Mines Branch Information Circular IC 300

ROLL COMPACTION OF METAL POWDERS
BIBLIOGRAPHY FOR PERIOD 1900 TO 1972

by

J. A. Strasser*

- - - - - - - -

AUTHOR'S PREFACE

The references used in this bibliography have been collected from many sources such as metallurgical abstracts and Metal Powder Report. The references are grouped into yearly divisions and each year is arranged alphabetically by senior author. Annotated references have been inserted wherever possible to assist the reader in determining the value of the publication for his individual needs. Patents are included in the bibliography in the year that the application for patent was made by the inventor.

Several references are included in the bibliography which do not deal directly with the roll compaction of metal powders. These references are cited to provide the reader with a more complete insight into the relevant factors involved in the roll compaction process.

---

*Research Scientist, Nuclear and Powder Metallurgy Section, Physical Metallurgy Division, Mines Branch, Department of Energy, Mines and Resources, Ottawa, Canada.

Direction des mines
Circulaire d'information IC 300

LE LAMINAGE (COMPACTION) DES POUDRES MÉTALLIQUES

UNE BIBLIOGRAPHIE DE LA PÉRIODE DE 1900 À 1972

par
J. A. Strasser*

AVANT-PROPOS

L'auteur a rassemblé les références utilisées dans cette bibliographie de plusieurs sources telles que les résumés métallurgiques et les Rapports de poudre métallique. Il a groupé les références par divisions annuelles et chaque année, les références sont classifiées alphabétiquement par auteur principal. L'auteur a inséré les références avec commentaire à l'occasion pour aider au lecteur à déterminer la valeur de la publication pour ses besoins particuliers. Il a inclus les brevets d'invention et l'année de la demande du brevet d'invention.

L'auteur a aussi inclus plusieurs références dans la bibliographie qui ne traitent pas directement du laminage (compaction) des poudres métalliques. Il a cité ces références pour donner au lecteur une connaissance plus complète des facteurs pertinents et compris dans le procédé de laminage (compaction).

---

*Chercheur scientifique, Section de la métallurgie nucléaire et des poudres, Division de la métallurgie physique, Direction des mines, ministère de l'Énergie, des Mines et des Ressources, Ottawa, Canada.

TABLE OF CONTENTS

INTRODUCTION

The technical and commercial development of powder metallurgy has increased substantially in the past several decades. The major reasons for the increased interest in the use of metal powders has been the reduction in their cost of manufacture and the improvements in the properties of the product. Roll compaction of metal powders represents one of the newer techniques for the compaction of metal powders and, although the general concept of the rolling of powder particles originated over one hundred years ago, most of the research done to determine the parameters involved in powder rolling has been within the last quarter century.

The roll compaction of metal powders offers an alternative to the conventional methods of strip production and the advantages of powder rolling can be both economical and technical. In an economic consideration, the process is attractive if the cost of metal powders is low, if conventional methods lead to high scrap losses, or if these same methods require too much capital. From a technical viewpoint, roll compaction of powders is desirable because the process lends itself to the preparation of materials that are difficult or impossible to make by other methods. Brittle alloys, bimetallic and clad strip, composite materials such as graphitized bronze sheet, multilayer sheet, and neutron-absorbing materials for atomic energy applications are some of the products which are being investigated for possible production by rolling of powder particles. The process is especially advantageous for alloys such as tin, bronze, and stainless steel which work-harden readily and, therefore, need fewer passes to produce strip or sheet. Roll compaction of the metal powder may be ideal for low-melting-point materials which are very reactive (eliminated by sintering in vacuum or inert atmosphere) and difficult to produce by conventional methods.

Although about one third of the total output of alloys and the four base metals - copper, brass, aluminum, and steel - is in the form of strip, the roll compaction of these metal powders is not on the industrial scale that was envisioned in the early research stages of the field. There are many factors contributing to this situation but it becomes apparent that the process does not readily lend itself to the production of either wide or thick strips and becomes uneconomical when the cost of powder is high and when either

long sintering times or high sintering temperatures are needed to achieve a high-quality strip.

This survey was conducted with a view to providing a base for the extensive research in the Physical Metallurgy Division directed to improving the technical and economic factors bearing on the increased utilization of Canadian-produced metal powders, with respect to both process technology and product quality.

1900-1949

1902 - 1. Siemens U. and Halske A. G.; Patent (German) 154,998.

This patent was the actual starting point for the serious consideration of the roll compaction of metal powders. A method for compacting powders of high-melting-point metals by feeding the particles between two rolls whose axes are in the same horizontal plane is suggested.

1905 - 2. Bessemer, Sir Henry, F.R.S.; Autobiography, Engineering, page 68, London, 1905.

The start, by accident, of the rolling of metal powders in 1843 is reported. Bessemer, attempting to produce powder, inadvertently turned brass turnings into a solid sheet of brass by rolling the turnings.

1909 - 3. Patent (U.S.A.) 936,403.

1927 - 4. Short, C. R.; Method of Compressing Powdered Materials; Patent (U.S.A.) 1930, 287 (21/12/27

A method of making porous metallic bodies by feeding powdered materials to a conveyor which carries the powder between compacting rolls is described.

1933 - 5. Hardy, Charles; Patent (U.S.A.) 2,134,366 (1933).

The rolling of powders transported through the rolls by a carrier is described.

1936 - 6. Calkins, W. G. and A. J. Langhammer; Bearing Manufacture; Patent (U.S.A.) 2,178,529 (1/5/36).

A method is suggested which provides for the formation of sheet stock for bearing material by the roll compaction of metal powders.

1940 - 7. Jevons, J. D.; The Metallurgy of Deep Drawing and Pressing; page 480, Chapman and Hall, London, 1940.

The results of tear-length tests done on electrolytic and atomized copper strips made by powder rolling indicated that the rolled strips were anisotropic in the thickness range between 0.025 and 0.035 inch.

1941 - 8. Marvin, John T.; Method and Apparatus for Briquetting of Powdered Metal; Patent (U.S.A.) 2,341,732 (4/4/1941).

Roll and hopper arrangements are suggested which provide for the rolling of metal powders using one hopper, two hoppers with powder feed to the rolls from opposite directions, inclined rolls, and for the rolling of multilayer strip.

1941 - 9. Nadai, A. and M. J. Monjoine; Journal Applied Mechanics, 8, A82, 1941.

1946 - 10. Patent (U.K.) 624,424 (15/2/46).

A compacting mill with rolls arranged with axes in the same horizontal plane is proposed for the production of bar stock and rod.

1949 - 11. Long, J. R. and E. G. Hayes; Investigation Report No. 4464, Bureau of Mines, U.S.A., 1949.

The rolling of Ti powder and the fabrication of Ti products is described with particular emphasis on the sheath rolling of the metal.

1950

1950 - 12. Franssen, H.; Stahl und Eisen, Vol. 70, No. 1003, 1950 (discussion).

13. Naeser, G. and F. Zirm; Rolling of Strip from Iron Powder; Stahl und Eisen, Vol. 70, pages 995 to 1004, 1950. (see also references 18, 23.)

An investigation by the authors of the cold-rolling of atomized Fe powder and bronze powder is described. Self-regulated compaction occurred when the powders were gravity-fed through rolls with appropriate gap and roll speed. A rolling test developed by the authors is suggested as a valid method for determining the suitability of powder for metal part production.

14. Patent (U.K.) 702,920 (2/3/50.)

The effect of wetting the rolls on the thickness of strip produced is described.

15. Pavlov, I. M.; Theory of Rolling; Metallurgizdat, Moscow, 1950. In Russian.

A method for calculating the density of raw strips rolled from metal powders is given.

1951

1951 - 16. Aksenov, G. I. and Pyryalov, L. A.; Proceedings of the All Union Inter-University Conference on Powder Metallurgy, Kubyshev, 1951.

17. Leadbeater, C. J., L. Northcott and F. Hargreaves; Powder Metallurgy; Selected Government Research Reports, Vol. 9, H. M. Stationery Office, London, 1951.

The relationship of the powder flow in the hopper to the area of the aperture and the inclination of the bottom of the hopper to the horizontal plane is discussed.

18. Naeser, G. and F. Zirm; Metal Progress, Vol. 59, No. 4, page 586, April 1951. (see also references 13, 23.)

19. Patent (German) 939,241 (19/3/51).

The design of a feed-apparatus for powder rolling is proposed.

20. Patent (German Application Number F5408 (15/1/51). Withdrawn.

The "split-sintering' technique is proposed as a method for the production of razor-blade strip from sintered carbide.

21. Pearson, B. M.; Steel Strip Experimentally Rolled from Metal Powder - Parts I and II; Iron Age, Vol. 167, No. 5, pages 110 to 114; No. 7, pages 95 to 99, February 1951.

The relationship between powder composition and the properties of the rolled strip product is discussed as it applies to roll-formed steel and non-ferrous alloy strip. An analysis is presented of the effect of roll velocity and clearance, compacting pressure, sintering and annealing.

1952

1952 - 22. Franssen, H.; Metall, Vol. 6, No. 15/16, pages 444 to 445, 1952.

An investigation at the Sundwiger Messingwerke A. G. on bronze and brass strip rolled from powder and sintered in an operation synchronized by means of photocells is reported.

23. Naeser, G.; 4th International Mechanical Engineering Congress, Stockholm, 1952, 13 pp. (see also references 13, 18.)

The roll compacting, sintering and subsequent cold and hot rolling of Fe powders is discussed. The properties of Cu, Fe and brass strip made from metal powders are given.

1953

1953 - 24. Evans, P.; U. K. Provisional Patent No. 34541, 1953.

The use of a standard two-high rolling mill for the roll compaction of metal powders is described.

25. Franssen, H.; Manufacture of Semis by Powder Metallurgy and Their Application; Konstruktion, Vol. 5, No. 4, pages 111 to 117, 1953.

A review of the rolling techniques for metal powder compaction is presented.

26. Kolerov, A. A.; New Investigations of Metal Deformation during Rolling; Mashgiz, 1953.

27. Patent (German) Application No. M18,078, (9/4/53).

The grooving of rolls for the compaction of metal powders to avoid variable density zones is discussed.

28. Vambersky, A.; Hutnicke Listy, Vol. 8, No. 5, pages 235 to 241, 1953.

The hot-rolling, between 950 and 1000°C, of a sintered matrix 29% Ni, 17% Co, 54% Fe) prepared from metal powders is described.

1954

1954 - 29. Aksenov, G. I. (Zhdanov Polytechnic Institute); Poroshkovaya Metallurgiya, Metallurgizdat, Moscow, pages 160 to 166, 1954.

A description is given of the first successful experiment in powder rolling in the U.S.S.R., in 1948, and later experiments to 1954 are discussed. A theory is presented which attempts to quantitatively describe the powder-rolling process and a diagram is included from which the rolling conditions of various powders can be determined. An attempt is made to determine the relationship between strip thickness, roll diameter, and the ratio of strip density to powder density.

30. Aksenov, G. I.; Rolling of Strips from Metal Powders; Trudy VNITOM, 1954. (See also reference 31.)

A formula is derived from Pavlov's earlier formula (1950) for the density of raw strips rolled from powders.

31. Aksenov, G. I.; The Rolling of Metal Powder Strip; Collection: Powder Metallurgy, VSNITO, 1954. In Russian. (See also reference 30.)

32. Evans, P. E. and G. C. Smith; The Continuous Compacting of Metal Powders; Symposium on Powder Metallurgy, Iron and Steel Institute, London, 1954.

A short survey of the previous work done in the roll compaction of metal powders is followed by a description of the author's apparatus (two-high rolling mill) and procedure for the rolling of electrolytic copper powder. The effect of various roll parameters on the properties of the strip product is described.

33. Forward, F. A.; Bulletin Institute of Metals, Vol. 2, page 113, 1954.

34. Franssen. H.; The Production of Copper Strip by Means of Powder Metallurgy; Zhurnal fur Metallkunde, Vol. 45, No. 6, pages 328 to 331, 1954.

The production of Cu ribbon by the roll compaction of the powder is described. A method for testing the uniformity of the strip is described.

35. Franssen, H.; The Production of Powder Metal Products by Rolling and the Industrial Prospects of the Process; Metall, Vol. 8, No. 9/10, pages 365 to 368, 1954.

A review of the early attempts at powder rolling is presented and the new possibilities for the process are discussed.

1954 - 36. Gershteyn, L. I. and Yu. N. Semenov; Student Thesis (L. I. Gershteyn); Trudy Gorkovskoyo Politekhnicheskogo Instituta, 1954.

A report is given on the investigation to determine whether a strip could be produced from iron powder which would have magnetic properties that would satisfy the condition of the All-Union Government Standard 3836-47 on low-carbon sheet steel for transformers.

37. Jones, W. D.; The Manufacture of Sheet Metals from Metal Powders; Proceedings Metal Powders Association, 10th Meeting, Pages 60 to 67, 1954; American Machinist, Vol. 98, pages 142 to 144, 1954; Metal Treatment and Drop Forging, Vol. 21, No. 102, pages 421 to 424, 1954.

The history of the rolling of metal powders and a detailed description of the process is given by the author. A discussion is included at the conclusion of the paper.

38. Khromov, V. G.; Rolling and Heat Treatment in the Production of Titanium Powder Strip; Abstract of Dissertation, 1954. In Russian.

39. Mannesmann Aktiengesellschaft, Dusseldorf, Germany; Improvements in or Relating to Processes and Mills for Rolling Metal Powders; Patent (U. K.) 751,254 (19/3/54).

A method for rolling metal powders, especially iron, is proposed.

40. Metal Treatment and Drop Forging; Vol. 21, No. 104, pages 215 to 223, 1954.

The results of an investigation into the continuous compacting of metal powders at the University of Cambridge is given in this report. The effect of compacting and sintering variables upon the properties of the roll strip are reported.

41. National Research Development Corporation, London; Patent (U. K.) 798,793 (23/11/54).

A method is suggested for the roll compaction of powders which are heated prior to entry into the roll gap. The advantages of using heated powders are discussed.

42. Nussbaum, A. I.; A Combination Mill for Experimental Rolling of the "new" Metals; Metal Progress, Vol. 65, No. 4, page 121, 1954.

A description is given of the two-high and four-high combination mill which was developed to produce the widest range of bar, strip, and rod reduction while hot and cold rolling Ta, Nb, Mo, W, and V metal powders.

1954 - 43. Patent (German) 1,013,798, 1954.

A ratio of 50:1 for strip thickness: roll diameter is indicated for successful production of strip.

44. Patent (U.K.) 773,375 (10/9/54).

A device which can be incorporated in the powder feed unit to overcome cupping and frilling of strip is suggested.

45. Patent (U.S.S.R.) 107,525 (1954).

46. Shaw, J. D.; Copper Sidesteps the Crucible; Steel, Vol. 135, No. 25, pages 76 to 77, December 1954.

The production of Cu strip by the roll compaction of the metal powder is discussed. The use of roll compaction for the production of fine wire is suggested.

47. Storchheim, S., J. Nylin and B. Sprissler (Sylvania Electric Products, Inc.); U. S. Atomic Energy Commission Publication, SEP-161; July 1954, 55 pp.

A report is given of the investigation carried out in the above laboratories on the effect of various rolling variables, sintering conditions and post sintering operations on the properties of stainless steel strip.

48. Vacek, J.; Pokroky Praskove Met., Sbornik konf., Brno, 1953, pages 268 to 274, 1954.

The rolling of heated Mo and W metal powders is described.

1955

1955 - 49. Aksenov, G. I. and A. N. Nikolaev; Poroshkovaya Metallurgiya, 2M, pages 54 to 58, 1955.

It is reported that, in the rolling of metal powder, a forward flow of metal powder (1 to 1.5%) is accompanied by either a lag or sliding. The effect of these regions on the properties of the rolled product is discussed.

50. Aksenov, G. I., A. I. Nikolaev and Yu. I. Semenov; Problems of Powder Metallurgy, No. 2, Kiev, 1955. In Russian.

51. Anonymous; Continuous Compacting of Metal Powder; The Engineer, Vol. 199, No. 5168, page 215, 1955.

An account is given of a process developed for the roll-bonding of non-ferrous powders into sheet, strip, rod, and wire. Powder is compacted between rolls and the porous strip is sintered, re-rolled and annealed to yield a product which has properties similar to those of conventional rolled materials.

52. Evans, P. E.; Patent (U. K.) 776,544 (1955).

A feed apparatus for cold rolling of metal powders is described.

53. Evans, P. E. and G. C. Smith; The Continuous Compacting of Metal Powders; Sheet Metal Industries, Vol. 32, pages 589 to 592, 1955.

A comparison is given of the data obtained by the authors for the rolling variables involved in the composition of metal powders to those of previous workers, notably that of Naeser and Zirm in Germany.

54. Franssen, H.; Metal Industries, 86, 227, 1955.

The coiling of green strip to enable sintering in batch form is advocated.

55. Hausner, Henry H.: Powder Metallurgy - Its Rapid Development; Metal Progress, pages 101 to 105, September 1955.

The rolling of metal powders is discussed as one of the new techniques for the compaction of metal powders.

56. Heck, F.; Improvements Relating to the Rolling of Metallic Powder; Patent (U.K.) 771,630 (22/2/55).

A modified form of the known type of rolling mill is proposed.

1955 - 57. Nikolaev, A. N.; Izvest. Vysshikh Ucheb. Zavedenii Chernaya Met., No. 2, pages 113 to 121, 1955.

A description is given of the basic principles involved in the roll compaction of metal powders. The effect of powder chemistry, applied pressure and other variables on the properties of the rolled strip are discussed.

