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CHAPTER XXVIII.

MISCELLANEOUS.

§ 1. Patents, Trade Marks and Designs.

1. **Patents.**—(i) *General.* The granting of patents is regulated by the Commonwealth Patents Act 1903–1935, which, in regard to principle and practice, has the same general foundation as the Imperial Statutes, modified to suit Australian conditions. The Act is administered by a Commissioner of Patents. Fees totalling £10 are sufficient to obtain letters patent for the Commonwealth of Australia and the Territories of Papua, New Guinea and Norfolk Island. A renewal fee of £5 is payable before the expiration of the seventh year of the patent on all patents granted on applications lodged prior to 2nd February, 1931. On patents granted on applications made on or after the 2nd February, 1931, renewal fees are payable as follows:—£1 before the expiration of the fifth year and an amount progressively increasing by ten shillings before the expiration of each subsequent year up to the fifteenth, when the fee becomes £6. If a renewal fee is not paid when it becomes due, an extension of time up to twelve months may be granted on grounds specified in the Act, and subject to the payment of prescribed fees.

(ii) *Summary.* The number of separate inventions in respect of which applications were filed during the years 1933 to 1937 is given in the following table, which also shows the number of letters patent sealed in each year:—

PATENTS, AUSTRALIA.—SUMMARY.

Particulars.	1933.	1934.	1935.	1936.	1937.
No. of applications	5,040	4,984	5,110	5,484	5,585
No. of applications accompanied by provisional specifications	3,511	3,286	3,238	2,384	3,094
Letters patent sealed during each year	1,701	2,063	2,129	2,429	2,642

(iii) *Revenue.* The revenue of the Commonwealth Patent Office during the years 1933 to 1937 is shown hereunder:—

PATENTS, AUSTRALIA.—REVENUE.

Particulars.	1933.	1934.	1935.	1936.	1937.
	£	£	£	£	£
Fees collected under Patents Act	30,121	33,488	35,980	37,515	42,614
Receipts from publications	1,311	1,359	1,532	1,569	1,870
Total	31,432	34,847	37,512	39,084	44,484

2. **Trade Marks and Designs.**—(i) *Trade Marks.* Under the Trade Marks Act 1905 the Commissioner of Patents is also Registrar of Trade Marks. This Act has been amended from time to time, the last amendment having been made in 1936. Special

provisions for the registration of a "Commonwealth Trade Mark" are contained in the Act of 1905, and are applicable to all goods included in or specified by a resolution passed by both Houses of Parliament that the conditions as to remuneration of labour in connexion with the manufacture of such goods are fair and reasonable.

(ii) *Designs.* The Designs Act 1906, as amended by the Patents, Designs and Trade Marks Act 1910 and the Designs Acts 1912, 1932, 1933 and 1934, is now cited as the Designs Act 1906–1934. Under this Act a Commonwealth Designs Office has been established, and the Commissioner of Patents appointed "Registrar of Designs."

(iii) *Summary.* The following table shows the applications for trade marks and designs received and registered during the years 1933 to 1937 :—

TRADE MARKS AND DESIGNS, AUSTRALIA.—SUMMARY.

Applications.	1933.	1934.	1935.	1936.	1937.
RECEIVED.					
Trade Marks	1,905	2,087	2,071	2,215	2,189
Designs	646	1,670	2,319	1,494	1,190
REGISTERED.					
Trade Marks	1,316	1,268	1,349	1,664	1,372
Designs	497	1,465	2,085	1,546	971

(iv) *Revenue.* The revenue of the Trade Marks and Designs Office during the years 1933 to 1937 is given hereunder :—

TRADE MARKS AND DESIGNS, AUSTRALIA.—REVENUE.

Particulars.	1933.			1934.			1935.			1936.			1937.		
	Trade Marks.	Designs.	Publications.	Trade Marks.	Designs.	Publications.	Trade Marks.	Designs.	Publications.	Trade Marks.	Designs.	Publications.	Trade Marks.	Designs.	Publications.
	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£
Fees collected under Commonwealth Acts ..	12,720	814	13	20,469	1,052	17	15,580	1,053	13	16,434	1,110	19	16,580	1,006	18

No fees in respect of Trade Marks have been collected under State Acts since the year 1922.

§ 2. Copyright.

1. **Legislation.**—Copyright is regulated by the Commonwealth Copyright Act 1912–1935 wherein, subject to modifications relating to procedure and remedies, the British Copyright Act of 1911 has been adopted and scheduled to the Australian law.

Reciprocal protection of unpublished works was extended in 1918 to citizens of Australia and of the United States of America under which copyright may be secured in the latter country by registration at the Library of Congress, Washington. The Commonwealth Government promulgated a further Order in Council which came into

operation on the 1st February, 1923, and extended the provisions of the Copyright Act to the foreign countries of the Copyright Union, subject to the observance of the conditions contained therein.

2. **Applications and Registrations.**—The following table shows under the various headings the number of applications for copyright received and registered, and the total revenue obtained for the years 1933 to 1937 :—

COPYRIGHT, AUSTRALIA.—SUMMARY.

Particulars.		1933.	1934.	1935.	1936.	1937.
Applications received—						
Literary		1,463	1,611	1,408	1,463	1,442
Artistic		90	108	78	86	92
International		2	3	2	3	2
Applications registered—						
Literary		1,350	1,514	1,346	1,389	1,367
Artistic		72	91	69	78	74
International		..	..	..	1	1
Revenue	£	382	433	378	388	384

§ 3. Local Option and Reduction of Licences.

Local option concerning the sale of fermented and spirituous liquors is in force in the States of South Australia and Tasmania. In Victoria, Queensland and Western Australia State wide polls have superseded the local polls, while in New South Wales the taking of local option polls has been suspended since 1913, though a special State wide referendum was taken in 1928 on the question of State wide prohibition with compensation. At the poll held in Victoria on 8th October, 1938, the voting was as follows :—

For abolition of licences	368,676
Against abolition of licences	721,704
Informal	7,648

The percentage of electors who voted was 95.38.

In all States other than South Australia a maximum number is established above which licences shall not be increased except under certain specified conditions (the principal case being the greater demand for service of a considerably increased population). Licences Reduction Boards are in operation in New South Wales and Victoria and in all other States machinery exists for the reduction of licences where it seems desirable or where there is a local option vote in favour of the reduction of licences.

In earlier issues of the Year Book (see No. 22, pp. 1005–1008), details, by States, were published of polls taken and of the operations of the Licences Reduction Boards.

§ 4. Lord Howe Island.

Lord Howe Island is situated in latitude 31° 30′ south, longitude 159° 5′ east, about 436 miles north-east of Sydney, and has an area of 3,220 acres. The climate is mild and the rainfall abundant, but on account of the rocky formation of its surface only about 300 acres are suitable for cultivation, most of which are devoted to the production of Kentia Palm Seed. The land belongs to the Crown and is occupied rent-free on sufferance.

Discovered in 1788 the Island was first settled by a small party of Maoris in 1853 ; afterwards a colony was settled from Sydney. Constitutionally the Island is a dependency of New South Wales and is included in King, one of the electorates of Sydney. A Board of Control at Sydney manages the affairs of the Island and supervises the palm seed industry. At the Census of 30th June, 1933, the population was 161.

§ 5. Commonwealth Council for Scientific and Industrial Research.

1. **General.**—By the Science and Industry Research Act 1920–37, the previously existing Commonwealth Institute of Science and Industry was reorganized under the title of the Council for Scientific and Industrial Research. An account of the organization and work of the former Institute was given in earlier issues of the Official Year Book. (See No. 18, p. 1062.)

2. **Science and Industry Research Act 1920-37.**—This Act provides for a Council, consisting of—

(*a*) Three members nominated by the Commonwealth Government;
(*b*) the Chairman of each State Committee constituted under the Act; and
(*c*) such other members as the Council, with the consent of the Minister, co-opts by reason of their scientific knowledge.

The three Commonwealth nominees form an Executive Committee which may exercise, between meetings of the Council, all the powers and functions of the Council, of which the principal are as follows:—(*a*) To initiate and carry out scientific researches in connexion with primary or secondary industries in the Commonwealth; (*b*) to train research workers and to establish industrial research studentships and fellowships; (*c*) to make grants in aid of pure scientific research; (*d*) to establish industrial research associations in any industries; (*e*) to test and standardize scientific apparatus and instruments; (*f*) to establish a Bureau of Information; and (*g*) to act as a means of liaison between the Commonwealth and other countries in matters of scientific research.

State Committees, whose main function is to advise the Council as to matters that may affect their respective States, have been constituted in accordance with prescribed regulations.

3. **Science and Industry Endowment Act 1926.**—Under this Act, the Government has established a fund of £100,000, the income from which is to be used to provide assistance (*a*) to persons engaged in scientific research, and (*b*) in the training of students in scientific research. Provision is made for gifts or bequests to be made to the fund, which is controlled by a trust consisting of the three Commonwealth nominees on the Council. In accordance with the Act, arrangements have been made to send a number of qualified graduates abroad for training in special fields of work.

4. **Work of the Council.**—The full Council held its first meeting in June, 1926, and thereafter at about half-yearly intervals. It has adopted a policy of placing each of its major fields of related researches under the direction of an officer having a standing at least as high as, if not higher than, that of a University Professor.

The main branches of work of the Council at present are (i) plant problems, (ii) soil problems, (iii) entomological problems, (iv) animal health and nutrition problems, (v) forest products, (vi) food preservation and transport, (vii) radio research, (viii) ore-dressing (gold) and mineragraphic investigations, and (ix) fisheries investigations. Successful results have been obtained in a number of directions, particularly in regard to bitter pit in apples, spotted wilt in tomatoes, water blister of pineapples, blue mould of tobacco, the cultivation and drying of vine fruits, the cultivation of citrus fruits, contagious pleuro-pneumonia of cattle, the feeding of sheep for increased wool production, black disease, infectious entero-toxæmia, pulpy kidney and caseous lymphadenitis of sheep, internal parasites, coast disease of sheep, soil surveys, paper making from Australian timbers, timber seasoning and preservation, and the preservation and transport of bananas, oranges, chilled beef and other foodstuffs. The work of the Council has in the past been directed almost exclusively to the solution of problems affecting primary industries. The Commonwealth Government has decided to extend the activities of the Council so as to enable it to enter the field of secondary industrial research. Action is accordingly being taken for the erection of a National Standards Laboratory in Sydney, and an Aeronautical Research Laboratory in Melbourne. The nucleus of an Information Section has already been established

at the Council's head offices, Melbourne, and plans are being developed for the initiation of research into problems affecting secondary industries. More detailed information concerning the work of the Council may be found in Year Book No. 22, pp. 1009 and 1010.

§ 6. Australian Institute of Anatomy.

