alloys which were melted in argon, in a H.F. induction

Investigation of Phase Transformations in Certain Iron-Base Alloys

furnace. After a homogenising treatment the cast ingots were forged to 8 mm diameter rods from which one group of experimental test pieces were prepared. In the first series of experiments, the as-forged specimens placed in evacuated ampoules and quenched from 1150°C were aged for 4 hrs at temperatures ranging from 350 to 650°C, and hardness H_v, electrical resistivity ρ, and magnetic saturation $4\pi J_s$ of the alloys both in the quenched condition and after ageing were measured. The results reproduced graphically on Fig.1 show that in the case of alloys No.1,2,3 and 4 (the Fe-V and Fe-V-Mo alloys) the heat treatment had no effect on any of the investigated properties. Since no characteristic points were observed on the dilatometric curves taken on the specimens of these alloys heated and cooled at the rate of approx 2°C/minute, and since in all known cases the disorder-order transformation and the transformation leading to the formation of the K-state occur in the temperature range employed in the present investigation, the experimental results were taken to indicate that no such transformations occur in these 4 alloys. On the

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Investigation of Phase Transformations in Certain Iron-Base Alloys

other hand, the electrical resistivity of alloy No.5 (the Fe-V-Al alloy) was slightly increased after ageing which indicated a small K-state effect, caused evidently by the aluminium addition. According to Kê Tin-sui (Ref.9), the causes and the mechanism of the onset of the K-state are the same as those of the Konobeyevski-Robenski effect, known also under the name of "anabatic diffusion" (Ref.6 and 7), the only difference being that in the latter phenomenon the atomic segregation takes place in the strain field, while the K-state is associated with atomic segregation in the regions surrounding dislocations. On the other hand, Hasiguti (Ref.10) who studied "anabatic diffusion" in plastically deformed brass postulated that this effect is also caused by atomic segregation in the vicinity of dislocations. If this were true, the changes of various properties due to both effects should be the same. However, while the onset of the K-state is accompanied by an increase of both hardness and electrical resistivity, intensive "anabatic diffusion" - which also results in an increase of hardness when a

Investigation of Phase Transformations in Certain Iron-Base Alloys

plastically deformed alloy is annealed in a certain temperature range below the recrystallisation temperature - has been shown on the example of aluminium bronze (Ref.7) to cause a decrease of electrical resistivity. In order to ascertain whether the same applies in the case of other materials, and to find out whether an alloy in which no K-state is observed after quenching and ageing is free drom this effect also when annealed after having been plastically deformed, the investigated iron-base alloys, previously subjected to 40% plastic deformation, were annealed at 400 and 450°C, and the variation of their hardness and electrical resistivity (H_v and ρ) was measured, the time-dependence of these properties being reproduced graphically on Fig.2 and 3. No evidence of "anabatic diffusion" was found in the case of alloy No.1, but it was observed in alloys No.2, 3 and 4 whose H_v increased and ρ decreased during the annealing treatment. In alloy No.5, the increase of H_v was accompanied by a slight (1%) increase of ρ, which indicated that in this case the transformation from normal to the K-state had occured. It was concluded

Investigation of Phase Transformations in Certain Iron-Base Alloys

from these results that: (i) Alloys in which no transformation to K-state occurs during ageing of previously quenched specimens, are also free from this effect while being annealed after having been subjected to cold, plastic deformation. (ii) The effects of a transformation from normal to the K-state are different from those of "anabatic diffusion". (iii) In iron-base alloys which contain elements characterised by the body-centred cubic crystal lattice, and in which no elements crystallising in the face-centred cubic lattice are present, the transformation from normal to the

Investigation of Phase Transformations in Certain Iron-Base Alloys

K-state does not occur. There are 3 figures, 1 table and 11 references of which 6 are Soviet, 3 English and 2 German.

ASSOCIATION: Moskovskiy Institut Stali Imeni I.V.Stalina
(Moscow Steel Institute imeni I.V.Stalin)

SUBMITTED: 18th June 1957.

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LIVSHITS, B.G.

Reports of an Inter-vuz Conferenceon
Relaxation Phenomena in Pure Metals and Alloys
2 - 4 Apr 58, at Moscow Int. of Steel.