58. Nucleonics; Powder Metallurgy Makes Better Reactor Fuels and Components; Vol. 13, No. 127, pages 24 to 26, 1955.

The possible use of roll compaction of metal powders for the production of fueld elements is discussed.

59. Patent (U.K.) 36,066 (15/2/55).

A description of a feed apparatus for powder rolling is given.

60. Patent (U.K.) 21,030 (20/7/55).

The split-sintering technique is proposed as a method for imparting ductility to metal powders before rolling.

61. Shaw, J. D. and W. V. Knopp; Presented at AIME (New York), December 1955.

The advantages of powder rolling over conventional methods of compaction is discussed. The effect of cheaper methods of raw powder production on the industrial conception of roll compaction of metal powders is analyzed. The properties of various rolled products are given.

62. Storchheim, S., J. Nylin and B. Sprissler; Rolling of 18-8 Stainless Steel Powder into Strip; Sylvania Technologist, Vol. 8, pages 42 to 44, April 1955. (see also Reference 47.)

A summary is given of the procedures used by the authors in the rolling of stainless steel powders into strip. The properties of the rolled product are given.

63. Vinogradov, G. A.; Author's Certificates No. 111743, 115055, 1955.

A report on the possible use of roll-compacted powder for compensation linings when soldering hard-alloy plates on a tool.

64. Work, L. T., J. D. Shaw and W. V. Knopp; Rolled Metal Powder Sheet; Metal Progress, Vol. 68, No. 4, pages 115 to 116, 1955.

Copper strip of high quality was produced from roll-bonded Cu powder. A tensile strength of 40,000 psi and an elongation of 30% are reported.

1956

1956 - 65. Aksenov, G. I. and A. N. Nikolaev; Trudy Gorkovskogo Politekhnicheskogo Instituta, Vol. 11, No. 5, pages 22 to 26, 1956.

The theories previously published on the angle of grip of metal powders by the rolls are examined. A new equation, based on the author's investigation, is suggested which involves the coefficient of friction, the Poisson ratio of the metal and the relative density of the powder. The application of this angle of grip equation to one Cu and three Fe powders is given.

66. Blagin, V. I., M. G. Yefimov, Yu. N. Semenov and A. Sh. Christopol; Mechanical Properties and Wear Resistance of Articles from Iron Powder of Ministry of Ferrous Metallurgy Plant; Poroshkovaya Metallurgiya Collection, izd. Yaroslavskaga NTO, Mashprom, 1956.

A report is given of the use of strip prepared by the direct roll compaction of the powder for bearing liners.

67. Engineer, The; Roll Compacting of Powdered Metals, Vol. 202, No. 5243, pages 104 to 105, July 1956.

The application and economic considerations of powder rolling are examined. The influence of various parameters such as rolling apparatus, sintering time and temperature, on the properties of rolled stainless steel powder are noted.

68. Evans, P. E.; The Continuous Compacting of Metal Powders; Ph.D. Dissertation, Cambridge University, 1956. (see also Reference 53, 32).

A complete account of the roll-compaction of Cu powders is presented.

69. Evans, P. E. and G. C. Smith; Iron Steel Institute, London, Special Report No. 58, pages 131 to 136, 1956. See also Reference 68, 53, 32).

A publication of the paper presented by the authors at the 1954 Symposium on Powder Metallurgy, held in England is given. The effect of rolling and sintering variables on the tensile strength, microhardness, and structure of direct rolled electrolytic Cu powder is discussed.

70. Heck, F.; Patent (U.K.) 812,169 (20/4/56).

Discs, which are free to move in the axial direction of the rolls, are used to close the roll gap to ensure the densification of the strip and the regularity of the edges of the rolled strip.

1956 - 71. Heck, F.: Devices for the Rolling of Strip from Metal Powder; Patent (U.K.) 2,904,829 (30/4/56).

A method is proposed in which discs projecting beyond the edge of the rolls are provided for the lateral limitation of the width of the material. It is suggested that the discs will assist in rolling edges of strip which are uniformly dense.

72. Heck, F.: Patent (U.K.) 792,890 (6/5/56).

The guiding of Cu strip solely by varying the thickness of the roll gap at opposite ends while holding the gap constant in the middle is proposed.

73. Heck, F.; Patent (U.K.) 810,678 (26/6/56).

Green Cu strip is coiled into separate bundles which are uncoiled and passed through a continuous furnace for sintering and then hot-rolled at 700-900°C.

74. Hoar, T. P.; Discussion paper of P. E. Evans and G. C. Smith in Special Report No. 58, Symposium on Powder Metallurgy, Iron and Steel Institute, London (1954), 1956, page 345.

75. Industrial Laboratories; Rolling Metal Powder into Strip; September 1956, 3 pp.

76. Metallurgia; Sheath-Working of Metal Powders; Vol. 53, No. 315, pages 31 to 33, 1956.

The hot-rolling of Ti powders in a closed Fe sheath is described.

77. Mond Nickel Company, Ltd., Thames House, Millbank, London, S.W. 1; Improvements Relating to the Manufacture of Alloy Strip; Patent (U.K.) 829,640 (6/7/56).

A method for the production of alloy strip by the roll-compaction of metal powders is given.

78. Nussbaum, R. I.: Iron and Steel Engineer, Vol. 33, No. 11, 1956.

An account is given of the rolling of radioactive materials in a rolling mill equipped with remote control.

79. Patent (German) 19,623 (15/6/56). (see reference 60.)

This is a modification of Patent 21,030 (1955). The use of split-sintering techniques to produce ductility in a metal powder before rolling is discussed.

1956 - 80. Patent (U.K.) 16,610 (29/5/56).

A design for a feed apparatus for powder rolling is explained.

81. Patent (U.K.) Application No. 23,998 (3/8/56).

The replacement of the air in metal powder agglomerates with a lower velocity gas, such as hydrogen, to facilitate the rolling of metal powders is reported.

82. Patent (U.K.) Application No. 28,425 (17/9/56) and Application No. 34,585 (12/11/56).

The production of composite neutron-absorbing materials for atomic energy applications from powder rolled metal powders is described.

83. Storchheim, S.; Metal Powder Rolling - A New Fabrication Technique; Metal Progress, Vol. 70, No. 3, pages 120 to 126, 1956.

The influence of rolling variables such as powder feed, diameter of rolls, width of roll opening, roll speed, and average particle size of the powder is discussed. Some data on the properties of rolled U and hot-rolled Al strip is given.

1957

1957 - 84. Agte, C. and K. Octek; Metallfilter, Berlin 1957, see also Metallokeramicheskiye fil'try (Cermet Filters). Sudpromgiz, 1959.

The possible use of silver strip prepared by the direct roll compaction of the powder for filters and electrodes of accumulators is suggested.

85. Aksenov, G. I. and A. N. Nikolaev; Referativnyi Zhurnal Met., 2M, pages 54 to 58, 1955; No. 5, 7806, 1957.

The forward flow and sliding of metal powders is discussed. The relationship of these areas to the volume of powder compressed is theorized.

86. Aksenov, G. I. and Yu. N. Semenov; Rolling of Metal Powders in Rolls; Moscow, Metallurgizdat, 1957. In Russian.

87. Evans, P. E.; Method for the Continuous Compacting of Powdered Metallic Materials; Patent (U.K.) 776,544, 1957.

88. Hayden, W. N., J. D. Shaw and W. V. Knopp; Metal Powders to Solid Strip - Present Status of Commercial Production; Presented at Metal Powder Association - American Society for Metals Symposium, November 1957. (see also references 99, 112).

89. Iron Age; Powder Metal is Ready to Roll; Vol. 179, No. 19, page 76, May 1957.

A description is given of a U.S. plant which will be used for the roll compaction of Cu powders produced by hydrometallurgical processes.

90. Iron Age; New Process Makes Rolled Steel Directly from Pig Iron; pages 97 to 99, June 1957.

A description is given of the Stora-Powder Steel Process for converting pig iron to rolled steel.

91. Kalling, B., S. Eketorp and S. Backstrom; Sweden: Iron Powder to Rolled Steel in One Operation; Journal of Metals, Vol. 9, No. 11, pages 1440 to 1444, 1957: Jernkontorets Ann., Vol. 141, No. 6, pages 317 to 331, 1957: Iron Age, Vol. 179, No. 26, pages 97 to 100, 1957. (see also reference 90.)

The direct rolling at 1100°C of a mixture of pig iron powder and 15% iron ore concentrate packed into a box of thin steel is described.

1957 - 92. Metal Bulletin (London); No. 4221, page 22, August 1957.

The production of strip, tube and other products from Cu, Ni and Ti powders at the E. W. Beiss Co., U.S.A. is described. The strip produced is compared favourably to that made by conventional rolling.

93. Metal Progress; New Horizons in Powder Metallurgy; page 95, July 1957.

94. Morden, J. F. C.; Powder Metallurgy - VI; Metal Industry, pages 23 to 25, January 1957.

95. Naeser, G., (Mannesmann A.G., Dusseldorf); Patent (German) 1.005.812 (12/9/57).

A modification of the standard powder-rolling process from roll compaction for further processing as wire is reported. The modification occurs in the powder container arrangement which, in the process, provides holes rather than a continuous slit which yields the "string" effect.

96. Nucleonics; Vol. 15, No. 1, page 108, 1957.

A vertical rolling mill which takes metal powder from a hopper located above the rolls and delivers a compacted strip is described.

97. Perry, D. A.; Doctoral Dissertation, Rensselaer Polytechnic Institute, U.S.A., 1956, 119 pp; Dissertation Abstracts, Vol. 17, No. 1, page 124, January 1957.

A method for the fabrication of a porous stainless steel sheet with a controlled permeability by powder rolling in a conventional two-high rolling mill is developed. Operating variables are related to sheet thickness, porosity and permeability and some of the physical properties of rolled strip are given.

98. Richards, C. E.; Electrical Manufacturing Company, 60, pages 104 to 109, 1957.

The production of magnetic alloy strip by sintering mixed powder and cold-rolling the billets is described.

99. Shaw, J. D. and W. V. Knopp; Current Developments in the Rolling of Both Ferrous and Non-Ferrous Powders; Metal Powder Association: Proceedings Thirteenth Annual Meeting, Chicago, April 30 to May 1, pages 33 to 41, 1957. (see also references 88, 112.)

The history of powder rolling is traced and the rolling operation and operational variables are given. The influence of roll speed is examined and the properties of seven roll-compacted powders are cited. The future of powder rolling is discussed.

1957 - 100. Storchheim, S.; U. S. Atomic Energy Commission, SEP-146; 1957.

The preliminary results of the rolling of various metal powders, especially Al, are given.

101. Sump, Cord H.; New Horizons in Powder Metallurgy; Metal Progress, page 95, July 1957.

The roll compaction of metal powders is discussed.

102. Times Rev. Ind.; Remote-Control Mill for Reactor Metals; Vol. 11, No. 124, 1957.

A rolling mill equipped with remote control is suggested for use when rolling radio-active materials for nuclear applications.

1958

1958 - 103. Aksenov, G. I., V. G. Khromov, A. N. Nikolaev, and Yu. N. Semenov; Collection: Titanium and Its Alloys; Vol. 2, Izd. ANSSR, 1958.

104. Aksenov, G. I. and Yu. N. Semenov; Production of Cermet Strip Rolling Powder; Proceedings of Trudy Gorkovskovo Politechnicheskogo Instituta, Vol. 14, No. 2, 1958.

105. Aksenov, G. I., Yu. N. Semenov, L. I. Gershtein and A. M. Yuferov, Author's Certificate; Patent 105, 704 (11/8/58).

106. Bradbury, E. J. et al.; Proceedings U.N. International Conference on Peaceful Uses of Atomic Energy, Geneva, 5, 382, 1958.

The continuous rolling of pre-mixed powders of Al/B_4C and Ti/Gd_2O_3 to produce sheet and strip is described.

107. Buescher, W. E.; Using Nickel Strip with Tailored Properties; Materials in Design Engineering, page 160, 1958.

108. Chekmarev, A. P. and P. A. Klimenko; Nauch. Doklady Vysshei Shkoly, Metallurgiya, 1958.

The construction of a dynamometer is described and a procedure for determining the specific friction force and the coefficient of friction during rolling is outlined.

109. Engineer, The; Combination Strip and Powder Rolling Mill; Vol. 206, No. 5364, page 787, 1958.

A description is given of a heavy-duty, high-precision, two-high/four-high combination mill capable of conversion from a conventional strip mill to a mill for compaction of metal powders.

110. Fedorchenko, I. M. and G. A. Vinogradov; Author's Certificate No. 115868, 1958.

The author's report on a method of manufacturing cermet hollow cylindrical articles by hot rolling of powder in a vacuum or protective atmosphere.

111. Fedorchenko, I. M. and G. A. Vinogradov; Byull. izobretenii, No. 11, page 101, 1958.

A method is proposed for the high-speed rolling of articles of specific thickness by the compaction of metal powders.

1958 - 112. Hayden, W. N., J. D. Shaw and W. V. Knopp; Making Metal Strip from Metallic Powder; Precision Metal Molding, Vol. 16, No. 1, page 48, 1958. (see also references 88, 89.)

A description is given of the roll compaction of metal powders.

113. Hill, M., R. Holman and E. Kulinski; Equipment for Hot-Rolling Strip in Vacuum; Vacuum Technology Transactions, S124/28, Pergamon Press, New York, 1958.

114. Iron Steel Engineer, Vol. 35, No. 3, pages 171 to 172, 1958. (see also reference 109.)

The production of ferrous and non-ferrous metal-powder strip in a horizontal rolling mill is described. The mill, which is convertible to a vertical two-high/four-high combination mill, is useful for fabrication of nuclear fuel elements.

115. Lund, J. A.; Roll-Compacting Produces Pure Nickel Strip; Journal of Metals, Vol. 10, No. 11, pages 731 to 734, November 1958. Presented at AIME Annual Meeting (Institute of Metals Division), New York, February 17, 1958.

The production of pure Ni strip by the continuous roll compaction of Ni powders precipitated by H_2 from ammoniacal nickel sulphate solutions (Sherritt Gordon Mines, Ltd. process) is reported. The physical properties of the rolled strip are discussed.

116. Miller, E. L. and N. I. Larionov; Byull. izobretenii, No. 3, 1958.

A report is given of a hopper with an outlet slot regulated by a gate which effectively controls the thickness of the rolled powder strip.

117. Naeser, G. and W. Scholz; Kolloid-Z., Vol. 156, pages 1 to 8, 1958.

An investigation is conducted into the reactivities of solid bodies when mechanically worked at room temperature. Some results are given on the roll compaction of oxide powders of Fe, Ni, Mo, W and Cu.

118. Naeser, G. and F. Zirm; Met. Rev., (1/2), 85, 1958. (see also reference 148.)

A report is given on the rolling of metal powders to date.

119. Nikolaev, A. N.; Steel Strips Produced by Using the Method of Powder Rolling: Trudy Gorkovskogo Politechnicheskogo Instituta, Vol. 14, No. 2, page 16, 1958.

1958 - 120. Nikolaev, A. N.; Force Applied to the Rollers and the Tripping Angle in Rolling Iron Powders; Trudy Gorkovskogo Politechnicheskogo Instituta, Vol. 14, No. 2, page 30, 1958.

121. Nikolaev, A. N.; Izvestiya Vysshikh Uchebnykh Zavedenii-Chernaya Metallurgiya, No. 2, pages 113 to 221, 1958.

The results of theoretical and experimental investigations in the field of powder rolling are presented. The effects of various parameters on the rolled strip product are considered and the possible industrial use of the technique is suggested.

122. Nikolaev, A. N.; Roll Pressure and Angle of Bite in Rolling Iron Powders; Proceedings of Trudy Gorkovskogo Politechnicheskogo Instituta, Vol. 14, No. 12, 1958.

123. Patent (U.S.S.R.) 115868.

124. Semenov, Yu. N.; Byull. izobretenii, 3, 1958.

The production of rolled strip from metal powder is described. A method for obtaining shaped articles by moving the feeder supply of powder along the roll opening during rolling is suggested.

125. Semenov, Yu. N.; Zavodskaya Lab., Vol. 24, No. 10, pages 1246 to 1247, 1958.

A description is given of the use of the technique of powder rolling for the production of rolled "special alloy" strip for use as anti-friction bearings, porous sheet, filter components and porous electrodes.

126. Smirnov, U. S.; Transactions of an Inrercollegiate-Scientific Technical Conference on Recent Advances in Rolling Production, Vol. 1, Leningrad Engineering Institute, 1958.

127. Smucker, R. A.; Perfected and Practical Methods of Processing Powder into Commercial Strip; Iron and Steel Engineer, page 562, 1958.

128. Steel, Vol. 143, No. 10, pages 114 to 115, 1958.

The production of copper strip by the direct roll compaction of the powder is discussed. The work being done on the hot-rolling of copper strip from powders at the Bliss Co. in the United States is reviewed.

129. Storchheim, S.; Metal Powder Rolling; Powder Metallurgy in Nuclear Engineering; American Society for Metals, Cleveland, Ohio, pages 180 to 192, 1958. (see also references 47, 62)

The technique of rolling metal powders is discussed and the results of cold-rolling, hot-rolling and sintering 18-8 stainless steel strip are reported.

1958 - 130. Storchheim, S.; Paper presented at Nuclear Engineering Conference, Chicago, Illinois, 1958.

The powder rolling techniques used to fabricate control rods of B_4C in stainless steel and B_4C in Al are described.

131. Wasserman, K.; VDI Zeitschrift, Vol. 100, No. 1, pages 22 to 23, 1958.

132. Williams, J.; Powder Metallurgy, Powder Metallurgy Joint Group Iron Steel Institute and Institute of Metals, London, pages 94 to 103, 1958.