1. **Foundation of Institute.**—The Australian Institute of Anatomy, situated in Canberra, occupies a monumental building erected by the Federal Government under the Zoological Museum Agreement Act of 1924. Prior to the passing of this Act, the Federal Government had expressed regret that the Australian Nation possessed neither a collection of specimens of the unique and fast disappearing fauna of Australia, nor a Museum in which such specimens could be preserved for future generations. Comparative anatomy is the basis of medical science, and while the importance of a study of Australian animals in the solution of various medical problems had for years been recognized by other countries and steps taken by them to procure specimens for their museums, national effort in this direction was neglected in Australia. The late Sir Colin MacKenzie, the first Director of the Institute of Anatomy, however, very kindly presented to the Federal Government his entire private collection, and this magnificent gift was acquired and provision was made for its proper housing under special legislation by the Federal Government.

2. **Additions to Original Collection.**—In addition to the original collection, which has been greatly augmented, the following free gifts have been made to the Australian Nation, and are on view in the Institute :—

(1) *Horne-Bowie Collection.*—Dealing with the life of Central Australian aborigines, and throwing valuable light on the psychology of this Stone Age people.

(2) *Burrell Collection.*—This deals with the life history of the platypus, and is unique in the world. The platypus is the most primitive mammal known to science, and is the link between the bird, the reptile and the mammal.

(3) *Milne Collection.*—This is an anthropological and ethnological collection dealing with the aborigines of New South Wales, and contains many valuable and now unobtainable native weapons and implements.

(4) *Murray Black Collection* of anatomical material representative of the aborigines of Southern Victoria and the River Murray.

(5) *Nankivell Collection,* illustrating the anatomy of the aborigines of the Murray Valley.

(6) *Harvard University Collection.*—This includes a collection of specimens from the Harvard University, U.S.A., representing a carefully worked out epitome of archaeology of the United States, and, together with two rare skeletons of primitive North American Indians, was a goodwill gift from the University to the Institute of Anatomy.

(7) *The Sir Hubert Murray Collection.*—The ethnological and osteological collection of Sir Hubert Murray, Lieutenant-Governor of Papua. This deals especially with the anthropology of Papua.

(8) *The Rabaul Ethnological Collection.*—This concerns chiefly the Ethnology of the Mandated Territory of New Guinea.

(9) *The Basedow Collection.*—This collection has been recently purchased by the Commonwealth Government. It deals especially with the anthropology of Central and Northern Australia and was assembled, after many years of research, by the late Dr. Herbert Basedow of Adelaide, who was formerly Protector of Aborigines.

(10) Many hundreds of specimens and books received from numerous interested scientists, the most outstanding being those from Mr. E. Hill, of Nagambie, Victoria ; Mrs. Harry Burrell, New South Wales ; and medical books for the Library from the estates of the late Drs. Molloy, David Grant and Robert Stirling.

3. **Endowments for Orations and Lectures.**—In addition to the aforementioned donations of material, there have been several endowments for Orations and Lectures as follows :—

(1) *The Halford Oration.*—Endowed with a gift of £1,000 by the family of the late Professor G. B. Halford, founder of the first medical school in the Southern Hemisphere. The interest on this amount is given to a prominent scientist to deliver an oration on a subject suggested by the life and work of the late G. B. Halford.

(2) *The Anne MacKenzie Oration.*—Founded with a gift of £1,000 by the late Sir Colin MacKenzie, in memory of his mother. The orator receives the annual interest for delivering an oration on any phase of " Preventive Medicine ".

(3) *The Dr. G. E. Morrison Memorial Lecture on Ethnology.*—Founded by Chinese residents in Australia, in memory of a great Australian who rendered important services to China.

(4) *The Kendall Lecture in Veterinary Science.*—Endowed by the sons of the late Dr. W. T. Kendall, who was the founder of the first Veterinary School in the Southern Hemisphere.

(5) *The Charles Mackay Lecture on Medical History.*—Endowed by Miss C. MacKenzie with a gift of £607 as a memorial to her grandfather, an educationalist, who arrived in Melbourne in 1852 and died at Kilmore, Victoria.

(6) *The Cilento Medal.*—This bronze medal has been endowed in perpetuity by Sir Raphael Cilento, Director-General of Health for Queensland, to be awarded annually to the scientist deemed to have accomplished the best practical work for the furtherance of Tropical Hygiene and Native Welfare in Australia.

4. **Ultimate Scope of the Instutute.**—The Institute of Anatomy may be regarded as the first unit of a National University of Australia, and has already become the most important centre in the Southern Hemisphere for the study of comparative anatomy and of its application to human health and disease. Research work in many branches of this subject is being carried out, and an extensive collection of material for the use of future generations is being catalogued. The microscopic specimens of Australian fauna number many thousands, and are unique in the world. They represent normal mammalian tissues unaffected by disease or domestication, and with these, human tissues such as those affected with cancer can be compared. The building is used to a large extent for educational purposes. From 1931 to 1935 all the University College lectures were given there. Public lectures of an educational nature are delivered in the lecture theatre, and many conferences dealing with Commonwealth health problems are held in the Institute building. The general public is admitted to the two great Museums of Osteology and Applied Anatomy, and large numbers take advantage of this concession.

§ 7. The Commonwealth Solar Observatory.

1. **Reasons for Foundation.**—The Commonwealth Solar Observatory was established for the study of solar phenomena, for allied stellar and spectroscopic research, and for the investigation of associated terrestrial phenomena. It is so situated to complete the chain of existing astrophysical observatories round the globe separated by 90 degrees of longitude. In addition to advancing the knowledge of the universe and the mode of its development, it is hoped that the eventual discovery of the true relation between solar and terrestrial phenomena may lead to results which will prove of direct value to the country.

2. **History of Inauguration.**—A short account of the steps leading up to the establishment of the Observatory will be found in Official Year Book No. 19, p. 979.

3. **Site of the Observatory.**—The site selected for the observatory is on Mount Stromlo, a ridge of hills about 7 miles west of Canberra. The highest point is 2,560 feet above sea level, or about 700 feet above the general level of the Australian Capital City.

4. **Equipment.**—The bulk of the telescopic equipment is due to the generosity of supporters of the movement in England and Australia. The gifts include a 6-in. Grubb refracting telescope presented by the late W. E. Wilson, F.R.S., and Sir Howard Grubb, F.R.S., trustees of the late Lord Farnham ; a 9-in. Grubb refractor with a 6-in. Dallmeyer lens presented by the late Mr. James Oddie, of Ballarat ; while Mr. J. H. Reynolds of Birmingham presented a large reflecting telescope with a mirror 30 inches in diameter. A sun telescope including an 18-in. cœlostat has been installed, and further additions include a spectrohelioscope, cosmic ray apparatus, radio research equipment and spectroscopes for the examination of spectra in the infra-red, violet and ultra-violet regions. Donations amounting to over £2,500 have been received, and form the nucleus of a Foundation and Endowment Fund.

5. **Observational Work.**—The observational work embraces the following :—(*a*) solar research ; (*b*) stellar research ; (*c*) spectroscopic researches ; (*d*) atmospheric electricity ; (*e*) cosmic radiation ; (*f*) radio research ; (*g*) ozone content of the atmosphere ; (*h*) luminosity of the night sky ; and (*i*) meteorological observations. A more detailed account of the observational work cannot, owing to limits of space, be published in this issue, but may be found in earlier issues (see No. 22, p. 1011).

§ 8. Standards Association of Australia.

This Association was established under the aegis of the Commonwealth and State Governments for the promotion of standardization and simplified practice.

In addition to the Council and Standing and Organization Committees, the following Sectional Committees have been appointed to formulate Australian standard specifications and codes :—A.—*Safety Codes Group*—(1) Boiler Regulations (including Gas Cylinders) ; (2) Concrete and Reinforced Concrete Structures ; (3) Cranes and Hoists ; (4) Electrical Wiring Rules ; (5) Lift Installations ; (6) Pump Tests ; (7) Refrigeration ; (8) Steel Frame Structures ; (9) Welding ; (10) Fireproof Construction ; (11) Building By-laws ; (12) Electrical Service Rules ; (13) Handling and Use of Explosives ; (14) Air lock Operation ; (15) Street Lighting ; (16) X-ray Installations ; (17) Interior Illumination of Buildings. B.—*General Technical Standard Group*—(1) Bore Casing ; (2) Building Materials ; (3) Calcium Carbide ; (4) Cement ; (5) Coal—Sampling and Analysis ; (6) Colliery Equipment ; (7) Provisional Electrical Approval Standards ; (8) Electrical ; (9) Firebricks ; (10) Locomotive and Railway Rolling-stock ; (11) Lubricants ; (12) Machine Belting ; (13) Machine Parts ; (14) Non-ferrous Metals ; (15) Paint and Varnish ; (16) Pipes and Plumbing ; (17) Railway Permanent Way Materials ; (18) Roadmaking Materials ; (19) Strutural Steel ; (20) Testing, Weighing and Gauging ; (21) Timber ; (22) Tramway Rails ; (23) Typography ; (24) Galvanizing and Galvanized Products ; (25) Roadmaking Machinery ; (26) Sugar Mill Machinery ; (27) Creosote ; (28) Safety Glass for Automobiles ; (29) Agricultural Implement Parts ; (30) Metal Windows. C.—*Co-ordinating Committees*—(1) Concrete Products ; (2) Ferrous Metals ; (3) Non-ferrous Metals. D.—*Commercial Standards Division Committees*—(1) Building Materials Classification ; (2) Three-ply Wood Panels for Use in Stock Door Manufacture ; (3) Institutional Supplies and Co-ordinated Purchasing (Hospitals, Asylums and other Public Institutions) ; (4) General Conditions of Contract ; (5) Purified Feathers ; (6) Commercial Paper Sizes ; (7) Road Gully Gratings ; (8) Street Name Plates and Building Number Plates ; (9) Sheet Metal Guttering, Ridging and Downpiping ; (10) Laminated Steel Springs for Motor Cars ; (11) Shellgrit for Poultry ; (12) Road Signs and Traffic Signals.

A Power Survey Committee to deal with the collection of data and the framing of recommendations for assistance in the development and co-ordination of power schemes has also been appointed.

The association administers the Australian National Committees of the International Electro-technical Commission, the World Power Conference and the International Commission on Large Dams.

The objects of the Association include the following:—To prepare and promote the general adoption of standards in connexion with structures, materials, etc.; to co-ordinate the efforts of producers and users for the improvement of materials, processes and methods; and to procure the recognition of the Association in any foreign country.

The sole executive authority of the Association is vested in the Council, which undertakes the whole of the organization of the movement, the raising of the necessary funds, the controlling of the expenditure, the arranging of the subjects to be dealt with by the various sectional and sub-committees, and the authority for the issue of all the reports and specifications.

The Association was established in July, 1929, by amalgamation of the Australian Commonwealth Engineering Standards Association and the Australian Commonwealth Association of Simplified Practice.

§ 9. Valuation of Australian Production.