SOV-3-58-9-25/36

manganese and molybdenum. I.N. Chernikova (Moscow Institute of Steel), B.G. Livshits and N.G. Makhukov (Moscow Institute of Steel and Groznyy Petroleum Institute) told of processes of annealing in different alloys. Reports on the internal friction of "metastable" solid solutions were delivered by B.G. Livshits, Yu.S. Avraamov, S.O. Mezhennaya, V.B. Osvenskiy, and L.N. Belyakov (Moscow Institute of Steel). G.M. Ashmarin (Moscow Institute of Steel) reported on the temperature dependence of internal friction of iron alloys with vanadium. The reports of K. Mishek and K. Toman (Institute of Technical Physics of the Czechoslovakian Academy of Sciences, Prague), G.K. Mal'tseva and V.S. Postnikov (Kemerovo Pedagogical Institute) were devoted to the decomposition of supersaturated solid solutions. L.F. Usova (Moscow Institute of Steel), A.V. Grin', V.A. Pavlov (Institute of Physics of Metals USSR AS in Sverdlovsk), R.S. Lebedev and V.S. Postnikov (Kemerovo Pedagogical Institute), O.I. Datsko, R.I. Garber, T.T. Mogil'nikova (the latter two of the Physico-Technical Institute, UkrSSR AS in Khar'kov) and N.S. Borisov and V.M. Rozenberg (Institute for the Science of Metals and Physics of Metal TsNIIChM) delivered reports on a number of related subjects. S.O. Tsobkallo (Leningrad Polytechnical

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Vest. Vyssh. Shkoly, 9, 72-3, 1958.

AUTHORS: Avraamov, Yu. S., Livshits, B. G., Osvenskiy, V. B. SOV/48-22-10-19/23

TITLE: Modification of Structural Transformations in Permalloy During Alloying With Molybdenum (Izmeneniye strukturnykh prevrashcheniy v permalloye pri legirovanii molibdenom)

PERIODICAL: Izvestiya Akademii nauk SSSR. Seriya fizicheskaya, 1958, Vol 22, Nr 10, pp 1263 - 1268 (USSR)

ABSTRACT: On the basis of measurements of the electric resistance, of the strength, of the temperature dependence of the internal friction, and of the saturation magnetization in the present paper the nature of the structural transformations in Fe-Ni-Mo alloys was explained and the critical temperature range was exactly defined. The examined alloys are listed in the table. The information collected permits to draw the following conclusions: In the hardened solid alloy the molybdenum atoms are in the free state. For this reason under the influence of the external strains a coordination takes place without hindrance, i.e. a new orientation of the atom-pairs of molybdenum (according to the model by Siner). When the alloy is worked unto the K-state, zones

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(of the type of the Guinet (Gin'ye) - Preston zones) containing the molybdenum atoms are formed. The alloy beh .ves as if an intraphase separation had taken place in it. The molybdenum atoms in this case are no longer in the free state and therefore cannot participate in the coordination under the action of a strain. Therefore the maximum of the internal friction initially decreases and in the case of a protracted tempering completely disappears. The measurements of the internal friction showed that the molybdenum atoms in the case of the formation of the K-state apparently are removed from the solid solution. This fact proves that in solid solutions during the process of tempering zones are forming which contain the molybdenum atoms and which in their composition differ from the basic solid solution. The investigation of the temperature dependence of Young's modulus in Fe-Ni-Mo alloys showed that this modulus increases when the K-state forms. There are 5 figures, 1 table, and 11 references, 7 of which are Soviet.

Modification of Structural Transformations in Permalloy During Alloying With Molybdenum SOV/48-22-10-19/23

ASSOCIATION: Laboratoriya metallografii Moskovskogo instituta stali imeni I. V. Stalina (Laboratory of Metallography of the Moscow Institute of Steel imeni I. V. Stalin)

Card 3/3

LIVSHITS, B.G., prof., doktor tekhn. nauk; KOSSAKOVSKAYA, N.N., kand. tekhn. nauk.