A description of various methods of powder compaction are given. The physical properties of sheath materials and the applications of the sheath-working technique are discussed.

133. Worn, D. K.; The Continuous Production of Strip by the Direct-Rolling Process; Powder Metallurgy, Powder Metallurgy Joint Group Iron Steel Institute and Institute of Metals, London, pages 85 to 93, 1958.

The raw material requirements, general capabilities and limitations, product quality, and economic consideration of direct powder-rolled production of strip are discussed.

134. Worn, D. K.; Engineering, Vol. 195, No. 4805, page 472, 1958.

1959

1959 - 135. Canadian Metalworking; High-Quality Strip from Powder Metals; Vol. 22, pages 20 to 21, 1959.

Some experiments in the development of high-quality, hot-rolled strip are described. Copper strip rolled by this method is cited as having superior properties to that produced by conventional methods.

136. Daugherty, T. S.; Iron and Steel Engineer, Vol. 36, No. 7, page 124, 1959.

137. Ellis, L.; Proceedings Metal Powder Industries Federation, S67, 1959.

138. Emley, F. and C. Deibel (Westinghouse Electric Corporation); New Method for Compacting Metal or Ceramic Powders into Continuous Sections; Presented at Metal Powder Industries Federation Fifteenth Annual Meeting, Detroit, Michigan, 1959. (see also references 161, 343).

The production of powder strip by the continuous cyclic compaction of metal powders is described. The authors have suggested their method as an alternative to the roll compaction of powders.

139. Evans, P.; The Mechanism of the Compaction of Metal Powders by Rolling; Planseeberichte fur Pulvermetallurgie, Vol. 7, No. 3, pages 102 to 116, December 1959. (see also references 32, 53, 68, 69.)

The results of the investigations carried out by the author at the University of Cambridge, England from 1952 to 1959 are described. The results of roll and powder variables on the compaction of various metal and alloy powders, especially Cu, are given.

140. Evans, P. and G. C. Smith; Some Preliminary Experiments on the Continuous Compaction of Titanium, Molybdenum and Tungsten; Metallurgia, Vol. 59, No. 353, pages 117 to 120, March 1959.

The results of the tests done on the roll compaction of Ti, Mo and W powders are given.

141. Evans, P. and G. C. Smith; The Compaction of Metal Powders by Rolling. I - The Properties of Strip Rolled from Copper Powders; Powder Metallurgy, No. 3, pages 1 to 25, 1959.

The results of work done on the roll compaction of Cu to study the effect of powder variables on strip properties and the variation of tensile strength and electrical resistance with direction.

1959 - 142. Evans, P. E. and G. C. Smith; The Compaction of Metal Powders by Rolling. II - An Examination of the Compaction Process; Powder Metallurgy, No. 3, pages 26 to 44, 1959.

The process of compaction of Cu powder by rolling was examined. The effect of roll pressure, strip thickness, surface condition of the rolls, rolling temperature and Speed, and "force-feeding" are discussed.

143. Gebauer, B. W.; Iron Steel Engineer, Vol. 36, page 118, July 1959.

144. Materials in Design Engineering; Steel Strip Rolled from Powder; Vol. 50, No. 2, page 136, August 1959.

A brief history of the rolling of metal powders is given and the continuous process used by the Republic Steel Corporation is described in detail. The advantages and economics of powder rolling are discussed.

145. Metal Progress; New Uses for Powder Metallurgy; pages 97 to 99, June 1959.

146. Metalworking Production, Vol. 103, No. 3, page 104, 1959.

The production of hot-rolled Cu strip from powder is described and some properties of the strip are given.

147. Moyer, K. H. and I. Sheinhartz; Feasibility Study for the Direct Rolling of Beryllium Powders; Sylvania Corning Nuclear Corporation, Report SCNC-305, Bayside, N. Y., ASTIA, AD159875, November 1959, 42 pp.

148. Naeser, G. and F. Zirm; Met. Revs., Vol. 4, No. 14, pages 179 to 187, 1959. (see also reference 118.)

A review is given of the manufacturing of sheet and strip by the rolling, sintering, and re-rolling of metal powders.

149. Scholefield, H. H. and S. G. Richardson (Telegraph Construction and Maintenance Co. Ltd., England); The Fabrication of Soft Magnetic Alloy Strip from Powders; Powder Metallurgy, No. 4, pages 44 to 45, 1959.

An investigation into the production of strip of Ni-Fe, Co-Fe and Si-Fe for use as soft magnetic alloy strip is reported. The use of powder rolling techniques for the production of magnetic strip is discussed from an economic viewpoint.

150. Semenov, Yu. N.; Author's Certificate; Patent (USSR), 127124, 1959.

1959 - 151. Smucker, R. A. (E. W. Bliss Co., U.S.A.); Perfected and Practical Methods for Processing Powder into Commercial Strip; Iron and Steel Engineer, pages 118 to 124, July 1959. (see also reference 127.)

A description is given of the continuous powder-rolling process developed by the author and applied on a commercial scale. The results of investigations into the rolling of electrolytic Cu powder is given.

152. Weik, H., G. Ogiermann and R. Ergang (Battelle Institute), Frankfurt 1 Main, Germany; Metall, Vol. 13, No. 5, pages 398 to 404, May 1959.

An investigation into the direct rolling of Zn and Zn:Pb metal powders is reported. Results are given of the mechanical properties of the strip and the corrosion resistance of the strip prepared by conventional methods.

153. Worn, D. K.; The Continuous Production of Strip by the Direct Rolling Process; Presented to London Iron and Steel Institute and Institute of Metals, 1959.

The roll compaction of metal powders is discussed.

154. Worn, D. K. and R. P. Perks; Production of Pure Nickel Strip by the Direct-Rolling Process; Powder Metallurgy, No. 3, pages 45 to 71, 1959.

An investigation into the production of strip from carbonyl Ni powder is reported. The rolling and sintering and subsequent processing stages are described and the effect of roll variables on the resultant strip product are discussed.

155. Ziegfeld, R. L. (Lead Industries Association, New York); Presented to the Metal Powder Industries Federation Fifteenth Annual Meeting, Detroit, Michigan, 1959.

The rolling of Pb powder into thin sheet with approximately double the tensile strength of conventional cast and roll strip is reported and the results of preliminary investigation on the rolling of Pb is discussed.

1960

1960 - 156. Aksenov, G. I., V. G. Khromov, A. N. Nikolaev, and Yu. N. Semenov; Rolling of Titanium Powder into Thin Strips According to the GPI Method; Titanium and Its Alloys, Izd. ANSSR, No. 3, 1960.

157. Aksenov, G. I. and Yu. N. Semenov; Metal Powder Rolling; Metallurgizdat, 1960.

Experimental data for the "angle of bite" using a method proposed by Semenov are reported.

158. Bakulin, N. I.; Pretsizionnye Splavy, Sbornik Trudov. TsNIIChM No. 23, pages 23 to 33, Moscow: Metallurgizdat, 1960.

The experimental work conducted at the Central Research Institute for Ferrous Metallurgy on the rolling of Fe-Ni carbonyl powders to produce materials with improved magnetic properties is described.

159. Borok, B. A., V. K. Gavrilova, G. M. Karpman and V. G. Khromov; Tsvetnye Metally, Vol. 33, No. 11, pages 69 to 76, November 1960.

Details are given of the powder composition and properties, rolling equipment, and procedure used for the study of the rolling of Ti powder at the Central Research Institute for Ferrous Metallurgy and the Polytechnic Institute in the U.S.S.R. The properties of the rolled strip are discussed.

160. Broughton, A. R., D. K. Worn and R. P. Werks; Improvements Relating to Methods of, and Apparatus for Producing Metal Strip from Metal Powder; U. K. Patent Specification No. 824,443 (27/7/60).

161. Deibel, C., D. R. Thornburg and F. Emley; Continuous Compacting by Cyclic Pressing: Powder Metallurgy, No. 5, pages 32 to 44, 1960. (see also references 138, 343.)

An alternative to the roll compaction of powder is given in which a cyclic pressing operation is used to produce thick bars of unlimited length from metal powder.

162. Hunt, D. G. and R. Eborall; The Rolling of Copper Strip from Hydrogen-Reduced and Other Powders; Powder Metallurgy, No. 5, pages 1 to 23, 1960.

The results of the rolling of copper powders (three prepared by ammoniacal leaching followed by hydrogen reduction under pressure, one by electrolysis, and one by atomization) are given. The sintering, annealing and re-rolling procedures are described and the results of mixing of the powders is analyzed.

1960 - 163. Jones, W. D.; Continuous Powder Metallurgy; Fundamental Principles of Powder Metallurgy, Edward Arnold (Publishers) Ltd., London, pages 924 to 955, 1960.

The parameters involved in the production of rolled powder strip are discussed and the advantages of rolling metal powder into strip over the conventional methods of strip production are reviewed. The work done on both the rolling and sintering of strip by various investigators to date is described.

164. Kurtz, B. E. and A. J. Barduhn; Compacting Granular Solids; Chemical Engineering Progress, Vol. 56, No. 1, pages 67 to 72, January 1960.

165. Marshall, A. F.; Some Mechanical Requirements of Plant for the Roll-Compacting Process; Powder Metallurgy, No. 5, pages 24 to 31, 1960.

The author has reviewed the published information on the roll compaction of metal powder and has presented some theories on the requirements for a mill to roll compact metal powders. Many of the variables involved in the compaction process are discussed in their relationship to the resultant strip product.

166. Nikolaev, A. N.; Met. Science Heat-Treat Metals, (1/3), 35, 1960.

167. Patent (Czechoslovakia) 97,390 (15/11/60). From Referat Zhurnal: Metallurgiya (Moscow), No. 3, 3G322, 1960.

A method is suggested whereby the strip of rolled metal powder is backed by paper which prevents the coils of the strip from sticking together and which can be burnt off during sintering.

168. Powder Metallurgy; Direct Rolling Processes in Powder Metallurgy; No. 6, pages 189 to 192, 1960. (Discussion).

A discussion on the direct roll compaction of metal powder is presented.

169. Steel; 84, November 1960.

The roll compacting of nickel powder is described.

170. Storchheim, S.; New Powder Rolling Process; Journal of Metals, Vol. 12, No. 3, page 225, March 1960.

The consolidation of metal powders by roll compaction is described. Data are presented on the rolling of Pb and Al powders and the effect of powder characteristics on the resultant product is discussed.

1960 - 171. Vinogradov, G. A.; Metal Powder Rolling in a Mill with a Single Driving Roll; Information Letter No. 226, Academy Science Ukrainian SSR Press, 1960.

172. Vinogradov, G. A. and Yu. N. Semenov; Rolling of Metal Powders; Metallurgizdat: Moscow, 1960, 88 pp.

A collection of the results of metal powder rolling published to date are given in this publication. The work done by Aksenov and Nikolaev in the USSR and the University of California and Argonne National Laboratory in the U.S.A. are discussed.

173. Wolff, F. M.; Metall, Vol. 14, No. 2, pages 131 to 132, February 1960.

The early work in the field of powder rolling of metal powders is described.

174. Worn, D. K. and A. Eccles (Mond Nickel Co.); Patent (U.K.) 829,640 (2/3/60).

The production of thin strip, such as Fe-Co alloys, by the roll compaction of metal powders is suggested for patent.

1961

1961 - 175. Evans, P. E.; Continuous Hot Compaction of Metal Powders; Powder Metallurgy, edited by W. Leszynski, pages 553 to 561, 1961.

The possible use of hot rolling metal powders is discussed. Actual data compiled on the hot rolling of copper powders is reported.

176. Fedorchenko, I. M. and R. A. Andrievskii; Fundamentals of Powder Metallurgy; Izd. An. Ukrainian SSR, Kiev, 1961.

177. Journal of Metals; 115, February 1961.

The direct rolling of nickel powder into strip with an average purity of 99.9% at the Metals for Electronics, Inc. of Hamden, Conn. is described.

178. Khromov, V. G.; Proceedings of the All-Union Inter-University Conference on Powder Metallurgy; Kuibeyshev, 1961.

179. Lenz, W. H. and C. E. Peterson; The Powder Rolling of Molybdenum and Tungsten; U. S. Atomic Energy Commission, IAMS-2612, Washington, D. C., June 1961, 41 pp.

180. Lezynskii, W., Editor; Powder Metallurgy; Interscience Publishers, New York, 1961, 847 pp.

181. Obinata, I. and Y. Masuda; Report contracted with Electrical Communications Laboratory, U.S., 1961.

The results obtained on sintering Cu powder strip prepared by the roll compaction of the powder are given.

182. Pickens, Dennis K.; Comments on Copper Strip Rolled from Chemically Produced Powders; Powder Metallurgy; Proceedings of International Conference, New York, June 1960, edited by W. Leszynski, pages 543 to 552, 1961.

The production of Cu strip from powder obtained by gaseous reduction of ammoniacal solutions is described. A comparison of the properties of finished strip made by chemical, electrolytic, and ordinary methods is tabulated.

183. Precision Metal Molding; New Mill Produces Nickel Strip from Powder; Vol. 19, No. 1, page 10, January 1961. The Engineer, January 1961. (see also references 317, 344.)

The development of a powder-rolling mill by the Loma Machine Manufacturing Company, Incorporated, New York, is illustrated. The ideal use of the mill for the production of Ni strip is suggested. The feed rate, rolling, sintering, and post sintering operations are described.

1961 - 184. Schloemann, A. G., Dusseldorf, Germany; Patent (U.K.) 975,506 (14/2/61).

The details of the method used to form an Al_2O_3 film on Al powder particles to impart various properties to the strip are given. Some data on the physical properties of the Al strip are given.

185. Semenov, Yu. N.; Trudy Proektnogo Tekhnologicheskogo i Nauchno-Issledovatel' skogo Instituta Gor'kovskogo Sovnarkhoz, Vol. 1, No. 7, Pages 59 to 66, 1961. From Referat. Zhurnal: Metallurgiya (Moscow), No. 12, G333, 1961.

The production of 0.3 to 4-mm thick Ni strip of 70 to 75% porosity from carbonyl powder is reported.

186. Semenov, Yu. N.; Poroshkovaya Metallurgiya, Vol. 1, No. 5, pages 69 to 73, September-October 1961.

The rolling of metal powders to produce thin, highly-porous strip of uniform properties for filters or electrodes is discussed.

187. Sherritt Gordon Mines Ltd., Toronto, Press Release, 1961.

The use of powder rolling techniques at the Company's Fort Saskatchewan refinery to produce high quality strip for use at the Royal Canadian Mint and to meet electronic requirements is described.

188. Storchheim, S. and A. Cross; Continuous Production of High Strength Lead Strip by Direct Powder Rolling; Planseeberichte fur Pulvermetallurgie, Vol. 9, No. 1/2, pages 21 to 25, April 1961.

Powder rolling is used to develop high-strength, creep-resistant Pb sheet capable of shielding aircraft nuclear reactors at 300°F and a maximum stress of 300 psi. The effect of lubrication of the rolls, the physical characteristics of the powders and the rolling parameters of the mill on the properties of the strip product are discussed.

189. Vinogradov, G. A. and I. M. Fedorchenko (Institute of Powder Metallurgy and Special Alloys, Kiev); Effect of the Gaseous Phase on the Pressing of Powders by Rolling; Poroshkovaya Metallurgiya, Vol. 11, No. 1, pages 61 to 67, January-February 1961.

The influence of the gaseous phase on the roll compaction of powders is discussed in detail. Experiments with fine carbonyl Ni powder and with Fe powder using gaseous media of different viscosities are described.

1962

1962 - 190. Aksenov, G. I.; The Effect of Air on Rolling Conditions of Powders; Proceedings of the 6th All-Union Conference on Powder Metallurgy (Moscow), 1962. In Russian.

191. Aksenov, G. I.; Fundamentals of Powder Metallurgy; Kuibyshev. 1962. In Russian.

192. Buescher, W. E., R. Silverman and L. S. Castleman; Rolling of Metal Powder Strip with Tailored Properties; Progress in Powder Metallurgy: Proceedings of 18th Annual Technical Conference, Metal Powder Industries Federation, pages 42 to 47, 1962.

The production of cathode alloy strip for electron tube use by the roll compaction of very pure nickel powder is discussed.

193. Canadian Chemical Process, pages 46 to 52, 1962.

The production of nickel powder strip on a pilot plant scale is discussed.

194. Chekmarev, A. P.; Collection: Theory of Rolling; Metallurgizdat, 1962. In Russian.

195. Chekmarev, A. P., P. L. Klimenko and G. A. Vinogradov; Transactions of the Seminar on Metal Powder Rolling; Leningrad Engineering Institute, Leningrad, 1962.

196. Crooks, S. R.; The Rolling of Strip from Iron Powder; Iron Steel Engineer, 39, pages 72 to 76, February 1962.

197. Cross, A. and S. Storchheim (Alloys Research and Manufacturing Corp., U.S.A.); Materials in Design Engineering, Vol. 55, No. 4, pages 158 to 159, April 1962.

Data are provided on the properties of lead strip rolled from metal powder.

198. Deibel, C. and F. Emley; Investigation of Nickel Powders to Fabricating Pure Nickel Strip; Planseeberichte fur Pulvermetallurgie, Vol. 10, No. 1/2, pages 3 to 14, April 1962.

Nickel powder of five different types was used to investigate the feasibility of producing pure nickel strip by the Westinghouse cyclic continuous compacting or step passing process as an alternative to roll compaction of powders. Data are presented on the properties of the strip product.

1962 - 199. Ern, H.; Stahl und Eisen, Vol. 82, No. 4, pages 221 to 224, February 1962.