1. **Value of Production.**—(i) *Net Values.* The annual value of production was defined by the Conference of Statisticians in 1924 as the sum available each year for distribution among those concerned in industry, i.e., workers, proprietors (including landlords) and providers of capital. In the past the want of complete uniformity in the methods of compilation and presentation of statistics of recorded production rendered it very difficult to make a satisfactory valuation of the various elements of production in accordance with the above definition. At the conference of 1924 and those subsequently held the method of determining the gross value, marketing costs and production costs was laid down into a definite procedure. This arrangement enabled the State Statisticians to compile the various elements of costs on a uniform basis which permitted the aggregation of the figures for each State to obtain a total for Australia.

The figures shown in the following table have been compiled by the Statisticians of the several States and, to a large extent, are based upon actual records. Where these have not been possible careful estimates have been made from the best available data. Absolute uniformity has not been attained in every detail but the few remaining differences of procedure are of little importance. This matter is referred to in the note at the head of the table.

Attention is directed to the fact that the value shown in the table refers only to recorded production and excludes the building and construction industry, those industrial establishments not classified as factories, and agricultural and farmyard produce obtained from areas of less than one acre.

The following is a brief explanation of the terms used in the table:—

(*a*) "Gross value" is the value placed on gross production at the wholesale price realized in the principal markets. (In cases where primary products are consumed at the place of production or where they become raw material for a secondary industry, these points of consumption are presumed to be the principal markets.)

(*b*) "Local value" is the gross production valued at the place of production and is ascertained by deducting marketing costs from the gross value. (Marketing costs include freight, cost of containers, commission and other charges incidental thereto.)

(*c*) "Net value" represents the net return to the producer after deducting from the gross value costs of marketing and of materials used in the process of production. Materials used in the process of production include seed, fodder consumed by farm stock, manures, dips, sprays and other costs. No deduction has been made for depreciation and maintenance costs. This matter is more fully dealt with in Production Bulletin, No. 31, Part II., issued by this Bureau.

It should be noted that the costs of maintenance of farm buildings and fences have not been deducted from the value of production of rural industries, as particulars are not available for all States. In Queensland the costs for the pastoral industry are not as exact as might be desired, but it is hoped to bring them into line in due course. The value shown for Mines and Quarries in Tasmania is understated owing to the omission

of Quarries. This understatement, however, is more or less offset by the inclusion of production costs in Mining. As explained in the note (*a*) below production costs are not available for all States in respect of Fisheries, and Local Values have been used for this industry with consequent overstatement.

GROSS, LOCAL AND NET VALUE OF RECORDED PRODUCTION—AUSTRALIA, 1936-37.

Industry.	Gross Production valued at Principal Markets.	Local Value—Gross Production valued at place of Production.	Net Value of Production (without deduction of depreciation or maintenance).
	£	£	£
Agriculture	91,296,975	79,025,116	63,113,485
Pastoral	95,429,294	87,476,297	84,421,276
Dairying	36,097,428	33,738,546	27,547,062
Poultry and Bees	10,822,206	9,812,450	5,825,042
Total Rural (*c*) ..	233,645,903	210,052,409	180,906,865
Trapping	3,401,836	3,081,472	3,081,472
Forestry	8,380,565	7,503,687	7,305,921
Fisheries	1,916,059	1,638,000	(*a*) 1,638,000
Mines and Quarries.. ..	27,283,247	26,839,305	22,252,545
Total Non-rural ..	40,981,707	39,062,464	34,277,938
Total All Primary	274,627,610	249,114,873	215,184,803
Factories	(*b*) 177,685,141	(*b*) 177,685,141	177,685,141
Total All Industries ..	452,312,751	426,800,014	392,869,944

(*a*) Local value. Production costs not available for all States. (*b*) Net value. (*c*) The term "Rural" is used to cover those industries ordinarily considered to be farm industries.

The net value of production in each State is shown hereunder :—

NET (*a*) VALUE OF RECORDED PRODUCTION IN STATES, 1936-37.

Industry.	New South Wales.	Victoria.	Queensland.	South Australia.	Western Australia.	Tasmania.	Total.
	£'000.	£'000.	£'000.	£'000.	£'000.	£'000.	£'000.
Agriculture ..	19,364	16,356	10,706	9,058	5,921	1,709	63,114
Pastoral	39,300	19,502	14,112	5,217	4,597	1,693	84,421
Dairying ..	9,128	10,778	4,957	1,588	554	542	27,547
Poultry and Bees ..	2,229	2,347	327	272	309	341	5,825
Total Rural (net)	70,021	48,983	30,102	16,135	11,381	4,285	180,907
Trapping	1,450	882	333	86	181	149	3,081
Forestry	2,096	732	2,186	571	1,314	407	7,306
Fisheries (local) ..	650	162	336	185	224	81	1,638
Mines and Quarries	8,350	1,594	2,408	2,436	5,803	1,661	22,252
Total Non-rural (local and net)	12,546	3,370	5,263	3,278	7,522	2,298	34,277
Total All Primary..	82,567	52,353	35,365	19,413	18,903	6,583	215,184
Factories.. ..	76,754	58,712	17,185	12,272	7,947	4,815	177,685
Total All Industries ..	159,321	111,065	52,550	31,685	26,850	11,398	392,869

(*a*) See letterpress at head of previous table.

NET (a) VALUE OF RECORDED PRODUCTION PER HEAD OF MEAN POPULATION, 1936-37.

Industry.	New South Wales.	Victoria.	Q'land.	South Australia.	Western Australia.	Tasmania.	Total.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Agriculture ..	7 4 6	8 16 8	10 17 7	15 7 11	13 2 0	7 7 2	9 5 6
Pastoral	14 13 2	10 10 7	14 6 9	8 17 4	10 3 6	7 5 9	12 8 1
Dairying	3 8 1	5 16 5	5 0 9	2 14 0	1 4 6	2 6 8	4 1 0
Poultry and Bees ..	0 16 8	1 5 4	0 6 8	0 9 3	0 13 8	1 9 5	0 17 1
Total Rural (net)	26 2 5	26 9 0	30 11 9	27 8 6	25 3 8	18 9 0	26 11 8
Trapping.. ..	0 10 10	0 9 6	0 6 9	0 3 0	0 8 0	0 12 10	0 9 0
Forestry	0 15 8	0 7 11	2 4 5	0 19 5	2 18 2	1 15 1	1 1 6
Fisheries (local) ..	0 4 10	0 1 9	0 6 10	0 6 3	0 9 11	0 7 0	0 4 10
Mining (local) ..	3 2 4	0 17 3	2 8 11	4 2 10	12 16 10	7 3 0	3 5 5
Total Non-rural (local and net)	4 13 8	1 16 5	5 6 11	5 11 6	16 12 11	9 17 11	5 0 9
Total All Primary (local and net)..	30 16 1	28 5 5	35 18 8	33 0 0	41 16 7	28 6 11	31 12 5
Factories.. ..	28 12 8	31 14 0	17 9 3	20 17 2	17 11 9	20 14 9	26 2 3
Total All Industries ..	59 8 9	59 19 5	53 7 11	53 17 2	59 8 4	49 1 8	57 14 8

(a) See letterpress at head of previous Table.

(ii) *Gross Values.* The estimated gross value of production shown in the following table is a continuation of the method previously used by this Bureau. It cannot be compared with the gross values shown in the table above on account of the difference in the methods used and the change in the computing authority. It is proposed to discontinue the publication of this table once the net values have been satisfactorily established.

ESTIMATED GROSS VALUE OF PRODUCTION.—AUSTRALIA.

Year.	Agriculture.	Pastoral.	Dairy, Poultry, and Bee-farming.	Forestry.	Fisheries.	Mining.	Manufacturing.(a)	Total.
	£'000.	£'000.	£'000.	£'000.	£'000.	£'000.	£'000.	£'000.
1926–27 ..	98,295	111,716	46,980	11,046	1,744	23,939	153,634	447,354
1927–28 ..	84,328	124,554	50,261	10,339	1,842	23,015	158,562	452,901
1928–29 ..	89,440	116,733	50,717	9,449	2,168	19,539	159,759	447,805
1929–30 ..	77,109	84,563	49,398	9,103	2,268	17,912	149,184	389,537
1930–31 ..	70,500	69,499	43,067	6,488	1,825	15,361	112,966	319,706
1931–32 ..	74,489	61,540	41,478	6,033	1,670	13,352	106,456	305,018
1932–33 ..	75,562	64,851	39,622	6,791	1,679	15,583	114,136	318,224
1933–34 ..	70,731	95,613	40,306	7,985	1,620	17,608	123,355	357,218
1934–35 ..	68,587	74,556	44,763	9,221	1,635	19,949	137,638	356,349
1935–36 ..	75,388	91,286	47,533	9,737	1,687	23,248	155,891	404,770
1936–37 ..	91,403	105,499	49,886	9,760	2,005	27,381	170,811	456,745

(a) Net Values. These amounts differ from those given in the previous two tables and in Chapter XXIV., Manufacturing Industry, which include certain products included under Dairy Farming and Forestry in this table.

2. **Productive Activity.**—In previous issues an attempt was made to measure he quantity of material production by means of production price index-numbers. It was found, however, that these were not satisfactory in their application to factory production. In the absence of a satisfactory measure of the *quantity* of production, the retail price index-numbers have been applied to the value of production, in the same manner as they have been applied to nominal wages, to measure their relative purchasing power. The results may be taken to indicate the purchasing power in retail prices of the things produced, and for convenience will hereafter be called *real* production.

Two tables are given :—The first shows *real* production per head of population, but any deductions therefrom must take into account the following considerations. The production considered is material production only, and takes no account of services. As civilization advances, material production becomes less important relatively to services, and a smaller proportion of the population is engaged in such production. For example, the use of the motor car, the cinema and wireless is comparatively recent, and these employ a much larger number of people in services than in material production. Hence, material production per head of population will not measure accurately the progress of productive efficiency, but will tend to give too low a value. Unemployment, of course, will also depress it.

A better measure is afforded by *real* production per person engaged in material production. The second table attempts to give this. The result affords a better measure of productive efficiency, but does not take into account the effect of unemployment, though the index may be somewhat depressed by short time and rationing.

The two tables tell different stories. Before unemployment became severe in 1930 *real* production per head (as shown in the last two columns of the first table) had remained substantially steady with minor fluctuations since 1906. Whatever gain had been made in productive efficiency had been off-set by the gradual transfer of labour from production of goods to production of services. Coincident with the heavy increase in unemployment between the years 1930 and 1933, the maximum being reached in 1932, the index-numbers fell sharply from their normal level of about 100 to 76 ("A" Series) and 78 ("C" Series) in 1930–31. This would imply a fall in average *real* income of nearly one-fourth from the normal level, taking unemployment into account. Apart from a slight recession in 1934–35 due to a drop in wool values the index-numbers rose continuously from 1931–32 onwards; the pre-depression level was reached in 1935–36 and the peak of 1924–25 was almost equalled in 1936–37.