Investigating the kinetics of dissociation and the heat-resistance of KhN80T alloys. Sbor. Inst. stali no.38:433-450 '58. (MIRA 11:8)

1. Kafedra metallografii Moskovskogo instituta stali im. Stalina.
(Chromium-nickel-titanium alloys--Metallography)
(Heat-resistant alloys)

PHASE I BOOK EXPLOITATION SOV/4062

Livshits, B.G., Doctor of Technical Sciences, Professor

Fizicheskiye svoystva metallov i splavov (Physical Properties of Metals and Alloys) [4th ed., rev.] Moscow, Mashgiz, 1959. 368 p. Errata slip inserted. No. of copies printed not given.

Reviewer: Ye.I. Kondorskiy, Doctor of Physics and Mathematics, Professor; Ed.: A.G. Rakhshtadt, Candidate of Technical Sciences, Docent; Managing Ed. for Literature on Metalworking and Machine-Tool Construction (Mashgiz): R.D. Beyzel'man, Engineer.

PURPOSE: This textbook is intended for students of schools of higher technical education specializing in metallurgy. It may also be useful to staff members of plant laboratories and scientific research institutes.

COVERAGE: The book deals with thermal, volumetric, magnetic, electrical, elastic, and other properties of metals and alloys. Emphasis is given to the relationship between physical properties and compo-

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sition and structure. The use of physical methods for solving problems in metallography and heat treatment of metals and alloys is also discussed. Chapter IX was written by Candidate of Technical Sciences Yu.V. Piguzov; pages 312-315 of Chapter VII were written by Candidate of Technical Sciences N.A. Solov'yeva. There are 392 references, primarily Soviet, English, and German.

TABLE OF CONTENTS:

18(3), 18(7)

AUTHORS: Wang Jun , Livshits, B. G., Usikov, M. P.

SOV/163-59-1-33/50

TITLE: Rehabilitation Phenomena After Aging in the Alloy N36KhT (Yavleniye vozvrata svoystv posle stareniya splava N36KhT)

PERIODICAL: Nauchnyye doklady vysshey shkoly. Metallurgiya, 1959, Nr 1, pp 170 - 174 (USSR)

ABSTRACT: The investigation of the non-magnetic corrosion resistant spring alloy N36KhT (Ref 1) showed that after hardening at temperatures above 900° an oversaturated solid solution was formed. A consolidation occurs if the alloy is aged afterwards. The consolidating phase is the intermediate phase of the $(Ni,Fe)_3Ti$-type with a hexagonal lattice. The electric resistance of the alloy increases in the initial stage of aging at 400-600°, and decreases at higher temperatures. This anomalous phenomenon has for the first time been discovered in Al-Cu alloys (Ref 2). The constituents of the alloy under consideration are as follows: 34.5% Ni, 12.43% Cr, 3.62% Ti, remainder Fe. The maximum increase

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of the electric resistance was found at 400-500° and a halting time of 15 hours. If aging is carried out above 600° the electric resistance decreases reaching its minimum value at 700°. The metallographic analysis showed that the consolidating phase separates only at 500° and above. Hence it appears that during aging two processes occur in the alloy N36KhT, which, however, cannot clearly be distinguished in the temperature curve. In order to determine the nature of the process at lower temperatures the influence of cold working upon the properties of the samples was investigated. The rehabilitation phenomena were investigated after aging at 400, 450 and 500°. This effect was also ascertained with the help of a dilatometer. The investigations allow to make the following statements: The aging process in the alloy N36KhT proceeds in two stages. At 400-500° it is primarily that of a formation of the K-state, whereas at temperatures above 500 ° the $(Ni, Fe)_3Ti$-phase is primarily separated. The increase of the hardness and of the electric resistance by aging at 350-550° is basically due to the K-state. This structural state is removed by cold working. An aging at 500°

after cold working leads to a rehabilitation of this state. The anomalous rise of the electric resistance due to aging at low temperatures is apparently a result of an independent process (the formation of the K-state) and not a result of the preparation for the separation of the second phase. The incomplete rehabilitation of properties indicates that by a short-term heating to high temperatures the K-state is destroyed, whereas the separations of the second phase are stable. A comparison of the results obtained in this work with earlier results (Ref 6) shows that in N36KhT the same processes occur during aging as in Invar steel alloyed with niobium. A comparison of the aging process in alloys of the Fe-Mo-, Fe-W-, and Fe-Ni-Nb systems (Refs 6,7) with that of N36KhT indicates that the rehabilitation of properties is found in such alloys, in which an anomalous modification of properties (primarily of the electric resistance) occur in the intial stage of aging, which is connected with the formation of the K-state. There are 4 figures and 7 references, 4 of which are Soviet.