The roll compaction of metal powders is reviewed to date. The work of Naeser and Zirm, Franssen, Evans and Smith and major corporations in the U.S.A. are described. The advantages and economics of the process are discussed.

200. Franssen, H. and N. Franssen; Zeitschrift fur Metallkunde, Vol. 53, No. 2, pages 78 to 85, February 1962. (Translation HB5596 by Henry Buitcher, Altadena, California, 1962, 28 pp.)

The present status of powder rolling is reviewed by the authors. The work on roll compaction of metal powders in the U.S.A., Germany, England and Sweden is discussed.

201. Katrus, O. A., I. M. Fedorchenko and G. A. Vinogradov; Investigation of the Magnetic Properties of Strip made from Iron Powder; Poroshkovaya Metallurgiya, No. 1, pages 37 to 44, January 1962. Translated in Soviet Powder Metallurgy and Metal Ceramics, pages 25 to 30, 1962.

The effect of sintering conditions, structure and porosity on the magnetic properties of iron strip rolled from metal powders is described.

202. Katrus, O. A. and G. A. Vinogradov; Three-Layer Copper-Iron-Copper Strips of Metal Powder; Poroshkovaya Metallurgiya, No. 5, pages 60 to 67, September-October 1962. Translated in Soviet Powder Metallurgy and Metal Ceramics, pages 357 to 362, 1962.

The production of layered strip by roll compaction of the powders is described. The properties of the strip product are discussed.

203. Krantz, T. and Vilnis Silins (Sherritt Gordon Mines Limited, Canada); Apparatus for Roll Compacting Metal and Metal-Coated Particles; Patent (U.S.) 3,144,681 (14/5/62).

A method which provides for the confinement of metal powder to the roll gap and for the close control of density across the width of the green strip is described.

204. Lozhechnikov, E. G.; Promyshlennost's Belorussi, 11, 39, 1962.

205. Martin, A. J. and G. C. Ellis; Powder Metallurgy in the Nuclear Age; Plansee Proceedings, 1961, edited by F. Benesovsky, pages 645 to 667, 1962.

The direct rolling of Be powders is discussed as part of a paper which deals with methods for the consolidation of Be powder.

1962 - 206. Materials in Design Engineering; Lead Strip for Structural Purposes; pages 158 to 159, April 1962.

Data accumulated on the rolling of lead strip from the metal powder are given.

207. National Materials Advisory Board; State of the Art on Powder Metallurgy; Report MAB-139-M4, National Academy Science National Research Council, Washington, D. C. May 1962, 41 pp.

208. Pozin, Yu. M., O. I. Bondarenko and B. I. Fishman; Poroshkovaya Metallurgiya, No. 3, page 80, 1962.

209. Schey, J. A.; (IITRI Invention Disclosure No. 880) Means of Preventing Edge Cracking in Rolling; Patent Applied for 11/12/62.

A method is suggested for preventing edge cracking in rolled materials by an apparatus which provides for edge restraint of the rolled strip.

210. Schloemann, A. G., Dusseldorf, Germany; Patent (U.K.) 965,810. (23/3/62).

A description of equipment suitable for rolling metal powders into bands, wires, and sections of various thicknesses is given.

211. Sylvania Electric Products, Wilmington, Delaware, U.S.A.; Patent (U.K.) 1,006,424 (19/4/62).

A description is given of a new method to produce low-density thin strips from metal powder.

212. Vinogradov, G. A.; Poroshkovaya Metallurgiya, No. 4, page 63, 1962.

A method is suggested for calculating the density and thickness of strip produced by the roll compaction of metal powders.

213. Vinogradov, G. A.; Application of the Method of Reference Points for Calculating the Density of Strip Rolled from Powders; Poroshkovaya Metallurgiya, No. 4, pages 63 to 71, July-August 1962. Translated in Soviet Powder Metallurgy and Metal Ceramics, pages 275 to 282, 1962.

An analysis is presented of the experimental data accumulated on the relationship between the density and thickness of strips rolled from Fe, Ni, Al, Ti and stainless steel powders.

1962 - 214. Vinogradov, G. A. and L. M. Komarova; Investigation of the Friability of Metal Powders in Connection with Rolling Conditions; Poroshkovaya Metallurgiya, No. 1, pages 27 to 33, January-February 1962. Translated in Soviet Powder Metallurgy and Metal Ceramics, pages 17 to 22, 1962.

The free flow characteristics of Fe, Cu and Al powders were studied under conditions simulating those existing in the roll compaction of metal powders. Results are given for trials done in vacuum and data is reported on the effect of particle size, roll surface condition and roll speed.

1963

1963 - 215. Aksenov, G. I., B. A. Borok, A. P. Malin and U. G. Khromov; Rolling of Metal Powders in the Industry; Proceedings of Trudy Leningradskogo Politechnicheskogo Instituta imeni M. I. Kalina, No. 222, 1963.

216. Chekmarev, A. P., P. A. Klimenko and G. A. Vinogradov; Investigation of Specific Pressure, Specific Friction and the Coefficient of Friction during Metal Powder Rolling; Poroshkovaya Metallurgiya, No. 2, pages 26 to 30, 1963.

The distribution of the specific pressure on the powder in the grip arc during the rolling of metal powders is discussed. The results of an investigation done on the rolling of iron powder are given.

217. Ayers, M. D.; Continuous Production of Strip and Other Metal Products from Molten Metal; Patent (U.S.A.) 3,281,893 (4/11/63).

A method is suggested for continuous production of strip from molten metal. The metal is converted into powder and is directly compacted between rolls.

218. Chromov, V. G.; Determination of the Angle of Grip in Metal Powder Rolling; Trudy Leningradskogo Politechnicheskogo Instituta imeni M. I. Kalina, No. 222, pages 73 to 74, 1963.

219. Fisher, R. B.; Incandescent Rolling Mill; Journal of Metals, Vol. 15, No. 11, pages 840 to 842, November 1963.

An experimental rolling mill which consists of rolls made of Cr_3C_2 and can operate at roll temperatures of 1200° to 1300°F is described. The potential use for the hot rolling of metal powders is seen as one of the possibilities of such a system.

220. Goetzel, C. G.; Treatise on Powder Metallurgy, Vol. 3, 1962; Vol. 4, 1963, Interscience Publishers, New York, N. Y.

221. Grant, N. J.; Patent (U.S.A.) 3,270,409 (10/2/63).

A method is proposed for the development of flat metal shapes of almost full density by the continuous hot rolling of metal powders.

222. Katrus, O. A. and G. A. Vinogradov; Three-Layer Strip Copper-Iron-Copper Produced from Powders; Trudy Leningradskogo Politechnicheskogo Instituta imeni M. I. Kalina, No. 222, 1963.

223. Khromov, V. G.; Dissertation, G01 in A. A. Zhdanova, 1963. In Russian.

1963 - 224. Khromov, V. G.; Collection: Plastic Working of Metals; Trudy Leningradskogo Politechnicheskogo Instituta imeni M. I. Kalina, No. 222, pages 73 to 74, 1963.

The determination of the angle of grip in metal powder rolling is described by the author. Data is given on the rolling of Ti powder.

225. Kimura, T., H. Hirabayashi and M. Tokuyoshi; Continuous Production of Iron Strip from Metal Powder; Journal Japan Powder Metallurgical Society, 10, pages 172 to 180, 1963. (see also references 227, 228, 257.)

226. Kimura, T., H. Hirabayashi and M. Tokuyoshi; Journal Japan Society of Technology, Plasticity, 4, 259, 1963.

The precise control of the powder feed rate for roll compaction of metal powder is determined.

227. Kimura, T., H. Hirabayashi and M. Tokuyoshi; Properties of Strips Made from Domestic Iron Powder by the Powder Rolling Method; Transactions Japan Institute Metals, 4, pages 152 to 168, 1963. (see also references 225, 228, 257.)

228. Kimura, T., H. Hirabayashi and M. Tokuyoshi; Rolling of Steel Strips from Iron Powder; Nippon Kinzoku Gakkai-Shi, 27, 571, 1963. (see also references 225, 227, 257.)

229. Lozhechnikov, E. G.; New Techniques and Progressive Technology; Trudy BPI izd. Ministerstva Vysshego, Srednego. Spetsial'nogo i Professional'nogo Obrazovaniya BSSR, Minsk, 53, 1963.

The direct rolling of Al powder on a special roll mill is described.

230. Mackiw, V. M., N. Yoshida, T. Krantz and R. W. Fraser (Sheritt Gordon Mines Ltd., Toronto, Canada); Patent (U.S.A.) 3,268,368 (21/10ρ63).

The method used at the Company's operations for the production of high quality Ni strip is described in detail.

231. Nikolaev, A. N.: The Compaction and Rolling of Metal Powders; Poroshkovaya Metallurgiya, No. 1, pages 42 to 48, January-February 1963. Translated in Soviet Powder Metallurgy and Metal Ceramics, pages 30 to 34, 1963.

The effect of the porosity of metal powders on the properties of the manufactured part is examined. The mechanical properties of strips rolled from different brands of iron powder were investigated.

1963 - 232. Palik, R. R. and W. F. Duncan; Steel, 152, 39, April 1963.

233. Semenov, Yu. N.; Effect of Highly Dispersed Non-metallic Inclusions on the Mechanical Properties and Recrystallization in Powder Strip; Proceedings of Trudy Leningradskogo Politechnicheskogo Instituta imeni M. I. Kalina, No. 222, 1963.

234. Semenov, Yu. N., G. S. Shmakov and N. T. Berrdyaeva; The Rolling of Copper Powder to Strip; Proceedings of Truday Leningradskogo Politechnicheskogo Instituta imeni M. I. Malina, No. 222, 1963.

235. Severdenko, V. P. and E. B. Lozhechnikov; Doklady Academii Nauk BSSR 7, 1, pages 27 to 29, 1963.

A description is given of the experiments used to calculate the specific pressure along the arc of grip in the rolling of strip from iron powder. The measurements of the pressure were done with a dynamometer and a description is given of the instrument and the results obtained in the process are tabulated.

236. Severdenko, V. P. and E. B. Lozhechnikov (Physico-Technical Institute, Belorussian Academy of Science, Minsk); Docklady Academii Nauk BSSR 7, 4, pages 244 to 246, 1963.

An equation is derived for the forward slip encountered in the rolling of strip from metal powders. The results of experiments using Fe and Cu powders are reported.

237. Sherritt Gordon Mines Ltd., Toronto, Canada; Apparatus for Roll Compacting metal and Metal Coated Particles; Patent (U.K.) 1,001,297 (18/4/63).

A method is suggested for controlling the flow of metal powder to the ends of the roll gap. Five diagrams are included which show the arrangement of belts in relation to the hopper and other details of design.

238. Smirnov, V. S. and N. N. Pavlov; Rolling and Sintering of Metal Powders; Trudy Leningradskogo Politechnicheskogo Instituta imeni M. I. Kalina, No. 22, pages 31 to 39, 1963.

The results of an investigation into the rolling and sintering of Ni and Ni alloy powders is reported. The effect of powder characteristics and rolling variables on the properties of the strip product in the rolling of Ni, Mo. Ni-Mo, Ni-Si, Ni-Ti, etc., are discussed.

239. Tikhonov, G. F., L. A. Pyryalov and G. V. Lebedeva; Effect of Cold Deformation on the Properties of Stainless Steel Powders; Proceedings of Trudy Leningradskogo Politechnicheskogo Instituta imeni M. I. Kalina, No. 222, 1963.

1963 - 240. Tikhonov, G. F., V. K. Sorokin and V. G. Khromov; Rolling of Highly Porous Filter Strip from Metal Powder; Trudy Leningradskogo Politechnicheskogo Instituta imeni M. I. Kalina, No. 222, pages 71 to 72, 1963.

The results of the rolling of Ti powders is reported. The relationship between the strip product and the powder characteristics and rolling variables is discussed. A description of the filtration tests done on the strip is given.

241. Vinogradov, G. A.; Method of Calculating the Density and Thickness of Porous Rolled Strip; Poroshkovaya Metallurgiya, No. 5, pages 15 to 20, September-October 1963. Translated in Soviet Powder Metallurgy and Metal Ceramics, pages 356 to 360, 1963.

A method is suggested for calculating the density and thickness of strip formed by the direct rolling of metal powders.

242. Vinogradov, G. A.; Investigation of the Process of Rolling of Metal Powders' Dissertation, 1963. In Russian.

243. Vinogradov, G. A.; Study of Specific Pressure during the Rolling of Metal Powders; Poroshkovaya Metallurgiya, No. 3, pages 30 to 36, May-June 1963. Translated in Soviet Powder Metallurgy and Metal Ceramics, pages 198 to 203, 1963.

The effect of specific pressure on the rolling of metal powders is investigated. The relationship between critical angle, contact angle, maximum specific pressure and the properties of the rolled strip product is discussed.

244. Vinogradov, G. A. and I. D. Radomysel'skii; Compaction and Rolling of Powder Metallurgical Materials; Mashgiz, 1963. In Russian.

1964

1964 - 245. Ayers, M. D. (Metal Innovations, Inc.); Production of Powder Strip and Other Metal Products from Refined Molten Metal; Patent (U.S.A.) 3,334,408 (8/10/64).

A method is described which includes the production of rolled sheet from powder. The production of powder by atomization and the subsequent production of powder strip is described.

246. Ayers, M. D. (Metal Innovations, Inc.); Process for Producing Shaped Thin Articles from Metal Powders; Patent (U.S.A.) 3,328,166 (27/20/64).

A method is given which provides for the production of shaped articles of metal sheet. The investion, according to Ayers, is particularly advantageous in the production of sheets for use in the manufacture of transformers. solenoids. and rings for automotive transformers.

247. Daugherty, T. S.; Aluminum Sheet from Finely Divided Particles; Journal of Metals, Vol. 16, No. 10, pages 827 to 830, October 1964.

A full description is presented of the method used by the Reynolds Metal Co. for the direct rolling of Al particles into sheet.

248. Davy and United Engineering Limited, Sheffield, Yorkshire; Production of Metallic Strip; Patent (U.K.) 1,039,548 (22/10/64).

A method is proposed for producing metallic strip by electrostatically attracting metallic particles onto a substrate and compacting the particles between rolls.

249. Fraser, R., W., D. J. I. Evans and V. N. Mackiw; Properties and Applications of Cobalt Strip; Metal Progress, Vol. 86, No. 1, pages 80 to 84, July 1964; Cobalt, 231, 72, 1964.

A description is given of the conversion of Co powder into ductile strip. The properties of the strip product are discussed with the aid of graphs.

250. Frumin, I. I., G. A. Vinogradov, O. A. Katrus and M. M. Nerodenko; Author's Certificate No. 163,055; 1964.

251. Gehring, Eckard (Schloemann Aktiengesellschaft, Dusseldorf, W. Germany); Methods and Means for Rolling Metal Powders; Patent (U.S.A.) 3,309,735 (27/4/64).

A method is proposed for the rolling of metal powders conveyed from a hopper to the rolls.

1964 - 252. Head, Peter; Rolling Metal Powders Seen Limited by Cost; Metalworking News, Vol. 5, No. 178, page 6, January 1964.

253. Helms, H. H. Jr. and E. Adams; Sendust Sheet-Processing Techniques and Magnetic Properties; Journal of Applied Physics, Vol. 35, No. 3, pages 871 to 872, March 1964.

The production of Fe-Si-Al magnetic strip by the roll compaction of metal powders is described. The properties of the strip product are discussed by the authors.

254. Katrus, O. A. and G. A. Vinogradov; Calculation of the Layer Thickness Ratio in the Rolling of Two and Three Layer Strips from Metallic Powder; Poroshkovaya Metallurgiya, No. 4, page 19, 1964. Translated in Soviet Powder Metallurgy and Metal Ceramics, pages 26 to 32, 1964.

The layer thickness ratio during the rolling of two and three layer strip was calculated from experimentally determined data on the relationship of the thickness to the velocity of powder in various hopper sections.

255. Katrus, O. A. and G. A. Vinogradov; Proceedings of the 2nd All-Union Conference of Powder Metallurgy; Erevan, 1964.

256. Khromov, V. G.; Rolling and Heat Treatment in the Production of Titanium Powder Strip; Dissertation, 1964.

257. Kimura, T., H. Hirabayashi and M. Tokuyoshi; Study on the Continuous Rolling Fabrication of Iron Strip from Metal Powders; Review Electrical Communication Laboratory, Vol. 12, No. 4, pages 215 to 232, March-April 1964. (see also references 225, 227, 228.)

The results of an investigation into the direct rolling of Fe powder is described. Data are presented on the properties of the rolled strip.

258. Korbin, C. L.; Iron Age, Vol. 193, No. 17, pages 89 to 91, April 1964.

The future of powder rolling is considered. The results obtained by various companies in the U.S.A. are discussed in the light of possible application on a full-scale production basis.

259. Mannesmann Aktiengeseltschaft, Dusseldorf, West Germany; Patent (U.K.) 1,051,775 (26/2/64).

A method for the manufacture of chromium-nickel steel sheet, wire or tubes from the powder is proposed.

1964 - 260. Materials in Design Engineering; Nickel Strip Has Better Electrical Conductivity; Vol. 59, No. 1, page 97, January 1964.

The production of Ni strip (SG-100) by Sherritt Gordon Mines Ltd. is described. The physical, mechanical and magnetic properties of the strip are tabulated and compared with the properties of conventional rolled strip.

261. Metallverarbeitung, Vol. 13, No. 11, page 348, November 1964.

A rolling mill, suitable for roll compaction of metal powders, developed by the Institute of Materials Technology Academy of Sciences, Ukraine, is described.