The index-numbers of *real* production per person engaged as given in the last two columns of the second table show, on the other hand, an appreciable upward tendency. They rose steeply during the war, as might have been expected, fell somewhat after the war and recovered again. In 1929–30 they fell substantially, due partly to the lag in the fall of retail prices. They increased during the next four years to 125 and 126 only to fall again in 1934–35 to 115 and 117 with the fall in wool prices during that year. Recovering most of this loss in 1935–36 they advanced to new records of 128 and 134 in 1936–37. This high figure for *real* production per person engaged implies a high *real* wage for *those in employment* and is consistent with available information concerning rates of *effective* or *real* wages, which more than maintained in recent years the high level reached in the years 1927 to 1929.

The data for the second table are not complete. The numbers engaged in timber-getting are not accurately known, so that the value of production on this account, and the corresponding persons engaged, are both left out of account. Further, the information concerning women engaged in primary production is unsatisfactory, and only males are counted in primary industries. In manufacturing, the numbers are converted into equivalent male workers on the basis of relative wages for male and female workers. The column headed " numbers engaged " is, therefore, rather an index than the absolute number of individuals occupied in material production, but, as an index, it should be accurate enough to give a satisfactory measure of production per person engaged.

PRODUCTION PER HEAD OF POPULATION.—AUSTRALIA.

Year.	Gross Value of Material Production.			Retail Price Index-numbers. (a) 1911 = 1,000.		Real Production per head of population (1911 = 100) measured in purchasing power over regimen of—	
	Total.	Per head of population.					
		Actual.	Index-Number. 1911 = 100.	"A" Series.	"C" Series.	"A" Series.	"C" Series.
	£'000.	£					
1906 ..	147,043	35.9	87	902	..	97	..
1911 ..	188,359	41.2	100	1,000	(1,000)	100	100
1913 ..	220,884	45.1	110	1,104	..	99	..
1914 ..	213,552	43.0	104	1,140	1,140	92	92
1916 ..	261,996	53.3	129	1,324	1,319	98	98
1917 ..	279,418	56.1	136	1,318	1,406	103	97
1918 ..	291,875	57.5	140	1,362	1,501	102	93
1919–20 ..	343,697	64.9	158	1,624	1,695	97	93
1920–21 ..	390,644	72.2	175	1,821	1,935	96	91
1921–22 ..	344,426	62.5	152	1,600	1,680	95	90
1922–23 ..	379,445	67.4	163	1,642	1,619	100	101
1923–24 ..	400,276	69.6	169	1,714	1,664	99	102
1924–25 ..	454,580	77.3	188	1,690	1,637	111	115
1925–26 ..	431,670	72.0	175	1,766	1,673	99	104
1926–27 ..	447,354	73.1	178	1,763	1,663	101	107
1927–28 ..	452,901	72.5	176	1,776	1,676	99	105
1928–29 ..	447,805	70.5	171	1,785	1,693	96	101
1929–30 ..	389,537	60.6	147	1,783	1,688	83	87
1930–31 ..	319,706	49.2	120	1,574	1,528	76	78
1931–32 ..	305,018	46.5	113	1,432	1,406	79	80
1932–33 ..	318,224	48.2	117	1,358	1,344	86	87
1933–34 ..	357,218	53.7	130	1,365	1,344	96	97
1934–35 ..	356,349	53.2	129	1,399	1,366	92	95
1935–36 ..	404,770	60.0	146	1,437	1,392	101	105
1936–37 ..	456,745	67.1	163	1,489	1,431	110	114

(a) For explanation of "A" and "C" Series see Chapter XVII.

PRODUCTION PER PERSON ENGAGED.—AUSTRALIA.

Year.	Number engaged in Material Production.(a)	Value of Material Production per person engaged in production. (a)		"Real" Production per person engaged (1911 = 100) measured in retail purchasing power over regimen of—(b)	
		Actual.	Index-number. 1911 = 100.	"A" Series.	"C" Series.
	('000)	£			
1906	659	223	87	96	..
1911	728	257	100	100	100
1913	756	290	113	102	..
1914	733	289	113	99	99
1916	685	381	148	112	112
1917	683	408	159	120	113
1918	685	424	165	121	110
1919-20 ..	743	460	179	110	106
1920-21 ..	760	510	199	109	103
1921-22 ..	775	441	172	107	102
1922-23 ..	793	475	185	113	114
1923-24 ..	810	491	191	111	115
1924-25 ..	826	547	213	126	130
1925-26 ..	831	515	201	114	120
1926-27 ..	841	527	205	116	123
1927-28 ..	838	536	209	118	125
1928-29 ..	830	536	209	117	123
1929-30 ..	803	482	187	105	110
1930-31 ..	728	431	168	108	112
1931-32 ..	741	411	160	112	114
1932-33 ..	781	407	158	117	118
1933-34 ..	815	437	170	125	126
1934-35 ..	862	412	160	115	117
1935-36 ..	901	448	174	121	125
1936-37 ..	930	491	191	128	134

(a) See explanatory remarks above tables. (b) See note (a) to previous table.

§ 10. Film Censorship.

1. **Legislation.**—The censorship of imported films derives its authority from section 52 (*g*) of the Customs Act, which gives power to prohibit the importation of goods. Under this section regulations have been issued prohibiting the importation of films except under certain conditions and with the consent of the Minister. The regulations provide, *inter alia*, that no film shall be registered which in the opinion of the censor is (*a*) blasphemous, indecent or obscene; (*b*) likely to be injurious to morality, or to encourage or incite to crime; (*c*) likely to be offensive to the people of any friendly nation; (*d*) likely to be offensive to the people of the British Empire; or (*e*) depicts any matter the exhibition of which is undesirable in the public interest.

The regulations governing the exportation of Australian-made films are similar, with the addition that no film may be exported which in the opinion of the Censorship is likely to prove detrimental or prejudicial to the Commonwealth of Australia.

The Censorship consists of a Censorship Board of three persons and an Appeal Censor, the head-quarters being in Sydney. There is also a right of appeal to the Minister.

In addition to the censorship of moving pictures, the Censorship may refuse to admit into Australia any advertising matter proposed to be used in connexion with the exhibition of any film. Such control does not, however, extend to locally-produced publicity.

2. **Imports of Films.**—Imported films dealt with by the Censorship for the year 1937 were as follows:—1,538 films of 4,150,256 feet passed without eliminations, 157 films of 750,500 feet passed after eliminations, and 17 films of 87,861 feet rejected in first instance, making a total of 1,712 films of 4,988,617 feet (one copy). The countries of origin were as follows:—United States of America, 1,152 films of 3,579,495 feet; United Kingdom, 459 films of 1,302,851 feet; and 101 films of 106,271 feet from other countries.

The above figures relate to standard size films (35 millimetres). There were also imported during 1937, 1,189 miniature films (16, 9.5, and 8 millimetres) of 526,556 feet.

3. **Exports of Films.**—The number of films exported for the year 1937 was 1,044 of 1,263,843 feet (one copy), of which 903 films of 1,145,557 feet were sent to places in the British Empire including Mandated Territories.

§ 11. Marketing of Australian Commodities.

1. **Introduction.**—Particulars in respect of the various Commonwealth Acts and Regulations together with the operations of the Boards or Councils appointed to assist or control the marketing of Australian commodities are set out below.

2. **Dairy Produce.**—(i) *The Dairy Produce Export Control Act* 1924–1936. Introduced at the request of the dairying industry this Act was passed by the Commonwealth Parliament with the object of organizing the overseas marketing of Australian dairy produce. A Dairy Produce Control Board was appointed and was in existence from 1924 to 1935. It dealt with matters relating to the organization and supervision of overseas marketing of dairy produce. In the course of its functions the Board regulated shipments to ensure regularity of supply in the London market, controlled forward selling, obtained reductions in overseas freights and insurance rates, and participated in an advertising campaign in the United Kingdom.

Prior to the appointment of the Dairy Produce Control Board a voluntary body—the Australian Dairy Council—was established to advise and make recommendations to the Governments on problems connected with the production, manufacture and quality of dairy produce, pasture improvement, and diseases of dairy cattle.

Following a recommendation by the Australian Agricultural Council the functions of these bodies were combined by an Amending Act of 1935 under the Australian Dairy Produce Board and provision was made for the allocation of money from the Board's funds for research and investigation into pastures, diseases of dairy cattle, and the quality of butter.

(ii) *The Dairy Produce Export Charges Act* 1924–1929. This Act provides for the imposition of a levy on all butter and cheese exported from the Commonwealth to cover the administrative expenses of the Board and for advertising and other purposes. The rate of the levy is fixed by regulation.

(iii) *The Dairy Produce Act* 1933–1935. In § 1 par. 3 of Chapter XXI. reference is made to the voluntary and compulsory plans introduced for the purpose of stabilizing the prices of dairy produce in Australia. Under State legislation regulating authorities fixed the proportion of the States' output to be sold within the respective States, and the Dairy Produce Act was passed by the Commonwealth Parliament to protect these "quotas" from the effects of interstate competition. A recent decision of the Privy Council, however, held that the Commonwealth had no power under its Constitution to control interstate trade and the Commonwealth legislation is therefore inoperative. The industry is now carrying on its stabilization plan on a purely voluntary basis.

3. **Dried Fruits.**—(i) *The Dried Fruits Export Control Act* 1924–1938. This Act was passed by the Commonwealth Parliament at the request of the dried fruits industry to organize the overseas marketing of Australian dried vine fruits. The Dried Fruits Control Board, consisting of eight members—including five growers' representatives, two members with commercial experience, and one Government nominee—was appointed

to control the export, and the sale and distribution after export, of Australian sultanas, currants and lexias. In conjunction with its London agency, the Board has improved the marketing of Australian dried fruits overseas, and has increased the demand for the product. Its system of appraisement has resulted in more satisfactory realizations. Its methods of ensuring continuity of supply and regulating shipments and its participation in the advertising campaign of the Australian Overseas Trade Publicity Committee have benefited the industry considerably. No dried fruits may be exported excepting by means of a licence, which is issued subject to conditions recommended by the Board.

(ii) *Dried Fruits Export Charges Act* 1924–1929. This Act provides for the imposition of a levy on all sultanas, currants and lexias exported from the Commonwealth for the purpose of defraying the administrative expenses of the Board and the cost of advertising, etc. The rate of the levy is fixed by regulation. Under an amendment made in 1927 provision was made for the exemption of sultanas, currants and lexias from the levy upon recommendation by the Board.

(iii) *The Dried Fruits Act* 1928–1935. In previous issues of the Year Book reference has been made to the Dried Fruits Act and its provisions outlined (see page 894 of Official Year Book, No. 28). The legislation is on similar lines to that for dairy produce referred to in par. 2 (iii) above.

