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F O R E W O R D

In line with its function of disseminating information of importance to the mineral industry, the Mines Branch is, indeed, pleased to publish this bibliography on rock bolting methods.

Rock bolting is now a well established support system in mines. Much literature has been published over the years, particularly during the early period of experimental application.

Mrs. J.H. Paterson, née Mary Ruth Corlett of Kingston, Ontario, compiled the bibliography in 1958 at the University of London (Britain), as part of the requirements leading to a diploma in Library Science.

This work is the result of an extensive search of the published literature describing rock bolting practice in various countries. The bibliography includes abstracts which are expected to make this a useful and convenient reference work for both mining and operational staffs. It is intended to follow up Mrs. Paterson's publication with a companion information circular (Part II) on reference works on rock bolting for the decade 1958-1967, to be prepared by our mining research and technical information staff.

John Convey,
Director,
Mines Branch.

Ottawa, September 18, 1968.

AVANT-PROPOS

A titre de service à l'industrie minérale, la Direction des mines est heureuse de publier cette bibliographie sur les méthodes de boulonnage.

Le boulonnage des roches est une technique de soutènement bien établie dans l'exploitation minière. Beaucoup d'ouvrages ont été publiés sur ce sujet depuis déjà plusieurs années, en particulier durant la période des premières applications expérimentales.

Mme J.H. Paterson, née Mary Ruth Corlett à Kingston (Ontario), a rassemblé cette bibliographie en 1958 à l'Université de Londres (Grande-Bretagne); ce travail faisait partie des exigences pour l'obtention d'un diplôme en bibliothéconomie.

Ce travail est le résultat d'une recherche approfondie sur les ouvrages publiés décrivant les méthodes de boulonnage de la roche pratiquées dans plusieurs pays. La bibliographie comprend des résumés qui rendront cet ouvrage fort utile aux mineurs et au personnel de bureau. On prévoit qu'une circulaire d'information (Partie II) traitant des travaux de référence sur le boulonnage de la roche pour la décennie 1958 à 1967, suivra la publication de l'ouvrage de Mme Paterson; elle sera préparée par notre personnel d'information technique sur le génie minier.

John Convey

John Convey,
Directeur,
Direction des Mines.

Ottawa, le 18 septembre 1968.

Mines Branch Information Circular IC 207

BIBLIOGRAPHY ON ROCK BOLTING METHODS IN MINING PRACTICE.

PART I: ABSTRACTS FROM WORLD LITERATURE TO END OF 1957

by

Mary Ruth Corlett Paterson *

SYNOPSIS

Issued as Part I of a proposed series, the bibliography which comprises this information circular represents a serious attempt to assemble all the published information of the theory and practice of rock bolting to the end of 1957. It was completed as a two-year project in library research in London, England, in 1958. Part II, now in preparation, will cover the decade 1958-1967.

In this bibliography, some 280 references (each with a brief abstract) are grouped according to subject matter under main headings of Theory, Testing Equipment, Specifications and Standards, Drilling and Dust Control, Safety Precautions, Practice (General), and Practice (Regional--by countries). Chronology is from late to earlier.

Three appendices list Conferences, Suppliers of Equipment, and Sources of Information. Indexes are included of Authors, of Companies and Other Public Bodies, and of Subjects.

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* In 1958, then Miss Mary Ruth Corlett of Kingston, Ontario, Mrs. Paterson compiled this bibliography at the University of London (England) as part of her requirements for a diploma in Library Science. Reassembled and co-ordinated at the Mines Branch, Ottawa, during the summer of 1968, it is being reproduced and distributed by the Mines Branch as a Canadian contribution to scientific knowledge, by permission of the author.

Direction des mines

Circulaire d'information IC 207

BIBLIOGRAPHIE SUR LES MÉTHODES DE BOULONNAGE DANS LES EXPLOITATIONS MINIÈRES. PARTIE I: RÉSUMÉS D'ÉTUDES PUBLIÉES DANS LE MONDE ENTIER JUSQU'À LA FIN DE 1957

par

Mary Ruth Corlett Paterson*

RÉSUMÉ

La bibliographie qui fait l'objet de la présente circulaire vise à reunir tous les ouvrages publiés jusqu'à la fin de 1957 sur la théorie et la pratique du boulonnage des roches. Cette bibliographie est le résultat de deux années de recherche en bibliothéconomie entreprise en 1958 à Londres. Une deuxième circulaire, en voie de préparation, couvrira la période de 1958 à 1967.

Dans cette bibliographie, quelque 280 ouvrages de référence (chacun accompagné d'un bref résumé) sont groupés selon leur sujet sous les titres suivants: théorie, appareils d'essai, prescriptions techniques et normes, forage et suppression de la poussière, mesures de sécurité, pratique (générale), pratique (régionale ou par pays). La chronologie va du plus récent au plus ancien.

On trouvera dans trois appendices une liste des conférences qui ont porté sur ce sujet, des fournisseurs de matériel et des fournisseurs de matériel et des sources de renseignement. On trouvera aussi les index des auteurs, des sociétés et autres corps publics et des sujets.

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* En 1958, Mme Paterson, alors Mlle Mary Ruth Corlett de Kingston (Ontario), a établi cette bibliographie à l'Université de Londres en vue de l'obtention d'un diplôme en bibliothéconomie. Réorganisée et coordonnée à la Direction des mines (Ottawa) durant l'été de 1968, cette bibliographie sera reproduite et distribuée par la Direction des mines à titre de contribution canadienne à l'avancement de la science, avec la permission de l'auteur.

AUTHOR'S PREFACE (1958)

Rock bolting as a method of ground support in underground mining has received considerable attention during the past ten years. Generally speaking, this method involves either the bolting together of thinly bedded rock to simulate a thick bed, or the anchoring of unstable rock to more solid rock above.

There are two basic types of bolts: the slot-and-wedge, commonly referred to as the wedge-type or slotted type, and the expansion shell. As well as these, wooden bolts and concrete injection-type bolts are also used.

Applications of bolts in rock support have been recorded in Europe as early as 1912 and in the U.S.A. in 1917. Much early development work was done in the U.S.A. by the St. Joseph's Lead Co., Missouri, and the U.S. Bureau of Mines. In the U.K. coalfields, research was carried out by Z.S. Beyl, a Dutch engineer. At present the method has been tested and used for many purposes in coal and metal mines in sixteen countries of the world.

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An attempt has been made, in this bibliography, to assimilate all the published information of the theory and practice of rock bolting up to the end of 1957. Material has been collected from a number of libraries in London (England): the Institution of Mining and Metallurgy Library, the Institution of Mining Engineers' Library, the National Coal Board Library, the Patent Office Library, and the Guildhall Library.

The following bibliographical sources were used: D.S.I.R. Translated Contents of Russian Scientific Periodicals; Engineering Index; Fuel Abstracts; I.M.M. Abstracts; Safety in Mines Research Establishment, Abstracts of Current Publications; and U.S. Bureau of Mines, List of Publications. The 1957 volumes of many important mining journals have been individually checked to ensure that the bibliography is up to date.

In each case the original paper has been studied and abstracted. The small number of references which were not available have been marked with an asterisk (*). A number of unpublished translations have also been recorded.

To assist the reader the references have been grouped according to subject matter and arranged chronologically. A limited number of cross references have been included, but to locate all the articles on any particular aspect it is necessary to refer to the subject index.

Because the practice of rock bolting is developing in both coal and metal mining in many different countries, it is difficult to follow a standard form of nomenclature. Generally the terms found in the original text have been used in the abstract. In the subject index, an attempt has been made to include *See* references to guide the reader to the appropriate heading.

I should like to thank Mr. A. Grierson of the Royal School of Mines, Mr. R. Staveley of the School of Librarianship, University of London, the Librarians of the libraries listed above, and Miss Leila Crisp for their assistance in compiling this bibliography.

Mary Ruth Corlett

Kingston, May 1958

CONTENTS

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A. THEORY

1. POTTS, E.L.J. & JENKINS, J.P.
   Le boulonnage du toit, les mouvements des couches et les propriétés des roches (Roof bolting, bed movement, and the properties of rocks).
   Rev. Ind. Minérale 1957 39 (11) Nov 1003-1012.
   This is a theoretical discussion of rock bolting in terms of elasticity of rocks, anchorage characteristics, and tension of the bolt.

2. SHIROKOV, A.P.
   Kvoprosy opredeleniy parametrov ankernod krepi (Determination of parameters of rock bolts).
   Ugol 1957 (9) 23-27.
   Includes detailed graphs and diagrams. 6 references to Russian literature.

3. JOHNSTON, A.G.
   Roof bolting in mines: theory and practice.
   Iron & Coal Trades Rev. 1956 173 (4615) 2 Nov 1077-88; discussion 1088-90.
   A detailed account is given, with many diagrams and illustrations: principles of roof bolting; laboratory investigations and results (suspension support, compound beam, arched roadway support); underground observations; strata movement; tension testing. Tests were carried out at Northfield Colliery, Lanarkshire. 17 references.

4. CORLETT, A.V.
   Rock bolting in the Voussoir beam: the use of rock bolts in ground support.
   Can. Min. & Met. Bull. 1956 49 (527) Mar 156-60; discussion 1956 49 (535) Nov 763-4.
   C.I.M.M. Trans. 1956 59 88-92; discussion 1956 59 431-2.
   Principles of rock bolting practice are discussed. The theory of beam formation is developed; a numerical example shows the magnitude of the strain along the Voussoir arch. Factors which influence the effectiveness of support by bolting include scaling, early support, anchorage, tension. References.

5. PANEK, L.A.
Principles of reinforcing bedded mine roofs with bolts.
U.S. Bur. Mines, Rep. Inv. 1956 (5156) Mar 26p.
Attempt to develop bolting theory; beam theory; function of roof bolts; behaviour of bolted roof; bolting pattern. Numerous models, load-strain graphs, tables are given. References.

6. PANEK, L.A.
Theory of model testing as applied to roof bolting.
U.S. Bur. Mines, Rep. Inv. 1956 (5154) Mar 11p.
Description of models, method (centrifugal) and model prototype relations are given. By using dimensional analysis, a general expression for a roof-bolting design formula in terms of structural variables has been obtained. References.

7. PANEK, L.A.
Design of bolting systems to reinforce bedded mine roof.
U.S. Bur. Mines, Rep. Inv. 1956 (5155) Mar 16p.
Mining Eng. 1955 7 (10), Oct 954-7; discussion by
J.P. ZANNARAS 1956 81 (12) Dec 1228.
A method (with design chart) for designing systems of vertical bolts to reinforce horizontally bedded mine roofs, developed from model tests, is given. References.

8. HOFFMAN, H.
Wirkungsweise und Anordnung der Anker in Abbaustrecken
(The method of functioning and arrangement of roof bolts in gate roads).
Glückauf 1955 91 (9-10) 26 Feb 239-41 (Typescript N.C.B., Translation A933/ME).
The author is concerned with the best bolting pattern in relation to the dip of the strata. Work is based on theories advanced by Jacobi, who compared the strata with planks piled on top of each other. This theory and those of Grabsch, Hoevels and Rolshoven are discussed. Diagrams and 4 references.

9. THOMAS, E.M.
Rock bolting finds wide application.
Mining Eng. 1954 6 (11) Nov 1080-5.
This general article gives the following classifications with examples of bolting techniques: suspension; beam building; reinforcement of the skin areas; reinforcement of walls.
17 references.

10. GRABSCH, W.
Neuere Erkenntnisse über die Gebirgsbewegungen beim Ankerausbau in Abbaustrecken (Recent findings on rock movements with rock bolting at the face).
Glückauf 1953 89 (10 Oct) 1037-48 (Typescript M.F.P., Translation L.T.S. 1337).
Discussion under the following headings: specifications in roof support; support and rock bolting; comparison of subsidence measurement, using set support and anchor bolts; measurement of movement in higher hanging walls; wall movement and anchor bolting; suggestions for suitable bolt. Theories of rock movement and support are discussed; numerous diagrams and illustrations show bolting patterns, rock movement with different types of support, etc. 11 references.

11. HERZOG, H.
Dachschieferbergbau und theorie des Ankerausbau (Roofing slate mining and the theory of rock bolting).
Bergbau Rundschau 1953 5 (Feb) 73-4.
With reference to work done by Hoevels, Rolshoven and Jacobi, bolting of roof and wall is discussed.

12. JACOBI, O.
Zur Statik der Ankerausbaues (The statics of rock bolting).
Bergfreiheit 1952 17 (1) 9-16 (Typescript N.C.B., Translation A 850/FWH).
A discussion of theory of bolting is put forward in which roof layers bolted together are compared with timber boards. It is stated that timber boards subjected to bending stress will deflect 9 times more when loosely packed than when dowelled together. The following topics are discussed: theoretical beam of unstratified rock without rock bolts; dowel action of rock bolts; thrust reinforcement, tension reinforcement; arch formation; rock bolts in semi-plastic and plastic rock. Diagrams show clearly the effect of pressures on rock formation before and after bolting.

13. BEYL, Z.S.
The prestressed state of the earth's crust, its causes and preservation.
Conf. Rock Pressure & Support, Liege, 1951. 395-407.
A detailed discussion is presented under the following headings: stress distribution in the rock mass; prestressed state of the rocks; the so-called "Pressure-Wave" application of rock pressure to support; the "Beyl Reinforcement". Tests were carried out at Glebe Colliery, Washington Coal Co., Durham, 1942; Bickersham Seam, Maypole Colliery, Wigan, Lancs., 1946; Silksworth Colliery, Sunderland, Durham,

1947-49; Bowland-Forest Tunnel, Lowgill, Lancs., 1949. Numerous diagrams and illustrations are given.

14. PRICE, P.H. & CROSS, A.T.
Geologic considerations in roof bolting.
Coal Mine Modern. Yearb. 1951 97-111.
Discusses, using numerous examples of American coal mines, the nature of various rocks associated with coal - shale, sandstone, clay - and their reactions to bolting. Excellent diagrams are given.

15. SCOLLON, J.A.
Roof bolting vs. roof rock stresses.
Mechanization 1951 15 (10) Oct 105-9.
Studies of rock stresses are outlined, showing the effect of bolting in carrying the load and developing an effective arch. Various patterns are illustrated.

16. BUCKY, P.B.
Theory of rock bolting.
Coal Mine Modern. Yearb. 1950 13-24.
The following are discussed: geological structural elements that affect rock bolting; elastic theory limitations; present research using Barodynamic model studies on thick strong immediate roof and thin bedded roof.

17. BEYL, Z.S.
Rock pressure and roof support.
Colliery Eng. 1945 22 (Sep) 206-8, 213; (Oct) 220-2; 228; 1946 23 (Apr) 84-8; (Jun) 149-51; (Aug) 213-6; (Oct) 260-4.
Following an outline of the compressive forces operating in rock pressure, the author shows how the use of rock bolts to hold laminated strata in the form of a beam will support a mine roof. Successful tests using Rawlbolts are described; installation cost is considered; bolting patterns are presented. The last article deals with the development of knowledge on the problem of rock pressure from 1892. 13 references.

18. BEYL, Z.S.
Suggested methods of roof control.
Iron & Coal Trades Rev. 1943 146 (3919) 9 Apr 533.
A brief account of the use of reinforcing anchors sunk in sand and clays to support walls. Method has been used in the Netherlands. Tests are being carried out in a British colliery.

<u>See also abstracts</u>

135 MCKENSEY: Roof bolting and pillar workings. (Australia)

B. TESTING

19. POTTS, E.L.J.
Further progress in the scientific approach to strata control.
Inst. Mining Eng. Trans. (London) 1957 117 (3) Dec 203-219.
In this article, dealing with developments in instrumentation in relation to strata control, a device for the measurement of bed separation and the development of continuous recording equipment for measuring the loads on face supports and bolts are discussed. Numerous illustrations and diagrams are included. 4 references.

20. PANEK, L.A.
Anchorage characteristics of roof bolts.
Mining Congr. J. 1957 (11) 43 Nov 62-64, 89.
Discusses the significance of head displacement and evaluates anchorage performance. It is possible to state the most effective bolt assembly using expansion or wedge-type bolt.

21. CHEMICAL ENGINEERING AND MINING REVIEW
Rubber compression pad for measuring tension in roof bolts.
Chem. Eng. Mining Rev. 1957 49 (12) 16 Sep 44-46.
A description is given and application described of the rubber compression pad developed by U.S. Bureau of Mines and Goodyear Tire & Rubber Co.

22. SPINDLER, G.R. & WORREL, D.T.
Geological aspects of mine roof action and control.
Mining Congr. J. 1957 43 (7) Jul 68-70.
A report of the Committee on Roof Action, of the American Mining Congress. Graphs and tables are put forward to give relation of strength of bolt anchorage to installation torque and to hardness and stability of strata.

23. FORRESTER, G.N.
Smaller drilled holes... high strength rock bolting...
takes hold in Canadian mines.
Can. Mining J. 1957 78 (3) Mar 66-9.
Results of tests carried out by the Steel Co. of Canada are outlined. Tests were done on breaking strengths and pull, to show effect of changing the size and the material of the bolt. Trends in Canadian rock bolting are briefly outlined; recommended practice is put forward. Numerous diagrams illustrate equipment.

24. IRON AND COAL TRADES REVIEW
Measurement of roof bolt tensions.
Iron & Coal Trades Rev. 1957 174 (4628) 1 Feb 277.
S. African Mining Eng. J. 1957 67 (3325) 2 Nov 701, 703.
The compression pad developed by Goodyear Tire & Rubber Co. is described.

25. WOJCIECHOWSKI, J.J. & HOLLAND, C.T.
Some aspects of roof bolt action in a coal mine roof.
Mineral Ind. J. Virginia Polytech. Inst. 1956 3 (4) Dec 1-7.
Summary in Mining Ind. Rev. 1957 101 (1) 31 Jan 33.
An investigation of the following factors: holding strength of wedge and expansion bolts; anchor holding strength of sandstone and shale roofs at various depths of insertion; roof sag in mine entries having different types of support; load variations on an installed bolt. Numerous tables, graphs and diagrams illustrate results. References.