262. Pavlov, N. N.; Physiomechanical Properties of Metal Powders and Rolled Powder Strip; Metalworking, Leningrad Engineering Institute Press, 1964.

263. Precision Metal Molding; Nickel Strip by Powder Metallurgy; Vol. 22, No. 2, pages 33 to 35, February 1964. (see also reference 260.)

Detailed information is given on the physical and mechanical properties of Ni strip produced by the Sherritt Gordon process from powder made by hydrometallurgical methods.

264. Ready, T. J., W. V. Green and H. D. Lewis; Fabrication and Evaluation of Powder Rolled Tungsten-Uranium Dioxide Dispersions; U. S. Atomic Energy Commission Report LA-2845, Washington, D. C., June 1964, 45 pp.

265. Reen, O. W.; The Production of Tool Steel Strip from Pre-Alloyed Powders; Progress in Powder Metallurgy, Vol. 20, Metal Powder Industries Federation, pages 194 to 201, New York, 1964.

266. Schloemann, A. G., Dusseldorf, Germany; Improvements in Methods and Means for Rolling Metal Powder; Patent (U.K.) 1,055,764 (3/4/64).

An invention for speeding up the rolling of metal powders is described.

267. Severdenko, V. P. and E. B. Lozhechnikov; Roll Pressure during Rolling of Metal Powder Strips; Izv. Vysch. Utseh. Zaved. Cernaja Met., No. 11, pages 120 to 123, 1964.

268. Severdenko, V. P. and E. B. Lozechnikov; Strip Rolling from Metal Powders; Ductility and Working of Metals, Nauka i Tekhnika Press, Minsk, 1964.

1964 - 269. Severdenko, V. P., E. B. Lozhecknikov and V. A. Shelamov; Tsvetniye Metally, Vol. 37, No. 11, pages 88 to 90, November 1964. (see also reference 302.)

The results of an investigation into the hot and cold rolling of Al powder is reported. A special rolling mill for this project is described and the results of tensile and yield strength tests are given. The effect of annealing temperature is tested and recommendations are made for the satisfactory production of SAP strip.

270. Smedstan, J. A.; Continuous Compacting of Iron Powder to Strip; Jernkontorets Ann. 148, pages 883 to 884, 1964.

271. South African Mining Engineering Journal; 1608, December 11, 1964.

272. Steel; Tool Steel Strip Rolled from Powder; Vol. 154, No. 18, pages 118 to 120, 1964.

273. Steinitz, R., C. Wurms, and L. Seigle; Rolling of Molybdenum Powder to Sheet; Planseeberichte fur Pulvermetallurgie, Vol. 12, No. 1, pages 3 to 11, April 1964.

The paper is a condensed version of the results reported under a project entitled "Feasibility Study of Powder Rolling of Molybdenum Sheet", investigated by the Bureau of Naval Weapons. U. S. Navy under contract No. 60-6018-C. The production of Mo sheet by the roll compaction of the powder is described.

274. Tamura, K., and T. Noda; Journal of the Japan Society of Powder and Powder Metallurgy, Vol. 11, No. 5, pages 236 to 242, October 1964.

275. Vinogradov, G. A.; Method of Calculating Roll Pressure in Metal Powder Rolling; Poroshkovaya Metallurgiya, No. 6, pages 12 to 16, November-December 1964. Translated in Soviet Powder Metallurgy and Metal Ceramics, pages 451 to 454, 1964.

A formula is derived for the mean radial pressure exerted on the powders during roll compaction.

276. Vinogradov, G. A. and V. P. Katashinskii; Poroshkovaya Metallurgiya, No. 1, 1964.

277. Vinogradov, G. A. and V. P. Katshinskii; Investigation of the Kinematics of Powder Motion in Hoppers during Rolling; Poroshkovaya Metallurgiya, No. 1, pages 81 to 90, January-February 1964. Translated in Soviet Powder Metallurgy and Metal Ceramics, pages 63 to 70, 1964.

The motion of powder in the hoppers during roll compaction was investigated using X-ray techniques. The effect of powder motion in the hopper on the rolled product was discussed.

1964 - 278. Vinogradov, G. V. and I. D. Radomysel'ski; Compacting and Rolling of Cermet Materials; reviewed by R. A. Andrievskii in Poroshkovaya Metallurgiya, No. 1, pages 111 to 112, January-February 1964. Translated in Soviet Powder Metallurgy and Metal Ceramics, page 92, 1964.

The recent book by the authors is reviewed by Andrievskii.

1965

1965 - 279. Blore, M. D., V. Silins, S. Romanchuk, T. W. Benz and V. N. Mackiw; Nickel Strip by Powder Rolling, American Society Metals Technical Report, D5-3.4, October 1965. (see also reference 313.)

280. Borok, B. A. et al; Rolling Powders in an Industrial Mill; Sb. Tr. Centu-Nautsch. Inst. Tschernaja Met., No. 43, pages 53 to 59, 1965.

281. Eppelsheiner, D. S. and R. C. Wilcox; Rolling Textures of Cobalt; Journal Institute of Metals, 93, pages 229 to 230, 1965.

The Schulz-Decker technique is used to measure the texture of cobalt prepared by the roll compaction of the powder.

282. Evans, P. E.; Theoretical Optimum Rolling Speed in Powder Compaction; Presented at the 1965 International Powder Metallurgy Conference, New York, June 14 to 17, 1965, 13 pp.

The effect of rolling speed on the properties of the rolled strip product is discussed.

283. Fraser, R. W., D. J. I. Evans and V. N. Mackiw; The Production and Properties of Ductile Cobalt Strip; The Canadian Mining and Metallurgical Bulletin, 58, pages 338 to 345, March 1965. (see also reference 249.)

The production of ductile Co strip by the roll compaction of the metal powder is described. The chemical, physical and mechanical properties of the rolled strip are discussed.

284. Fraser, R. W., B. Meddings, D. J. I. Evans and V. N. Mackiw; Dispersion-Strengthened Nickel by Compaction and Rolling or Powder Produced by Pressure Hydrometallurgy; Modern Developments in Powder Metallurgy, Vol. 2, edited by H. Hausner, pages 87 to 111, Plenum Press, New York, 1965.

The fabrication of nickel-thoria strip by compaction and rolling of the powders is described. High-temperature properties are produced which are superior to nickel-base alloys prepared by conventional methods.

285. Huffman, H. R., B. Meddings and V. N. Mackiw; Modern Materials: Advances in Development and Applications; edited by B. W. Gouser, Vol. 5, pages 105 to 159, 1965.

The production of rolled strip by direct rolling of Ni, Co and Cu powders prepared by hydrogen precipitation is described. The characteristics of the powders produced by Sherritt Gordon Mines Ltd. are discussed and their economic applications to powder rolling is considered.

1965 - 286. Johnson, J. R.; A Rolling Theory for Granular Solids; Journal of Applied Mechanics (ASME Paper 65-APMW-16), 1965.

287. Katashinskii, V. P. and G. A. Vinogradov; A Method of Studying Specific Friction Force and Pressures in the Rolling of Metal Powders; Poroshkovaya Metallurgiya, Vol. 2, pages 4 to 8, February 1965. Translated in Soviet Powder Metallurgy and Metal Ceramics, pages 91 to 94, 1965.

A description is given of the method used to determine the specific friction force and radial pressure on the contact arc during the rolling of metal powders.

288. Katashinskii, V. P. and G. A. Vinogradov; Investigation into the Compactability of Metal Powders during Rolling; Poroshkovaya Metallurgiya, No. 5, pages 9 to 16, May 1965. Translated in Soviet Powder Metallurgy and Metal Ceramics, pages 356 to 361, 1965.

The compactability of metal powders during rolling is discussed. Data is presented for the relationship between density, thickness, maximum specific pressure and other parameters involved in powder rolling.

289. Katashinskii, V. P. and G. A. Vinogradov; The Rolling of Metal Powders in a Mill With a Single Driving Roll; Poroshkovaya Metallurgiya, No. 6, pages 1 to 4, 1965. Translated in Soviet Powder Metallurgy and Metal Ceramics, pages 435 to 437, 1965.

A description is given of the rolling of metal powders in a mill with a single driving roll. Data is presented on the specific pressure distribution during rolling and the mechanical properties of the rolled strip.

290. Katrus, O. N. and G. A. Vinogradov; Poroshkovaya Metallurgiya, No. 4, pages 34 to 41, January-February 1965.

The calculation of formulae to determine the ratio of the layers during rolling of two- and three-layer strip are given. Data from investigations using Fe, Cu, Ni and stainless steel powders are reported.

291. Katrus, O. A. and G. A. Vinogradov; Calculation of the Minimum Speed of Powder Rolling; Poroshkovaya Metallurgiya, No. 4, pages 9 to 12, April 1965. Translated in Soviet Powder Metallurgy and Metal Ceramics, pages 270 to 271, 1965.

Experimental work done on Fe, Ni and Cu powders to determine the minimum speed of rolling is reported.

1965 - 292. Katrus, O. A. and G. A. Vinogradov; Experience of Electrode Manufacture by Powder Rolling; Poroshkovaya Metallurgiya, No. 9, pages 28 to 33, September 1965. Translated in Soviet Powder Metallurgy and Metal Ceramics, pages 718 to 721, 1965.

The properties of Fe and Co electrode strip prepared by the roll compaction of metal powder is discussed.

293. Kennecott Copper Corporation; Process of Making Sheet Metal; Patent (U.K.) 1,115,723 (8/17/65).

A process is proposed which comprises the formation of metal sheet from a slurry mixture of metal powder and a plastic binder which can be burnt off during sintering. The process is especially applicable to the production of copper strip.

294. Lund, J. A. H.; Method for Compacting Metal Powder; Patent (U.S.A.) 3,162,708 (21/6/65).

A method is described in which flanges are mounted on the rolls to confine the metal powder within the roll gap and prevent flow or leakage from the ends of the rolls.

295. Maltsev, M. V., A. N. Nikolaev and V. G. Khromov; Determination of the Limiting Angle of Feed in Rolling Metal Powders; Poroshkovaya Metallurgiya, No. 5, pages 17 to 19, 1965. Translated in Soviet Powder Metallurgy and Metal Ceramics, pages 362 to 364, 1965. (see also reference 352.)

The limiting angle of feed in rolling iron and various brands of titanium powder is determined.

296. Naeser, G.; On the Continuous Compacting of Metallic Powders; Presented at the International Powder Metallurgy Conference, New York, June 14 to 17, 1965. (see also reference 328.)

The advantages of using roll compaction of powders over conventional methods for the preparation of strip products is discussed.

297. Pozin, Y. M., A. P. Murachkovskii and O. I. Bondarenko; Storage Battery Electrodes Made by Rolling Carbonyl Nickel Powder; Poroshkovaya Metallurgiya, No. 10, pages 5 to 10, 1965. Translated in Soviet Powder Metallurgy and Metal Ceramics, pages 787 to 791, 1965.

A description is given of the production of continuous electrode strip for Ni-Cd alkaline storage batteries by the roll compaction of carbonyl Ni + urea.

1965 - 298. Pozin, Y. M., M. S. Vogman, E. I. Gamaskin and O. I. Bondarenko; Production of Electrode Strip from Cadmium Oxide by Powder Rolling; Poroshkovaya Metallurgiya, No. 8, pages 103 to 107, August 1965. Translated in Soviet Powder Metallurgy and Metal Ceramics, pages 686 to 689, 1965.

The production of continuous electrode strip by roll compaction of cadmium oxide with addition of nickelous hydroxide and Na-carbonymethyl celluse is described.

299. Ready, T. J. and H. D. Lewis; A Technique for Powder Rolling Tungsten and Tungsten-45 V/O UO_2 Dispersion; International Journal of Powder Metallurgy, No. 1, pages 56 to 63, 1965.

The successful preparation of W and W-45 V/O UO_2 dispersion alloy strip by the roll compaction of the alloy powder is described.

300. Semenov, Y. N., I. Y. Kondratov and R. A. Semenov; The Application of Current-Conducting Powder Composition on Metal Parts by the Method of Roller-Welding Rolling; Poroshkovaya Metallurgiya, No. 7, pages 108 to 111, July 1965. Translated in Soviet Powder Metallurgy and Metal Ceramics, pages 602 to 604, 1965.

A method is developed for applying powder compositions to metal parts by the method of electric roller welding in combination with rolling of the powder.

301. Shaw, J. D. and W. V. Knopp; Roll Compacting of Copper Powders; American Society of Metals Technical Report, D5-3-3, 1965. (see also reference 333.)

302. Shelamov, V. A.; On the Possibility of Producing SAP Foil by Powder Rolling; Poroshkovaya Metallurgiya, No. 2, pages 104 to 109, February 1965. Translated in Soviet Powder Metallurgy and Metal Ceramics, pages 170 to 172, 1965. (see also reference 269.)

The studies carried out at the Belorussia Polytechnic Institute for the production of Al strip are reported.

303. Smirnov, U. S. and N. N. Pavlov; Trudy Leningradskogo Politechnicheskogo Instituta imeni M. I. Kalina, No. 260, 1965.

304. The British Iron and Steel Research Association, London, SW1; Patent (U.K.) 1,109,798 (5/11/65).

The compaction of metal powders between two rolls to form a self-supporting strip is described. Two jets of fluid passed between the rolls are used to define the desired strip width.

305. Tracey, V. A. and N. J. Williams; Electrochemical Technology, 3, 1965.

1965 - 306. Vinogradov, G. A., G. Y. Kalutskii and S. M. Ruvinskii; Manufacture of Steel-Aluminum Wire by the Powder Metallurgy Method; Poroshkovaya Metallurgiya, No. 10, pages 11 to 18, 1965. Translated in Soviet Powder Metallurgy and Metal Ceramics, pages 792 to 797, 1965.

A method for the manufacture of steel-aluminum wire by the roll compaction of Al powder on a steel core is described.

307. Vinogradov, G. A. and V. P. Katashinskii; The Rolling Coefficients of Metal Powders; Poroshkovaya Metallurgiya, No. 8, pages 19 to 22, August 1965. Translated in Soviet Powder Metallurgy and Metal Ceramics, pages 620 to 622, 1965.

An analysis is done, using a point dynamometer of the rolling coefficients of metal powders.

308. Vinogradov, G. A. and V. P. Katashinskii; The Angle Parameters of the Metal-Powder Rolling Process; Poroshkovaya Metallurgiya, No. 9, pages 34 to 39, September 1965. Translated in Soviet Powder Metallurgy and Metal Ceramics, pages 722 to 726, 1965.

The effect of maximum specific pressure and other rolling variables on the angle of feed, etc., involved in the roll compaction of metal powders was investigated. Data is given for the rolling of Al, Fe, Cu and Ni powders.

309. Vinogradov, G. A. and V. P. Katashinskii; The Mechanism of Compaction of Powders in Rolling; Proceedings of the 3rd International Conference on Powder Metallurgy, Eisenach, Berlin, 1965.

310. Williams, N. J. and V. A. Tracey; The Effect of Residual Porosity on the Properties of Roll-Compacted Nickel Strip; Symposium sur la Metallurgie des Poudres, Paris, 1964. Ed. Metaux Paris, pages 351 to 361, 1965.

311. Zhilkin, V. Z. and L. M. Gaidar; On the Assessment of Some Factors Involved in Rolling Metal Powders; Poroshkovaya Metallurgiya, No. 10, pages 19 to 26, October 1965. Translated in Soviet Powder Metallurgy and Metal Ceramics, pages 798 to 804, 1965.

Dimensional analysis is used to determine the relationship between the factors involved in the roll compaction of metal powders and the properties of the strip produced.

1966

1966 - 312. Aksenov, G. I. and V. P. Revyakin; Poroshkovaya Metallurgiya, 7, 1966.

313. Blore, M., D. V. Silins, S. Romanchuk, T. W. Benz and V. N. Mackiw; Pure Nickel Strip by Powder Rolling; Presented at Metals/Materials Congress, Detroit, 1965; Metals Engineering Quarterly, Vol. 6, No. 2, pages 54 to 60, 1966. (see also reference 279.)

The production of pure strip by the direct rolling of Ni powder produced by the Sherritt Gordon process is described. Properties of the finished strip are given and possible applications of the strip are suggested.

314. Borok, B. A. et al; Experiments with Powder Rolling in an Industrial Mill; Researches in Powder Metallurgy, ed. by B. A. Borok, pages 71 to 77, 1966.

The results of rolling experiments carried out on Fe, 1819 stainless steel, Ti, Mo, and oxidized Al powders in an industrial mill are reported.

315. Borok, B. A.; Recent Developments in Powder Metallurgy; Researches in Powder Metallurgy, ed. by B. A. Borok, pages 47 to 59, 1966.

The possible use of direct rolling of metal powder as a method for the commercial production of strip material is discussed.

316. Daugherty, T. S.; Fabrication of Commercial Aluminum Sheet from Finely Divided Particles by the Compacted Sheet Process; Modern Developments in Powder Metallurgy, ed. by H. Hausner, Plenum Press, New York, 1966.

The production of sheet by the roll compaction of hot Al particles is described.

317. Engineer, The; Rolling Mill Produces Thin Gauge Strip from Powder; Vol. 222, No. 5777, page 580, October 1966. (see also references 183, 344.)

A description is given of the rolling mill designed and built by Loma Machine Manufacturing Company, New York.

1966 - 318. Evans, P. E.; The Theoretical Optimum Rolling Speed in Powder Compaction; Modern Developments in Powder Metallurgy, ed. by H. Hausner, Plenum Press, New York, Vol. 1, pages 247 to 252, 1966. (see also reference 282.)