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Moscow Steel Inst.
Submitted: Mar. 1958

18(3), 18(7)

AUTHORS: Livshits, B. G., Makhukov, N. G. SOV/163-59-1-34/50

TITLE: Mechanism of Structural Transformations Occurring During the Drawing of Cold-worked Alloys of the Type K40NKhM (Mekhanizm strukturnogo prevrashcheniya pri otpuske kholodnodeformirovannykh splavov tipa K40NKhM)

PERIODICAL: Nauchnyye doklady vysshey shkoly. Metallurgiya, 1959, Nr 1, pp 174-178 (USSR)

ABSTRACT: The drawing of cold-worked spring alloys of the type K40NKhM at 400-500° leads to an increase in hardness, to a rise of the proportional limit, of the electric resistance and of Young's modulus. In other papers (Refs 1, 2) the authors voiced the opinion that by drawing the temper of these alloys a K-state results. This state is characterized by the existence of segregates of homogeneous atoms of the Gin'ye-Preston zone type. By using the dilatometric method it was demonstrated that in drawing cold-worked alloys of the K40NKhM type two processes are released. They result in a reduction of the volume and of the strain coefficient. From the information gained by measurements of internal friction (Ref 1) it was assumed that the K-state in alloys of a K40NKhM type consists in the

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Mechanism of Structural Transformations Occurring During the Drawing of Cold-worked Alloys of the Type K40NKhM

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formation of segregations of molybdenum and tungsten atoms. Two alloys were investigated: the Co-Cr-Ni-Fe basis of the K40NKhM alloy, and the same basis, to which molybdenum was alloyed additionally. The investigation showed that an addition of molybdenum facilitates the formation of a K-state in the alloy, and that in this process also other atoms (probably chromium) participate. A similar influence is also exerted by molybdenum upon the elastic limit of the alloys. After drawing at 500° the elastic limit of a molybdenum alloy increases from 110 to 160 kg/mm^2. If the drawing temperature is increased the elastic limit is reduced. The data collected demonstrate that the high elastic limit of such an alloy is due to the molybdenum (and tungsten) content of the solid solution. An increase of the electric resistance, which is typical of the K-state, was found in the molybdenum alloy. In the alloy containing no molybdenum no anomalous increase of the electric resistance was found. In conclusion it is said that the improvement of the elastic properties can mainly be ascribed to

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Mechanism of Structural Transformations Occurring During the Drawing of Cold-worked Alloys of the Type K40NKhM

SOV/163-59-1-34/50

the presence of molybdenum in the alloy and that the carbon constituent plays only a minor part in the increase of Young's modulus and of the electric resistance due to drawing. There are 3 figures, 1 table, and 2 Soviet references.

ASSOCIATION: Moskovskiy institut stali (Moscow Steel Institute)

SUBMITTED: May 20, 1958

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SOV/163-59-2-42/48

18(3)
AUTHORS: Wang Jun , Livshits, B. G.

TITLE: Phenomena of Recovery Properties After Aging of the Alloys Fe-Mo and Fe-W (Yavleniye vozvrata svoystv posle stareniya splavov Fe-Mo i Fe-W)

PERIODICAL: Nauchnyye doklady vysshey shkoly. Metallurgiya, 1959, Nr 2, pp 227-232 (USSR)

ABSTRACT: The recovery of properties after aging was investigated in the systems Fe-Mo (21 and 13% Mo) and Fe-W (16 and 9% W). The samples were hardened and then tempered at different temperatures and stored for aging. The dependence of the properties of the Fe-Mo (21% Mo)- and Fe-W alloys (16% W) on the tempering temperature was investigated and the results are given in figure 1. The kinetic aging curves in the Fe-Mo alloys (12% Mo) show at 600° that the aging process proceeds in three stages; spontaneous decomposition in the case of an aging duration of 30 minutes; colloidal equilibrium after an aging of 1 - 10 hours and coalescence after an aging duration of more than 10 hours. The change of the properties in Fe-Mo alloys in the case of heating below 400° is given in figure 4. The alloy of the system Fe-W (16% W)

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shows that no recovery of the properties after the aging at a tempering temperature of 600° and in the case of further heating up to 800° (Fig 5). The aging in the alloys Fe-Mo and Fe-W has the same character. The change in the properties of the alloys of the two systems is connected with the occurrence of a second phase. There are 5 figures and 10 references, 6 of which are Soviet.