26. SMEDBERG, M.
Provdragning av bergförankring (Anchorage testing of mine rock bolts).
Jernkontorets Ann. 1956 140 (Dec) 930-45. (Swedish text- English summary).
Anchorage testing of bolts, both wedge and expansion type, is described. Results are based partly on U.S. Bureau of Mines reports, but mainly on tests at Swedish coal mines of the Höganäs-Billesholms Company. 16 references.

27. ANTONIDES, L.E.
How you can predict rock falls.
Eng. Mining J. 1955 156 (12) Dec 75-7, 103.
This equipment, consisting of a geophone, amplifier and earphones, tests the effectiveness of ground support such as rock bolting. Field procedure is outlined, with graphs.

28. KRONER, R.
Der Drehmomentenschlüssel beim Ankerausbau im Erzbergbau (The torque key in rock bolting in ore mines).
Bergbau Rundschau 1955 7 (Nov) 597-602.
A theoretical discussion of its use with graphs, diagrams, formulae. 32 references are given to German and American sources.

29. OBERT, L. & BARRY, A.J.
Roof bolt compression pad, a new device for measuring tension in roof bolts.
Mining Congr. J. 1955 41 (7) Jul 35-6.
Designed by U.S. Bureau of Mines, and produced by Goodyear Tire & Rubber Co., this pad permits rapid determination of bolt tensions up to 20,000 lb with accuracy of ± 1000 lb. It is designed for use with 1-in. slotted-type bolts and smaller-diameter expansion-type. References.

30. BARRY, A.J., PANEK, L.A. & McCORMICK, J.A.
Anchorage testing of mine roof bolts.
Part 1. Slotted-type bolts.
U.S. Bur. Mines Rep. Inv. 1954 (5040) Mar 12p.
Testing apparatus consists of a hydraulic jack assembly and a device (extensometer or cathetometer) for measuring displacement of the bolt as it is loaded. Numerous graphs, illustrations, tables are given. References.
Part 2. Expansion type, ¾-in. bolts.
U.S. Bur. Mines Rep. Inv. 1956 (5194) Feb 19p.
Tests carried out show various factors affecting anchorages: deformation of expansion plug; hole diameter; slotted-type versus expansion-type. References.
Part 3. Expansion type, 5/8-in. bolts.
U.S. Bur. Mines Rep. Inv. 1957 (5310) Feb 8p.
Tests on five makes of expansion-type shells and two grades of bolts (mild steel and high strength) used in sandstone and shale roof. Anchorages obtained in all cases were stronger than either grade of bolt. A graph gives relationship for evaluating anchorage effectiveness of 5/8-in.- and ¾-in.-diameter, headed, expansion-type bolts. References.

31. COAL AGE
Wood headers cause a decrease in roof-bolt tension.
Coal Age 1953 58 (Dec) 112-13.
A graph shows changes in bolt tensions with various setups of wood headers. A diagram illustrates laboratory method used to study bending and compression loading of wood pieces for effect on bolt tension. Work was done by Ohio Brass Co.

32. PANEK, L.A.
Roof bolt testing.
Mining Congr. J. 1953 39 (6) Jun 47-9.
Details given here are contained in U.S. Bureau of Mines Reports of Investigations 4967, 5040, 5080, 5154, 5156, 5194, 5228, 5155, 5310. (Nos. 5, 6, 7, 30, 34)

33. WUERKER, R.G.
Testing of roof bolting systems installed in concrete beams.
Mining Eng. 1953 5 (6) Jun 606-14.
Following a brief review of the theories of rock bolting, a testing procedure is outlined to determine whether or not the bolts would increase strength in the same way horizontal bars and stirrups increase the strength of the common reinforced concrete beam. Numerous diagrams, graphs and illustrations are included.
42 references.

34. BARRY, A.J., PANEK, L.A., & McCORMICK, J.A.
Use of torque wrench to determine load in roof bolts.
Part 1. Slotted-type bolts.
U.S. Bur. Mines Rep. Inv. 1953 (4967) May 7p.
Equipment and procedure for testing slotted-type bolts is outlined. Tests show that a torque of 260 ft-lb applied to a nut on a slotted-type bolt will produce a load of 10,000 ± 2,700 lb on the bolt. Neither the type of thread nor the type of rock affects the torque-load relationship. The torque wrench is considered a practical instrument for checking the tightness of bolts.
Part 2. Expansion-type $\frac{3}{4}$-in. bolts.
U.S. Bur. Mines Rep. Inv. 1954 (5080) Oct 17p.
Factors influencing the torque-load relationship for various bolts. References.
Part 3. Expansion-type, 5/8-in. bolts.
U.S. Bur. Mines Rep. Inv. 1956 (5228) May 13p.
A study of torque-load relationship showed that it was not significantly affected by the type of bolt or expansion shell unit but might have been affected by the type of rock. References.

35. WHITTAKER, J.S.
Roof bolt testing.
Mining Congr. J. 1952 38 (12) Dec 65.
Abstract of report given at 1952 American Mining Congress. Work being carried out on testing bolt tension and the load-bearing capacity of the bolt anchorage are outlined.

*36. MOORE, R.B.
Roof bolt testing and testing equipment.
Paper at Rocky Mountain Coal Mine Institute Meeting, Salt Lake City, 1951.

37. THOMAS, E.M.
Suggestions for inspection of roof bolt installations.
U.S. Bur. Mines Inf. Circ. 1951 (7621) Sep 6p.
A guide to inspectors of bolting applications, giving reasons for failures and standards for evaluation of installations.

See also abstracts

125 OHIO BRASS COMPANY: Effect of lubrication in roof bolt installation.
126 FORBES: Progress in roof bolting.
188 MORATH & KIND: Anchorage testing. (Sweden)
189 ERDHEIM: Load testing. (Sweden)

C. EQUIPMENT

(1) GENERAL
(2) VARIOUS BOLTS
(3) WOODEN BOLTS
(4) USE OF CEMENT

(1) GENERAL

38. BARRY, A.J., PANEK, L.A. & THOMAS, E.M.
Le boulonnage du toit aux États Unis (Rock bolting in U.S.A.).
Rev. Ind. Minérale 1957 39 (8) Aug 731-48.
A detailed description of rock bolting equipment and testing based on U.S. Bureau of Mines information.

39. COLLIERY GUARDIAN
Roof bolting.
Colliery Guardian 1957 194 (4 Apr) 463-6.
Bolting equipment made by Bayliss, Jones & Bayliss Ltd. is described. The lantern-head expansion bolt, the Bayliss wedge-and-sleeve bolt, the jack-and-ratchet tensiometer and the complete unit are illustrated. This equipment is used extensively in Great Britain and is now being used in some German coal mines.

40. CANADIAN MINING JOURNAL
Safety device in rock bolting and gadding.
Can. Mining J. 1957 78 (3) Mar 65.
Describes with diagram the use of a piece of scrap pipe as a loose-fitting sleeve between a drill-steel shank and a rock bolt or gad being driven by a rock drill. A short piece of 1-in. pipe guides and holds 7/8-in. hex drill steel against rock bolts and gads and permits free rotation of the steel in the sleeve.

41. SCHMUCK, H.K.
How western mines use metallic fabric lagging for support between roof bolts.
Mining World 1956 18 (Nov) 62-4.
Describes the use of C.F. & I. (Colorado Fuel & Iron) Realock chain-link fabric to prevent spally or blocky ground from falling out of back or walls between the bolts. Various applications are shown, including one with triangular plates as used in Scandinavia. Specifications for the fabric are tabulated.

42. SMEDBERG, M.
Kontrol av bergförankring (Rock bolting control).
Tryckluft 1956 11 (4) 1-6.
This descriptive article shows equipment for bolting. Excellent diagrams illustrate auxiliary equipment; e.g. Goodyear's compression pad, bolt tightener, etc. 19 references.

43. MECHANIZATION
Efficiency increased 400% in roof bolt assembly program.
Mechanization 1952 16 (5) May 99.
The manufacture of expansion shell and plug bolts of ½-in. or 5/8-in. diameter, 34 in. long, at Princess Elkhorn Coal Co., David, Kentucky is described. Blacksmith can assemble 225 bolts in 7¼ hours.

44. TROLLER, T.H. & CALDER, A.W.
Mechanical equipment for roof bolting in coal mines in U.S.
Conf. Rock Pressure & Support, Liege 1951 338-94.
(English and German texts).
Available American equipment is described: wedge- and expansion-type bolts, portable compressor, wagon-mounted stoper, dust collector, self-propelled rotary drill, hydraulic roof drill attachment, hydraulic impact wrench, roof-hole gauging instrument.

45. ENGINEERING AND MINING JOURNAL
How to make your own roof bolts.
Eng. Mining J. 1950 151 (12) 112.
A brief description of the jigs, troughs and Airco Radiograph used to make wedge-type steel bolts at East Diamond Mine, West Kentucky Coal Co., Madisonville, Ky.

See also abstracts

21 CHEMICAL ENGINEERING AND MINING REVIEW: Rubber compression pad.
29 OBERT & BARRY: Roof bolt compression pad.
30 BARRY & others: Anchorage testing of mine roof bolts.
31 COAL AGE: Wood headers cause a decrease in roof bolt tension.
34 BARRY & others: Use of torque wrench.
137 RABCEWICZ: The Forçacava Hydroelectric Scheme (use of netting with bolts).
175 SANDVIK & others: Roof bolting in mines (use of triangular plates, cement injection, wire mesh).
187 SMEDBERG: Roof bolting in Swedish mines (Perfo bolt, triangular plates).
193 WRIGHT: Roof bolting techniques in Great Britain (standard U.K. equipment).
279 BOWIE: Special roof bolt applications (wire mesh and guniting).

(2) VARIOUS BOLTS

46. POPOV, G.N., RICHIK, F.F., RYMINTSEV, V.G & TARAKANOV, G.M.
Shtangovai Krepi Y ochistnich virabotkach (Rock bolting at the face).
Gornyi Zhurnal 1957 (9) 27-29.
The bolt does not appear to be a conventional type. It has a conical plug at the end and an expanding brace about halfway down the rod. The bolt is 1050 mm long.

47. SHEWMAN, D.C.
Take the guess out of bolting a roof.
Coal Age 1957 62 (8) Aug 80-82.
A means of estimating necessary rock bolt length by measuring drilling time is put forward. A design for a bolt having two heads with a shear zone between is presented. This shear zone would be designed to fail at a particular torque, thus providing a definite torque limit. Means of making such a bolt are discussed.

48. WETLINSKY, W. de
Les boulons plafonniers. Leur utilisation dans les mines (Roof bolts; their use in mines).
Tech. Moderne 1956 48 (9) Sep 465-9.
This well illustrated article gives basic information on rock bolts - wedge, Hubbard, Pattin, G.H.H. and Boltex types. The Perfo tube is also described. 3 references.

49. MECHANIZATION
Was this the beginning of roof bolting?
Mechanization 1956 20 (Aug) 61.
In 1917, J.C. BALDWIN of Sagamore Mine, Pocahontas Fuel Co., W.Va., used $\frac{3}{4}$-in.-diameter, 18-in., wedge-type bolts to support loose intermediate roof.

50. SMEDBERG, M.
In-och utlandska-nyheter på bergbultsomradet (Swedish and foreign advances in rock bolting).
Tryckluft 1956 11 (1) 5-13.
Review gives recent advances in equipment: Republic Steel Corp. expansion bolt; West Virginia Manufacturing Co. expansion bolt, and others. Excellent diagrams are given.

51. BERGBAU RUNDSCHAU
Mehrteiliger Gebirgsanker für den Ankerausbau (Construction of a new rock bolt).
Bergbau Rundschau 1956 8 Jan 17-8
(Typescript N.C.B., Translation M 3581/DJS). (An abridgement)

In this bolt the outer sleeve is made of flexible material to form a continuous elastic casing, the diameter of which is greater than the borehole when the sleeve is relaxed. The sleeve anchors itself against the walls of the hole. To increase the elastic force of the bolt and thus to improve its load-bearing capacity, a central rod is used. A diagram is given.

52. MINING JOURNAL
Parallel expansion of roof bolts.
Mining J. (London) 1955 245 (6274) 18 Nov 587.
The Victor Products (Wallsend) Ltd. parallel-expansion bolt has been developed specifically for use with rotary drills. It requires no impact for tightening. Equipment is illustrated.

53. ECUER, R.
Le boulon d'ancrage au terrain; matériaux du boulonnage (Rock bolting; bolting materials).
Rev. Ind. Minérale 1955 36 (617) Feb 268-77 (Typescript N.C.B., Translation A 988/SEH).
Describes in detail wedge- and expansion-type bolts and their application. Excellent diagrams of the positions of the bolts during installation are given.

54. FULTON, K.E.
Rock bolts and allied techniques of ground control.
Assoc. Mine Managers, S.Africa, Papers and Discussions 1954-55 355-63; Contributed remarks by J.C. Hall 363-64.
Since 1945 at Van Dyck Consolidated Mines, South Africa, shale footwall has been controlled by driving old drill steel into holes 42 in. deep. As a result of experience gained with these steel pins, 1-in. wedge-type rock bolts were used in stope tracks and development ends. Subsequently $\frac{3}{4}$-in. wire rope was used in place of bolts to prevent dangerous side-wall conditions in deeper areas. Details, including costs, are given.

55. ORLOWSKI, L.
Nowy system obudowy Kotwiowostropnicowej w Kopalniach wegla (A new system of rock bolting in collieries).
Wiadomosci Gorni. 1954 (3) Mar 70-74 (Typescript N.C.B., Translation A.767/AB).
Tests have been carried out using bolts and channels at Wieczorek and Pawel collieries in Poland. Bolts are conically tapered bars, 40-45 mm in diameter, 650-700 mm long, with ribs for increased friction. A wedge-type pin, 40 mm in diameter, joins the roof bar and bolt together. Applications have been in headings and airways. Installation and withdrawal details are given; detailed diagrams show various applications.

56. HAFLIDSON, R.S., SHORT, E.S., GAUTHIER, A., & GRIEVE, A.R.
Replacement of rock bolts with used hoisting rope cuts costs of holding ground.
Eng. Mining J. 1953 154 (1) Jan 100-2.
At East Malartic Gold Mines Ltd., Norrie, Quebec, the roof consists of highly sheared, taloose greenstone and greywacke. In the latter, rock bolting has been successful, but has been replaced by the use of wire hoisting rope and cement. Three examples of its use are outlined.

57. ECUER, R.
Le boulon d'ancrage dans la roche outil de base du soutènement suspendu; le boulonnage du toit; le "Boltex", création francaise (Roof bolting. The Boltex, a French invention).
Rev. Ind. Minérale 1952 33 (587) Dec 979-86 (Typescript M.F.P., Translation L.T.S. 118).
Following a brief discussion of the fundamental aspects, the Boltex is favourably compared with the Hubbard expansion bolt. Numerous diagrams illustrate their functions.

58. ROSEAUX des, E.
Le boulonnage du toit; effet du glissement d'ancrage, un boulon sans glissement. (Rock bolting. The effect of slipping. A slipless bolt.).
Rev. Ind. Minérale 1952 33 (585) Oct 784-6.
Following a distinction between the terms "broche" (peg) and "boulon" (bolt), a recoverable "broche pour raclage" (peg for support) is described. It consists of a bolt, a rubber sleeve, casing, a peg, and support.

59. ALLIMAN, G.
Le boulon d'ancrage à expansion "Ancrall" (Expansion bolt "Ancrall").
Rev. Ind. Minérale 1952 33 (585) Oct 787-89.
Describes the "Ancrall" expansion bolt used at Petite-Roselle collieries, Lorraine.

60. SCHATZ, H.J.
Der Ausbau mit Ankerbolzen (Bolted support).
Bergbau Rundschau 1952 4 579-80.
Description and application of wedge and split-sleeve bolts.

61. ENGINEERING AND MINING JOURNAL
New wrinkles in roof bolting.
Eng. Mining J. 1950 151 (12) Dec 105.
"Coal companies are experimenting with three unusual roof-bolting techniques: (1) Wooden pins of 2-in. diameter with slots at both ends. A wedge at one end is driven against the bottom of the hole and a wedge at the other clinches the roof surface. (2) Grouting holes with cement to replace pins. This cements crevices together and prevents initial rock alteration and slough. (3) Grouting steel pins in place to increase bond between steel and rock."
(Complete text)

62. ZEITSCHRIFT FÜR BERGBAUHÜTTENWESEN UND SALINENWESEN
Streckenausbau mit eisernen Ankern (Support with iron anchors).
Z. Berg.-Hüttenw. u. Sal. 1919 67 Versuche und Verbesserungen 7-8.
This is a section in a review of mining in Prussia, 1918. An installation, at Friedenshütte (Bergrevier Königshütte O.-S) in the Ruhr district, in which anchor bolts were used is described. The bolts were long enough so that the end was firmly held in solid rock. Anchorage was achieved by a series of 'Keilringe' (trapezoid-shaped objects) near the end of the rod. When the bolt was tightened, these shapes were forced together thus expanding to hold the bolt firm. This work was done by A. BUSCH.

See also abstracts

147 MINE AND QUARRY ENGINEERING: Lake Shore Mine '"Foran" bolt.
159 TRAMBLAY & VERDET: Support in face areas and roadways in the Nord-Pas-du-Calais coalfields. (Gruppe lens design)
200 CHABOT: Roof bolting in the red ore mines of the Birmingham district. (Use of pierced roof bolts)

(3) WOODEN BOLTS

63. KELLY, L.W.
Successful use of wooden roof bolts in Stony Point Mine, Stony Point Coal Co., Hopkins Co., Ky.
U.S. Bur. Mines Inf. Circ., 1952 (7637) Jun 4p.
At Stony Point Mine where the roof immediately over the coal is a stratum of laminated, hard black shale from 8-36 in. thick, slotted-type 1 5/8-in. wooden bolts, 3 ft long, are used. A pattern of 7 bolts for each 7-ft cut is used and four-bolt set is followed at an interval of 3½ ft by a 3-bolt set, and so on. Bolts are installed with sledge hammers immediately after loading machine leaves the face.