A report is presented on the investigation done by the author to determine the optimum speed to be used in the roll compaction of metal powders.

319. Ignatiev, B. G., L. B. Nejevenko, N. J. Polloratsky, G. S. Fomin and M. V. Yakutovich; Fabrication of Thin Plates from Refractory Carbides; International Journal of Powder Metallurgy, Vol. 2, No. 1, pages 33 to 39, 1966.

320. Katashinskii, V. P.; Analytical Determination of Specific Pressure during the Rolling of Metal Powders; Poroshkovaya Metallurgiya, No. 10, pages 1 to 10, October 1966. Translated in Soviet Powder Metallurgy and Metal Ceramics, pages 765 to 772, 1966.

Formulae are derived by the author to determine the specific pressure in the lag and forward slip zones. Relationships are also suggested between various other rolling parameters.

321. Katashinskii, V. P. and G. A. Vinogradov; Study of Specific Pressure during Metal Powder Rolling; Poroshkovaya Metallurgiya, No. 3, pages 21 to 26, March 1966. Translated in Soviet Powder Metallurgy and Metal Ceramics, pages 189 to 193, 1966.

A report is given on the investigation carried out to determine the distribution of specific pressure during metal powder rolling.

322. Katrus, O. A.; Some Problems on the Sintering and Densification of Rolled Powder Stock; Poroshkovaya Metallurgiya, No. 2, pages 31 to 39, February 1966. Translated in Soviet Powder Metallurgy and Metal Ceramics, pages 102 to 108, 1966.

The results of an investigation to determine the relationship between sintering time and temperature and the densification occurring in a rolled powder strip are reported.

323. Katrus, O. A., S. N. Kovalev, G. A. Vinogradov and E. B. Vernik; Manufacture of Diamond Tools by Rolling of Powders; Poroshkovaya Metallurgiya, No. 1, pages 81 to 84, January 1966. Translated in Soviet Powder Metallurgy and Metal Ceramics, pages 66 to 68, 1966.

The use of roll compaction of powders for the production of diamond tools is discussed.

324. Katrus, O. A., S. N. Kovalev, G. A. Vinogradov and E. B. Vernik; Proceedings of the 8th All-Union Conference on Progressive Methods of Metal Powder Parts; Minsk, 1966. (see also references 323, 325.)

1966 - 325. Katrus, O. A., S. N. Kovalev, G. A. Vinogradov and E. B. Vernik; Diamond-Bearing Grinding Materials Produced by Rolling Powders; Proceedings of the Second International Conference on Powder Metallurgy, Czechoslovakia, 1966. (see also references 323, 324.)

326. Malin, A. P., V. G. Khromov, G. F. Tikhonov and A. B. Suchkov; The Production of Sheets and Strips of Increased Density by the Direct Rolling of Electrolytic Titanium Powder; Researches in Powder Metallurgy, ed. by B. A. Borok, pages 79 to 86, 1966.

The methods used by the authors for the production of sheet from electrolytic Ti powder are described. Data are presented on the properties of the rolled strip.

327. Matsumura, G., S. Higuchi and M. Sasaki; Compaction of Reduced Iron Powder by a Sandwich Rolling Process; International Journal of Powder Metallurgy, Vol. 2, No. 1, pages 9 to 33, 1966.

A description is given of a process for forming Fe strip from Fe powder by the hot rolling of a sintered Fe sandwich consisting of Fe powder placed between two Fe sheets. The properties of the strip produced are given in the report.

328. Naesar, G.; On the continuous Compaction of Metallic Powders; Modern Developments in Powder Metallurgy, ed. by H. Hausner, Plenum Press, New York, Vol. 3, pages 202 to 205, 1966. (see also reference 296.)

329. Patwardhan, A. K. and G. S. Tendolkar; Roll Compacting of Metal Powder; Paper presented at the Nineteenth Annual Technical Meeting of the India Institute of Metals, Hyderabad, January 1966. Transactions of the Indian Institute of Metals, 19, pages 183 to 188, December 1966.

Results are given of the investigation into the rolling of electrolytic Cu powder in a standard two-high rolling mill. The effects of various roll variables on the strip produced were studied and the properties of the rolled product are listed.

330. Schey, J. A.; Prevention of Edge Cracking in Rolling by Means of Edge Restraint; Journal Institute of Metals, 94, pages 193 to 200, 1966.

An apparatus which has been used successfully during the rolling of metal powder is proposed for the prevention of edge cracking in rolled materials.

331. Severdenko, V. P. et al; Tsvetn. Metally, No. 7, 1966.

332. Severdenko, V. P. and E. B. Lozhechnikov; Proceedings of the 8th All-Union Conference on the Progressive Methods of Producing Metal Powder Parts; Minsk, 1966.

1966 - 333. Shaw, J. D. and W. V. Knopp; Roll Compacting of Copper and Copper Alloy Strip from Powders; International Journal of Powder Metallurgy, Vol. 2, No. 2, pages 29 to 34, April 1966. Paper presented at the National Metal Conference, Detroit, Michigan, 1965. (see also reference 301.)

The roll compaction of Cu alloy strip was investigated by the authors. Results of Tests are given and the properties of strip produced from the various alloy powders are tabulated.

334. Sobol, S. I., G. A. Vinogradov, V. A. Kononov and R. L. Oganyan; Manufacture of Copper Powder and Their Rolling; Izd. Tsvet., Moscow, 1966.

335. Spinov, U. A. and G. A. Vinogradov; Experience with the Production of Bronze-Graphite Strip by Powder Rolling; Poroshkovaya Metallurgiya, Vol. 6, No. 12, pages 9 to 14, December 1966. Translated in Soviet Powder Metallurgy and Metal Ceramics, pages 925 to 929, 1966.

The factors affecting the production and properties of strip rolled from Cu-Sn-graphite powders are discussed and data are given of the properties of the rolled product.

336. Tamura, K. and T. Noda; On Powder Rolling Process; Proceedings of Mining Lecture Meeting, Tokyo, pages 169 to 170, 1966.

337. Tikhonov, G. F. and A. V. Sivov; Proceedings of the 8th All-Union Conference on Progressive Method of Production Powder Metal Parts; Minsk, 1966.

338. Vinogradov, G. A. and V. P. Katashinskii (Institute for the Problems of Materials Technology, Kiev, (UKSSR) in Bericht uber die III. International Pulver-Metallurgische Tagung in Eisenach vom 13 to 15, pages 75 to 85, May 1966.

An examination of the rolling process for metal powders is conducted and angle parameters, specific rolling force, coefficient of expansion and physical properties of the strip product are investigated. Fe powder, in combination with two or more additives (Cr_3C_2, Co, Mo, Cr, W, Ni, Si, FeCr, and Mn), was used in the experiments.

339. Vinogradov, G. A., O. A. Katrus and R. L. Oganyan; Extending the Powder Rolling Velocity Range by Powder Wetting; Poroshkovaya Metallurgiya, No. 10, pages 16 to 26, October 1966. Translated in Soviet Powder Metallurgy and Metal Ceramics, pages 777 to 781, 1966.

The wetting of metal powder, when rolling with free gravity feeding is reported to extend the optimum rolling velocity range and increase output.

1967

1967 - 340. Aksenov, G. I., G. A. Vinogradov, E. B. Lozhechnikov and G. F. Tikhonov; Theory and Practice of Rolling Cermet Powders in the Soviet Union; Poroshkovaya Metallurgiya, No. 7, pages 9 to 18, November 1967. Translated in Soviet Powder Metallurgy and Metal Ceramics, pages 861 to 868, 1967.

A length review is given covering the investigation carried out in the Soviet Union from 1961 to 1967 on the roll compacting of metal powders.

341. Arbuzov, M. P. and T. I. Fedoruk; Poroshkovaya Metallurgiya, No. 3, 1967.

342. Berman, I., V. A. Shelomov and R. I. Shekhirev, Tsvetn. Metally, 8, 82, 1967.

343. Emley, F. and C. Deibel; A New Method for Compacting Metal or Ceramic Powders into Continuous Sections, New Methods for the Consolidation of Metal Powders, edited by H. Hausner, K. Roll and P. Johnson, Plenum Press, New York, pages 83 to 98, 1967. (see also references 161, 138.)

344. Engineer, The: Combination Horizontal-Vertical Rolling Mill; Vol. 224, No. 5418, page 142, July 1967. (see also references 183, 317.)

A description is given of an extra versatile, heavy-duty, high-precision, two-high and four-high combination rolling mill which can be used for rolling metal powders into strip. The mill was developed by the Loma Manufacturing Co., New York.

345. Evans, P. E.; The Mechanism of the Compaction of Metal Powders by Rolling; New Methods for the Consolidation of Metal Powders, edited by H. Hausner, K. Roll and P. Johnson, Plenum Press, New York, pages 99 to 118, 1967.

346. Evans, P. E. and G. C. Smith; The Compaction of Metal Powders by Rolling; New Methods for the Consolidation of Metal Powders, Edited by H. Hausner, K. Roll and P. Johnson, Plenum Press, New York, pages 119 to 168, 1967.

347. Gehring, E.; Methods and Means for Rolling Metal Powder; Patent (U.S.A.) 3,309,735 (21/3/67).

1967 - 348. Ioffe, R. S.; Analysis of Stresses in Powder Rolling; Poroshkovaya Metallurgiya, No. 5, pages 23 to 30, May 1967. Translated in Soviet Powder Metallurgy and Metal Ceramics, pages 357 to 363, 1967.

The results of an investigation by the author on the stresses generated in the hopper and in the lag zone during the powder rolling process are described.

349. Katashinskii, V. P. and G. A. Vinogradov; Elastic Compression of Rolls during the Rolling of Metal Powder; Poroshkovaya Metallurgiya, No. 7, pages 37 to 41, July 1967. Translated in Soviet Powder Metallurgy and Metal Ceramics, pages 542 to 544, 1967.

A report is given of the analysis of the elastic compression of rolls during the rolling of metal powders. The relationship between the angle of elastic roll compression and maximum pressure is established for Cu, Fe and Ni powders.

350. Lee. R. S. and E. G. Schwartz; An Analysis of Roll Pressure Distribution in Powder Rolling; International Journal of Powder Metallurgy, Vol. 3, No. 4, pages 83 to 92, October 1967.

The Coulomb type of yield criterion is used to describe the rolling of metal powder and the analytical expression is compared with published Russian theories.

351. Maltsev, M. V.; Investigation of the Rolling Process of Metal Powders; Dissertation, 1967.

352. Maltsev, M. V.; Calculation of the Limiting Feed in Vertical Powder Rolling; Poroshkovaya Metallurgiya, No. 3, pages 7 to 10, March 1967. Translated in Soviet Powder Metallurgy and Metal Ceramics, pages 174 to 177, 1967. (see also reference 295.)

An analytical expression is proposed for the conditions of the powder rolling process and data is presented on the limiting feed angles calculated for the expression.

353. Malvezzi, A.; Presented at Non-Ferrous Metal Congress, Italian Metallurgical Association, Milan, October 8 to 11, 1967. 16 pp.

The basic parameters of powder-rolling are discussed and some comparisons are made between sheet products obtained by rolling Ni, Cu, Ti, Pb, Al and Zn powders and the rolled strip manufactured by conventional methods.

1967 - 354. Spinov, V. A. and G. A. Vinogradov; Experimental Investigation of Specific Forces in Powder Rolling; Poroshkovaya Metallurgiya, No. 9, pages 1 to 5, September 1967. Translated in Soviet Powder Metallurgy and Metal Ceramics, pages 685 to 688, 1967.

A description is given of the method developed by the authors to study the force field in the deformation zone during powder rolling.

355. Spinov, V. A., G. A. Vinogradov and G. Y. Kalutskii; Influence of Air on the Rolling of Powders; Poroshkovaya Metallurgiya, No. 8, pages 97 to 99, August 1967. Translated in Soviet Powder Metallurgy and Metal Ceramics, pages 673 to 675, 1967.

The effect of the air stream in the hopped on the rolling of metal powders is discussed.

356. Tunderman, J.; Ph.D. Thesis, University of Wales, 1967.

357. Wright-Patterson Air Force Base, Ohio. Air Force Systems Command, Foreign Technology Division N68-26806 (FTD-MT-67-67: AD 668029), June 23, 1967, 94 pp.

A translation is presented of the book "Rolling of Metal Powders" by G. A. Vinogradov and Y. N. Semenov published in 1960. (see also reference 172.)

1968

1968 - 358. Aksenov, G. I., O. K. Kolerov and V. P. Revyakin; An X-ray Diffraction Study of Consolidation Processes in the Rolling of Nickel Powders; Poroshkovaya Metallurgiya, No. 5, pages 59 to 67, May 1968. Translated in Soviet Powder Metallurgy and Metal Ceramics, pages 385 to 391, 1968.

A study is presented of the compressibility of Ni powders in strip rolling. X-ray diffraction techniques are used to examine the starting material and the rolled product.

359. Claus, K. and E. Gehring; Presented at 2nd European Symposium on Powder Metallurgy, Stuttgart, 1968.

360. Daugherty, T. S.; Direct Roll Compacting Sheet from Particles; Powder Metallurgy, Vol. 11, No. 22, pages 342 to 354, Autumn 1968.

The direct roll-compacting process for the consolidation of particulate material into sheet form is described and comparisons are made between the compacting characteristics of fine and coarse particles. The method used for the roll compaction of powders at the Reynolds Metal Co. is discussed and some data is given on the properties of the sheet produced by the process.

361. Davies, I., A. G. Harris and W. H. Gibbon; Thin Steel Strip from Powder; Powder Metallurgy, Vol. 11, No. 22, pages 295 to 313, Autumn 1968.

A process for producing thin strip from iron and stainless steel powders is described and an economic assessment of the powder rolling method is given.

362. Evans, P. E.; The Continuous Roll Compaction of Powders; Metals and Materials, Vol. 2, No. 8, pages 235 to 240, August 1969.

A brief account of the powder rolling process is presented and some data is given on the properties of stainless steel strip rolled under moderate pressure.

363. Fraser, R. W. and D. J. I. Evans; The Properties of Cobalt-Iron Alloys Prepared by Powder Rolling; Powder Metallurgy, Vol. 11, No. 22, pages 358 to 378, Autumn 1968.

The production of Co-Fe alloys by Sherritt Gordon Mines Ltd. is described. An addition of 7% Fe suppressed the $\alpha \rightleftarrows \epsilon$ transformation in Co and this alloy was chosen for further study.

1968 - 364. Gaidar, L. M. and V. Z. Zhilkin; Forward Slip in the Rolling of Strip from Metal Powders; Poroshkovaya Metallurgiya, No. 4, pages 10 to 14, April 1968. Translated in Soviet Powder Metallurgy and Metal Ceramics, pages 258 to 261, 1968.

An analysis of the forward slip involved in the rolling of metal powders is presented.

365. Johnson, Peter; Industrial Research, October 1968.

366. Katashinskii, V. P.; Determination of the Rolling Moment in Metal Powder Rolling; Poroshkovaya Metallurgiya, No. 12, pages 13 to 17, December 1968. Translated in Soviet Powder Metallurgy and Metal Ceramics, pages 941 to 944, 1968.

A technique is proposed for the determination of the rolling moment of metal powders and the method of calculation is tested against experimental data.

367. Katrus, O. A., R. L. Oganyan and A. P. Savitskii; Physio-Mechanical Properties and Microstructure of Densified Strip Rolled from Copper Powder; Poroshkovaya Metallurgiya, No. 10, pages 15 to 21, October 1968. Translated in Soviet Powder Metallurgy and Metal Ceramics, pages 765 to 769, 1968.

The mechanical properties of Cu strip produced by the roll compaction of the powder are given. The results of powder wetting experiments on the properties of the rolled product are discussed.

368. Kimura, T., H. Hirabayashi and M. Tokuyoshi; Study on Continuous Rolling Fabrication of Iron Strip from Metal Powders; Iron Powder Metallurgy, edited by H. Hausner, K. Roll, and P. Johnson, Plenum Press, New York, N. Y. pages 161 to 183, 1968.

369. Lyon, D. L., Report AFML TR67-387, Amplex Division, Chrysler Corp., Detroit, Michigan, Contract AF 33 (615) 3998, January 1968.

370. Maltsev, N. V., Trudy Gorkovskogo Politechnichstogo Instituta, Vol. 24, No. 3, pages 78 to 79, 1968. Referativnyi Zhurnal, Metallurgiya, No. 9, 9G331, September 1968.

The parameters involved in the rolling of metal powders are discussed.

371. Maltsev, M. V., A. N. Nkkolaev, G. F. Tikhonov and V. G. Hromov; Trudy Gorkovskogo Politechnichskogo Instituta, Vol. 24, No. 3, pages 79 to 80, 1968.

Many different powders were used in an experiment to determine the maximum angle of grip, coefficient of friction, and coefficient of lateral pressure.

1968 - 372. Malvezzi, A; La Metallurgia Italiana, Vol. 60, No. 6, pages 553 to 556, June 1968.

The physical and technological characteristics of the rolled products produced from brass, Cu, Zn, and Pb powders are discussed.

373. Malvezzi, A. and J. Tangerini; La Metallurgia Italiana, Vol. 60, No. 11, pages 945 to 948, November 1968.

The rolling of Zn granules (0.2 to 1.0 mm size) in a conventional rolling mill with 250-mm-diameter rolls is described. The strip is compared to that produced by conventional methods.

374. Missol, W. and A. Cyunczyk; Rudi i Metale Niezelazne, Vol. 13, No. 9, pages 444 to 449, September 1969.

The theory of powder rolling from its inception at the turn of the century is discussed. The parameters involved are examined in detail and a description is given of the sintering and post-sintering operations.