4. **Canned Fruits.**—(i) *The Canned Fruits Export Control Act* 1926–1935. This legislation was introduced at the request of canners and representative organizations of fruit growers with the object of organizing the overseas marketing of canned fruit. The original Act referred to canned apricots, peaches and pears only, but canned pineapples and canned fruit salads consisting of not less than 75 per cent. of specified fruits were subsequently brought within the scope of the Board's operations. The personnel of the Board consists of one representative each from proprietary and privately owned canneries, co-operative canneries, State controlled canneries, pineapple interests, and the Commonwealth Government. No canned fruits to which the Act applies are permitted to be exported except under a licence issued in accordance with conditions recommended by the Board. The system of marketing adopted by the Board, including the fixation of minimum selling prices overseas, the appointment of a London agency and the engaging in overseas trade publicity, has resulted in the satisfactory disposal of the annual exportable surplus of canned fruits. The distribution of canned fruits has been widened and the exporting side of the industry placed on a sounder basis through the Board's operations.

(ii) *The Canned Fruits Export Charges Act* 1926–1935. This Act provides for the imposition of a levy on the export of canned fruits to meet the administrative and other commitments of the Board. The rate of the levy is fixed by regulation from time to time. An amendment in 1929 provided for certain exemptions from payment of the levy when recommended accordingly by the Board.

5. **Wine.**—(i) *The Wine Overseas Marketing Act* 1929–1936. This Act was introduced at the request of the viticultural interests in Australia with the object of placing the overseas marketing of Australia's surplus wine on an orderly basis. The Wine Overseas Marketing Board was appointed to supervise the exports, and the sale and distribution after export of Australian wine.

The name of the Board was changed to the Australian Wine Board in 1936. No wine may be exported except by means of a licence, which is issued under conditions recommended to the Minister by the Board; these include the withholding of shipments as directed by the Board. The Board has a London agency which advises on marketing conditions. The methods of marketing adopted by the Board, including its participation in the advertising campaign of the Australian Overseas Trade Publicity Committee, have resulted in the widening of the distribution of Australian wines overseas.

(ii) *The Wine Grapes Charges Act* 1929. This Act provides for the imposition of a levy on all grapes used in the Commonwealth for the manufacture of wines or spirit. The proceeds of the levy are used to defray the administrative and other expenses of the Board, and provision is made for such exemptions from the levy as the Board may recommend.

6. **Meat.**—(i) *The Meat Export Control Act* 1935–1936. This Act was introduced following a decision of a conference of Commonwealth and State Ministers with members of the Commonwealth Meat Advisory Committee, held in October, 1935, to set up a Meat Board with defined statutory powers. The Australian Meat Board, which was appointed under the Act in January, 1936, consists of eighteen members, representative of producers, processors, exporters and the Commonwealth Government. Provision is made for the appointment from within the Board of an Executive Committee and a Beef Committee. Export of meat is controlled by licence. The Board has power to regulate shipments of meat and to arrange contracts in respect of freights and insurances; to promote overseas sales by advertising and to foster research into meat problems; and to supervise the issue of export licences. The Board also has power to appoint a London representative.

(ii) *The Meat Export Charges Act* 1935. By means of a levy collected on all meats exported from the Commonwealth, funds are provided for the purpose of defraying the expenses and charges incurred by the Australian Meat Board in the course of its business. The customary provision is made for exemption from the levy when recommended by the Board.

7. **Apples and Pears.**—(i) *The Apple and Pear Organization Act* 1938. This Act which was passed by the Commonwealth Parliament at the request of the Apple and Pear industry, provides for the establishment of an Australian Apple and Pear Board for the purpose of organizing and controlling the export trade in fresh apples and pears.

The Act provides that the Board shall consist of one member to represent the Commonwealth Government; eleven members to represent the growers of apples and pears on the basis of four from the State of Tasmania, two each from Victoria and Western Australia, and one each from New South Wales, Queensland and South Australia; and four members to represent exporters of apples and pears on the basis of one from each of the States of Victoria, South Australia, Western Australia and Tasmania.

This Statutory Board will replace the voluntary body known as the Australian Apple and Pear Council which, through the organization of affiliated producing and exporting interests, has dealt with the general affairs of the industry.

(ii) *The Apple and Pear Export Charges Act* 1938. This Act provides for the imposition of a levy on all apples and pears exported from the Commonwealth for the purpose of providing the funds necessary to meet the administrative and other expenses of the Board.

(iii) *The Apple and Pear Publicity and Research Act* 1938. Under this Act, the Australian Apple and Pear Board is empowered to expend moneys, specifically collected and appropriated, for the purpose of increasing and extending the consumption of apples and pears throughout Australia by publicity, research, or any other means.

The fund for this purpose is to be created from the proceeds of a tax levied on all apples and pears sold for consumption in Australia as fresh fruit. Apples and pears exported or to be exported, or processed or to be processed, are exempt from the tax.

The related taxing measures are:—The *Apple and Pear Tax Act* 1938 and the *Apple and Pear Tax Assessment Act* 1938.

8. **Wheat Industry Assistance Act 1938.**—This legislation supplements legislation of a uniform type passed by all the State Parliaments and is designed to enable the operation of a home consumption price scheme for the wheat industry on a Commonwealth basis.

The legislation is based on a home consumption price of 5s. 2d. a bushel, free on rail, Williamstown, equivalent to 4s. 8d. at country sidings. When the price of wheat falls below that level the returns of growers will be supplemented by payments from a fund established from the proceeds of a flour tax which varies inversely with the price of wheat. When the export price rises above that level provision is made for a tax on wheat sold, the proceeds of which are to be applied to ensure that the cost of wheat gristed for home consumption shall not exceed 5s. 2d. per bushel.

Out of the general fund a sum not exceeding £500,000 per year will be reserved for special purposes including the transfer of producers growing wheat on marginal lands to other areas where they will be able to engage in mixed farming or to enable them to increase the size of their holdings to make wheat growing worth while.

A Wheat Stabilization Advisory Committee has been established to determine the appropriate times for a variation in the rate of tax which will be fixed on the basis of a rigid formula.

The State legislation undertakes to ensure that prices charged to consumers are reasonable and the Commonwealth legislation contains provision that no State shall be entitled to receive payments where that undertaking is not carried out.

9. **Export Guarantee Act.**—For a considerable time this Act has not been invoked to directly provide for assistance in the marketing of primary products. The Dried Fruits Advances Act, disbursements under which were made for the appropriation pursuant to the Export Guarantee Act, has ceased to operate. The Board of Trade, which was formed to advise and recommend on expenditure proposed under the Act, has not functioned for some years. The only recent expenditure under the Act has been in respect of special overseas trade publicity, but since 1st July, 1934, expenditure under that heading has been made the subject of a separate appropriation. The total assistance granted under the Act during its period of operation amounted to £670,574 which included substantial payments on account of both the Dried Fruits Advances Act and overseas trade publicity. Although the Export Guarantee Act has not been repealed, it is not proposed that any further payments shall be made under it.

10. **Australian Agricultural Council.**—Particulars of the formation, personnel and functions of the Australian Agricultural Council are given in Chapter XX.—Agricultural Production.

§ 12. The National Safety Council of Australia.

The National Safety Council of Australia was founded in Melbourne in 1927 for the purpose of developing mainly by means of education safety on the road, at work and in the home, and its activities have developed in other directions wherever the need for reducing the toll of accidents has been shown. In various States it issues by courtesy of the Traffic Authorities a booklet with every motor driver's licence, and conducts continuous propaganda through the press and other sources. It also forms Junior Safety Councils in the schools for developing a safety conscience among children. The children themselves are officers of these Councils and patrol the roads in the neighbourhood of the schools and conduct the scholars across in safety. Posters are available to schools at cost in connexion with Health and Safety lessons in the schools. Small films specially taken are available for children's and home safety instruction.

A "Safe Driving" campaign for individual motor drivers is conducted as well as a "Freedom from Accidents" competition among employee drivers, those completing a year free from any accident for which they are responsible being given a certificate to that effect. A Factories' Service of four posters per month, together with slips for pay envelopes, constitutes a regular service for the dissemination of safety advice, and was supplied to over 45,000 workers in factories last year. Committees deal with specific problems regarding traffic, films, safety in industry, air safety and home dangers. The Air Safety Committee has issued a 32-page booklet "Air Sense" for distribution with "A" pilots' licences through the Civil Aviation Branch of the Defence Department.

The Council is supported by public subscription and sales of service, and is a non-profit organization. Numerous lectures are given throughout the year on the work of the Council, and on various aspects of safety, and lectures are always available for any organization which makes application to the Secretary.

§ 13. League of Nations.

Australia was one of the original signatories of the Treaty of Versailles of 28th June, 1919, under which the League of Nations was established, and thus became a Member of the League and its kindred organizations—the International Labour Organization and later the Permanent Court of International Justice. On 2nd October, 1933, Australia was elected a non-permanent member of the Council of the League of Nations for a period of three years, and was succeeded by New Zealand in September, 1936. There are now four permanent members of the Council (Great Britain, France, Italy and the Union of Soviet Socialist Republics) but of these Italy gave notice of her withdrawal from the League on 11th December, 1937, and, although such notice does not become effective for two years, Italy has not taken any part in League affairs since it was given, and eleven non-permanent members, viz., Belgium, Bolivia, China, the Dominican Republic, Greece, Iran, Latvia, New Zealand, Peru, Sweden and Yugoslavia. The term of the non-permanent members is three years.

Australia has been represented at each Assembly of the League from its inauguration in 1920, and at nearly all of the conferences of the International Labour Organization. The contribution of Australia towards defraying the expenditure of the League of Nations and its kindred organizations is on the basis of 23 of 932 units, and for the year 1938 amounts to 724,787 Swiss francs, or, in Australian currency at the present rate of exchange, approximately £33,555, out of a total budget of 29,416,884 Swiss francs. Australia holds a mandate, issued through the League of Nations, for the former German territory of New Guinea, and, by agreement with Great Britain and New Zealand, administers the Mandated Territory of Nauru, for which a mandate was issued to the British Empire.

§ 14. War Service Homes.

The operations of the War Service Homes Commission at 30th June, 1938, may be briefly set out as follows:—Total applications approved, 43,532; expenditure on provision of homes, purchase of land for future use, etc., £29,570,003; 21,291 houses had been completed; and 34 homes had been enlarged.

In addition, the Commission had purchased on behalf of eligible applicants, 12,967 already existing properties, and had taken over mortgages existing on 2,929 dwelling houses. Dual assistance had been approved in respect of 59 applications, making the total number of homes provided under the War Service Homes Act, 37,280. Homes are insured under a comprehensive policy, the total insurances in force including cover notes amounting to £20,957,945. The total receipts of the Commission to 30th June, 1938, were £25,092,653, of which £9,290,648 was paid to the National Debt Sinking Fund. Arrears of instalments outstanding at the close of the year equalled £808,345 or 3.73 per cent. of the total instalments due.

§ 15. National Health and Pensions Insurance.