See also abstracts

181 YAKOVLEV & others: Industrial use of wooden anchor bolt support.
222 FARMIN & SPARKS: The use of wooden rock bolts in the Day Mines.
232 EDWARDS: How wood pins serve Mary Gail.
235 LANIER; Pinning roof with wood.

(4) USE OF CEMENT

64. MAIZE, E.R. & WALLACE, J.J.
Cementation of bituminous roof strata. Part 1. Determining penetrability of mine roof by injecting oil and water.
U.S. Bur. Mines Rep. Inv. 1956 (5304) Nov 17p.
Development from roof bolting. Strengthening the roof by bonding the various strata by injecting chemical bonding materials into bedding planes is tested. References.

65. CHOUTE, R.B.
An unusual roof bolt.
Mining Congr. J. 1956 42 (7) Jul 69.
The Swedish technique in rock bolting, a method using cement in conjunction with bolts, is described. The Perfo tube is available through the Sika Chemical Corp., Passaic, N.J. The technique, used in weak ground, has already been applied in the Assouan Dam, Egypt, as well as in Sweden's Kilforsen and Stornorrfors hydroelectric plants.

See also abstracts

156 VOLUMARD & BASTIDE: Roof anchorage before blasting. (Cement and sand injection)
176 AUSTIN & TROFTEN: Roof sewing. (Use of cement)
177 PENSA: Roof bolting in Trepça lead-zinc mine. (Perfo tube)
184 SMEDBERG & PILCH: Perfo bolting.
186 SMEDBERG & PILCH: Anchor bolting with Perfo bolts in Bjuvs mine.

D. SPECIFICATIONS AND STANDARDS

(1) U.S.A.
(2) OTHER

(1) U.S.A.

66. MAHOOD, G.P., DEMPSEY, J.B., ROBERTSON, A.K., SANFORD, J.H. & THOMAS, E.M.
Specifications for roof bolting materials.
Mining Congr. J. 1956 42 (7) Jul 70-1.
Recommendations of the Committee on Roof Action are put forward. Detailed diagrams of the specified bolts are given.

67. INTERNATIONAL LABOUR OFFICE
Safety in coal mines. Vol. 2. Legislation.
Geneva, I.L.O. 1955. Studies and Reports, New Series No. 33.
On p. 150, in a chapter on roof control, U.S. legislation includes details of roof bolting (Federal legislation FMC 1953). There is no legislation on bolting in the sections dealing with other countries.

68. AMERICAN SOCIETY FOR TESTING MATERIALS
Standard specifications for structural steel for ships.
Amer. Soc. Testing Materials, A.S.T.M. Standards. 1955. A 131-55.
This standard establishes tolerances for tensile strength and elongation of steel. These were accepted for rock bolts at a Washington conference on May 22, 1950, of bolt manufacturers, steel suppliers and U.S. Bureau of Mines.

69. COMMITTEE ON ROOF ACTION
Specifications for roof bolting materials.
Mining Congr. J. 1951 37 (3) Mar 60-1.
Tentative recommendations for sizes and designs of bolts and accessories.

See also abstract

216 STEVENS: Successful roof bolting in Alabama.

(2) OTHER

70. NATIONAL COAL BOARD
Roof bolts.
N.C.B. Stand. Spec. P131/1955. London. 1955. 2p.
Establishes two standard sizes of bolts and lays down requirements for the threads and the quality of the material. British Standards are quoted for steel specifications.

See also abstracts

135 McKENSEY: Roof bolting and pillar workings. (Australian steel specification for bolts)
138 CORLETT: Ground support. Mention of Canadian policy.

E. DRILLING AND DUST CONTROL

71. CALDER, A.W., ROBSON, O. & FLETCHER, R.
Thrust and speed for rotary drilling.
Mining Congr. J. 1955 41 (7) Jul 41-4.
A report of the Committee on Roof Action. Topics covered are: thrust, speed and bit life; drilling techniques; auger and carbide bits; bit tips. Importance of good records is emphasized; variation in bolt-torque reading is discussed.

72. LINKOUS, C.E.
Wet and dry roof drilling.
Coal Mine Modern. Yearb. 1952 14-20.
Compares efficiency and cost of wet and dry drilling in bolting operations. Results show advantages of one balance the advantages of the other.

73. HOUGH, C.E.
The use of portable equipment for roof bolting in thin seams.
Coal Mine Modern. Yearb. 1951 88-94; discussion 94-96.
The use of portable Chicago pneumatic drills at Imperial Smokeless Coal Co., Quinwood, W.Va., is discussed.

74. WESTFIELD, J.
Roof drilling with dust control equipment.
Coal Mine Modern. Yearb. 1951 112-119.
Discusses methods of dust control in wet and dry drilling. Graphs and tables show allowable dust concentrations and various methods used.

75. WESTFIELD, J., ANDERSON, F.G., OWINES, C.W., HARMON, J.P. & JOHNSON, L.H.
Roof bolting and dust control.
U.S. Bur. Mines Inf. Circ. 1951 (7615) Aug 8p.
The danger of high concentrations of silica-bearing dusts where drilling has been done is considered. Means of combatting the problem: wet pneumatic drilling; dust-collecting devices adapted to electric rotary drills. A graph shows allowable dust concentrations relative to free-silica content of atmosphere.

76. BERRY, J.K.
Wet rotary drilling improves roof bolting results.
Coal Age 1951 56 (5) May 74-6.
The development of a water swivel which fits between the hydraulic drill motor and its chuck is described.

77. TROLLER, T.H.
Mechanical equipment for roof bolting.
Coal Mine Modern. Yearb. 1950 44-52.
The author, vice-president of Joy Manufacturing Co., evaluates available equipment: rotary and percussion drills, mine-car compressor with boom-mounted roof drill, wagon-mounted stoper with dry dust collector, hydraulic roof-drill attachment, carriage-mounted hand-operated roof drill, roof-hole gauging instruments.

<u>See also abstracts</u>

131 HORSEMAN: Roof bolting at John Darling Colliery, Belmont, New South Wales.
231 FLETCHER & PRUNTY: Roof drilling equipment and practices.
234 BERRY: Roof bolting with large mobile equipment. (Hydraulic drilling)
250 BERRY: Rotary drilling in sand rock for roof bolting.
251 VALERI & FITZWATER: Pneumatic drilling for roof bolting, using a central air-compressor station.
268 GREENWALD & PRICE: Methods and results with mine roof bolting. (Rotary drilling)
269 COAL AGE: Dry, percussion roof-drilling successful in hard sandstone.

F. SAFETY PRECAUTIONS

78. THOMAS, E.M.
Bolting for safety.
Mining Congr. J. 1957 43 (1) Jan 65-6.
A discussion of poor working habits in rock bolting, holdovers from timbering practices. Company regulations must be adjusted to take full advantage of the safety of bolting techniques. For example, bolting machines have booms or telescoping jacks to bear against roof and serve as support.

79. ASH, S.H.
Health and Safety in mineral industry.
Mining Eng. 1953 5 (2) Feb 174-6.
Statistics show a decrease in roof-fall accidents since the introduction of bolting. Graphs give breakdown by type of mine.

80. WESTFIELD, J. & ANDERSON, F.G.
Hazards of roof bolting.
Coal Mining 1952 29 (6) Jun 10-12, 14.
Gives 21 hazards incident to bolting, mainly concerned with care in installation. Dust problem is discussed with reference to the Königsborn dust exhauster. Paper read at 65th Meeting of Coal Mining Institute of America.

81. MILLER, P.S.
Roof bolting in tunnels.
Mining Congr. J. 1952 38 (6) Jun 30-2.
Advantages of roof bolting are discussed generally (based on a talk given before the National Safety Council Meeting, Chicago, Ill.).

82. BROWN, E.H. & BIERER, J.
Roof bolting in West Virginia.
Mining Congr. J. 1951 37 (5) May 31-5.
Development from 1947-1950. Following an outline of causes of accidents in bolting practices, e.g., bolts too far apart, or inadequate pillar support, rules which should be followed are put forward. A table gives comparative study of roof and timber accidents.

83. THOMAS, E.M.
Roof bolting to prevent accidents.
Coal Mine Modern. Yearb. 1950 40-43.
A short review of bolting developments, with emphasis on safety aspects. A diagram shows details of a roof-fall accident. Location is not given.

84. COAL AGE
Coal mining section surveys progress in mine safety at National Safety Congress.
Coal Age 1950 55 (12) Dec 136-7, 165-84.
Among papers presented at the Congress and reviewed in this article are those by the following on bolting: G.O. TARLETON, Consolidation Coal Co. (Ky.), Jenkins, Ky.; A.T. CROSS, West Virginia Geological Survey, Morgantown, W.Va.; G. McCOA, Consolidation Coal Co. (W.Va.), Fairmount, W.Va.; G.N. McLELLAN, Weirton Coal Co., Isabella, Pa.; A. METCALFE, U.S. Bureau of Mines Dept., Fairmount, W.Va.; P. PRICE, State Geologist, Morgantown, W.Va.

See also abstract

99 BURCHELL: Rock bolting.

G. COSTS

85. MINING CONGRESS JOURNAL
Some rock bolting costs.
Mining Congr. J. 1956 42 (4) Apr 75-7.
Based on U.S. Bureau of Mines statistics, an analysis is given of bolting procedures and costs in 30 U.S. metal and nonmetallic mines.

86. SALL, G.W.
Some roof bolting costs.
Mining Congr. J. 1956 42 (1) Jan 29-31.
Based on material from U.S. Bureau of Mines, an analysis of bolting procedures and costs is given for 66 bituminous coal mines. Table includes data on seam height, type of roof, type of drilling, bit used, bit cost, depth of hole, bolt cost, size of bolting crew, bolts reused, tonnage per crew per shift.

87. MCLELLAN, G.N.
Economy of roof bolting.
Mining Congr. J. 1951 37 (9) Sep 37-9.
Comparison of costs of timbering and bolting at 10 U.S. coal mines. It was found that there was no great difference between the costs of the two methods.

See also abstracts

54 FULTON: Rock bolts and allied techniques of ground control. (South Africa)
72 LINKOUS: Wet and dry roof drilling. (U.S.A.)
99 BURCHELL: Rock bolting. (Canada)
134 HILL: Roof bolting in metal mines. (Australia)
150 BROWN: Roof bolting in Canadian coal mines.
151 CANADIAN MINING JOURNAL: Rock bolting practices in Canadian metal mines. (A symposium)
164 LÜCK: Withdrawal of roof bolting support. (Germany)
165 MIDDENDORF & JANSSEN: Bolting experience. (Germany)
173 LOCKINGTON: Roof bolting at Wairaki State Mine. (New Zealand)
174 TROFTEN: In Norway it's roof sewing.
187 SMEDBERG: Roof bolting in Swedish mines.
199 BOURNE & WHALLEY: Roof bolting. (U.K.)
229 STACHURA: Economics of roof bolting. (Indiana)
230 KELLY: Economies through roof bolting in an Indiana mine.
248 LANG: Better bolting at lower costs. (Oregon)
263 BOYD: Roof bolting at the U.S. and Lark Mines. (Utah)

H. PRACTICE - GENERAL

88. JOSEPH, R.D. & THOMAS, E.M.
Roof support with continuous mining.
Mining Congr. J. 57 43 (9) Sep 69-72.
With reference to work at U.S. Bureau of Mines on the use of bolts in continuous mining, bolting patterns in a 2-place square-block system, in room-and-pillar work and in open-end pillar recovery are discussed. Diagrams illustrate methods.

89. JOHNSON, L.H. & PANEK, L.A.
Design of mine roof bolting systems.
Mining Congr. J. 1957 43 (8) Aug 92-4.
Report of the American Mining Congress Committee on Roof Action. A roof-bolting design chart first published in U.S. Bureau of Mines Report of Investigations No. 5155 (No. 7) is given and discussed. 5 references.

90. SCHMUCK, H.K.
Theory and practice of rock bolting.
Colo. School Mines Quart. 1957 52 (3) Jul 233-63.
A comprehensive discussion, with excellent illustrations, of bolting techniques and theory. Numerous methods and applications of rock bolting in U.S.A. are outlined: bolts and channel irons, reinforcement of arched openings, support of main haulage ways, cut-and-fill stope application, vertical wall bolting, cliff faces; bolts and channel irons, bolts with wooden hanger boards, use of link fabric, etc. 12 references.

91. GIMM, W. & MAUERSBERGER, F.
Verheitung und Anwendungs möglich Keiten des Ankerausbaus im Erzbergbau (Scope and applications of rock bolting in ore mines).
Neue Hütte 1957 2 (2-3) Feb-Mar 129-38.
A general article giving details on equipment and techniques in numerous countries. Numerous illustrations and diagrams are included. References.

92. ECUER, R.
Roof bolting.
Colliery Eng. 1956 33 (Sep) 371-5.
A bolting formula is presented. It is stated that one rock bolt per square metre is needed; each bolt must be capable of supporting the roof within its range without slip of the anchorage and with a safety factor of 3. The various bolts available are described with comments on the principles of their use: the Boltex, G.H.H. (German), Hubbard expansion bolts, and the split-rod-and-wedge type of bolt.

*93. ENGINEERING AND CONTRACT RECORD
Rock cuts, tunnelling speeded by bolting.
Eng. & Contract Rec. 1956 69 (6) Jun 120, 122.

94. FLETCHER, R.J., PACE, E.M., & ROBSON, O.
Roof bolting procedures.
Mining Congr. J. 1956 42 (5) May 67-70.
A report of the American Mining Congress Committee on Roof Action. Training programme of four mines in Eastern U.S.A. are presented.

95. HUMPHREY, J.L.
Steel bolts in mine roof support.
Mining Eng. 1956 8 (5) May 491-5.
General review of procedures, types of bolts, etc., with reference to U.S. Bureau of Mines work.

96. SPRUTH, F.
Steckenausbau in Stahl (Steel roadway support).
Essen, Verlag Glückauf 1955 220pp. 18 DM.
Textbook on steel timbering for mines, particularly coal mines, including roof bolting practices in U.K. and Europe.

97. THOMAS, E.M.
Latest developments in mine-roof bolting.
Coal Mine Modern. Yearb. 1955 89-93.
General review of developments. There is mention of an attempt to use a 5/8-in. bolt of higher-grade steel rather than to overload the $\frac{3}{4}$-in. bolt.

98. RABCEWICZ, L.v.
Effect of modern constructional methods on tunnel design.
Water Power 1955 7 (12) Dec 452-7;
1956 8 (1) Jan 25-9.
Three methods of tunnel support are discussed:
(1) Austrian method using crown beams;
(2) the use of steel arches;
(3) roof bolting. The latter is not described in detail, as reference is made to the author's earlier paper in Water Power, April, 1954. (No. 108)

99. BURCHELL, H.J.
Rock bolting.
Can. Mining Met. Bull. 1955 48 (522) Oct 631-8.
C.I.M.M. Trans. 1955 58 361-68.
General article covering history and objectives of rock bolting, types of bolts available, bolting patterns in Canadian mines, safety precautions, comparison of timbering and bolting costs, average installation cost, advantages in their use. Diagrams show bolt construction and application. References.

100. HODKIN, O.H. & LAWRENCE, R.
Some factors influencing the behaviour of roof bolts in mines.
Inst. Mining Eng. Trans. 1955 114 (10) Jul 834-52; discussion 852-59.
Résumé of information on bolting, with mention of work done at U.S. Bureau of Mines, and in Great Britain at Yorkshire collieries. Numerous graphs and tables are included. References.

101. TAYLOR, R.W.
Roof bolting in mines.
Iron & Coal Trades Rev. 1955 171 (4552) 8 Jul 95-8.
The following topics are discussed: function of bolting; drilling (Holman "Dryducter"); bolt anchorage; wedges; testing; advantages of roof bolting.

102. ANNALES DES MINES DE BELGIQUE
Journées des épontes et du soutènement (Conference on props and roof supports).
Ann. Mines Belg. 1955 54 (4) Jun-Jul 640-61; discussion 661-4; (5) Sep 803-37; discussion 837-9.
This is an account of the Conference organized by Inichar, 1955. Part 1: Study of quality of props, by P. STASSEN, A. HAUSMAN & R. LIÈGEOIS. Part 2: Roof support at coal face. In this part there is a section on bolting and bolting with channel irons.

103. RUMPF, K. & RANKE, W.
Erfahrungen im Ausbau mit Firstankern (Experience in development with roof anchorage).
Bergbau 1955 5 127-129.
Deals with bolting patterns.

104. RABCEWICZ, L.v.
Bolted support for tunnels.
Mine & Quarry Eng. 1955 21 (Mar) 111-16;
(Apr) 153-9.
S. African Mining Eng. J. 1955 66 (1) 28 May 513-23.
Translation in Gornyi Zhurnal 1956 (1) 36-39.

Details are presented on the following: principles of rock bolting; types of bolts available; determination of the suitability of rocks, using an impact tester; the reinforced concrete anchor to prevent floor lift; the testing of bolts with a torque meter. 11 references. In the second article, the material and construction of bolts are discussed, the history of the technique is given, and developments are outlined. 14 references.

105. JUDY, G.L.
Pillar extraction methods, results and recovery.
Coal Mine Modern. Yearb. 1954 66-73; discussion 74-76.
Advantages of this application of bolting are compared, timewise and costwise, with timbering.

106. WOODRUFF, S.D.
Rock bolts.
Western Construction 1954 29 (7) Jul 61-5; (8) Aug 76-80.

107. HUSTON, E.F.
How to install roof bolts.
Coal Age 1954 59 (6) Jun 98-100.
With numerous diagrams and illustrations, the installation and checking of bolts are demonstrated.