375. Missol, W. and A. Cyunczyk; Rudi i Metale Niezelazne, Vol. 13, No. 10, pages 512 to 517, October 1968.

A state-of-the-art report of powder rolling is presented and the trends in roll compaction are examined. A schematic diagram is given of an experimental rolling mill for studying the porosity of bronze strip.

376. Nikolaev, A. N.; Trudy Gorkovskogo Politechnichskogo Instituta, Vol. 24, No. 3, page 83, 1969. Referativnyi Zhurnal Metallurgiya, No. 9, 9G 389, September 1968. (see also reference 377.)

The hot rolling of metal powders is described.

377. Nikolaev, A. N. and Yu. A. Shmotkin; Hot Rolling of Blanks from Copper and Nickel Powders; Poroshkovaya Metallurgiya, No. 6, Pages 25 to 28, June 1968. Translated in Soviet Powder Metallurgy and Metal Ceramics, pages 444 to 447, 1968. (see also reference 376.)

The hot rolling of preformed blanks of electrolytic Cu and carbonyl Ni powders is described and the mechanical properties of the product are cited.

378. Revyakin, V. P.; Investigation of Some Metal Powder Rolling Techniques; Dissertation, 1968.

379. Roman, O. V.; Some New Methods of Metal Powder Compacting; Vortrag. 2nd European Symposium Pulvermetallurgie, Stuttgart, Berlin, No. 4, 1968.

1968 - 380. Schloemann, A. G.; Streinstrasse, Dusseldorf, Germany, Patent (U.K.) 1,243,649 (13/8/68).

The manufacture of metal strips by rolling particles contained in a tube closed at one end is described.

381. Shakespeare, C. R.; The Economics of Stainless-Steel Strip Production by Roll Compaction; Powder Metallurgy, Vol. 11, No. 22, pages 379 to 399, Autumn 1968.

The economics of stainless steel strip production by roll compaction is analyzed.

382. Shmotkin, Y. A.; Trudy Gorkovskogo Politechnichskogo Instituta, Vol. 24, No. 3, page 95, 1968. Referativnyi Zhurnal, Metallurgiya, No. 9, 9G3448, September 1968.

The investigation of such factors as chemical composition and annealing temperature on the properties of hot rolled Fe, Cu, and Ni is described.

383. Smirnov, V. S., N. N. Pavlov and N. N. Tselin; Analytical Method for Determining the Rolling Angle; Poroshkovaya Metallurgiya, No. 3, pages 6 to 10, March 1968. Translated in Soviet Powder Metallurgy and Metal Ceramics, pages 165 to 168, 1968.

Analytical relationships are suggested for determining the rolling angle involved in the roll compaction of metal powders and the distribution of the density over the arc of rolling.

384. Smirnov, V. S., N. N. Pavlov and N. N. Tselin: Microstructure of Pressed and Rolled Porous Powder Blanks; Poroshkovaya Metallurgiya, No. 6, pages 21 to 24, June 1968. Translated in Soviet Powder Metallurgy and Metal Ceramics, pages 441 to 443, 1968.

The microstructure of pressed and rolled porous blanks made from Fe and Carbonyl Ni powder is examined.

385. Sorokin, V. K.; Trudy Gorkovskogo Polytechnichskogo Instituta, Vol. 24, No. 12, pages 9 to 11, 1968.

The compaction of metal powders occurring during the roll-compaction process is analyzed.

386. Spinov, V. A. and G. A. Vinogradov; Relationship between the Maximum Thickness and Width of Roll Compacted Strip; Poroshkovaya Metallurgiya, No. 8, pages 1 to 4, August 1968. Translated in Soviet Powder Metallurgy and Metal Ceramics, pages 593 to 595, 1968.

A report is given by the authors on the determination of the relationship between the thickness and width of strip compacted by rolling. The mechanical properties of the product are discussed.

1968 - 387. Stephens, D. M. and G. Greetham; The Production of Porous Nickel Strip by Direct Rolling of Powder; Powder Metallurgy, Vol. 11, No. 22, pages 330 to 341, Autumn 1968.

An experimental mill used for the production of thin porous Ni sheet is described and an illustration of the technique of powder rolling is presented. The effect of strip porosity on the permeability, pore size and tensile strength of the product is discussed.

388. Sturgeon, G. M., G. Jackson, V. Barker and G. M. H. Sykes; The Production of Stainless-Steel Strip from Powder; Powder Metallurgy, Vol. 11, No. 22, pages 314 to 329, Autumn 1968.

The production of stainless-steel strip from water-atomized powder is described. The properties of the strip product are given.

389. Tamura, K., T. Noda and O. Yamazaki; Journal of the Japan Society of Powder and Powder Metallurgy; Vol. 15, No. 1, pages 19 to 25, January 1968.

A comparison is presented on the properties of Mo strip rolled from metal powders and those of conventionally rolled sheet.

390. Tamura, K., T. Noda and O. Yamazaki; Journal of the Japan Society of Powder and Powder Metallurgy, Vol. 15, No. 11, pages 16 to 30, January 1968.

A discussion is given on an investigation conducted by the authors into the packing of Mo powder in the roll gap during roll compaction of the powder.

391. Tunderman, J. H. and A. R. E. Singer; The Flow of Iron Powders during Roll Compaction; Powder Metallurgy, Vol. 11, No. 22, pages 261 to 264, Autumn 1968.

A description is given of the direct rolling process used to compact several Fe powders into strip. The variables concerned with powder feed are related to the flow properties of the powders and to the physical properties of the resultant strip.

392. Visconti, I. C., Metallurgiya Italiana, 60, 11, 908, 1968.

393. Wong, S. and R. Davies; Some Effect of High Speeds in Metal Powder Compaction; Vortrag, International Machine Tool Design Research Conference, Birmingham, 1968.

1968 - 394. Williams, N. J. and V. A. Tracey; Porous Nickel for Alkaline Battery and Fuel Cell Electrodes: Production by Roll Compaction; International Journal of Powder Metallurgy, Vol. 4, No. 21, pages 47 to 62, 1968.

The parameters associated with the roll compaction of carbonyl Ni powders are outlined and the application of roll compaction to the production of electrode strip, by this method, for use in alkaline battery systems is discussed.

1969

1969 - 395. Aksenov, G. I. and V. P. Revyakin; Research on Intensifying the Rolling of Metal Powders; Poroshkovaya Metallurgiya, Vol. 75, No. 3, pages 32 to 37, March 1969. Translated in Soviet Powder Metallurgy and Metal Ceramics, pages 198 to 201, 1969.

A report is given on the experiments carried out to determine the effect of roller magnetization and additional pressure on powders in the hopper on the force parameters, the main angle of rolling and the properties of the rolled strip.

396. Aksenov, G. I. and V. P. Revyakin; Investigating the Main Angles and Force Factors of Rolling; Poroshkovaya Metallurgiya, Vol. 76, No. 4, pages 18 to 25, April 1969. Translated in Soviet Powder Metallurgy and Metal Ceramics, pages 272 to 277, 1969.

Fifteen types of powder, distinguished by method of manufacture or compaction, were rolled and the influence of their physical properties on the force parameters, powder feed angles and quality of rolled strip is reported.

397. Arbuzov, M. P. and I. I. Fedoruk; Texture of Strip Rolled from Nickel Powder; Poroshkovaya Metallurgiya, No. 3, pages 26 to 28, March 1969. Translated in Soviet Powder Metallurgy and Metal Ceramics, pages 192 to 193, 1969.

A report is presented on the investigation carried out to determine the grain orientation resulting from the rolling of Ni powder.

398. Ayres, M. D.; The Production and Properties of P/M Steel Strip; Progress in Powder Metallurgy, pages 53 to 62, Metal Powder Industries Federation, New York, 1969.

The process used at the Metal Innovations Inc. plant at Stamford, Conn. for the production of steel strip is described.

399. Borok, B. A., G. F. Tikhonov, A. N. Nikolaev and Y. N. Shmotkin; Metallokeran Materialy i Izdiliya Erivan, pages 102 to 106, 1969. Referativnyi Zhurnal, Metallurgiya, 11, 11G 411, 1969.

The hot rolling of two types of Fe powder is described.

400. British Iron and Steel Research Association; Patent (U.S.) 3,632,244 (30/10/69).

A method is proposed which improves the means for producing sheet from metal powders. A gauge is used to measure the density of the rolled product and a signal arrangement from the gauge can alter the feed arrangement to give a strip of constant density.

1969 - 401. Gaidar, L. M.; Periods of Metal Powder Rolling; Poroshkovaya Metallurgiya, No. 3, pages 29 to 31, March 1969. Translated in Soviet Powder Metallurgy and Metal Ceramics, pages 195 to 197, 1969.

The influence of rate of rolling, the space between the rollers and the initial thickness of powder bulk on the various periods of rolling are discussed. Results of an investigation of the above parameters using steel powder are presented.

402. Huffman, R.; Presented at 8th Conference of Metallurgists, University of Windsor, Canada, August 25 to 27, 1969.

The present problems and future possibilities for powder rolling are discussed in terms of powder available, operation and product quality.

403. Ioffe, R. S.; Poroshkovaya Metallurgiya, Vol. 74, No. 2, pages 3 to 6, February 1969.

An analysis was done on the stresses involved during the rolling of powders at low compaction pressures and the dependence of the boundary angle of supply on roll parameters.

404. Iron Age Metalworking International, Vol. 8, No. 10, page 32, October 1969.

The BISRA process for the production of Fe and stainless steel strip is described and the cost of production is assessed. The mechanical properties of the rolled material are compared to those of conventional rolled strip.

405. Jaffrey, W. G., I. Davies and R. Taylor; Thin Steel Strip from Powder; Science Journal, pages 61 to 67, September 1969.

The production of thin steel strip from powder by roll compaction of a wetted Fe powder spread on a substrate is described.

406. Joyce, J. F.; DMIC Review of Recent Developments; June 1969, 4 pp.

Recent work done in the area of powder metallurgy is reviewed. Powder rolling is one of the topics discussed by the author.

407. Katrus, O. A. and V. K. Gribkov; Mechanical Properties and Microstructure of Two-Layer Rolled Nickel-Molybdenum Strip; Poroshkovaya Metallurgiya, No. 8, pages 31 to 33, August 1969. Translated in Soviet Powder Metallurgy and Metal Ceramics, pages 628 to 629, 1969.

A technique for the production of multi-layer components by using Mo coated with a ductile metal such as Ni is described.

1969 - 408. Lucas, Joseph (Industries) Ltd., Birmingham, England; Patent (U.S.A.) 3,608,027 (29/7/69).

A description is given of the paremeters necessary to give optimum results during the rolling of powders to form dispersion strengthened lead.

409. Metal Bulletin, Vol. 34, No. 5387, April 1969.

A report is given of work done in the U.K. on the making of stainless steel strip from powder.

410. Powder Metallurgy, Vol. 12, No. 23, pages 255 to 261, Spring 1969.

A discussion is presented of the papers given at the 1968 meeting of the Powder Metallurgy Joint Group in Swansea.

411. Severdenko, V. P., E. B. Lozhechnikov, Z. V. Goryacheva, E. I. Pavlovskaya and U. A. Shtutman; Plasticheskaya Deformatseya i Olrabotka Metallov Davleniem, Minsk, Nauka i Tekhnika, pages 117 to 123, 1969.

The results of experiments done by the authors in the rolling of porous strip directly from atomized stainless steel powders is given.

412. Thiagarajan, K. and G. S. Tendolkar; Evaluation of Powder Characteristics for Rolling; Transactions of the India Institute Metals, Vol. 22, No. 2, pages 43 to 46, June 1969.

The investigation conducted to relate the physical and mechanical properties of strip rolled from Rz iron powder to the characteristics of the powder from the same roll parameters is described. An attempt is made to determine the optimum characteristics of the powder for the production of high-quality strip.

413. Tikhonov, G. F. and V. K. Sorokin; Preparation of Porous Titanium by Rolling Powder; Poroshkovaya Metallurgiya, Vol. 9, No. 2, pages 107 to 109, February 1969. Translated in Soviet Powder Metallurgy and Metal Ceramics, pages 167 to 169, 1969.

The roll compaction of Ti powder in a vertical roll mill is described. Data is presented on the properties of the rolled strip.

414. Tracey, V. A.; The Roll Compaction of Metal Powders; Powder Metallurgy, Vol. 12, pages 598 to 612, 1969.

1969 - 415. Tundermann, J. H. and A. E. Singer; Deformation and Densification during the Rolling of Metal Powders; Powder Metallurgy, Vol. 12, pages 219 to 242, 1969.

The deformation of particles during roll compaction and the process of densification which occurs during the rolling is discussed.

416. Vinogradov, G. A. and G. Y. Kalutskii; Anisotropy of Roll Compacted Aluminum Strip; Poroshkovaya Metallurgiya, No. 7, pages 45 to 50, July 1969. Translated in Soviet Powder Metallurgy and Metal Ceramics, pages 554 to 558, 1969.

The plasticity, tensile strength and electrical resistance of powder rolled Al sheet is studied in both the transverse and longitudinal directions.

417. Vinogradov, G. A., Y. N. Semenov, O. A. Katrus and V. P. Katashinskii; Metal Powder Rolling; Metallurgiya, 1969, 381 pp. In Russian.

The subject of powder rolling is treated in a fundamental way in this book. The authors have reviewed many sources (predominantly USSR) dealing with the roll compaction of metal powders.

418. Visconti, I. C.; The Direct Rolling of Metal Powders in Fibre Metallurgy; Metallurgiya Italiana 61, pages 550 to 555, 1969.

A state-of-the-art report is given on the direct rolling of metal powders. The author's own experiments are included in the review. An English translation is available from Henry Brutscher, Technical Translations, P. O. Box 157, Altadena, California (HB 8134).

1970

1970 - 419. Akensov, G. I.; Theory of Powder Rolling, Part I; Poroshkovaya Metallurgiya, No. 5, pages 23 to 28, May 1970. Translated in Soviet Powder Metallurgy and Metal Ceramics, pages 370 to 374, 1970.

An examination is made of the first steps in the compaction of metal powders. The plastic deformation of the particles is examined and an attempt is made to explain the compressibility of the powder particles by a compaction equation.

420. Aksenov, G. I.; Theory of Powder Rolling, Part II; Poroshkovaya Metallurgiya, No. 6, pages 25 to 30, June 1970. Translated in Soviet Powder Metallurgy and Metal Ceramics, pages 456 to 460, 1970.

An equation is deduced which describes the distribution of specific pressure according to a compaction curve and by integration of the equation a formula is obtained which defines the total pressure on the rollers.

421. Aksenov, G. I. and L. A. Panova, Tr. Knibyshev. aviats inst., 42, pages 9 to 16, 1970.

The gas permeability of metal powders and the effect of the expulsion of gas during the rolling of metal powders on the strip product are examined. An attempt is also made to determine the critical permeability on the height of the powder in the bunker.

422. Bokov, L. C., Trudy Gorkovskogo Politechnichskogo Instituta, No. 15, pages 28 to 32, 1970.

The production of the strip by the roll compaction of Al powder is described.

423. Evans, P. E.; Maximum Powder Rolling Speed, Theoretical and Experimental; Presented at International Powder Metallurgy Conference, New York, N. Y., 1970. (see also references 282, 318, 458.)

424. Harris, H. M., B. L. Forkner and H. J. Kelly; Rolling Forming Strip from Oxide Powders; Bureau of Mines, Department of the Interior, U.S.A., RI 7463, December 1970.

The results of an investigation to determine the conditions and parameters required to form ceramic strip from oxide powders is reported.

1970 - 425. Hirsch, H. H.; The Production of Aluminum Strip Heaters Using a Novel Hot Powder Rolling Technique; Presented at the International Powder Metallurgy Conference, New York, N. Y., 1970.

The production of strip heaters by the roll compaction of hot Al powders around a resistance wire is described.

426. International Lead Zinc Research Organization Inc., New York, U.S.A.; Patent (U.K.) 1,258,214 (16/3/70).

A method is disclosed in which Zn or Zn alloy strip is formed by the hot rolling of the powder. A continuous process to produce strip from the molten metal stage is also suggested.

427. Kamijo, T. and K. Sekind; Rolling Texture in Copper Powder; Nippon Kinzoku Gakkashi, 34, pages 913 to 915, 1970.

428. Katrus, O. A., R. L. Oganyan and V. N. Artemiev; Powoshkovaya Metallurgiya, No. 10, page 1 to 3, October 1970.

The effect of gas permeability in metal powders on the roll compactability of the powders is discussed.

429. Lancaster, J.; Aluminized Steel Strip through Powder Metallurgy; Precision Metal Molding, pages 85 to 87, March 1970.

430. Lyon, D. L.; A Slip Casting Process for Rolling Metal Powders into Strip and Steel; Presented at International Powder Metallurgy Conference, New York, N. Y., 1970.

431. Maltsev, M. V., V. G. Khromov and Z. N. Malyshkina; Trudy Gorkovskogo Politechnichskogo Instituta, Vol. 26, No. 15, pages 33 to 40, 1970.

The production of Ti strip by the roll compaction of Ti powder is described.

432. Missol, W. and S. Z. Kierkowski; Metallurgia Proszkow, No. 1, pages 12 to 18, 1970. In Polish.

A description is given of the process used for the production of high-porosity Ni strip by powder rolling. The strip is used for the manufacture of flat electrodes for alkaline accumulators.

433. Musikhin, A. M., E. D. Ter-Pogosyan, R. K. Ognev, G. G. Kolomov and A. I. Perevyazko, Sbornik Trudov. Vsesoyuznyi Nauchno Issled. tel'skii in Proektnyi Institut Titana, 4, pages 157 to 161, 1970.