ASSOCIATION: Moskovskiy institut stali (Moscow Steel Institute)

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AUTHORS: Livshits, B.G. and Makhukov, N.G.

TITLE: Investigation of the Tempering Process of the Cold Deformed Alloy K40NKhM

PERIODICAL: Fizika metallov i metallovedeniye, 1959, Vol 8, Nr 3, pp 400-405 (USSR)

ABSTRACT: The alloy K40NKhM has a complex chemical composition with the system Co-Cr-Ni-Fe as its basis. Borodkina, Makhukov and Sol'ts have shown (Ref 1 and 2) that the alloy, as quenched from a temperature of 1100 to 1150°C, possesses a one-phase structure with a face-centred cubic lattice. On cold working by rolling or wire-drawing, followed by tempering at 400 to 500°C, the alloy acquires high elastic properties, strength and hardness. Fig 1 shows the change in hardness, elastic limit and electrical resistance of a K40NKhM alloy, containing 0.05% C, on tempering (soaking for 2 to 4 hours) after a 70% cold deformation. The authors of this paper undertook an investigation of this alloy with the aim of establishing the mechanism of hardening during tempering. The chemical composition of the alloys investigated is given in the table on p 401. In Fig 2, the % elongation and the true

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...soaking) on the magnitude

Investigation of the Tempering Process of the Cold Deformed Alloy K4ONKhM

of the peak of internal friction of K4ONKhM alloys of the following carbon contents: a - 0.12%, b - 0.05%. B - 0.015%. (State of the alloys before tempering: 1 - deformed 70%, 2 - deformed 30%, 3 - water quenched from 1100°C.) The authors arrive at the following conclusions: 1. Two independent processes take place during tempering in cold worked K4ONKhM type alloys. One of them occurs preferentially in the temperature range 300 to 350°C and probably leads to the formation of atomic segregations of the Guinier-Preston zone type (K-state). The second process occurs preferentially in the temperature range 550 to 700°C and leads to the precipitation of a second phase from the solid solution as well as to an acceleration of relaxation and recrystallization. 2. The low temperature process is accompanied by increase in hardness, elastic limit, modulus of elasticity and electric resistance and by a decrease in volume and the true coefficient of expansion of the alloy. 3. In a homogeneous solid solution (after deformation) of alloys of the K4ONKhM type, containing

Investigation of the Tempering Process of the Cold Deformed Alloy E4ONKhM

atoms of metallic components of different diameter and carbon atoms, a peak appears on the curve $Q^{-1}(T)$ for internal friction at 300 to 350°C. This peak is due to the relative displacement of carbon atoms and atoms of large atomic diameter (Mo, W). 4. The magnitude of the internal friction peak increases with increase in carbon concentration and degree of deformation. 5. The segregation of Mo and W atoms is the reason for the decrease in the magnitude of the internal friction peak on tempering after cold working. This enables the process of the K-state formation to be studied by the internal friction method. In such an investigation C serves as an indicator for the formation of segregation of the constituent metal atoms. There are 8 figures, 1 table and 12 references, 9 of which are Soviet, 2 German and 1 English.

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AUTHORS: Livshits, B.G., Avraamov, Yu.S., Osvenskiy, V.B., Mezhennaya, S.O. and Belyakov, L.N.