108. RABCEWICZ, L.v.
Bolted support for tunnels.
Water Power 1954 6 (4) Apr 150-5; (5) May 171-5.
A detailed account with many diagrams of rock bolting in unstable rock. Examples are drawn from the Foiçacava, Brazil and New York tunnels. Development is outlined and recommended techniques are given.

109. HORST, U.
Der Ankerausbau im Steinkohlenbergbau (Rock bolting in an iron mine).
Freiberger Forschungehefte 1954 A20 115-135; discussion 135-136.
A general descriptive article with numerous diagrams and illustrations. Examples are drawn from German and American sources. Lengthy bibliography.

110. SHARPE, C.
Roof and floor bolting; effect on strata control.
Iron & Coal Trades Rev. 1953 167 (4468) 27 Nov 1243-6.
This general article describes equipment, bolting patterns, and the fixing of bolts.

111. GRIERSON, A.
Principles and practice of roof bolting.
Mining J. (London) 1953 241 (6160) 11 Sep 298-300.
Describes the expansion-shell and wedge types of bolt, the equipment required for their installation, load tests, and installation procedures. It is stated that the reinforcement of strata by means of rods was first put forward by Z.S. Beyl in 1912 and was applied in 1914 in U.S.A.

112. YOUNKINS, J.A.
Roof support for continuous mining (in coal mines). A report of the Mechanical Loading Subcommittee, describing methods and practices of roof support in several coal fields.
Mining Congr. J. 1953 39 Jul 44-6.
Summary of reports proposed for roof support in continuing mining:
(1) drills for bolting mounted on the continuous machine;
(2) a modified mining system to eliminate delays for timbering;
(3) a step-face system to permit timbering nearer the face;
(4) a system of concurrent bolting and mining.

113. WRIGHT, A.
Roof bolting.
Sheffield Univ. Mining Mag. 1953 15-17.
Synopsis of a paper, presented to the Sheffield Mining Society in 1952, in which bolting equipment and practice are outlined.

114. WILLIAMSON, J.W.
Roof bolting vs. timbering.
Mechanization 1952 16 (12) Dec 92-4; 97.
A general article on bolting principles and practice.

115. BRESTAU_, TINCELIN_, HENIN_, HERDLICKA_ & PIERRE_.
Le soutènement suspendu dans les mines de fer (Rock bolting in iron mines).
Rev. Ind. Minérale 1952 33 (585) Oct 725-62.
An outline of rock bolting based on American practice, followed by discussions of experiments using various types of equipment, bolting patterns, fabrication of bolts, use of channels, overall costs, and a variety of applications of bolts underground. 16 references.

* 116. PEREZ, H.T.
Tunnelling costs drop down when bolts hold up tunnel roof.
Constr. Meth. & Equip. 1952 34 Mar 48-53.
(Includes diagrams.)

117. BROUGHTON, H.J. & JOHNSON, L.H.
Roof bolting.
Mining Congr. J. 1952 38 (2) Feb 124-7.
Review of bolting developments.

118. COMPRESSED AIR MAGAZINE
Roof bolting.
Compressed Air Mag. 1951 56 (11) Nov 298-9.
A short outline of bolting techniques.

119. MÜLLER, O.
Sicherung des Hangenden durch Ankerbolzen
(Safety of suspensions by anchor bolting).
Glückauf 1951 87 (11-12) 17 Mar 256-59.
A discussion of bolting techniques based mainly on North American practice. Numerous references are given.

120. CROSS, A.T. & PRICE, P.H.
Overhead roof support.
Mining Congr. J. 1951 37 (2) Feb 90-2.
General review of recent progress.

121. MEAKIN, W.D.
Roof bolting benefits ventilation.
Mining Congr. J. 1951 37 (1) Jan 41-3.
Advantages of bolting over timbering in airways is shown. Tables compare costs and ventilation efficiency.

122. NEYMAN, B.
Kotwienie Stropow wyrobisk Gorniczych
(Suspension bolts in mine workings).
Przeglad Gorniczy 1950 6 (9) Sep 450-5.
A general article, with diagrams, illustrating installations. Reference to American and British literature.

123. LEWIS, W.J.
Installation notes: roof bolts;
Mechanization 1950 14 (8) Aug 95-98.
Installation of the expansion-shell-and-plug bolt is described and illustrated.

124. THOMAS, E.M.
Roof bolting.
Can. Mining Met. Bull. 1950 43 (May) 268-76.
C.I.M.M. Trans. 1950 53 183-91.
Thirty-three illustrations are given with captions to show methods of bolting.

125. OHIO BRASS COMPANY
Effect of lubrication in roof bolt installation.
O-B Haulage Ways 1950 21 (5) May 1-4.
Tests show that lubrication under the head of the bolt has an appreciable effect on the amount of torque required to establish any specified amount of tension in the rock bolt. Tension-torque curves for dry and lubricated $\frac{3}{4}$-in. bolts with and without flasks are given.

126. FORBES, J.J.
Progress in roof bolting.
Illinois Mining Inst. Proc. 1950 21-27; discussion 27-30.
General article on bolting practice, with details on standardization and test methods.

127. OHIO BRASS COMPANY
How to install O-B roof support expansion shells and plugs using: (1) palnuts, and (2) rods with upset support ears.
O-B Haulage Ways 1949 20 (12) 4-5.
Diagrams illustrate these two methods.

128. METCALFE, A.
Roof suspension supports.
Coal Mining 1949 26 (7) Jul 15-6, 29-30, 33.
Discusses roof-suspension support method in which the reinforcement of roof material provides additional beam strength, i.e. to tie or bind together several thinly bedded rocks to simulate a thick bed. This method has been used at St. Joseph's Lead Co., Mo., for twenty years. Outlines practicability of these supports, equipment used, installation, drilling, wedging of suspension rods. Paper read at Mine Inspectors Institute of America, Pittsburg, 1949.

129. WINKAUS, G.P.
Ausbau mit Zugankern (Support with rock bolts).
Glückauf 1949 85 (1-2) 1 Jan 16-17.
A brief discussion of rock bolting principles with reference to North American practice and early work in Germany by A. BUSCH. Diagrams are included. (No. 62)

130. THOMAS, E.M.
Suspension roof support.
Coal Age 1948 53 (7) Jul 86-8.
Suspension-type support, consisting of channels bolted to rods anchored in roof holes is described, with diagrams.

I. PRACTICE - REGIONAL

(1) AUSTRALIA
(2) AUSTRIA
(3) BRAZIL
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(11) POLAND
(12) RUSSIA
(13) SOUTH AFRICA
(14) SWEDEN
(15) UNITED KINGDOM
(16) UNITED STATES

(1) AUSTRALIA

131. HORSEMAN, R.C.
Roof bolting at John Darling Colliery, Belmont, New South Wales.
Australasian Inst. Mining Met. Proc. 1954 (172) Mar-Jun 163-89.
Describes in detail bolting techniques since 1950 for supporting the shale-type roof. Wedge-type mild-steel bolts, 1-in. diameter, 4-5 ft long, are used. Various methods of drilling were tried in an effort to reduce dust hazard. Hydraulic rotary boring is now general practice, but a change to electric boring is anticipated in the future.

132. PARTEL, W.S.
Roof bolting in Australia.
Coal Mining Conf. Otago Univ. Proc. 1953. Paper No. 29. 9p.
Critically describes practices at Wangaville Colliery, New South Wales, and Phoenix Colliery, Collie coalfield, Western Australia, and experiments at Hebo, Old Bulli and Burwood, Stockton Borehole and Newstan Collieries, in New South Wales.

133. HILL, A.H.
Roof bolting in Australian metal mines.
Mining J. (London) 1953 240 (6141) 1 May 510-11.
This gives a brief account of practices in Australia. The only mine actually mentioned is Broken Hill, New South Wales.

134. HILL, A.H.
Roof bolting in metal mines.
Rhod. Mining Rev. 1953 18 (Mar) 17-19, 21.
General article on bolting practices in Australian metal mines, including costs.

135. MCKENSEY, S.B.
Roof bolting and pillar workings, Elrington and Hebburn No. 2 Collieries.
Australasian Inst. Mining Met. Bull. Supplement. 1952 (Feb) 40p.
Following a description of strata in these New South Wales collieries, experiments carried out and bolting practice are discussed. In each case, wedge-type bolts of 1 in. diameter have been adopted. Reference is made to Australian steel specification AS-A1-1940. The theory and mechanics of bolting are put forward; practical suggestions regarding equipment, supervision, bolt manufacture are given. Illustrations and diagrams are included.

(2) AUSTRIA

136. FABRICUS, O.
Betriebs versuche mit Ankerausbau im Braunkohlentiefbau (Experience with rock bolts in brown coal mines).
Berg.-hüttenmänn. Monatsh. montan. Höchschule Leoben. 1956 101 (7) Jul 141-51.
This detailed article describes bolting techniques in Trimmel Kam coal mine, Salzach-Kohlen-Bergbau-Ges. m.b.H., Oberösterreich. Various types of bolts are used.
16 references. Numerous graphs, etc.

(3) BRAZIL

137. RABCEWICZ, L.V.
The Forçacava Hydro-Electric Scheme.
Water Power 1953 5 (9) Sept 332-37; (10) Oct 370-77; (11) Nov 429-35.
This comprehensive article describes excavation for an underground machine hall with adjoining pressure shaft for the projected power plant at Forçacava, Brazil. Rock bolts, channels and netting were used successfully in sections of the pressure shaft where rock was very unstable, where gneiss was intersected by fault zones, of completely kaolinized material, mostly parallel to the stratification.

See also abstract

108 RABCEWICZ: Bolted support for tunnels (Forçacava, Brazil).

(4) CANADA

138. CORLETT, A.V.
Ground support.
Paper in Mining in Canada, p. 337-48.
Published by the General Committee of the Sixth Commonwealth Mining & Metallurgical Congress, Vancouver, B.C., Canada. 1957. 597pp. $10.
Outlines developments in rock bolting in Canadian mines. An analysis of practice, based on published reports and on information received from 76 Canadian mines, is given. Tables give statistics on the extent of use of rock bolts and the ratio of tons mined to bolts used in the various applications. Data on bolts and auxiliary equipment are analyzed to provide a basis for evaluation. It is mentioned that except in the case of Newfoundland none of the provinces has a stated policy on the use of bolts. Numerous installations are described and illustrated. 13 references.

139. SEMEVSKII, V.N.
Kreplenie metallicheskimi shtangami pri sploshnoi rasrabotke na shachtach "Dominion" v Kanada (Rock bolting in longwall working in the Dominion mines in Canada).
Ugol 1957 (9) 45-7.
Illustrated summary of article by L. FROST (No. 143.)

140. SEMEVSKII, V.N.
Shtangovai krepi na rydnikach Kanada (Rock bolting in Canadian mines).
Gornyi Zhurnal 1957 (5) 57-62.
Material is taken from articles published in Canadian Mining Journal 1953, and Canadian Mining and Metallurgical Bulletin 1955.

141. TEAL, J.K.
Roof bolting practice at Kerr-Addison.
Can. Mining Met. Bull. 1955 48 (521) Sep 541-4.
C.I.M.M. Trans. 1955 58 285-88.
Wedge-type bolts of 1-in. diameter, 5-8 ft long, are installed at a rate of approximately 1200 per month. First used in 1952, they are employed in drifts, raises, shaft stations, stopes, and gangways. Bolting patterns and average cost are given.

142. MCKELVEY, R.C.
Roof bolting practices at Lamaque.
Can. Mining Met. Bull. 1955 48 (521) Sep 545-47.
C.I.M.M. Trans. 1955 58 289-91.
Standard bolt is of wedge type of mild steel, of 5/8-in. diameter, and 5½-8 ft long. Bolt testing by torque wrench, standard installation techniques, cost, and advantages are outlined. Atlas Diesel equipment is used.

143. FROST, L.
Development of roof bolting in the collieries of the Dominion Steel & Coal Corp. Ltd. in the Sydney Coal Field.
Can. Mining Met. Bull. 1955 48 (521) Sep 548-56.
C.I.M.M. Trans. 1955 58 292-300.
Experimental work is outlined. Split bolts, 7/8-in. diameter, are standard. Operating details, e.g. dust problem, are considered. Numerous photographs and diagrams are included.

144. DEWEY, J.H.
Roof bolting at International Nickel Company.
Can. Mining Met. Bull. 1955 48 (521) Sep 557-62.
C.I.M.M. Trans. 1955 58 301-6.
Bolting is carried out in stopes which normally required square setting, in fresh-air raises and in shaft stations in place of the conventional steel beam support. Guniting is sometimes done in conjunction with bolting. 1-in. wedge-type bolts in 4- and 6-ft lengths, with left-hand rolled threads and 1 1/8-in. heavy hexagonal nuts, are standard.

145. SMITH, A.T.
Rock bolting practices at Britannia.
Can. Mining Met. Bull. 1955 48 (521) Sep 563-5.
C.I.M.M. Trans. 1955 58 307-9.
Standard bolts at Britannia are 3/4-in. expansion-shell type. Bolting practices, first applied in 1950, are carried out in drifts, crosscuts, shaft stations, charging stations and timber storage areas.

146. THOMAS, E.M.
Rock bolting; summary of symposium.
Can. Mining Met. Bull. 1955 48 (521) 566-8.
C.I.M.M. Trans. 1955 58 310-12.
Symposium includes the following papers: (Nos. 141-45.)

147. MORRISON, D. & FORSYTHE, A.
The institution and practice of roof bolting in the Cape Breton collieries of Dominion Coal Co., Ltd.
Can. Mining Met. Bull. 1954 47 (509) Sep 694-9.
C.I.M.M. Trans. 1954 57 452-57.
Bolting support in roadways in the various collieries is described. Wedge-type bolts, $\frac{3}{4}$-in. diameter, of various lengths, are used in patterns determined by the particular condition in each colliery. Difficulties due to side-squeezing, roof settlement, adjacent wall out of alignment and broken strata are considered. In some cases, rock bolting was unsuccessful.

148. MINE AND QUARRY ENGINEERING
Lake Shore Mine (Kirkland Lake, Ontario)
Mine & Quarry Eng. 1954 20 (6) Jun 240-52; (7) Jul 304-11.
The application of the "Foran" rock bolt, an expansion-type bolt with a rubber sleeve, made by Heath & Sherwood Ltd., Kirkland Lake, Ontario, is discussed briefly in the first article of the series.

*149. CASSIDY, P.M.
Roof bolting at the Ruffner Iron Ore Mines, British Columbia.
Current safety topics in the mining industry, 1953.
Nat. Safety Council Trans. 1953 20 42-44.

150. BROWN, A.
Roof bolting in Canadian coal mines.
Can. Mining Met. Bull. 1953 46 (450) Dec 744-56.
C.I.M.M. Trans. 1953 56 400-12.
Outline of the practices at Dominion Coal Co., Bras d'Or Co., and Inverness No. 5 Colliery, all in Nova Scotia; Canadian Collieries (Dunsmuir) Ltd.; T'Sable River Mine, Vancouver Island, B.C.; Lethbridge Collieries, Ltd., Galt No. 8 Mine, Alta; Red Deer Valley Coal Co. Ltd., Nacmine Colliery, Drumheller, Alta; Crowsnest Pass Coal Field, B.C. Gives comparative costs.

151. CANADIAN MINING JOURNAL
Rock bolting practices in Canadian metal mines.
A symposium.
Can. Mining J. 1953 74 (9) Sep 56-72.
Gives equipment, procedure and costs. Includes the following papers from Ontario Mines Accident Prevention Association Symposium:
(1) At Aunor Gold Mines Ltd. by S. THIB (slotted-type bolts);
(2) At Macassa by J.D. BRYCE (split-pin-type bolts);
(3) At Halnor (Ontario) by J.A. HALL (split-wedge-type bolts);
(4) At Lake Shore Mines by M. SEYMOUR (split-pin-and-wedge and "Foran" bolts);
(5) At Quemont by W.D. JAMIESON (slotted-type bolts);
(6) At Hollinger by B. AWDE (expansion-shell-and-plug bolts);
(7) Summary by E.M. THOMAS.

152. HUBER, W.G.
Complex excavation pattern cuts out underground power house.
Civil Eng. 1953 23 (6) Jun 396-401.
A description of operation at Kemano Alcan Development, B.C. There is brief mention of the use of slot-and-wedge pins or fish bolts to support rock areas above the roof arch which were loosened by blasting.

153. BALLACHEY, A.G., JAMIESON, W.D. & HAMBLETON, J.R.
Mining at Quemont.
Can. Mining Met. Bull. 1952 45 (477) Jan 58-69.
C.I.M.M. Trans. 1952 55 57-68.
In this general article on mining practice at Quemont Mine, Noranda, Que., brief mention is made of the use of split-wedge, 1-in.-diameter, 5-8 ft long, mild steel bolts to give additional support to both back and walls.

154. DWARKIN, L.M., DOXEY, F. & JOHNSTON, J.C.
Roof bolting (in coal mining).
Can. Mining Met. Bull. 1951 44 (476) Dec 779-87.
C.I.M.M. Trans. 1951 54 485-93.
General discussion of bolting followed by descriptions of practice at Four Star Colliery, Cape Breton, N.S., by J.C. JOHNSTON and at Dominion No. 20 Colliery, Sydney, N.S., by F. DOXEY. Comparative costs are given. Bibliography.

See also abstracts

56 HAFLIDSON and others: Replacement of rock bolts with used hoisting rope cuts cost of holding ground. (East Malartic Gold Mines, Ltd., Norrie, Que.)
99 BURCHELL: Rock bolting.

(5) EGYPT

See abstract

65 CHOUTE: An unusual roof bolt. (Assouan Dam, Egypt)

(6) FRANCE

155. WATER POWER
The St. Pierre-Cognet development.
Water Power 1957 9 (12) Dec 452-62.
Includes a section on rock bolting at this hydro power development on the River Drac in France. Bolts and cement are injected before blasting for traversing unsound rock.