1. **Historical.**—Social Insurance was first brought before the Australian people in 1910, when Sir George Knibbs, the Commonwealth Statistician, upon his return from an official visit to several European countries, published a bulletin setting forth the schemes in operation in Europe.

The war years which intervened deferred the consideration of any such scheme for Australia. The early post-war period saw a re-awakening of interest and the International Labour Office played a prominent part in advocating the introduction of insurance measures protecting workers against sickness and old age. Great Britain had adopted Health Insurance in 1911, and in a short time it was accepted by all classes of the community as an essential and necessary piece of social legislation.

In Australia proposals were put forward from various quarters and in 1923 a Royal Commission was appointed to inquire and report. In its first progress report the Commission stated:—

> "Your Commissioners are, therefore, of the opinion that it is both desirable and necessary that the Commonwealth Government institute a compulsory system of National Insurance in Australia which will provide for the payment of sickness, invalidity, maternity, and superannuation benefits to insured members. It is

considered that only by governmental control and supervision can equitable arrangements be made whereby definite and adequate benefits will be granted to all insured members, with that necessary economy in cost of administration, uniformity of method, effective co-ordination and unbiased control of the various sections of one comprehensive scheme. A compulsory basis is recommended, provided the system is supervised by the Government, as compulsory provisions can be effectively controlled by a national organization only, and there are no valid reasons why the Government should transfer its functions and responsibilities to private institutions."

The fourth and final report of the Commission was presented on 5th October, 1927, and in that year a National Insurance Advisory Committee was appointed. This Committee was supplemented in 1928 by an Actuarial Committee, which submitted recommendations and a draft Bill. The Honorable the Treasurer (Dr. Earle Page) introduced a Bill in September, 1928, but the intervening elections, followed by the depression years, resulted in the temporary abandonment of the measure.

In 1934 proposals were again examined by the Government which, in 1936, requested from the British Government the services of Sir Walter S. Kinnear, K.B.E., F.C.I.I., Controller of Insurance Department, Ministry of Health, and Deputy Chairman of National Insurance Joint Committee, Great Britain. This action followed upon a report by Sir Frederick Stewart, who had returned from the Geneva Conference where he had examined National Insurance schemes in operation overseas. Sir Walter Kinnear presented his report in June, 1937, and shortly afterwards the Government was returned at a general election with a mandate to provide National Insurance in Australia.

2. **Legislation.**—The Government forthwith introduced legislation, based on the report of Sir Walter Kinnear, which was passed by Parliament in June, 1938, and assented to on the 5th July, 1938. The legislation is contained in three Acts—

(*a*) National Health and Pensions Insurance Act 1938 (No. 25 of 1938), the main Act, "to provide for Insurance against certain contingencies affecting Employees, and the Wives, Children and Orphans of Employees, and for other purposes," and—

(*b*) The two contribution Acts (Nos. 26 and 27 of 1938) imposing on Employers and Employees the liability for contributions.

The division was adopted for Constitutional reasons. The Acts are to be read as one and are referred to as "the Act".

Three proclamations have been issued, enabling the entire scheme to be brought into operation on 4th September, 1939.

3. **Basic Principles of Scheme.**—The Scheme has four basic characteristics—

(*a*) It is compulsory and applicable to every person within its range;

(*b*) It is contributory so that it is, in fact, insurance and not public benevolence, and there are specific contributions from employers and employees and the Commonwealth Treasury;

(*c*) The benefits flow from contributions as such, without "means tests" of income or property; and

(*d*) It is financially sound and its costs, benefits and funds are related to one another.

4. **Administration.**—(i) *The Commission.* Subject to the control of the Minister, administration is vested in the National Insurance Commission, consisting of three Commissioners appointed by the Governor-General. The first Commissioners appointed are—

J. B. Brigden, M.A., Chairman;
D. McVey, A.M.I.E. (Aust.);
H. C. Green, F.S.S.

In each of the States Deputy Commissioners have been appointed and the work in districts is carried out by an inspection staff.

(ii) *Approved Societies.* The Act provides for the establishment of Approved Societies subject to the Commission which will administer sickness benefit, disablement benefit and the dependent child allowances. It will be their responsibility to see that the funds are used to the best advantage. Investments are restricted to those authorized by the Act. Actuarial valuations will be made at quinquennial periods.

5. **The Scope of the Act.**—Insurance is limited to employees, and details of insurable employment are set out in the first schedule to the main Act. In general, all persons who work for an employer under a contract of service will be insured between the ages of fourteen years and the ages when normally they will become entitled to receive the old-age pension. These ages are 60 for women and 65 for men. Other similar categories of employment, though not under contract of service, are also insurable and the Commission has power to include others within the limits set out in the Schedule. Certain exceptions are provided and include, *inter alia*—

(*a*) Government and semi-government employment in which benefits equal to those of National Insurance are provided and suitably safeguarded.

(*b*) Employment otherwise than by manual labour at a rate of remuneration exceeding £365 a year.

(*c*) Employment which is specified as subsidiary.

It is estimated that 1,350,000 men and 465,000 women will come within the scope of the Act at the commencement.

6. **Benefits.**—(i) *Medical.* Medical benefit means medical treatment by a qualified medical practitioner and provision of proper and sufficient drugs and medicines and prescribed medical and surgical appliances. The insured person is entitled to medical benefit while he remains in insurance, and if he is entitled to a pension on reaching pension age he receives medical benefit for life.

(ii) *Sickness.* Sickness benefit consists of periodical payments to the insured person during incapacity from work (commencing on the fifth day of incapacity) for a maximum period of 26 weeks. Sickness benefit is subject to a qualifying period of 26 weeks' insurance and payment of a minimum of 26 contributions. The rates of benefit are as follows :—

Adults and Married Minors—

Males	20s. per week.
Females	15s. per week.

Unmarried minors who have been in insurance for a period of 104 weeks and paid 104 contributions—

Males	15s. per week.
Females	12s. 6d. per week.

Unmarried minors (not being juvenile contributors) who have been in insurance for a period of less than 104 weeks—

Males	12s. per week.
Females	10s. per week.
Juvenile contributors, males and females ..	5s. per week.

Special conditions as to the period of benefit apply to juvenile contributors.

(iii) *Disablement.* Disablement benefit consists of periodical payments to the insured person in respect of any period after the termination of sickness benefit, during which incapacity for work due to sickness continues. Disablement benefit is payable after 104 weeks of insurance and contributions. The rate s are as follows :—

Adults and married minors—

Males	15s. per week.
Females	12s. 6d. per week.

Unmarried minors—

Males	12s. per week.
Females	10s. per week.

(iv) *Old-age Pension.* An old-age pension of £1 a week, in the case of males, and 15s. a week, in the case of females, is payable to persons who are in insurance when they reach the maximum age and who have built up the necessary qualifications. These qualifications relate solely to contributions paid and length of time in insurance and have no relation to property or income.

(v) *Widow's Pension.* A pension is payable to the widow of an insured man if he, during his lifetime, has built up the necessary qualifications, and consists of a payment of 12s. 6d. a week (which will be increased to 15s. in 1944) for life or until she re-marries.

(vi) *Orphan's Pension.* This consists of a payment of 7s. 6d. per week to any child, both of whose parents are dead, and whose last surviving parent was insured at death and satisfied certain conditions as to contributions; it ceases when the child attains the age of fifteen years, or sixteen if incapacitated.

(vii) *Dependent Child's Allowance.* Attached to cash benefits is the right to receive a weekly allowance of 3s. 6d. for each child under the age of fifteen years, or sixteen if incapacitated.

(viii) *Additional Benefits.* Provision is made in the Act for a valuation of the funds of Approved Societies every five years and if the valuation is favourable the Approved Society may be able to give to its members additional benefits.

7. **Finance.**—The funds of the Commission will come from three sources: (*a*) Contributions of employers, (*b*) Contributions of employees, and (*c*) Funds transferred from the Commonwealth Treasury.

Contributions will be collected by means of stamps. The employee will be required to present to his employer the card upon which the employer shall affix the stamp to the value of the total contribution payable in respect of the employee, and the employer will, in the case of persons below the maximum age, be entitled to recover from the employee, by a deduction from wages, half the value of the contribution payable. The contributions are payable under the special Acts supplementary to the main Act, and are as follows :—

TABLE OF CONTRIBUTIONS.

Payable by and in respect of.	Amount per week.	Distribution.	
	s. d.		*s. d.*
Males	3 0	Health	1 3
		Pensions	1 9
Females	2 0	Health	1 2
		Pensions	0 10
Juvenile Contributors—			
Males and Females	0 8	Health	0 8
For male persons who have attained the age of 65 years—Employer	1 6	Pensions	1 6
For female persons who have attained the age of 60 years—Employer	1 0	Pensions	1 0
Voluntary Contributors—			
Entitled to Medical Benefit—			
Males	3 0	Health	1 3
		Pensions	1 9
Females	2 0	Health	1 2
		Pensions	0 10
Not entitled to Medical Benefit—			
Males	2 8	Health	0 11
		Pensions	1 9
Females	1 8	Health	0 10
		Pensions	0 10
Special Voluntary Contributor (Female)	1 0	Pensions	1 0
Voluntary Contributor (Female) for additional Old-age Pension	0 6	Pensions	0 6

In the case of persons over the pension age no contributions are payable by the employee, but to prevent discrimination the employer's contribution is payable.

Treasury transfers to the funds of the Commission will be made as follows :—

(*a*) An annual amount of £100,000 towards the administration of Health Benefits ;

(*b*) An annual amount of 10s. for each insured person (limited as set out in the Act) towards the redemption of reserve values in respect of Health Insurance benefits ; and

(*c*) An annual amount towards pensions of £1,000,000 for the first five years, increasing thereafter by £500,000 a year until the transfer is £10,000,000, at which figure it will be stabilized.

8. **Voluntary Contributors.**—Under conditions set out in the Act, persons who have been in employment for as much as two years may continue as voluntary contributors. Female contributors may by the payment of an extra 6d. a week qualify for an old-age pension of £1 a week.

9. **Existing Pensions Legislation.**—The National Health and Pensions Insurance Legislation does not affect the provisions of the "Old-age Pensions" scheme which remains intact and is available to persons who can satisfy the "means" test associated therewith. Provision is, however, made against duplication of pensions.

10. **Miscellaneous.**—This synopsis deals only with the main features of the Act as it affects the great bulk of employers and employees. No mention has been made of the "free insurance period" by which the rights of insured persons are preserved after cessation of contributions for periods up to two years, nor of the relationship between the Act and State Workmen's Compensation Acts, and the various Repatriation Acts. Reciprocal arrangements may be made with any part of the British Empire where legislation substantially corresponding to the Act is in operation. The Act also provides for variations of the conditions under which the Act shall apply to employments of a seasonal nature, or subject to periodical fluctuation, and to casual or intermittent employment.