TITLE: Internal Friction of Metastable Solid Solutions

PERIODICAL: Fizika metallov i metallovedeniye, 1959, Vol 8, Nr 3, pp 440-448 (USSR)

ABSTRACT: The alloy of stoichiometric composition Ni_3Mn and alloys of the same composition alloyed with 1.34 and 2.77% Mo, respectively, were studied by measuring the temperature dependence of internal friction. Using this method, Ni_3Fe type alloys without molybdenum and those alloyed with molybdenum, and also EI437A type alloys (nimonic) were studied. The chemical composition of the investigated alloys is shown in the table on p 441. The internal friction was measured in wire specimens, 300 mm long and 0.7 mm diameter, in vacuum. The alloy Ni_3Mn is an ordered alloy with a Curie point of approximately 350°C (Ref 10 and 11). In the curve showing the temperature dependence of internal friction of a quenched Ni_3Mn alloy (quenched from a temperature above that at which ordering occurs) two peaks, A and B, with maxima at 120 and 290°C are observed (Fig 1). In the curve of the temperature

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Internal Friction of Metastable Solid Solutions

dependence of internal friction of a deformed Ni_3Mn alloy (75% deformation), the peaks A and B remain and an additional peak, D, having a maximum at 226°C, appears; the general level of internal friction rises sharply (Fig 2). An additional peak, C, having a maximum at 316°C, is evident in a carburized Ni_3Mn alloy containing 0.35% C (Fig 3). The appearance of this peak is due to the diffusion of carbon atoms in the elastic stress range. During the investigation of the influence of alloying the Ni_3Mn solid solution with molybdenum, it was found that supplementary maxima - peaks M and C at 52 and 316°C - appeared in temperature dependence of internal friction curves (Fig 4). In Fig 5, the influence of heat treatment on the temperature dependence of a Ni_3Mn alloy containing 1.34% Mo is shown. A similar result is obtained with an alloy containing 2.77% Mo. On measuring the internal friction of Ni_3Fe alloys alloyed with Mo (Fig 6) two peaks were obtained in the low temperature range, one in the region of 85°C (peak A) and the other at 170°C (peak B). Fig 7 shows the influence of heat treatment on the temperature dependence of internal

friction of the alloy Ni_3Fe. Fig 8 shows the influence of heat treatment on the internal friction of a nimonic alloy. In Fig 9, the change in internal friction with Ti content in a nimonic alloy is shown. The authors conclude that on measuring the temperature dependence of internal friction of metastable solid solutions characteristic effects can be expected even when the structural factor is exceedingly small. The magnitude of the effects in this case must be the greater, the greater the difference in free energy between a quenched and tempered alloy. A comparison of the internal friction of ordering alloys with that of alloys forming a K-state structure at low temperatures is exceedingly interesting (see Fig 4 and 6). On adding molybdenum to ordering alloys (Ni_3Mn) the metastability peak decreases as molybdenum decreases the degree of possible order. Conversely on adding this element to K-state alloys (Ni_3Fe + Mo) the metastability peak increases, as the increase in molybdenum concentration appears to increase the extent of atom segregation (K-state) in the solution. The same can be said about titanium in the alloy EI437

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(Fig 9). Thus measurement of the internal friction (metastability peaks) renders differentiation between ordering and K-state possible. There are 9 figures, 1 table and 19 references, 12 of which are Soviet and 7 Western.

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PHASE I BOOK EXPLOITATION SOV/4248

Livshits, Boris Grigor'yevich, and Vladimir Sergeyevich L'vov

Vysokokoertsitivnyye splavy na zhelezonikel'alyuminiyevoy osnove (Highly Coercive Iron-Nickel-Aluminum Base Alloys), Moscow, Metallurgizdat, 1960. 157 p. Errata slip inserted. 3,200 copies printed.

Ed.: Yu. F. Avraamov; Ed. of Publishing House: A.L. Ozeretskaya; Tech. Ed.: L.V. Dobuzhinskaya.

PURPOSE: This book is intended for physicists specializing in magnetometry and physical metallurgists studying problems of structural transformations and physical properties of highly coercive alloys.

COVERAGE: The book deals with the present state of knowledge of highly coercive iron-nickel-aluminum-base alloys according to Soviet and non-Soviet data and the basic scientific problems involved in the achievement of high magnetic properties for these alloys. The topics discussed include the phase equilibrium of ternary and more complex systems based on iron-nickel-aluminum alloys,

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the kinetics of phase transformations and the fundamentals of heat treatment. Data on the effect of alloying elements on magnetic and other properties of iron-nickel-aluminum-base alloys are presented. Examples of the utilization of the alloys in manufacturing and the results of a statistical analysis of magnetic properties under conditions of mass production are given. No personalities are mentioned. There are 123 references: 68 Soviet, 38 English, 17 German.

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