156. VOLUMARD, P. & BASTIDE, M.
Ancrage du toit avant abattage à St. Pierre-Cognet
(Roof anchorage before blasting at St. Pierre-Cognet).
Rev. Ind. Minérale 1957 39 (8) Aug 749-53.
Method involves cement or sand injection to stabilize the limestone roof.

157. PAJOT, G. & MARIA, H.
Lorraine iron mines.
Mine & Quarry Eng. 1956 22 (4) Apr 126-35.
In this general article the use of wedge-type rock bolts, 120 by 80 mm, to support the hanging wall is mentioned briefly. Average spacing is 0.8 bolt per 9 sq ft.

158. AUDIBERT, J.
Mesures des mouvements des épontes en voie
(Measurements of movements in roadway walls).
Ann. Mines Belg. 1953 52 (5) Sep 689-700; discussion 700-01.
A detailed study of convergence in bolted roofs in the collieries of the Groupe de Valenciennes, Bassin du Nord, Pas-de-Calais. Diagrams show bolting pattern and roof composition (shale and sandstone); tables and graphs give results of measurements.

159. TRAMBLAY, M.M. & VERDET _.
Versuche zur Verbesserung des Ausbau in den Abbauen
und Strecken im Bassin Nord und Pas-de-Calais
(Trials designed to bring about improvements in support practice in face areas and roadways in the North and Pas de Calais coalfields).
Grubensicherheit u. Grubenausbau 1952 157-65
(Typescript M.F.P., Translation L.T.S. 1160).
Consists of two papers read at the conference: The paper by Verdet deals with rock bolting tests carried out in crosscuts, roads using retreating systems, and longwall advancing. Equipment tested - expansion bolt, Gruppe lens design, wedge bolt and auxiliary equipment - is described, and methods of application are given.

160. BILLET, M.
Essais de boulonnage au groupe de Petite-Roselle, Lorraine (Bolting experiments at the Petite-Roselle group collieries, Lorraine).
Rev. Ind. Minérale 1952 33 (585) Oct 763-72.
Outlines successful experiments using both wedge- and expansion-type bolts in shale roof in Lorraine collieries, 1951-52.

161. AUDIBERT, J.
Some experiments of roof bolting in France.
Conf. Rock Pressure & Support, Liege 1951 408-11;
discussion 416-17. (English and German texts).
Tests have been carried out in Giraumont Iron Mines, Lorraine, potash mines in Alsace, and various coal mines in Northern France and Pas-de-Calais. Diagrams show methods of installation.

See also abstract

59 ALLIMAN: Expansion bolt "Ancrall" (Petite-Roselle collieries, Lorraine).

(7) GERMANY

162. SCHERING, E.
Über die Verwendbarkeit von Firstankern im Salzgestein
(On the application of rock bolts in rock salt).
Kali u. Steinsalz 1956 2 (Aug) 37-42.
A detailed description of the various types of bolts, with emphasis on the split-sleeve and expansion types, and their applicability in German salt mines. Graphs and illustrations are included.

163. GÖBEL, P.
Die Bewährung von Ausbau verschiedener Art beim Unterbauen und Überbauen Querschlagen und Richstrecken Sowie von Ankerausbau in abbaustrecken (Experiences with various methods of support when working below or above crosscuts and headings and with roof bolting of gate roads).
Glückauf 1956 92 (17 Mar) 305-20
(Typescript M.F.P., Translation L.T.S. 2056A (only pp 312-20)).
Includes details on bolting trials at Prosper III mine of Arenberg Bergbau GmbH, confirmed the value of bolts in gate roads. Emphasis is placed on trials in a middle road serving two faces. A fall during trials provided valuable information on causes involved.

164. LÜCK, H.
Erfahrungen beim Rauben von Ankerausbau
(Experience in withdrawal of bolting support).
Glückauf 1954 91 (13-14) 26 Mar 353-56
(Typescript M.F.P., Translation L.T.S. 1781).
A description of conditions of the roof at Albert I seam, Windgasser firm, Duisberg, after withdrawal of bolted support. No serious fall occurred. Method of withdrawal is given; efficiency and costs are outlined. Economic results were more favourable here than in a similar American experiment.

165. MIDDENDORF, R. & JANSSEN, K.
Erfahrungen mit dem Ankerausbau (Bolting experience).
Glückauf 1953 89 (33-34) 15 Aug 809-22
(Typescript M.F.P., Translation L.T.S. 1261).
A general discussion based on practice at the Neumühl colliery under the following headings; examination of rock by means of the Kugel chlaghammer (hardness tester); pull tests; design of bolts; applied tension; drilling of boreholes; examples of bolting Albert I seam, Gretchen seam; floor bolting; anchorage bolting supports in stone drifts; in upbrows and downbrows in virgin ground; bolting as ancillary to supports; economics of bolting; safety. A very detailed breakdown of costs at Albert I seam is given. 10 references.

166. GIMM, W.
Der Ankerausbau im Kalibergbau (Rock bolting in potash mines).
Bergbautechnik 1953 3 169-73.
Following a general description of practices in German potash mines, a theory of ground support in relation to bolting is discussed.

167. LANGECKER, F.
Versuche zur Verankerung der Gebirgeschichten, besonders im Liegenden (Experiments on bolting, particularly foot wall bolting).
Glückauf 1952 88 (45-46) 8 Nov 1086-90.
Experiments in bolting very broken strata, especially floor strata, were carried out in the Hausham and Peissenberg coal pits, Upper Bavaria. Bolting with concrete proved successful. Pressure tests on model workings are described. Bolts described are 14 and 19 mm diameter to withstand stresses of 6-8 tons and 10-14 tons respectively. Roof bolting has also been investigated but has not been applied.

168. BRUN, L.
Boulonnage du toit (Roof bolting).
Rev. Ind. Minérale 1952 33 (585) Oct 773-83.
Experiments were carried out at Griesborn colliery, Saar district, using wedge-type bolts 30 mm in diameter, about 1.50 m long. Numerous applications - roof, workings, shaft stations, etc. - and comparative costs are considered.

169. MIDDENDORF, H. & JACOBI, O.
Ankerausbau in Abbaustrecken (Rock bolting)
Glückauf 1952 88 (25-26) 21 Jun 636-45
(Typescript N.C.B., Translation No. A. 237/AB).
Report of experiments carried out at the Neumühl pit, Albert No. I seam, G.H.H. Co., Oberhausen. The geology of the mine and various theories of bolted support are discussed. Detailed diagrams show equipment used - wedge- and split-sleeve-type bolts. Results of experiments, testing methods, and bolting patterns are given. References.

170. HOEVELS, W. & ROLSHOVEN, H.
Betriebsversuche mit Ankerausbau auf dem Steinkohlenbergwerk Consolidation unter Berücksichtigung amerikanischer Erfahrungen (Working experiments with rock bolting at Consolidation colliery with reference to American experiences). Glückauf 1952 88 (13-14) 29 Mar 281-9.
Following a general background of rock bolting, including references to work done by A. BUSCH at Friedenshütte, Oberhausen (No. 62), three types of bolts - wedge, split-sleeve and expansion types - are described. Numerous illustrations of American installations are given, along with practice at Consolidation Bergbau-Aktiengesellschaft, Essen.

171. HEIDEMANN, W.
Vergleichende Untersuchungen der Produktivität im amerikanischen und im Ruhrbergbau und Nutzan wend für eine weitere Mechanisierung und Rationalisierung auf der Ruhr als Ergebnis einer Studienriese durch die Vereinigten Staaten (Comparative study of productivity in America and in the Ruhr district, and practical application for greater mechanization and planning in the Ruhr as a result of these studies in the United States). Glückauf 1952 88 (7-8) 1 Mar 150.
Bolting practice is one of the aspects reviewed.

See also abstract

62 ZEITSCHRIFT FÜR BERGBAUHÜTTENWESEN UND SALINWESEN: Support with iron anchors. (Friedenhütte, Bergreveir Königshütte O.S., Germany)

(8) ITALY

172. SEGUITI, T.
La bullonatura del tetto (Roof bolting).
Ind. Mineraria, 1953 4 (Mar) 107-18; (May) 199-206.
Part 1 covers materials and applications in Italy. Following a brief review of the history of bolting from the early work by BUSCH, the various types of bolts are described - wedge, expansion, split-sleeve, the Ancrall, Hubbard, Ohio Brass, Werner, and Boltex types. Installations in various foreign countries - U.S., France, Germany and in Italy - Nicciolota mine, Soc. Montecatini, Baccinello mine, Soc. Mineraria del Valdarno and the marble quarry of Soc. An. Marmi di Lasa, Val Venosta, Bolzano, are described. Part 2 discusses theory of rock pressure in relation to bolting, based on work by SPRUTH, FENNER, LABASSE, JACOBI, AND BUCEY, papers presented at the Liège conference, 1951, and work done by U.S. Bureau of Mines. Diagrams show installation patterns. 48 references.

(9) NEW ZEALAND

173. LOCKINGTON, F.E.
Roof bolting at Wairaki State Mine.
Coal Mining Conf. Otago Univ. Proc. 1953
Paper No. 30. 12 p (including discussion).
This was the first bolting application in New Zealand, in 1950. Bolting experiments using split-rod-and-wedge, $\frac{3}{4}$-in.-diameter, mild steel bolts $5\frac{1}{2}$ ft long, boring operations using rotary drills, and comparative costs are outlined. Bolts were applied to haulage roads, a fan drift and a stone drive, in moderately wet soft sandstone.

(10) NORWAY

174. TROFTEN, E.
In Norway it's roof sewing - in Sweden the method is simple (Perfo bolting).
Eng. Mining J. 1956 157 (9) Sep 78-81.
Details are given of the technique used at Sulitjelma mine, Norway. Difficult ground is supported by weaving a continuous arch of rock and concrete to carry the strain. A cost breakdown is given.

175. SANDVIK, P., HJELSETA, H., & BERGE, I.
Takbolting i gruver (Rock bolting in mines).
Tidsakr, Kjemi Bergvesn. Met 1956 16 (6) 93-9.
Norwegian bolting practice at the Orkla mine of the Løkken Co., Orkla Grube A/B; the Folldals mine, Folldal Verk A/S; and the Fosdals mine, Fosdalens Bergverks A/S. Detailed diagrams and illustrations show methods of installation. Wedge-type bolts are used with triangular-shaped plates, and sometimes in conjunction with wire mesh. The method of cementing boreholes is also applied.

176. AUSTIN, C.C. & TROFTEN, E.
Roof sewing.
Eng. Mining J. 1953 154 (9) Sep 91.
Describes practice at Sulitjelma Mines, Norway.
Cribbed pillars of schist blocks and conventional split-end bolts have been used in stopes for 20 years to support the top. Roof sewing is used where the bolt is not sufficient. It involves (1) a hole drilled 2-3 m deep; (2) wire rope; (3) vent pipe; (4) a short pipe connected to grouting pipe and a Silex plug; (5) grouting of hole with concrete gun at 300 lb pressure.

(11) POLAND

177. PENSA, A.
Viseca podgrada i njena primjena u rudniku Trepça
(Rock bolting and its application in Trepça lead-zinc mine).
Rudarako-Met. Zbornik 1956 (1) 1-21;
English summary 22-24.
Describes the various types of bolt, with emphasis on the "Perfo" tube which is especially applicable in Trepça in places where bands of very soft sericite schist and tectonic shale appear. Diagrams and graphs illustrate tests carried out. Bolting is now being applied in about 30% of the ore areas in Trepça. 4 references.

178. OLESINSKI, J.
Proby obudowy podwieszonej w naszych kopalniach.
(Experience with roof support in Polish mines).
Przeglad Gorniczy 1952 8 (9) 322-23.
Bolting experiments are described. 3 diagrams.

See also abstract

55 ORLOWSKI; A new system of roof bolting in collieries (Wieczorek and Pawel collieries).

(12) RUSSIA

179. KRAVCHENKO, G.I.
Opitnoe primenenie shtangovai krepi na calairskom rudnike)
(Experimental use of roof bolting in the Salair ore mine).
Gornyi Zhurnal 1957 (9) 25-28.
Bolting patterns using wedge-type bolts are shown.

180. SHIROKOV, L.P.
Shtangovai krepi na ugol'nich karyerakh (Anchor bolting in opencast coal mines).
Gornyi Zhurnal 1957 (9) 29-30.
Wedge-type bolts are used. Diagram shows installation.

181. YAKOVLEV, N.I., SHIROKOV, A.P. & ZAPREEV, S.I.
Promishlennoe primenenie derevynnoi ankernoi krepi)
(Industrial use of wooden anchor bolt support).
Ugol 1957 (4) 37-38.
Bolts are 800-1200 mm long, 35 mm diameter, with slots at each end. Diagrams show installations.

182. SHIROKOV, A.P.
Uderzhenie mezhgeriayentich tselikov bortovoi krepi s ankerovaniev (Holding up pillars between horizons with side support and anchor bolting).
Ugol 1957 (1) 16-18.
Diagrams show installation details. Wedge-type bolts, 25 mm long, are used.

See also abstract

46 POPOV and others: Roof bolting at the face.

(13) SOUTH AFRICA

183. ROUILLARD, R.J.
Roof bolting.
Assoc. Mine Managers S. Africa, Papers and Discussion. 1954-55. 337-42; contributed remarks by L.F. Calmeyer 342-54.
Assoc. Mine Managers Transvaal Circ. 1954 (1) 15 Jan. 3 p.
Bolting, it is stated, has not been generally accepted on the Rand but it has been used for various purposes during the last few years: (1) support of side wall and roof in a very high excavation; (2) support of shaft station roof; (3) temporary support in inclined shaft sinking; (4) semi-permanent support in haulages; (5) ventilation duct; (6) temporary support in a circular vertical shaft; (7) undercutting strata in stopes. Further applications at Durban Roodepoort Deep are put forward by CALMEYER.

See also abstract

54 FULTON: Rock bolts and allied techniques of ground control. (Van Dyck Consolidated Mines, S. Africa)

(14) SWEDEN

* 184. SMEDBERG, M. & PILCH, Z.
Försök med betongacceleratorer vid Perfo-bultning (Testing with concrete accelerators when using Perfo bolts).
Tidn. Byggnadskonst 1956 48 (17) 719-25.

* 185. SMEDBERG, M.
Bergförankring (Anchor bolting).
Tek. Tidskr. 1955 85 825-31

*186. SMEDBERG, M. & PILCH, Z.
Bergförankring med Perfo-bult i Bjuvs gruvs (Anchor bolting with Perfo bolts in Bjuvs mine (Sweden)).
Tidn. Byggnadskonst 1955 47 (10) 453-56.

187. SMEDBERG, M.
Bergförankring vid några svenska gruvföretag (Rock bolting in Swedish mines).
Tryckluft 1955 10 (1) 1-12.
Developed since 1950, bolting in Swedish mines, at Kiruna (L.K.A.B.), Idberget mine, Ställberg bolagen AB Zinkgruver and Höganäs mine, Höganäsbolaget, is described. Various types of bolts are used, including the Swedish Perfo bolt. Triangular-shaped plates and channel irons are used. Costs are included.

*188. MORATH, F. & KIND, H.
Redorgörelse för provdragning av grundbultar, anbringade in s.k. trasberg (Report of anchorage testing of bolts used in shale room).
Meddelande fran Kungl. Vattenfallsstyrelsen, Stamlinjebyggnaderna, Stockholm, 1954.

*189. ERDHEIM, B. & BERGMAN, S.C.A.
Dragförsök med Bergbultar (Load testing of bolts).
Report of the Kungl. Fortifikationsforvaltningen Befastningsbyran Forsknings- och Försökssektionem, Sweden. (Date?).

*190. FELLENIUS, B.
Rock bolting.
Report of tests by Kungl. Järnvägsstyrelsen bantekniskabyran, Sweden. (Date?).

See also abstracts

26 SMEDBERG: Anchorage testing of mine roof bolts. (Höganäs Billesholms Co. mines)
65 CHOUTE: An unusual roof bolt. (Kilforen and Sternorrfors, (Sweden)

(15) UNITED KINGDOM

191. WRIGHT, A. & ADCOCK, W.J.
Further progress with strata bolting.
Colliery Guard. 1957 194 (5017) Apr 559-63.
Inst. Mining Eng. Trans. (London) 1957 117 (3) Dec 186-97; discussion 197-201.
Outlines progress in bolting techniques in U.K. coal mines since 1952. Applications include bolting in longwall faces, machine stables, roadheads and rippings, large excavations and support of pipes. Factors influencing bolting pattern and bolt tensioning are discussed giving details of equipment used, e.g., compression pads, strain gauges. Includes graphs and tables. 5 references.

192. PESCHMANN, H.
Der Ankerausbau in englischen Gruben
(Rock bolting in British mining).
Bergbau 1957 8 (Jan) 7-10.
General account of British practices, with illustrations showing methods of installation.

193. WRIGHT, A.
Investigations into roof bolting techniques in Great Britain.
Intern. Strata Control Congr., Essen, 1956. 22p.
A comprehensive review of the state of the method in Britain. Standard U.K. equipment, including split-rod-and-wedge, wedge-and-sleeve, and umbrella-type bolts, is described; methods of testing bolt anchorage and tension are outlined. The strain gauge dynamometer proved most satisfactory. It was found that spring leaf washers and rubber compression pads were useful to minimize tension loss. Practical applications in coal headings, drifts, roadways and in floors are described. Numerous diagrams, graphs and illustrations are included.

194. WRIGHT, A.
The support and maintenance of roadways.
Symposium Strata Control Nottingham Univ. Proc. 1956 44-53; discussion 53-56.
Following a discussion of layout and planning of roadway support, bolting techniques are described with examples drawn from various British coal mines. 6 references.