The rolling of strip from Ti powder is described.

1970 - 434. Musikhin, A. M. and G. A. Vinogradov; High-Speed Rolling of Metal Powders; Poroshkovaya Metallurgiya, No. 6, pages 17 to 24, June 1970. Translated in Soviet Powder Metallurgy and Metal Ceramics, pages 450 to 455, 1970. (see also reference 435.)

An apparatus for force feeding of powders into the roll gap which permitted higher rolling speeds for the compaction of metal powder is described and illustrated. The effect of various parameters on the rolling of Fe and Ti powders is discussed.

435. Musikhin, A. M., G. A. Vinogradov, R. K. Ognev, G. G. Kolomov and E. D. Ter-Pogosyon; Sbornik Trudov Vsesoyuznyi Nauchno Issled. tel'skii in Proektnyi Institut Titana, 1, pages 100 to 105, 1970. (see also reference 434.)

Fe and Ti powders are used in an experiment to determine the effectiveness of force-feeding techniques in increasing the rate of rolling of metal powders.

436. Nikolaev, A. N. and V. A. Khrenov; Trudy Gorkovskogo Politechnichskogo Instituta, Vol. 26, No. 15, pages 7 to 11, 1970.

The effect of hopper feeding metal powders into a roll gap was investigated using Fe powder and an alloy containing 95% Fe and 5% Cu.

437. Nikolaev, A. and U. Shmotkin; Presented at Scientific Technical Conference on Shaping of Powder Materials, Leningrad, February 24 to 26, 1970. Trudy Gorkovskogo Polytechnichskogo Instituta, Vol. 26, No. 15, pages 18 to 23, 1970.

A description is given of a process for hot rolling of metal powders.

438. Podznyak, N. A.; Scientific-Technical Conference on the Shaping of Powder Materials; Poroshkovaya Metallurgiya, No. 6, pages 102 to 103, June 1970. Translated in Soviet Powder Metallurgy and Metal Ceramics, pages 517 to 518, 1970.

A general report is given on the articles presented in the conference on the production of powder materials.

439. Precision Metal; Future for Powder Metallurgy; September 1970.

440. Pyryalov, L. A., G. F. Tikhonov and A. V. Sivov; Effect of Surface Active Substances on the Properties of Porous Rolled Strip; Presented at Scientific-Technical Conference on the Shaping of Powder Materials, Leningrad, February 24 to 26, 1970.

441. Ramakrishman, P. and Vindykumar, A.; Poroshkovaya Metallurgiya, Vol. 10, No. 99, 1970.

1970 - 442. Repin, R. A., V. P. Severdenko and E. B. Lozhechnikov; Shaping and Properties of Al Strip Produced by Granule Rolling; Presented at Scientific-Technical Conference on the Shaping of Powder Materials, Leningrad, February 24 to 26, 1970.

443. Schey, J. A.; Metal Deformation Processes; edited by J. A. Schey, Chapters 2, 6, Marcel Decker Incorporated, New York, 1970.

444. Severdenko, V. P., E. B. Lozhechnikov and M. A. Boch; Izv. AN BSSR Ser., fiz-tekhn., No. 4, pages 124 to 127, 1970. In Russian.

The variation of the energy parameters involved in the rolling of metal powders with the thickness of the strip for a given density was determined and a formula was obtained for the relationship. Fe, Ni, Cu, and dispersion strengthened Ni and Cu powders were used in the investigation.

445. Sherritt Gordon Mines Ltd.; Toronto, Canada, Press Release, 1970.

A description is given of the physical properties of Co coiled strip (99% purity) rolled by Sherritt Gordon Mines Ltd.

446. Shishkin, B. G., N. Pavlov and A. M. Verblovskii; Production of Strip from Carbonyl Nickel Powders; Presented at Scientific-Technical Conference on the Shaping of Powder Materials, Leningrad, February 24 to 26, 1970.

447. Sorokin, V. K.; Effect of Rolling Pressure on the Density of Sintered Strip; Poroshkovaya Metallurgiya, No. 7, pages 18 to 20, July 1970. Translated in Soviet Powder Metallurgy and Metal Ceramics, pages 537 to 539, 1970.

The effect of the specific pressure of rolling on the density of rolled strip is discussed. Results are given of tests done on Fe, Ni, Ti, Cu, Al, and stainless steel powders.

448. Spinov, V. A.; Analysis of Shape Variations in the Deformation Zone during Powder Rolling; Poroshkovaya Metallurgiya, No. 7, pages 11 to 17, July 1970. Translated in Soviet Powder Metallurgy and Metal Ceramics, pages 532 to 536, 1970.

An analysis is presented on the compactability of metal powders in various regions during powder rolling.

449. Trudy Gorkovskogo Politechnicheskogo Instituta, Vol. 26, No. 15, Gor'kii, 1970. 41 pp.

The rolling and sintering of metal powders to give porous or dense sheets is discussed.

1970 - 450. Vinogradov, G. A.; Contemporary Problems; Nauk. Dumka, Kiev, pages 61 to 70, 1970. In Russian.

The possible applications and production techniques for roll compaction of metal powders is discussed. The effect of some variables on the properties of the strip product are analyzed.

451. Vinogradov, G. A. Y. N. Semenov, O. A. Katrus and V. P. Katashinskii; Rolling of Metal Powders; Poroshkovaya Metallurgiya, No. 6, page 101, June 1970. Translated in Soviet Powder Metallurgy and Metal Ceramics, pages 515 to 516, 1970.

The recently published book by the authors is reviewed by V. P. Severdenko and E. B. Lozhechnikov.

452. Visconti, I. C. and G. Tocchelti; New Technology of Making Metal Composites Based on Direct Rolling of Powders; Presented at International Powder Metallurgy Conference, New York, 1970.

1971

1971 - 453. Babaritskii, K. A., A. K. Gaiduchenko, E. Y. Popichenko and O. A. Katrus; Industrial Production of Sintered Electrode Strip; Poroshkovaya Metallurgiya, No. 1, pages 95 to 97, 1971. Translated in Soviet Powder Metallurgy and Metal Ceramics, pages 75 to 77, 1971.

The production of electrode strip on an industrial scale from grinding of the powders to the sintering of the strip is described.

454. Baralis, G. et al.; Metal Sheets by Particle Rolling; Presented at the Third European Powder Metallurgy Symposium, Brighton, England, November 9 to 12, 1971.

455. Beshtak, B., L. Gablyanovsky and V. Krokhnal; Rudy i Metale Niezilazne, No. 1, pages 16 to 21, 1971.

The methods and measurements used to determine the strength and energy parameters involved in the hot rolling of non-ferrous metals on a two-high rolling machine are studied.

456. Bocchini, G. F.; Rev. Mecc., Vol. 22, No. 490, page 55, 1971. In Italian.

The compaction of metal powders by direct rolling is discussed.

457. Dixon, C. and N. S. Spence; Examination of Cold-Rolled High Purity Nickel Produced by Sherritt Gordon Mines Limited for Coin Production; Mines Branch Investigation Report IR 71-51, August 1971.

The effect of cold work on the metallographic structure, hardness and magnetic permeability of Sherritt Gordon Mines Limited SGM Ni sheet is discussed.

458. Evans, P. E.; Maximum Rolling Speed: Theoretical and Experimental; Modern Developments in Powder Metallurgy, Vol. 4, edited by H. Hausner, Pages 549 to 556, Plenum Press, New York, 1971. (see also reference 423.)

An analysis is presented which can be used with direct fluidization cell measurements to predict the maximum rolling speed for a given powder.

1971 - 459. Harris, H. M., R. L. Forkner and H. J. Kelly (U.S. Bureau of Mines, Albany, Oregon); American Ceramic Society Bulletin, 50, (4), April 1971. Abstract of paper presented at the 73rd Annual Meeting of the American Ceramic Society, Chicago, 6-1P-71, April 1971. (see also reference 424.)

The roll parameters involved in the compaction of oxide powders were investigated. Rolled Strip was produced from alumina, zirconium and porcelain material by sintering roll strip formed from the powders which contained minimal amounts of binder and water.

460. Hirsch, H.; The Production of Aluminum Strip Heaters Using a Novel Hot Powder Rolling Technique; Modern Developments in Powder Metallurgy, edited by H. Hausner, pages 537 to 548, Plenum Press, New York, 1971.

The production of strip heaters by the roll compaction of hot Al granules on a resistance wire is described.

461. Ioffe, R. S.; Analysis of Shear Stresses and Strains in Powder Metallurgy; Poroshkovaya Metallurgiya, No. 2, pages 25 to 32, 1971. Translated in Soviet Powder Metallurgy and Metal Ceramics, pages 103 to 109, 1971.

An analysis of the pressure which occurs on metal powders during rolling and the shear stress involved in the roll compaction process is given.

462. Katrus, O. A. and A. V. Aleshina; Short-Time Sintering of Porous Rolled Strip from Stainless Steel Powders; Poroshkovaya Metallurgiya, No. 5, Pages 40 to 42, 1971. Translated in Soviet Powder Metallurgy and Metal Ceramics, pages 377 to 379, 1971.

A description is given of the production of filter materials from stainless steel powders rolled and then sintered in hydrogen at 1300-1400°C.

463. Katrus, O. A. and A. V. Aleshina; Poroshkovaya Metallurgiya, No. 12, pages 32 to 34, December 1971.

The production of porous Ti sheet by the roll compaction of the metal powder is described. The sintering of the rolled Ti sheet in argon at 1300-1400°C is discussed.

464. Katrus, O. A. and R. L. Oganyan; Poroshkovaya Metallurgiya, No. 7, pages 12 to 18, July 1971.

A formula is established for the cupper critical velocity of powder rolling from tests conducted on different grades of Fe powder, electrolytic Cu powder and reduced Ti powder.

1971 - 465. Katrus, O. A. and A. I. Otrok; Powoshkovaya Metallurgiya, No. 8, pages 36 to 40, August 1971.

The stratification of rolled sheet was investigated as a function of screen analysis, particle shape and surface state of the powder. Fe, Mo, Ti, Ni and Cu powders were used in the project.

466. Kuznetsov, N. V., V. N. Bogdonov and N. G. Bekin; 22nd Scientific Conference of the Yaroslovsky Technological Institute, 293, 1971.

A formula is derived which relates the specific thrust forces in the rollers and the shear stresses along the roller circumference.

467. Lafferty, W. D., W. E. Buescher and L. P. Clare; Powder Rolled, Oxide-Strengthened Cathode Nickel; Modern Developments in Powder Metallurgy, edited by H. Hausner, K. Roll and P. Johnson, pages 583 to 590, Plenum Press, New York, 1971.

The effect of adding ThO_2 to Ni powder for the production of cathode Ni for electron tube use is reported.

468. Maltsev, M. V.; Poroshkovaya Metallurgiya, No. 6, pages 19 to 24, June 1971.

Data is presented on the properties of sheet produced by rolling stainless steel powder containing Fe, Ti and Cu.

469. Milner, A. and T. M. Morris (Department of Metallurgical Engineering, University of Arizona, Tucson, U.S.A.); The Economics of a New Process of Electrolytic Powder Production for Rolling to Strip; Powder Metallurgy, pages 249 to 259, 1971.

The preparation of a new type of electrolytic powder is described. Its possible use for the powder rolling technique as a method for compaction is discussed.

470. Musikhin, A. M. and G. A. Vinogradov; Poroshkovaya Metallurgiya, No. 2, pages 104 to 106, 1971.

The effect of powder height in the hopper arrangement for powder rolling is discussed.

471. Ramakrishnan, P.; Production of Metal Strips by Roll Compaction; Presented at the Indian Institue of Metals Conference, 1971.

472. Ramakrishnan, P.; The Fabrication of Aluminum-Silicon Alloy Strip by Roll Compacting Granules; Third European Powder Metallurgy Symposium, Conference Supplement, Part I, pages 363 to 364, 1971. Powder Metallurgy Special Issue, pages 363 to 373, 1971.

A description is given of the production of Al-Si strip by roll compaction of the alloy powder. The effect of various roll variables on the resultant strip product is discussed.

1971 - 473. Severdenko, V. P., E. B. Lozhechnikov and R. A. Repin; Poroshkovaya Metallurgiya, No. 12, pages 25 to 31, December 1971.

The structural and technological properties of metal rolled from Al powders are given.

474. Shmelov, L. S.; Industrial Production of Porous Strip from Stainless Steel and Titanium Powder; Poroshkovaya Metallurgiya, No. 1, pages 93 to 94, January 1971. Translated in Soviet Powder Metallurgy and Metal Ceramics, pages 73 to 74, 1971.

The industrial application of the process developed at the GPI Institute in the U.S.S.R. for the production of porous Ti and stainless steel strip is described.

475. Singer, A. R. E.; Metal Bulletin Monthly, 10, pages 25 to 28, October 1971.

The use of cold rolling, slurries, hot rolling and direct rolling from a reduced concentrate are discussed as possible methods for the production of strip from metal powder.

476. Visconti, I. C.; Metallurgiya Italiana, Vol. 63, No. 3, pages 103 to 106, 1971. In Italian.

The rolling parameters involved in the roll compaction of powders is discussed. An investigation is reported on the powder rolling of metal powders with longitudinal fibres contained in the deformation zone.

477. Visconti, I. C. and G. Tocchetti; New Technology for Making Metal Composites Based on the Direct Rolling of Powders; Modern Developments in Powder Metallurgy, Vol. 4, edited by H. Hausner, K. Roll and P. Johnson, pages 527 to 536, Plenum Press, New York, 1971.

A new technique for producing metal powder strip reinforced with fibre is described.

1972

1972 - 478. Blore, M. H. D., B. W. Kushnir, W. R. Duncan and A. H. Lee; Production of Metal Strip by Powder Rolling; Sheet Metal Industries, pages 404 to 406, June 1972.

The history of roll compacting of metal powders is discussed briefly. The production of powder and the roll compaction, sintering, hot rolling, cold rolling, and annealing of powder as strip done at the Sherritt Gordon Mines Limited at Fort Saskatchewan, Alberta, Canada is described.

479. Dixon, C. F. and N. S. Spence; Effect of Cold Work on the Magnetic Permeability of Sherritt Gordon's High-Purity Nickel Strip; Mines Branch Investigation Report IR 72-6, February 1972.

A report is given of the investigation of the effect of 0 to 15% cold reduction on the microstructure, hardness and magnetic permeability of Sherritt Gordon's S6M Ni strip.

480. Gaidar, L. M.; Poroshkovaya Metallurgiya, No. 6, pages 5 to 9, June 1972. In Russian.

The author suggests formulae to determine the work and power required during powder rolling and to calculate the pressure on the rollers.

481. Generalov, M. B. and N. A. Chainikov; Rolling of Powders onto Parts; Poroshkovaya Metallurgiya, No. 7, pages 14 to 21, July 1972. Translated in Soviet Powder Metallurgy and Metal Ceramics, pages 525 to 531, 1972.

An analysis is presented on the theory involved in rolling of powders onto parts. Some theories of powder rolling are discussed in the presentation.

482. Nayar, H. S.; Strip Products Via Particle Metallurgy; Powder Metallurgy International, Vol. 4, No. 1, pages 30 to 36, February 1972.

The several approaches to powder rolling are compared to conventional strip rolling. The economic considerations of the process and the potential applications are discussed.

1972 - 483. Radchenko, K. M.; Length of the Arc of Contact with Allowance for Elastic Compression in the Densification Rolling of Powder Metallurgical Materials; Poroshkovaya Metallurgiya, No. 3, pages 31 to 37, March 1972. Translated in Soviet Powder Metallurgy and Metal Ceramics, pages 195 to 199, 1972.

A theoretical and experimental investigation of the determination of the length of the arc of contact associated with the rolling of metal powders is presented. Electrolytic Cu powder was used in the investigation and allowance was made for the elastic compression of the strip.

484. Radchencko, K. M.; Analysis of the Yield Strength Variation in the Densification Rolling of Sintered Materials; Poroshkovaya Metallurgiya, No. 7, pages 9 to 13, July 1972. Translated in Soviet Powder Metallurgy and Metal Ceramics, pages 521 to 524, 1972.

Yield strength functions are reported which can be used to solve the differential equations normally associated with an expression of the densification occurring during the rolling of metals.

485. Sturgeon, G. M., G. Jackson and V. Barker; Stainless-Steel Strip from Powder; Sheet Metal Industries, Vol. No. 22, pages 59 to 65, January 1972.

The production of stainless steel strip by the roll compaction of the alloy powder is described.

486. Techlink.; No. 851, 1972.

The production of high-quality porous or dense Al, Zr or porcelain strips by the roll compaction of powders at room temperature is described.

487. Vinogradov, G. A., N. V. Rukhailo and V. P. Kataskinskii; Mechanism of Metal Powder Rolling in the Initial Nonsteady-State Stage; Poroshkovaya Metallurgiya, No. 5, pages 22 to 25, May 1972. Translated in Soviet Powder Metallurgy and Metal Ceramics, pages 358 to 360, 1972.

A report is given of the investigation to determine the modes of powder deformation in the initial, non-steady-state range of powder rolling. Details are given of the technique developed to permit the investigation of the deformation in the rolling of metal powders which include a direct observation of slip lines.

ACKNOWLEDGEMENTS

The author thanks the staff of the Mines Branch Library for locating many of the references listed in this report; also, Mr. N. S. Spence, Head of Nuclear and Powder Metallurgy Section and Mr. J. A. Perry, Head of Metal Forming Section, for their advice and encouragement.

AUTHOR INDEX

SUBJECT INDEX