11. **Conclusion.**—The National Health and Pensions Insurance Act covers a greater geographical area than any scheme of a like nature heretofore introduced in any country of the world. It will in one measure provide insurance against contingencies which have, in other countries, been dealt with by successive stages, and will establish a basis upon which insurance on a National scale may be extended to wives and children of employed persons, to self-employed persons and to other sections of the community. It is based on the pooling of risk, and aims to prevent the burden of misfortune falling at a time when the individual is least able to assume that burden, and to provide, by the joint effort of employees, employers and the Government, a measure of security against old age and adversity.

The Tides of Australia.*

1. **Introduction.**—It was one of the many triumphs of Newton to demonstrate that the daily ebb and flow of the waters of the ocean, which we call the tides, are due to the gravitational attraction of the sun and the moon. From his theory the tide-producing force on the waters of the earth at any point can be computed with precision for any given disposition of the sun and moon. At any place it can be resolved into a vertical and a horizontal component. The vertical force, however, tending as it does to lift

* By Professor Sir Robert Chapman, C.M.G.

the water, amounts only to something of the order of a couple of grains weight per ton of water, which can produce no evident effect. It merely reduces the weight of the water to a very small degree and causes no horizontal motion. But the horizontal component of the tide-producing forces, although correspondingly small, can be effective in causing movement of the water in spite of its apparent insignificance. In the lower reaches of the Murray River the fall is only three-quarters of an inch to the mile, which means that the force producing the motion of the water is the resolved part of gravity down this almost level slope. This amounts to a force of about 185 grains weight per ton of water, and yet, little as it is, it is enough to cause the flow in the river. Small as this force is, however, it is about 80 times as much as the greatest horizontal forces producing the tidal movements throughout the oceans of the world. The tidal forces are very small, but they act all the time upon every ton of water in the seas and we observe the concentrated effects around the coastal boundaries, where the rise and fall of the water is usually much greater than it is at a distance from the land. For example, Captain T. J. J. See of the United States Navy gives the mean value of the tidal range for 78 island stations in the Pacific as 3.23 feet, whereas where the ocean laps the eastern shores of Australia the range of tide is about doubled. The enhanced range along the coastline is explained by the fact that as the tidal wave approaches the shores of a continent its energy is usually concentrated into shallower seas and narrowing inlets, although occasionally as in the case of Port Phillip we get a reverse effect. There the spring range at the heads is over 5 feet but, owing to the narrow entrance and the large area of the bay, the spring range at Williamstown is only 3 feet.

2. **The Progressive Wave Theory.**—The tide-producing forces at any place on the earth's surface undergo, of course, continuous variation owing to the revolution of the earth on its axis and to the movements of the sun and moon relative to the earth. These movements, however, though complex, are perfectly well known and it is still a practicable problem to compute exactly the magnitude of the tidal forces at any place at any particular time. It is one thing however to be able to compute the tide-producing forces and quite another thing to determine the effects which these forces produce upon the waters of the ocean. It would be possible to do this if the earth were covered by water of uniform depth or if the oceans of the earth were circular or rectangular or of some simple mathematical form and if the depth varied according to some simple law, but the actual shapes of the oceans are so exceedingly complex and the depths vary so erratically that in the present state of knowledge the calculation of the effects of the tidal forces is beyond our powers. Even now the fundamental problem as to the mode of origin of the tidal wave can hardly be regarded as definitely settled. The tidal wave is not a " free " wave, such as might be caused by a temporary disturbance, when the wave, once started, travels with a speed depending simply on the depth of water. In the case of the tides the generating forces are acting all the time and the theory of the first investigators, beginning with Laplace, was that the tidal forces set up what was known as a " forced " wave which necessarily travelled round the earth in a period harmonizing with that of the forces. It would be easy to picture this happening in an ocean which covered the whole earth, but in our real world there is only one ocean in which a wave could possibly travel right round the earth and that is the Great Southern Ocean, though even in this ocean the passage for such a wave is seriously restricted between Cape Horn and Graham Land on Antarctica. The theory therefore that has been generally held by tidal investigators, from Laplace, Lubbock, Whewell and Airy onwards, is that the tidal wave, travelling round the world continuously in the Southern Ocean, propagates its disturbance northwards into the Indian, Atlantic and Pacific Oceans in turn. This is commonly known as the Dynamic or Progressive Wave Theory. The 1936 edition of the *Oxford Advanced Atlas*, for example, in its map of co-tidal lines, shows an area of the Pacific Ocean west of South America marked " Origin of the Tidal Wave " and from this origin the wave is pictured as being propagated in a north-westerly direction into the northern half of the Pacific, and along the Southern Ocean, which is the source from which tidal waves travel, northward into the Indian and Atlantic Oceans. This is substantially the same assumption as is made by Whewell who drew the first map of the co-tidal lines of the world in 1836, and by Airy who followed him. Figure 1 is a

reproduction of a part of a map of the world, showing co-tidal lines in the oceans surrounding Australia, published in 1926 in a treatise entitled "New Dynamical Wave Theory of the Tides" issued by the Hydrographic Office of the United States Navy and compiled by Captain T. J. J. See, a vigorous champion of the progressive wave theory.

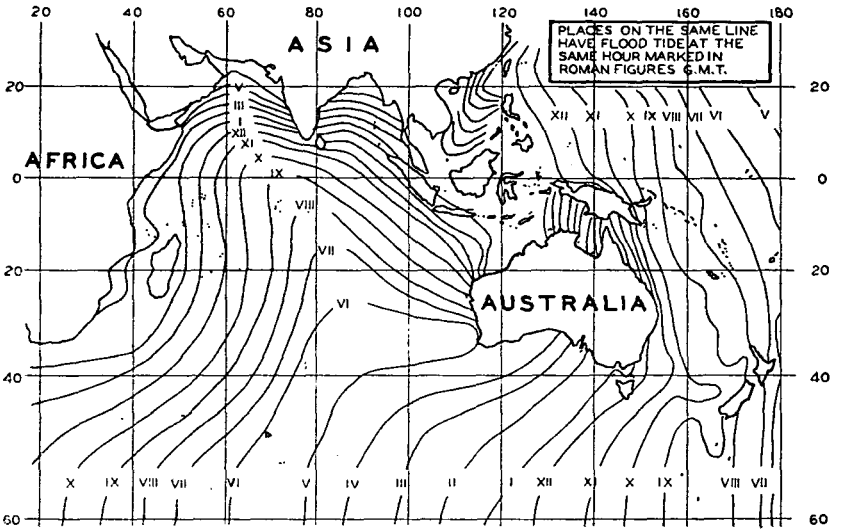

FIG. 1.—CO-TIDAL LINES.

From map by T. J. J. See, 1926.

The co-tidal lines show the onward march of the front of the tidal wave, it being high water at all points on the same co-tidal line at the one time. The co-tidal lines, drawn at hourly intervals, show the tidal wave approaching the eastern shores of Australia from the Pacific, then travelling from east to west along the Southern Ocean, and from there flowing in a north-westerly direction across the Indian Ocean. It is obvious that in the making of such a map of co-tidal lines the imagination of the author has to be brought into play quite considerably, because we have no observations of the rise and fall of the water at points far out from land, and our actual observations, upon which the map of co-tidal lines is based, are confined to places on the shores of the continents and to islands. Now there are no islands in the ocean to the south of Australia and it follows that the shape of the co-tidal lines in that region in this map must be determined by the progressive wave theory which the author has in his mind rather than by actual observation.

There are serious difficulties to the acceptance of this simple theory of the progressive wave. Dr. G. R. Goldsbrough, for example, in a paper contributed to the Royal Society of London in 1928, showed by mathematical calculation that, in an ocean extending from the South Pole to latitude 45 degrees or less, only quite small semi-diurnal tidal waves can be generated in such depths as are comparable with the Southern Ocean. If however the Atlantic tides are derived from the Southern Ocean, the large semi-diurnal tides of the Atlantic clearly require that there should be large tides of a similar kind in the Southern Ocean. Moreover, although the tidal wave appears to travel in the Atlantic from south to north it varies in height and speed in a way that is hard to understand if it is a simple progressive wave. If the phenomena of the tides along the south coast

of Australia, for instance, are due to a tidal wave moving from east to west, how is it that from Cape Howe to the Head of the Great Australian Bight, more than half way along, we have a mean spring range of tide running from 5 to 6 feet, whereas from there on to Cape Leeuwin the range is only about 2½ feet? It cannot be explained either by a variation in depth of the ocean or by a change in its width. Again, going along the west coast of Australia from south to north, the tidal range at Springs from Cape Leeuwin up as far as Dirk Hartog Island is less than 3 feet but from there it increases rapidly until at Port Hedland it is 19 ft. 3 in. The progressive wave theory alone does not give us any reasonable explanation of facts like these.

3. **The Resonance Theory of the Tides.**—There is another school of opinion that, at the beginning of the present century, was first firmly established by the work of Mr. Rollin A. Harris, then Chief of the Tidal Department of the United States Coast and Geodetic Survey. According to Harris, instead of looking for a progressive wave travelling right round the globe, we should rather consider the oceans as great basins of water which are continuously subjected to the disturbing effects of periodic tide-producing forces. These may be divided out into forces of several different periods and the basin of water is capable of oscillating, or setting up what is known as a stationary wave in many different ways. Out of all these many possible methods of oscillation there will probably be one or more that will keep time or nearly so with one or more of the tide-producing forces, which are continuously acting. If so the water will naturally swing or oscillate in those ways which will keep time with the forces and those particular methods of oscillation will be emphasized and perhaps given a relative importance out of proportion to the forces which produce them. It is the same principle as that of resonance. So, if the ocean is capable of oscillating in some way periodic, say, with the lunar forces, it will do so and the corresponding tidal forces will produce an effect greater in comparison with the effects produced by other tidal forces than we should expect from our knowledge of their magnitudes. Thus the tide-producing forces due to the moon are about 2.3 times as great as those due to the sun, but we do not find that the lunar semi-diurnal tide is everywhere 2.3 times as great as the solar semi-diurnal tide. There are places around the coast of Australia where the solar tide is just as big as the lunar tide and other places where the lunar tide is five or six or even, as on the New Zealand coast, ten times as big as the solar. The most reasonable explanation of such effects that has been advanced is that they are due to the selective resonance of some adjoining body of water. If, for example, the solar semi-diurnal tide is very much greater than we should expect, in comparison with the semi-diurnal tide due to the moon, the probable reason is that there is an adjacent basin of water that has a natural period of oscillation of just about twelve solar hours, which harmonizes with the period of the sun's tide-producing forces. The repeated application of the tide-producing forces tends therefore to increase and emphasize the wave due to those forces that have this particular period. Harris accordingly made the attempt to divide the oceans of the earth into areas which he calculated, from his knowledge of their shapes and the recorded depths, would oscillate in synchronism with one of the components of the tide-producing forces, and then he made a map of the co-tidal lines of the world, based of course as previous ones on actual observations of the tides round the shores, but with an entirely different view point in the mind of the author, Harris' map, so far as it affects the oceans around Australia, is reproduced in Figure 2, and it will be seen that the co-tidal lines, especially those to the south of Australia, are altogether different in form to those in the map of Dr. See, who had at the back of his mind the idea of the progressive wave. In Figure 1 the co-tidal lines to the south of Australia run prettly well north-east and south-west; in Figure 2 they run roughly east and west. According to Figure 1 the time of high water along the southern coast of Australia increases progressively as we go from east to west and it takes just over four hours for the tidal wave to move along the entire southern coast from Cape Howe to Cape Leeuwin, over about 35 degrees of longitude. On the other hand according to Figure 2 the tidal wave approaches the south coast of Australia from the south and it is high water at the west end of it at the same time as at the east end of it. It surely ought to be possible, one would think, to say definitely which of these two views is correct. The south coast of Australia appears, according to this, to be in the position

of being able to give decisive evidence for one side or the other. It is not however quite so simple as it may seem to form a definite opinion because, at most of our ports where observations are systematically recorded, the tidal wave has taken a considerable time to