195. MORGAN, W. & HOLDSWORTH, A.
Roof bolting: experience at Hartley Bank colliery.
Iron & Coal Trades Rev. 1956 173 (4621) 14 Dec 1433-42.
This continuation of an earlier article (No. 198) describes methods of recovering channel irons and plates (bolts could not be recovered) and the application of bolts and cement to prevent weathering of walls of roadways.

196. ADCOCK, W.J.
Roof bolting: its application in the East Midlands Division.
Iron & Coal Trades Rev. 1955 171 (4558) 19 Aug 425-33.
Outlines types of bolts and their relative merits, tests and bolting patterns, with diagrams of practice in low main seams, high main seams and main loading gate. Recommendations for thread and burned slot wedge-type bolts are put forward.

197. COWAN, J.R.
Some experiments on roof and floor bolting.
Inst. Mining Eng. Trans. (London) 1954 113 (6) Mar 545-61.
Bolting experiments at three Scottish collieries working the Meiklehill Coal Seam are described. Various types of bolts were tested.

198. MORGAN, W. & HOLDSWORTH, A.
Roof bolting in longwall roadways and headings. Experience at a West Yorkshire pit.
Iron & Coal Trades Rev. 1954 168 (4478) 5 Feb 325-40.
Bolting using 1-in., wedge-type bolts and channel irons was adopted at the Hartley Bank colliery. Diagrams show applications at a road junction, at a longwall cross-gate, at the face of a cross-gate, and at road head. Equipment and patterns are described.
(See No. 195.)

199. BOURNE, W.J.W. & WHALLEY, T.
Roof bolting.
Inst. Mining Eng. Trans. (London) 1953 112 (8) May 639-50; discussion 651-55.
Following a description of the three basic types of bolts - (1) slit-rod-and-wedge; (2) expansion shell; (3) expansion-shell-with-plug - tests at Maypole Colliery and Reedley Colliery, North Western Division, of the National Coal Board, are outlined. Cost breakdown is given.

200. CHABOT, L.S. Jr.
Roof bolting in the red ore mines of the Birmingham district.
Mining Congr. J. 1952 38 (11) Nov 33-6.
Started in 1948, bolting has proved successful. Pierced bolts, 5-8 ft long, are now used in preference to the slotted type.

201. GRUNDY, C.F.
Notable water tunnel.
Water Power 1951 3 (1) Jan 24-30.
Hanging bolts were used for roof support in underground pumping station, Bowland Forest Tunnel, near Manchester. This method was employed instead of steel arches where shale and gritstone beds were encountered. Expansion bolts, 1 in. in diameter, were used with bank bars and pages. One-sixth the quantity of steel was needed for these sections.

See also abstracts

3 JOHNSTON: Roof bolting in mines. (Northfield Colliery, Lanarkshire)
13 BEYL: The prestressed state of the earth's crust, its causes and preservation. (Glebe and Silksworth Collieries, Durham; Maypole Colliery, Lancs., and Bowland Forest Tunnel, Lowgill, Lancs.)
17 BEYL: Rock pressure and roof support. (Silksworth Colliery, Durham Co.)
100 HODKIN & LAWRENCE: Some factors influencing the behaviour of roof bolts in mines. (Yorkshire collieries)

(16) UNITED STATES

(1) GENERAL
(2) BY STATE

(1) GENERAL

202. SIMONDS, A.W.
L'emploi des boulons d'ancrage pour stabiliser les pentes rocheuses (Use of anchor bolts to stabilize rock slopes).
Two applications are described: a slope above a pumping station at Grande Coulee, Wash., where bolts were used prior to concreting; construction of a sluice gate situated below Hoover dam, Boulder Canyon, Arizona-Nevada, in 1953-54.

203. WRIGHT, A.
Recent American developments. 3. Roof bolting.
Inst. Mining Eng. Trans. (London) 1954 113 (10) July 865-86; discussion 887-93.
Outline of rock bolting practices in U.S.A. with critical examination of equipment and techniques, and development of practice in National Coal Board mines.

204. WILLIAMS, G.J.
Roof bolting.
Coal Mining Conf. Otago Univ. Proc. 1953, Paper No. 28, 17 p (including discussion).
Outlines principles, types of bolts including wooden bolts, techniques of installation with percussion and rotary drilling equipment, examples of application at Tennessee Coal, Iron & Railroad Co. Mine, Alabama; Sunnyside Coal Mine, Kaiser Steel Co., Utah; Boone Co. Coal Corp., Sharples, W.V.; Norton Coal Corp., Kentucky; Porter Tunnel, Philadelphia & Reading Coal & Iron Co., Schuylkill Co., Pa., and Consolidated Coal Co., Illinois. Dust hazards and safety are considered; various methods are compared. 18 references.

205. BOMAN, I.E.
Tillämpninger i U.S.A. av Bergfästning med bult (Adaptations of bolting in rock support in U.S.A.).
Tryckluft 1952 (3) 1-16.
Outlines history, theories and principles based on U.S. Bureau of Mines work, equipment and practical examples of American practice. Numerous diagrams and illustrations are included. 11 references to American and Canadian publications.

206. WEBSTER, N.E.
Strata control and its influence on underground and surface damage.
Inst. Mining Eng. Trans. (London) 1952 111 (7) Apr 445-75.
In a general discussion of the need to avoid wastage in coal extraction, there is brief mention of bolting practice in the U.S. References.

207. CROMBRUGGHE, O. de
Le soutènement suspendu (Hanging supports).
Ann. Mines Belg. 1951 50 (Special No.) 15 Feb 121-31.
Bergakademie 1952 (10) 400-08.
A general article, based on American practice, describing equipment and techniques. Numerous references.

208. THOMAS, E.M.
Conventional timbering vs suspension supports.
U.S. Bur. Mines Bull. 1950 (489) 175-81.
Diagrams show typical roof failure and its prevention by bolting. The expansion hanger method used by Consolidated Coal Co., Staunton, Illinois, and suspension support at Pittsburgh beds are illustrated. Paper from 5th International Conference on Support, 1950.

209. SOUTH AFRICAN MINING AND ENGINEERING JOURNAL
Roof bolting techniques.
S. African Mining Eng. J. 1950 61 Pt.1 (3013) 11 Nov 321,323.
A short review of American experience, with particular reference to U.S. Bureau of Mines work.

210. THOMAS, E.M.
Roof bolting in U.S.
U.S. Bur. Mines Inf. Circ. 1950 (7583) Sep 8p.
A review of history, dating from W.W. WEIGEL'S article in Engineering and Mining Journal 1943.

211. ARMANET, J.
Le boulonnage du toit (Rock bolting).
Echo Mines Met. 1950 (Sep) 379-83.
A general article based on American practice, particularly U.S. Bureau of Mines work. Detailed diagrams are included. 4 references.

(2) BY STATE

ALABAMA

212. TENNESSEE COAL & IRON DIVISION, U.S. STEEL CORP.
Investigating bolted roof falls at TCI coal mines.
Coal Age 1955 60 (10) Oct 54-8.
This is an attempt to evaluate rock bolting in terms of roof fall prevention. Various types of rock are encountered in the mines - laminated shale, hard sandy shale, thick sandstone.

213. YOUNG, H.C.
Roof bolting in Alabama coal mines and iron ore mines.
U.S. Bur. Mines Inf. Circ. 1954 (7678) Mar 15p.
Covers progress, 1948-53. Practice was pioneered in this area by Tennessee Coal & Iron Division of U.S. Steel Corp. Bolts have been applied to roadways, airways, manways, working faces, underground shops, etc. Bolts used are mainly 1-in. split-and-wedge type and $\frac{3}{4}$-in. expansion type.

214. REED, E.P.
Mechanization in iron ore mines of Tennessee Coal & Iron Division, U.S. Steel Corp.
Can. Mining Met. Bull. 1953 46 (499) Nov 685-9.
C.I.M.M. Trans 1953 56 381-5.
Describes, inter alia, roof support using wedge-type anchor bolts, of 0.906 in. diameter, 5-8 ft long, usually spaced on 4- or 5-ft centres.

In haulage drifts, air courses, intersections, and in places where the roof is particularly friable, 5-in. steel channels are installed.

215. COAL AGE
Modified roof bolts make convergence detectors.
Coal Age 1953 58 (7) Jul 87.
To measure roof subsidence at Gorgas Mine, Alabama Power Co., Alabama, bolts are used. The ends are ground conically to provide points between which measurements can be made. Typical convergence station and record are given.

216. STEVENS, E.H.
Successful roof bolting in Alabama.
Coal Mine Modern. Yearb. 1950 31-9.
Both wedge and expansion bolts were tested at Concord Iron Mine, Tennessee Coal, Iron & Railroad Co., Alabama, and the wedge, $\frac{3}{4}$-in. in diameter, was adopted as standard. Tentative specifications for coal and ore mines are outlined; studies on roof failures, development in stoping technioue and safety of bolting are put forward.

217. FIES, N.H.
Greater coal production at Gorgas Mine by roof bolting and continuous miner.
Mining Eng. 1950 2 (12) Dec 1238-43.
Wedge-type steel bolts, 1-in. diameter, are used at Gorgas Mine, Alabama Power Co., Walker Co., Ala, in conjunction with Joy continuous mining equipment. Cost breakdown is given.

218. JOHNSON, L.H.
Trackless mining improves ore production for T.C.I.
Mining Eng. 1950 2 (12) Dec 1225-9.
In this article on general mining practice at Tennessee Coal, Iron & Railroad Co.'s iron ore mines in Alabama, rock bolting methods started in 1948 are described. Standard bolt is 1-in.-diameter, rivet-steel bolt, 5-8 ft long, of the slot-and-wedge type.

219. BAKER, G.D.
Notes on a mining convention in Utah.
Mining Mag. 1950 83 265-76.
In this outline of the proceedings, American Mining Congress, 1950, a paper given by M.C. McCALL on rock bolting in Alabama is summarized.

COLORADO

220. ZELENKOV, S.E.
Roof support in Colorado.
Mining Congr. J. 1952 38 (5) May 32-4.
Experience at the Kokomo, Indiana unit of American Smelting & Refining Co., dating from 1949. Slotted-type bolts, 6-8 ft long, 1-in. diameter, were used. Cost was less than timbering.

221. HILANDER, A.C.
Roof bolting eliminates timber at Telluride.
Eng. Mining J. 1950 151 (12) 110.
Gives a diagram and brief description of use of bolts in occasional sections of tunnel of Telluride Mines, Inc., Telluride, Colo. The rock is red medium-bedde sandstone. Bolts are of $1\frac{1}{4}$-in. diameter, 5-10 ft long, wedge type.

IDAHO

222. FARMIN, R. & SPARKS, C.E.
The use of wooden rock bolts in the Day Mines.
Mining Eng. 1953 5 (9) Sep 922-4.
Describes the use of wooden bolts of wedge type, approximately 2-in. diameter, 4-6 ft long, using a headboard 30 in. long, at Day Mines Inc., Wallace, Idaho. Roof is shaly quartzite and argillate.
3 references.

223. FOSTER, W.B.
Rock bolting progress at Sunshine.
Mining Congr. J. 1953 39 (7) July 26-8.
In 1952, Sunshine silver mine in Shoshone Co., Idaho, began to use rock bolts of 1-in. diameter, 6 ft long with 3/8 by 8-in.-square plates. An Ingersoll-Rand 534 Impact Wrench was used. Bolting pattern was required to support 25 sq ft of ground for every 5 bolts. Difficulties due to a slabby hanging wall were overcome by installing 6-ft bolts in a fan-like pattern. Bolting is being used in stopes with success.

ILLINOIS

224. KELLY, L.W.
Economic benefits of systematic roof bolting in the Ziegler No. 3 Mine, Bell & Zoller Coal & Mining Co., Williamson Co., Ill.
U.S. Bur. Mines Inf. Circ. 1952 (7633) May 9p.
Describes bolting practice in this mine where the intermediate roof consists of 28 ft of soft white unstratified weak shale. The main roof consists of 10 ft of well-indurated black shale. Double expansion bolts, $\frac{3}{4}$-in. diameter and 5 ft long, were used in conjunction with occasional timber. Another application described is the support of trailing cables.

225. COAL AGE
Efficient machine mining.
Coal Age 1952 57 (4) Apr 74-7.
Includes description of roof support at No. 40 mine, Peabody Coal Co., Galatia, Ill., using steel crossbars and 1-in.-diameter, wedge-type bolts 30 in. long.

226. CONWAY, C.C.
Roof support with suspension rods.
Mining Congr. J. 1948 34 (6) Jun 32-7.
Illustrated article on bolting at Consolidated Coal Co.'s No. 7 mine at Staunton, Ill. Theory, equipment and procedure, methods and results, laminated shale made homogeneous by bolting, are the topics discussed. Reference is made to U.S. Bureau of Mines Report of Investigation 7471. (No. 239)

INDIANA

227. MCCULLOUGH, W.J.
Advantages of roof bolting at the Green Valley Mine.
Mining Congr. J. 1957 43 (1) Jan 63-4.
Using Joy equipment, 5/8-in.-diameter, 4-ft-long expansion bolts and 6-in. by 10-ft channels are installed in the shale roof at Green Valley Mine, Snow Hill Coal Corp., Terre Haute, Ind. Cost reduction is shown.

228. KIRK, N.
Roof bolting reduces accidents and costs.
Mining Congr. J. 1955 41 (12) Dec 38-40.
Expansion-type 5/8- and $\frac{3}{4}$-in. bolts, 4 ft long with 3 by 3-in. steel plates are used at Green Valley Mine of Snow Hill Coal Corp., Vigo Co., Ind.

229. STACHURA, J.A.
Economies of roof bolting.
Coal Mine Modern. Yearb. 1952 43-46; discussion 46-48.
Comparison of costs of bolting and timbering at Enoco Collieries, Inc., Bruceville, Ind., is given. Both expansion- and wedge-type bolts have been used.

230. KELLY, L.W.
Economies through roof bolting in an Indiana coal mine.
U.S. Bur. Mines Inf. Circ. 1952 (7653) Nov 10p.
Detailed analysis of the cost of roof bolting a main haulage road at King's Mine compared to the cost of timbering. Other applications are shown. Bolts used are 1-in.-diameter wedge type, 4 ft long, with 6 by 6 by 7/8-in. steel plates.

KENTUCKY

231. FLETCHER, R. & PRUNTY, M.E.
Roof bolting equipment and practices. Roof bolting equipment. Roof bolting practices and experiences at Jenkins, Ky.
Mining Congr. J. 1956 42 (11) Nov 80-4.
Available stopers, single rotary drills, two-drill machines, steels and bits, wet and dry drilling equipment are outlined. Experiences at No. 3 Elkhorn seam, Consol (Ky.), Jenkins, Ky., are discussed briefly. Standard bolt is 5/8 to $\frac{3}{4}$ in. diameter, expansion type, 36-72 in. long. Bolting pattern is fixed at 4-ft centres; wet rotary drilling equipment is generally used.

232. EDWARDS, J.H.
How wood pins serve Mary Gail.
Coal Age 1954 59 (3) Mar 182-4.
Since 1952, wood pinning has been used in this soft shale mine of Mary Gail Coal Co., Hyden, Leslie Co., Ky., using room mining techniques. Hickory pins are $1\frac{1}{2}$ in. diameter, 36 in. long, with 8-10 in. slots at each end. Pins do not begin to fail for about a year. Where immediate shale top is soft, plates are sometimes necessary.

233. KNIGHT, H.E.
Development of roof bolting equipment.
Coal Mine Modern. Yearb. 1953 25-35.
At Bell & Zoller Coal Co. mines, W. Kentucky and S. Illinois, where roof strata vary from soft shale to hard limestone, bolting is standard practice. Experiments at Ziegler No. 3 Mine using $\frac{3}{4}$-in. expansion bolts and Chicago pneumatic drills are outlined. A fuller account is given in U.S. Bureau of Mines Information Circular No. 7633 (No. 224). At Oriole Mine, where the roof is very weak shale, timbers are sometimes used in conjunction with bolts (expansion type). Roof bolting machines, mobile, twin-boom, built on tractor chassis, are described.

234. BERRY, J.K.
Roof bolting with large mobile equipment.
Coal Mine Modern. Yearb. 1951 84-87.
Description with illustrations of a hydraulically-operated, wet-drilling, single-boom, mobile unit made at No. 3 Elkhorn seam, Consolidated Coal Co., Ky. The chassis is a former timbering machine.

235. LANIER, S.S. Jr.
Pinning roof with wood.
Coal Age 1950 55 (6) Jun 78-80.
Wooden pins, 2 5/8-in. diameter, 5 ft 4 in. long, of oak or hickory, have been used at Rio Verde Mine, Norton Coal Corp., Nortonville, Ky., since 1949. Method of installation in stratified shale and sandstone roof is described. Pins are also used to support crossbars.

236. SINIFF, L.D.
Roof bolting in Elkhorn No. 3 Seam. (Consolidation Coal Co., Ky.)
Coal Mining 1949 26 (12) Dec 13-15, 23-24, 27.
Due to the weak structure when supported on crossbars, seam loosens to heights where bars will not support it. Trials were carried out in 1948 and since, using split-wedge-type $\frac{3}{4}$-in. and 5/8-in. bolts.

See also abstracts

43 MECHANIZATION: Efficiency increased 400 % in roof bolt assembly program. (Princess Elkhorn Coal Co., David, Ky.)
45 ENGINEERING AND MINING JOURNAL: How to make your own roof bolts. (East Diamond Mine, W. Kentucky Coal Co., Madisonville, Ky.)
63 KELLY: Successful use of wooden roof bolts in Stony Point Mine, Stony Point Coal Co., Hopkins Co., Ky.

MICHIGAN

237. EDWARDS, R.W.
Ground support in bulk mining.
Mining Congr. J. 1957 43 (6) Jun 69-71, 79.
Rock bolting is one of the methods being tried at Inland Steel Co. iron mines in the Lake Superior district. It has been tried particularly in the slate areas and has been used only for the spalling type of heavy ground but not where there is ground flow or subsidence.

MISSOURI

238. THOMAS, E.M., BARRY, A.J., & METCALFE, A
Suspensions of roof support. Progress report No. 1.
U.S. Bur. Mines Inf. Circ. 1949 (7533) Sep 13p.
Describes equipment and various techniques employed in bolting, including practice at St. Joseph's Lead Co., Mo.

239. THOMAS, E.M., SEELING, C.H., PERZ, F., & HANSEN, M.V.
Control of roof and prevention of accidents from falls of rock and coal; suggested roof supports for use at faces in conjunction with mechanical loading.
U.S. Bur. Mines Inf. Circ. 1948 (7471) May 9p.
In this general outline of methods of support, a section deals with suspension supports used at St. Joseph's Lead Co., Mo.

240. WRIGEL, W.W.
Channel iron for roof control.
Eng. Mining J. 1943 144 (5) May 70-72.
Split-end-and-wedge bolts, 1-in. diameter, are used in conjunction with 4-in. channel irons to support roof between pillars at St. Joseph's Lead Co. Mines, Leadwood, Mo. Bolts are also used to strengthen crumbling pillars.

See also abstract

128 METCALFE: Roof suspension supports (St. Joseph's Lead Co., Mo.)

MONTANA

241. POLLISH, L. & BRECKENBRIDGE, R.N.
Rock bolting in metal mines of the Northwest.
Mining Eng. 1954 6 (7) Jul 709-15.
A general outline of rock bolting practice with examples from various mines in Northwest U.S.A. Reference is made to a guniting-rock bolting application at Anaconda Copper Mining Co., Butte Mine, Montana, in an exhaust air crosscut in 1939. The three types of rock in the Coeur d'Alene district (Sunshine Mining Co.) are (1) Pre-Cambrian, (2) igneous rock, (3) unconsolidated sand, gravel and silt of the Tertiary and Quarternary Ages. Bolts generally used are 1-in. slot-and-wedge and $\frac{3}{4}$-in. expansion-shell type.

242. POLLISH, L. & SANDVIG, R.L.
Rock bolting experience in the Butte mines.
Mining Congr. J. 1952 38 (8) Aug 50-2; 123.
Rock bolting practice dates from 1939 and 1940 in the quartz monzonite or Butte granite at the Belmont mine. Procedures are outlined; bolts used are 1-in.-diameter, slot-and-wedge type. Pull testing is done with Continental Model ET-252 hydraulic roof bolt puller. Concludes that the bolt should key loose rock into a self-supporting structure; the idea of using the bolt to suspend rock is erroneous.

NEW MEXICO

243. MECHANIZATION
Roof bolting results in production gains.
Mechanization 1951 15 (3) Mar 93-4, 96.
Practices at Koehler Mine, St. Louis, Rocky Mountain & Pacific Coal Co., Colfax Co., New Mexico, are outlined. The roof consists of layers of coal and shale and is bolted with wedge-type bolts of 1-in. diameter, 5 ft long.

NEW YORK

244. ERNST, E. & RUNVIK, R.
Control of mine roof at Oakfield.
Mining Eng. 1957 9 (6) Jun 646-7.
At U.S. Gypsum Co. Mine, Oakfield, N.Y., a flat-lying vein of rock gypsum is mined by room-and-pillar method. Vein averages 4 ft thick and is 1200-1600 ft in mineable width. Overlying roof is 2-ft-thick disintegrated gypseous shale and fractured limestone. Arches are formed by bolting strata between pillars. Bolting equipment and installation are outlined. $\frac{3}{4}$-in., expansion-shell, mild steel bolts are installed on 5-ft centres.

245. PIERCE, J.C.
Pinning up an adequate roof.
Compressed Air Mag. 1953 58 (5) May 128-30.
Application of rock bolting techniques in the New York tunnel. Wedge-type bolts and channels are used. Bolting equipment, mounted on a jumbo, is shown.

246. PLATT, D.H.
Roof bolting the Delaware aqueduct.
U.S. Bur. Mines Inf. Circ. 1952 (7652) Nov 9p.
Suspension roof support in this large-diameter tunnel in New York State was adopted in 1951. Various bolts were tested and a 1-in., split-rod-and-wedge type of bolt, 6 ft long, was made standard.

See also abstract

108 RABCEWICZ: Bolted support for tunnels. (New York tunnel)

NEVADA

247. MCINTYRE, E.S.
Combined Metals' roof bolting experience.
Mining Congr. J. 1952 38 (9) Sep 26-8.
Slotted-type bolts, 1-in. diameter, 6 ft long, are used at the Nevada

properties. In the limestone rock, bolting was not effective in stopes. Practice adopted was bolting steel beams to the back and supporting the ground between the beams with 2 by 12-ft wood lagging resting on flanges of steel beams.

OREGON

248. LANG, E.T.
Better bolting at lower cost.
Coal Age 1955 60 (4) Apr 58-63.
At Powhaten Mining Co., Powhaten Point, Oregon, numerous experiments were carried out. Expansion-type bolts ($\frac{3}{4}$-in. diameter, 5-6 ft long), Pattin bolts with Palnuts, Ohio Brass expanders and steel plates, are used. Bolting patterns, costs, etc., are given.

PENNSYLVANIA

249. MECHANIZATION
Roof bolting through core drill holes.
Mechanization 1955 19 (12) Dec 60-1.
Bolting methods at Lancashire No. 20 Mine, Barnes & Tucker Co., Cambria Co., Pa., are described and illustrated. Expansion bolts of $\frac{3}{4}$-in. diameter, 42 in. long, are used. Roof consists of layers of bone and coal.

250. BERRY, J.K.
Rotary drilling in sand rock for roof bolting.
Coal Mine Modern. Yearb. 1954 15-20.
Description and application of the Fletcher drill which has sufficient torque to eliminate the need of an impact wrench to tighten bolts. A Mine Safety Appliances dry dust collector is built into the drill. Drilling and bolting procedures at two South West Virginia collieries of Clinchfield Coal Corp. are outlined; the problem of bit wear is discussed.

251. VALERI, M. & FITZWATER, M.M.
Pneumatic drilling for roof bolting, using a central air compressor station.
Coal Mine Modern. Yearb. 1954 21-30.
Following an outline of bolting practice using wedge-type bolts to hold roof of soft drawslate coal and shale, at Buckeye Coal Co., Nemacolin, Pa., the installation and use of a 2600-cfm compressor for drilling and ventilation purposes is described. Diagrams show piping system.

252. VALERI, M. & FITZWATER, M.M.
Pneumatic drilling for roof bolting.
Mining Congr. J. 1954 40 (5) May 45-8.
Review of rock bolting practices at Nemacolin Mine of Buckeye Coal Mine, Pa., using 1-in. wedge-type bolts, 5-6 ft long. Details of pneumatic drilling using a portable compressor are given. Diagrams show pipe line layout. A more detailed article on this subject is available (No. 251).

253. COAL AGE
Concurrent roof bolting with continuous miner.
Coal Age 1954 59 (4) Apr 102-3.
By placing bolts in seam-roof while machines cut at face, former timbering delays are avoided. Expansion-shell bolts, $\frac{3}{4}$ in. in diameter, 5 ft long, are used at Warwick No. 2 Mine, Duquesne Light Co., Greensboro, Pa.

254. COOPER, E.R.
Increasing reserves through roof bolting.
Coal Mine Modern. Yearb. 1953 16-20.
Successful application in roadways at Vesta Coal Mines, Jones & Laughlin Steel Corp., Pa., is described. The shale and slate roof is supported by bolts and channels. The type of bolt is not specified.

255. HOOD, A.R.
Advantages and problems of roof bolting.
Coal Mining 1952 29 (2) Feb 14-5, 22.
Bolting practice in conjunction with timbering at Cedar Grove Mines, Duquesne Light Co., Pa., is adapted to 3 types of conditions: (1) 8-12-in., medium to soft, laminated shale overlain with up to 20 ft of soft sandy shale, overlain with 40-60 ft of heavy grain sandstone; (2) intermediate top of laminated carbonaceous shale up to 15 in. thick, overlain with dark shale 1-3 in. thick, for a distance of 5-15 ft, overlain in turn with conglomerate sandy shale; (3) soft clay streaked with shaly fireclay. Paper read at 65th Meeting of Coal Mining Institute of America.

256. CARLAND, A.
Operating experiences with roof bolting.
Coal Mining 1952 29 (1) Jan 9-11.
Experiences at Warwick Mine No. 2, Duquesne Light Co., Pa., using expansion-sleeve bolts, $\frac{3}{4}$-in. diameter, 5 ft long, in conjunction with timbering. Paper read at 65th Meeting of Coal Mining Institute of America.

257. SLAGER, T.
Underground mushroom farm.
Compressed Air Mag. 1951 56 (5) May 119-22.
In this description of an abandoned limestone mine in Butler Co., W.Pa., used as a mushroom farm, bolting techniques, using $\frac{3}{4}$-in., wedge-type Hubbard bolts, installed with Ingersoll Rand stopehammer drills, are described.

258. INGERSOLL, D.E.
Applications in pitching measures.
Coal Mine Modern. Yearb. 1950 25-30.
Bolting in the Porter Tunnel, Philadelphia & Reading Coal & Iron Co., Schuylkill Co., Pa., is described. This tunnel through shale and red sandstone is driven across strata dipping at an inclination of 70-85° and will be 4800 ft long. Split-and-wedge 1-in. bolts, $5\frac{1}{2}$-$6\frac{1}{2}$ ft long, are used. Dust problem is eliminated by wet drilling.

259. PRICE, P.H.
Geologic considerations of roof support.
Mining Congr. J. 1949 35 (12) Dec 45-48.
A report of the Committee on Roof Action. Following a discussion of general geologic features and geologic phenomena in coal mines, roof characteristics of the Pittsburgh coal seams are discussed in relation to recommended bolting practices.

UTAH

260. MECHANIZATION
Variable factors determine roof bolting practice.
Mechanization 1956 20 (10) Oct 67-8.
First used in 1950, two-thirds of all roof support is now by bolting at Federal No. 1 Mine, Utah (?). The seam is overlain by normal, bedded strata of slate, coal and shale. One-in. wedge-type bolts, 60-80 in. long, are used on main entries and $\frac{3}{4}$-in. expansion-type are being replaced by 5/8-in. higher-carbon (10-40) steel bolts. Practice is outlined.

261. COAL AGE
Top benching solves thick coal problem.
Coal Age 1954 59 (11) Nov 92-3.
At Kingmine, U.S. Fuel Co., Hiawatha, Utah, instead of developing the bottom and then taking top coal and pillars, the process has been reversed to provide for development in the top of the seam and partial pillaring, all accompanied by bolting. Slot-and-wedge bolts are used.

262. COAL AGE
Uphill continuous mining.
Coal Age 1952 57 (12) Dec 94-5.
Use of bolting in conjunction with continuous mining at Kaiser Steel Co. No. 1 mine, Sunnyside, Utah.

263. BOYD, B.
Roof bolting at the U.S. and Lark mine.
Mining Congr. J. 1952 38 (7) July 33-5, 47.
Discusses rock bolting experiments undertaken in 1950 at this mine in Bingham District, Utah. Bolts used are of 1-in. split-rod type in 4-6 ft lengths with wedge. Bolting was successful in drifts and raises but not in stopes because of asymmetrical syncline formation of the limestone quartzite sedimentary column. Costs are given.

264. KEENAN, A.M.
Roof bolt testing ground.
Mechanization 1952 16 (3) Mar 107, 109-10.
Practice at Sunnyside Mine No. 2, Kaiser Steel Corp., Utah, is outlined. Wedge-type bolts, 1-in. diameter, 6 ft long, are used to support shale roof. Applications include driving rooms, back entries, crosscuts, airways, etc. Commercial firms supplying equipment are listed.

265. PEPERAKIS, J.
Roof bolting at Sunnyside.
Coal Age 1950 55 (10) Oct 66-9.
Supporting weak shale roof at Sunnyside Mines, Kaiser Steel Corp., Utah, with bolts. Both $\frac{3}{4}$-in. and 5/8-in. expansion-shell and 1-in. wedge types are used.

WEST VIRGINIA

266. TUDOR, B.
Roof support with continuous mining.
Mining Congr. J. 1957 43 (6) Jun 54-6, 68.
Bolting in conjunction with continuous mining at Compass No. 1 Mine, Clinchfield Coal Co., Barbour Co., W.Va., is described. Expansion-shell bolts, 5/8-in. diameter, 5 ft long, are used and approximately one bolt per foot in a $17\frac{1}{2}$-ft-wide room is used on 4-ft centres. Installation details are given.

267. COAL AGE
Increasing roof bolting efficiency with truck-mounted drills.
Coal Age 1957 62 (4) Apr 74-5.
Advantages of using a machine consisting of two Chicago Pneumatic RBD drills mounted on a truck are discussed. At No. 15 coal mine, Omar Mining Co., Omar, W.Va., expansion-type bolts, 30 in. long, are used on 4-ft centres in the drawslate roof.

268. GREENWALD, E.H. & PRICE, V.
Methods and results with mine roof bolting.
Coal Mine Modern. Yearb. 1955 94-105; discussion 105-7.
Practice at Boone Co. Coal Corp. mines, Sharples, W.Va., is discussed with the following aspects being considered: superiority of rotary drilling; elimination of manual bolt tightening; trials and tests to improve drilling; use of Joy RBD parallel double-boom drills; combination bolting and timbering; correction of design weaknesses; experiments with wood bolts.

269. COAL AGE
Dry percussion roof-drilling successful in hard sandstone.
Coal Age 1955 60 (8) Aug 82-4.
Outlines advantages of using dry-type percussion drill, Holman Dryductor, in bolting operations at Lorado Coal Mining Co., Lorado, Logan Co. W.Va.

270. HUNTER, J.C.
Roof bolting experiences and results.
Coal Mine Modern. Yearb. 1953 21-4.
Successful bolting practice using expansion bolts and Cleveland stoper drills at Jane Ann No. 4 mine, Powellton Coal Co., Logan Co., W.Va., is described.

271. FLOWERS, A.E.
Successful roof bolting at Idamay.
Coal Age 1953 58 (10) Oct 74-9.
Expansion-shell bolts, ¾-in. diameter, 5-8 ft long, have been adopted at Idamay, W.Va., for many applications: roadways, face (in conjunction with roof channels), pillar extraction, entries and main haulageway intersection (in conjunction with wire mesh and guniting). Roof is generally of laminated shale.

272. COAL AGE
Bolts conquer mean top.
Coal Age 1953 58 (6) Jun 89-91.
At Red Parrott Coal Co. No. 5 mine, Prenter, W.Va., bolts hold roof suspended from solid sandstone above. One-in. wedge-type mild steel bolts, 5-6 ft long, are used. Details of bolting patterns are given.

273. EDWARDS, J.H.
Bolting beats bad top.
Coal Age 1953 58 (1) Jan 94-9.
Roof at Stotesbury No. 8 mine, Eastern Gas & Fuel Associates, Raleigh Co., W.Va., is of laminated shale which in some places causes great difficulty. Use of 1-in. wedge-type bolts, 36 in. long, and channels has proved effective.

274. GILLEY, J.L.
Roof bolting in pillar recovery.
Coal Mine Modern. Yearb. 1952 25-33; discussion 33.
Applications of bolting in pillar extraction and in roadway support at five coal mines in W.Va. are briefly discussed.

275. SHUPE, D.B.
Overall economies of roof bolting.
Coal Mine Modern. Yearb. 1952 34-42.
Experiences at Pocahontas Nos. 3 and 4 coal beds, Eastern Gas & Fuel Associates, Kimball, W.Va., are outlined. At No. 3, the immediate roof is very weak shale and the main roof of stronger shale. Conventional bolting patterns, with 4-ft wedge-type bolts, are used. At No. 4, where roof pressure is unusually high, wedge-type bolts, 30-80 in. long with 80-in. channels, are used.

276. COAL AGE
Roof bolts up efficiency 50%.
Coal Age 1951 56 (9) Sep 86-8.
At Melville No. 11 mine, Hutchison Coal Co., Logan Co., W.Va., where the mine roof is weak (sandstone with immediate top of drawslate, black slate or laminated sandstone), bolting replaced timbering in 1949. Bolts are split-and-wedge type, 1-in. diameter, 46 in. long, made by Bethlehem Steel Co. Work cycle is outlined.

277. COAL AGE
Roof bolting for efficiency.
Coal Age 1950 55 (9) Sep 74-5.
At Boone Co. Coal Corp., Sharples, W.Va., both split-rod-and-wedge (1 in.) and expansion-shell ($\frac{3}{4}$ in.) bolts are used and wooden pins are being tested, so far with no positive results. Bolting was first used for the shale in 1949.

278. COAL AGE
Small bolts hold bad top.
Coal Age 1949 54 (9) Sep 92-4.
Expansion-shell-and-plug and wedge-type bolts, 5/8-in. diameter, are used in conjunction with cross bars at Christopher Coal Co. Mines, Monongalia Co., W.Va., where drawslate roof is difficult to hold.

See also abstracts

49 MECHANIZATION: Was this the beginning of roof bolting? (Sagamore Mine, Pocahontas Fuel Co., W.Va.)
73 HOUGH: The use of portable equipment for roof bolting in thin seams. (Imperial Smokeless Coal Co., Quinwood)
82 BROWN & BIERER: Roof bolting in West Virginia.

WYOMING

279. BOWIE, R.F.
Special roof bolt applications. Bolts and metal lath replace conventional timber in unique shaft sinking experiment.
Mining Congr. J. 1954 40 (1) Jan 42-3.
Account of airshaft construction at Union Pacific Coal Co., Wyoming, using bolts, wire mesh and gunite in place of timbering and plaster. Depth of shaft is 241 ft. Costs show this method to be more expensive than either concrete or conventional timbering, due to the high cost of guniting. Costs could have been reduced by using rust preventive on bolts and plates instead of guniting. 2000 ft of rock tunnel has also been bolted.

280. ENGINEERING AND NEWS RECORD
Diversion tunnel driving without liners, Keyhole Dam, Wyoming.
Eng. News Record 1951 146 (20) 17 May 30-31.
Wedge-type, 1-in. bolts, 6 ft long, were used to support sandstone roof of tunnel at Keyhole Dam. Another application was bolting of the face of portal prior to initial round of blasting to avoid moving the portal back at least 10 ft, thus saving open-cut excavation.

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APPENDIX I

LIST OF CONFERENCES INVOLVED

(Note: The numbers following the titles refer to papers from the conference that are listed in this bibliography.)

FORTHCOMING CONFERENCE (Oct. 14-16, 1958)

International Gebirgsdrucktegung, Leipzig.
c/o Deutsch. Akad. der. Wissenschaft
Berlin C 2,
Wallstrasse 9-13.

1957.
Sixth Commonwealth Mining & Metallurgical Congress (Canada).
See No. 138.

1956.
International Strata Control Congress (Essen, Germany).
See No. 193.
Symposium on Strata Control (Nottingham University, England).
See No. 194.

1955.
Canadian Institute of Mining & Metallurgy, Symposium.
See No. 146.
Conference on Props and Roof Supports, Inichar.
See No. 102.

1953.
Ontario Mines Accident Prevention Association, Symposium.
See No. 151.
Coal Mining Conference, Otago University, New Zealand.
See No. 204.

1951.
International Conference on Rock Pressure and Support in Workings, Liège, Belgium.
See Nos. 13, 44, 161; also general reports by STASSEN, P.: Ann. Mines Belg. 1953 52 (5) Sep 663-76; CROMBRUGGHE, O.de: Conf. Rock Pressure & Support, Liege, 412-15.

1950.
Fifth International Conference on Support, Washington (U.S.A.).
See No. 208.

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London, 1958.

APPENDIX II

SUPPLIERS OF EQUIPMENT

(Note: This is not a comprehensive list, but gives a limited number of suppliers in some of the countries where rock bolts are used.)

AUSTRIA

Atlas Copco Gesellschaft mbH,
Wien XIV,
Pfadenhauergasse 1.
(Bolts and drills)

Flottmann Wien Gesellschaft mbH,
Wien,
Grinzinger Strasse 117.
(Drills)

Sika-Plastiment Gesellschaft mbH,
Fabrik Chem. Baustoffe,
Bings-Bludenz,
Vorarlberg.
(Perfo bolts)

AUSTRALIA

Atlas Copco (Australia) Pty. Ltd.,
199-205 Parramatta Rd.,
Auburn, N.S.W.
(Bolts and drills)

Holman Bros.,
Kalgoorlie, W.A.
(Drills)

Ingersoll-Rand (Australia) Pty. Ltd.,
40 Maray St.,
South Melbourne, S.C.5.
(Drills)

Titan Manufacturing Co. Pty. Ltd.,
P.O. Box 292,
Newcastle, N.S.W.
(Wedge-type bolts)

BELGIUM

Ingersoll-Rand,
62, Chaussée de Mons,
Bruxelles.
(Drills)

CANADA

Atlas Copco, Ltd.,
Metropolitan Blvd.,
Dorval, P.Q.
(Drills and bolts)

Canadian Ingersoll-Rand Co. Ltd.,
Montreal, P.Q.
(Drilling equipment)

Canadian Ohio Brass Co. Ltd.,
Niagara Falls, Ont.
(Bolts)

Heath & Sherwood Co.,
Kirkland Lake, Ont.
(Foran bolt)

Holman Bros. (Canada) Ltd.,
97 Kent Ave.,
Kitchener, Ont.
(Drilling equipment)

Steel Co. of Canada Ltd.,
Hamilton, Ont.
(Expansion and wedge bolts, hooked anchors)

FRANCE

Atlas Copco, France,
29, rue Marbeuf,
Paris 8.
(Drills and bolts)

Forges et Boulonneries Hermant Hicuret et d'Ars-sur Moselle,
Usine d'Ars-sur-Moselle,
Moselle.
(Armex and Boltex bolts)

Goldenberg et Cie.,
Saverne,
B-Rhine.
(Bolts)

Ingersoll-Rand,
54, rue de Londres,
Paris 8.
(Drills)

FRANCE cont.

Lenoir et Mernier,
Levrezy,
Ardennes.
(Pattin bolts)

Meco,
15, Place de la Madeleine,
Paris.
(Bolts)

Sika,
164 Fg. St. Honoré,
Paris.
(Perfo bolt)

Viatour (Ets.),
23-26, rue Clemenceau,
Clouange-Rombas,
Moselle.
(Bolts)

GERMANY

Clever & Goebel,
Viktoriastr. 7,
Hagen (Westf.)
(Bolts)

Demag Aktiengesellschaft,
Wolfgang-Reuter-Platz,
Duisburg.
(Drills)

Eisenwerk Steel GmbH,
Dahlhauser Str. 106,
Essen-Stahle.
(Bolts)

Flettmann, Heinrich GmbH,
Strasse des Bohrhammers,
Herne.
(Drills)

Gutehoffnungshütte Sterkrade Aktiengesellschaft,
Oberhausen (Rheinl.)
(Bolts)

GERMANY cont.

Lippische Eisenindustrie Aktiengesellschaft,
Remininghausen (Lippe).
(Bolts)

Mannesmann-Export GmbH,
Berger Allee,
Düsseldorf.
(Bolts)

Maschinenfabrik Julius Schroeder,
Hollandstr. 17,
Dortmund-Breckel.
(Bolts)

ITALY

Atlas Copco Italia,
Milano,
Viale Marche 15.
(Bolts and drills)

Flottmann Italiana SpA.,
Milano,
Via Delfico 7/A.
(Drills)

NORWAY

Olav Fahre mek. Verksted,
Chr. Krohgagt, 30,
Oslo.
(Expansion bolts)

SOUTH AFRICA

Bethlehem Steel Co. Ltd.,
Bell Agencies (Pty.) Ltd.,
428 Commissioner St.,
Johannesburg.
(Bolts)

Consolidated Pneumatic Tool Co. S.A. (Prop.) Ltd.,
1, Rogers St.,
Selby, Johannesburg.
(Rotary drills, impact wrenches)

SOUTH AFRICA cont.

Delfos & Atlas Copco.,
Lincoln Rd.,
Benoni.
(Drills and bolts)

Holman Bros. (Pty.) Ltd.,
8th Floor, Mutual Bldgs.,
Harrison & Commissioner St.,
Johannesburg.
(Drills)

Ingersoll Rand Co. (S.A.) Ltd.,
P.O. Box 1809,
Johannesburg.
(Drills)

Ohio Brass Co.,
Edward L. Bateman Ltd.,
34 Amoshoff St.,
Johannesburg.

SWEDEN

Klint, Bernhardt & Co., A.B.,
Stockholm.
(Rotary drills)

Sandvikens Jernverks, Aktiebolag, Sandviken och Tryckluft,
Stockholm.
(Drilling equipment)

Sika Byggnadskemiska A.B.,
Norrtälje.
(Perfo bolts)

UNITED KINGDOM

Bayliss, Jones & Bayliss, Ltd.,
139 Cannon St.,
London, E. C. 4.
(Bolts)

Holman Bros.,
Camborne,
Cornwall.
(Drills)

Ingersoll-Rand Co. Ltd.,
20 Renfrew St.,
Glasgow C 2.
(Drills)

UNITED KINGDOM cont.

Ohio Brass Co.,
W.R. Kennion,
54, Victoria St.,
London, S.W. 1.
(Bolts)

Rawlplug Co. Ltd.,
Cromwell Rd.,
London, S.W. 7.
(Expansion bolts)

Victor Products (Wallsend) Ltd.,
Wallsend-on-Tyne.
(Bolts)

U. S. A.

Acme Machinery Co.,
Williamson,
W.Va.
(Drills)

Bethlehem Steel Co.,
Bethlehem, Pa.
(Bolts, etc.)

Chicago Pneumatic Tool Co.,
6 E. 44th St.,
New York.
(Drills, impact wrenches)

Colorado Fuel & Iron Corp.,
Continental Oil Bldg.,
Denver, Colo.
(Bolts, etc.)

Elreco Corp.,
Cormany & Township Ave.,
Cincinnati 25, Ohio.
(Bolts, etc.)

Hubbard Roof Bolt Co.,
Huntington, W.Va.
(Hubbard bolts)

Ingersoll-Rand,
11 Broadway,
New York 4.
(Vacujet bolting stoper)

U. S. A. cont.

Jeffrey Mfg Co.,
956 N. 4th St.,
Columbus 16, Ohio.
(Drills, impact wrench)

Manco Mfg Co.,
Washington & Locust St.,
Bradley, Ill.
(Roof bolt cutter)

Ohio Brass Co.,
100 Surrey Rd.,
Mansfield, Ohio.
(Bolts, etc.)

Oliver Iron & Steel Corp.,
S. 10th & Muriel St.,
Pittsburgh 3, Pa.
(Bolts)

Pittsburgh Screw & Bolt Co.,
P.O. Box 1708,
Pittsburgh, Pa.
(Bolts)

Republic Steel Corp., Bolt & Nut Div.,
1974 Carter Rd.,
Cleveland, Ohio.
(Bolts)

Sika Chemical Corp.,
37 Gregory Ave.,
Passaic, N.J.
(Perfo bolts)

W.Va. Steel & Mfg. Co.,
Haskell & Durkin St.,
Huntington, W.Va.
(Bolts, etc.)

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London, 1958.

APPENDIX III

SOURCES OF INFORMATION

1. SERIAL PUBLICATIONS AND CONFERENCE PROCEEDINGS

(Note: The abbreviated titles used in this bibliography are listed alphabetically. The full title and place of publication are given in each case.)

A.I.M.E. Trans. See Mining Eng.
Ann. Mines Belg. - Annales des Mines de Belgique. Brussels.
Assoc. Mine Managers, S.Africa, Papers and Discussions - Association of Mine Managers of South Africa, Papers and Discussions. Johannesburg.
Assoc. Mine Managers Transvaal Circ. - Association of Mine Managers of Transvaal, Circular. Johannesburg.
Australasian Inst. Mining Met. Proc. - Australasian Institute of Mining and Metallurgy, Proceedings. Melbourne.
Bergakademie. Berlin.
Bergbau. Hagen.
Bergbau Rundschau. Bochum.
Bergbautechnik. Berlin.
Bergfreiheit. Essen.
Berg-hüttenmann. Monatsh. montan. Hochschule, Leoben. - Berg-und hüttenmannische Monatshefte der montanische Hochschule in Leoben. Vienna.
C.I.M.M. Trans. - Canadian Institute of Mining and Metallurgy, Transactions. Montreal.
Can. Mining J. - Canadian Mining Journal. Gardenvale, Quebec.
Can. Mining Met. Bull. - Canadian Mining and Metallurgical Bulletin. Montreal.
Chem. Eng. Mining Rev. - Chemical Engineering and Mining Review. Melbourne.
Civil Eng. - Civil Engineering. New York.
Coal Age. New York.
Coal Mine Modern. Yearb. - Coal Mine Modernization Yearbook. Washington, D.C.
Coal Mining. Pittsburgh.
Coal Mining Conf. Otago Univ. Proc. 1953. - Coal Mining Conference, Otago University, Proceedings, 1953. Dunedin, New Zealand.
Colliery Eng. - Colliery Engineering. London.
Colliery Guardian. London.
Colo. School Mines Quart. - Quarterly of the Colorado School of Mines. Golden, Colorado.
Compressed Air Mag. - Compressed Air Magazine. Phillipsburg, N.J.
Conf. Rock Pressure & Support, Liege 1951. - Conference on Rock Pressure and Support in Workings, Liège, 1951. Published by Annales des Mines de Belgique, Brussels, 1951.
Construction Meth. Equip. - Construction, Methods and Equipment. New York.
Eng. & Contract Record. - Engineering and Contract Record. Toronto.
Eng. Mining J. - Engineering and Mining Journal. New York.
Echo Mines Met. - L'Echo des Mines et de la Métallurgie. Paris.

Eng. News Record. - Engineering and News Record. New York.
Freiberger Forschungsh. - Freiberger Forschungshefte. Berlin.
Glückauf. Essen.
Gornyi Zhur. - Gornyi Zhurnal. Moscow.
Grubensich. u. Grubenaus. - Grubensicherheit und Grubenausbau. Leoben.
Illinois Mining Inst. Proc. - Illinois Mining Institute, Proceedings. Springfield.
Ind. Mineraria. - Industria Mineraria. Rome.
Inst. Mining Eng. Trans. (London). - Institution of Mining Engineers, Transactions. London.
Intern. Conf. Rock Pressure Leoben 1950. - International Conference on Rock Pressure, Leoben, 1950. Vienna.
Intern. Strata Control Cong. Essen 1956. - International Strata Control Congress. Essen, 1956.
Iron & Coal Trades Rev. - Iron and Coal Trades Review. London.
Jernkontorets Ann. - Jernkontorets Annaler. Tidskrift för Svenska Bergshanteringen. Stockholm.
Kali u. Steinsalz. - Kali und Steinsalz. Essen.
Mechanization. Washington, D.C.
Mine & Quarry Eng. - Mine and Quarry Engineering. London.
Mineral Ind. J. Virginia Polytech. Inst. - Mineral Industries Journal. Mineral Industries Department of the School of Engineering and Architecture, Virginia Polytechnic Institute, Blacksburg, Va.
Mineria ital. - Mineria italiana. Rome.
Mining Congr. J. - Mining Congress Journal (American Mining Congress). Washington, D.C.
Mining Eng. - Mining Engineering. American Institute of Mining, Metallurgical and Petroleum Engineers, Inc. New York.
Mining Eng. Rev. Melb. - Mining and Engineering Review. Melbourne. (Incorporated in Chem. Eng. & Mining Rev.)
Mining Ind. Mag. - Mining and Industrial Magazine. Johannesburg.
Mining J. (London). - Mining Journal. London.
Mining Mag. - Mining Magazine. London.
Mining World. Chicago.
Nat. Safety Council Trans. - National Safety Council, Transactions. Chicago.
Neue Hütte. Berlin.
O-B Haulage Ways. - Ohio Brass Co. Haulage Ways. Mansfield, Ohio.
Przeglad Gorniczy. Warsaw.
Rev. Ind. Minérale. - Revue de l'Industrie Minérale. St. Étienne, Loire.
Rhod. Mining Rev. - Rhodesian Mining Review. Bulawayo.
Rocky Mountain Coal Mine Institute, Salt Lake City. 1951.
Rudarsko-Met. Zbornik. - Rudarsko-Metalurski Zbornik. Ljubljana, Yugoslavia.
S. African Mining Eng. J. - South African Mining and Engineering Journal. Johannesburg.
Sheffield Univ. Mining Mag. - Sheffield University Mining Magazine. Sheffield.

Symposium Strata Control Nottingham Univ. Proc. 1956. - Symposium on Strata Control, Proceedings, Nottingham University, Department of Mining and Fuels, 1956. Nottingham.
Tech. Moderne - La Technique Moderne. Paris.
Tek. Tidskr. - Teknisk Tidskrift. Stockholm.
Tidn. Byggnakskonst - Tidning för Byggnadskonst. Stockholm.
Tidsskr. Kjemi Bergvesen Met. - Tidsskrift för Kjemi, Bergvesen og Metallurgi. Oslo.
Tryckluft. Stockholm.
Ugol. Moscow.
U.S. Bur. Mines Inf. Circ. - United States Bureau of Mines, Information Circular. Washington, D.C.
U.S. Bur. Mines Rep. Inv. - United States Bureau of Mines, Report of Investigations. Washington, D.C.
U.S. Bur. Mines Bull. - United States Bureau of Mines, Bulletin. Washington, D.C.
Water Power. London.
Western Construction. San Francisco.
Wiadomosci Gorni. - Wiadomosci Gornicze. Warsaw.
Z. Berg-Hüttenw. u. Sal. - Zeitschrift für das Berg-, Hütten- und Salinenwesen im Preussischen Staat. Berlin.

2. BOOKS, REPORTS, AND STANDARDS

AMERICAN SOCIETY FOR TESTING MATERIALS
Standard specification for structural steel for ships.
Standard A131-55.

ERDHEIM, B. & BERGMAN, S.C.A.
Dragförsök med Bergbultar.
Sweden, Kungl. Fortifikationsforvaltingen Befastningsbyran Forsknings -och Försökssektionem. (Date?)

FELLENIUS, B.
(Rock bolting)
Sweden, Kungl. Jarnvägsstrelsen Banteniskabyran. (Date?)

INTERNATIONAL LABOUR OFFICE
Safety in coal mines. Vol. 2. Legislation.
Geneva, I.L.O. 1955. (Studies & Reports, New Series. No. 33)

MORATH, F. & KIND, H.
Redorgorelse för provdragning av grundbultar, anbringade in s.k. trasberg.
Stockholm, Kungl. Vattenfallstyrelsen, Stamlinjebyggnaderna. 1954.

NATIONAL COAL BOARD (U.K.)
Roof bolts. Standard specification P131/1955.

SIXTH COMMONWEALTH MINING & METALLURGICAL CONGRESS. 1957.
Mining in Canada.
Vancouver, B.C. The Congress. 1957. 597p. $10.

SPRUTH, F.
Streckenausbau in Stahl.
Essen, Verlag Glückauf. 1955. 220p. 18 DM.

3. TRANSLATIONS

M.F.P. Translations - Ministry of Fuel and Power, Thames House, Millbank, London, S.W.1.
N.C.B. Translations - National Coal Board, Hobart House, Grosvenor Pl., London, S.W.1.

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London, 1958.

INDEX OF AUTHORS

(Note: Underlined numbers refer to articles not written by the author but in which his work is mentioned.)

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INDEX OF COMPANIES AND OTHER PUBLIC BODIES

INDEX OF SUBJECTS

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London, 1958.