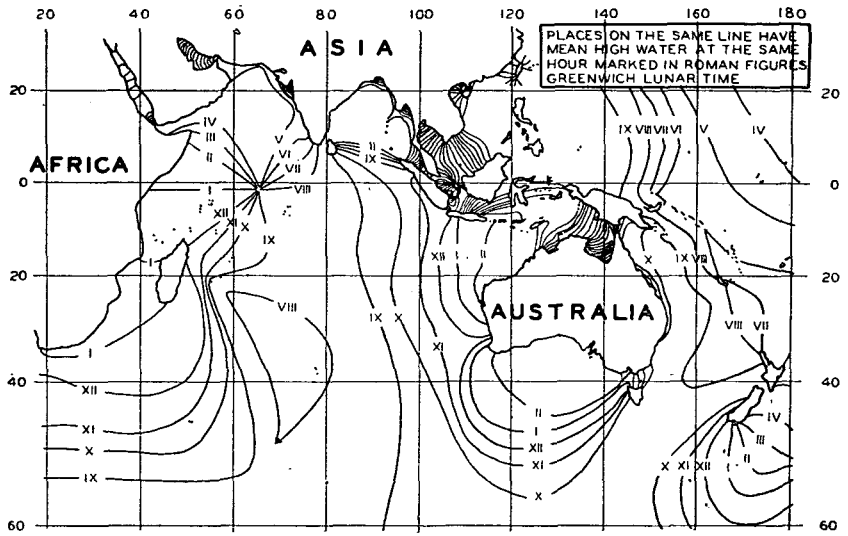

FIG. 2.—CO-TIDAL LINES.

From maps by R. A. Harris, 1904.

reach there from the open ocean. The tide, for example, takes over six hours to travel up the comparatively shallow water of Spencer Gulf, in South Australia, from the entrance up to Port Augusta at the top. It takes over three hours to traverse the shoals and channels of Port Phillip Bay from the Heads to Williamstown. Obviously we must consider only ports close to the open ocean to reach which the tidal wave has not been forced to move over long stretches of shallow water. The pamphlet on " South Australian Tide Tables for 1938 " issued by the South Australian Harbours Board gives the times of high water on full and change days at a number of ports along the coast. Taking the most easterly and the most westerly of these, Port Macdonnell, close to Cape Northumberland, and Port Eyre, near the head of the Bight, the time of high water is given as practically the same at both places, Port Macdonnell being two minutes later than Port Eyre. These ports are separated by about 8 degrees of longitude, so that according to the co-tidal lines of Figure 1 we should expect Port Eyre to be about one hour later than Port Macdonnell. Again the Tide Tables issued by the Victorian Ports and Harbours Authorities give a list of tidal differences with reference to Williamstown as a standard port for various ports both in Victoria and other States, and they give the time of high water at Springs at Port Macdonnell as about 27 minutes earlier than at Warrnambool which has over 2 degrees of longitude to the east of it. The time given at Port Campbell, which lies still further to the east, is within two minutes of that at Port Macdonnell. The Admiralty Tide Tables give a list of tidal differences for many ports along the Australian coast and they show the tide at Eucla Roads to be two and a half hours earlier than that at Port Eyre which has $3\frac{1}{2}$ degrees of longitude to the east, and, on the far-western side of the southern coast, the tide at West Cape Howe is from two to three hours earlier than at any one of six ports between that and Eucla from which records have been obtained. In the *Manual of Tides* by Rollin A. Harris, published by the United States Coast and Geodetic Survey, a table is compiled giving the co-tidal hour for high water at spring tides, that is the number of lunar hours between the time of

high water at the place and the last transit of the moon at Greenwich, for a large number of ports on all continents. The following list is taken from the table, for places on the southern coast of Australia, in order running from east to west :—

Station.	Co-tidal hour.	Station.	Co-tidal hour.
Port Fairy	3.02	Denial Bay	3.90
Portland Bay	3.05	Port Eyre	3.17
Port Macdonnell	2.65	Eucla Roads	2.11
Rivoli Bay	3.18	Esperance Bay	4.03
Kingston	2.78	King George Sound ..	2.81
Victor Harbour	3.86	West Cape Howe	0.85
Streaky Bay	3.13		

Instead of showing a progressive increase from east to west the table shows only such variations as might be expected from differing local conditions. According to the co-tidal map of Figure 1 there should be a gradual increase in the co-tidal hours in this list of about three hours from top to bottom, but nothing of the kind is shown. The evidence seems to be definitely against the theory of the tidal wave moving from east to west along the Southern Ocean to the south of Australia. On the other hand it shows that the front of the tidal wave approaching the southern coast must be in a general way approximately parallel to the shore.

The two co-tidal maps show that the northern coast of Australia is affected by tidal waves which approach it both from the Indian Ocean at the western end and from the Pacific on the east. These two tides mingle in the waters to the north of Arnhem Land. In Van Diemen Gulf at rising tide a stream setting westward enters the Gulf from the north through Dundas Strait where it meets a stream setting eastward which enters through Clarence Strait. Yet along the north shore of Arnhem Land the flood stream is in the main towards the east.

4. **Tidal Ranges round Australia.**—The range of tide along the northern coast of Australia is much greater than along the southern coast. From Torres Strait round to the western end of the coast of Arnhem Land the spring range is about 10 feet, falling a little to 8½ feet at Port Essington, but increasing as we go westward until at St. Asaph Bay on Melville Island the range is 14 feet. At Port Darwin the mean spring range is increased to 24 feet but it is sometimes as much as 30 feet. Further along, at Wyndham, at the apex of the Cambridge Gulf, it is 23 feet, and further along still, at Collier Bay and Kings Sound, where we have by far the biggest tides in Australia, the spring range is as much as 36 feet in Collier Bay with a mean spring range of 34 feet at Derby. Going further west the spring range gradually diminishes until we get to North West Cape. It is 28 feet at Broome, 19 ft. 3 in. at Port Hedland where a self-registering tide gauge has been established, 18 feet at Cossack and 13 ft. 6 in. at Fortescue. To the south of the North-west Cape the spring range of tide becomes very much less. It is only 6 feet at Maud Landing, just to the south of it, 5 feet at Carnarvon, and at Geraldton it is only 2 ft. 6 in. From here on, to the south as far as the Leeuwin and along the western end of the south coast as far as Eucla, the range is only 2 ft. 6 in. or less and we have along this corner of the Australian coast the smallest tides in all Australia. Going further to the east along the south coast the range increases. It is 5 ft. 6 in. at Port Eyre, 6 feet at Streaky Bay, Coffin Bay, Port Lincoln and at Cape Willoughby, on the eastern end of Kangaroo Island. The range, of course, increases beyond this as the tidal wave moves up the gradually narrowing Spencer and St. Vincent Gulfs. Further along on the ocean coast it is 5 feet, at Port Macdonnell, but diminishes to 3 feet at Portland and Warrnambool, and then increases again, being 5 feet at Apollo Bay and 5 ft. 3 in. at Port Phillip Heads. It is 8 feet at the entrance to Corner Inlet, but only 3 feet at Lakes Entrance and at the mouth of Snowy River. At Gabo Island the mean spring range is 6 feet and it stands at round about 6 feet all the way up the east coast as far as Wide Bay, at the southern end of Great Sandy Island off the Queensland coast. It is 5 feet at Jervis Bay, 6 feet at Sydney Heads, diminishing to 5.1 feet at Fort Denison, within the Harbour, 5.5 feet at the entrances to the Clarence and Richmond Rivers, and 6.6 feet at the Brisbane bar. From

here on, going north, the range increases. It is 11 feet at the entrance to the Mary River, 12 ft. 6 in. at Sea Hill, Keppel Bay, and at Broad Sound, where the rise at springs at different points in the Sound may be from 24 to 30 feet, the range being the greatest on the eastern coast. The *Australia Pilot*, issued by the Admiralty, says "In Broad Sound, the flood streams from northward and southward meet, thus producing the great range of tide here found". Doubtless this is accentuated by the configuration of the bay and by the shallowing water. From there on, going further north, it diminishes again, being 16 ft. 7 in. at the Flat Top Island Anchorage, Mackay, 7 ft. 9 in. at Townsville, 6 ft. 5 in. at Cairns, 6 ft. 3 in. at Cooktown and 10 feet at Cape Grenville, just south of Cape York.

Along the shores of Tasmania the highest tide is along the northern coast where the spring range is about 10 feet at Stanley, Devonport and Port Dalrymple, and at Roden and Hummock Islands in the Furneaux group at the eastern end of the north coast. At Hobart the mean spring range is 4 ft. 6 in. and at Macquarie Harbour, on the west coast, it is about 3 feet.

5. **Variations due to local conditions.**—A certain amount of this variation in the recorded heights of tides may be brought about by the narrowing and shallowing of the channel along which the tidal flood stream progresses. If the tidal wave enters a gulf which gradually contracts in width and decreases in depth the energy of the wave is spread over a continually diminishing area and the height of the wave is increased. There is a very good example of this in the behaviour of the tidal wave as it proceeds up the Spencer and St. Vincent Gulfs in South Australia. As we have already seen the tidal wave reaches Port Macdonnell, near the Victorian border, and Port Eyre, near the head of the Bight, at about the same time. It takes three hours and twenty-six minutes to traverse Investigator Strait and Backstairs Passage, separating Kangaroo Island from the mainland, to reach Rapid Bay, on the eastern side of the entrance to St. Vincent Gulf and a point near Sturt Bay on the other side. At Rapid Bay the mean spring range is about 6 feet. The wave at this stage starts to travel much faster in the deep water in the middle of the Gulf than it does in the comparatively shallow water at the sides, with the result that the wave front becomes more and more curved as it proceeds, being much more advanced at the centre than it is at each side. The consequence is that by the time it reaches the head of the Gulf, having traversed a distance a little short of 100 miles from the entrance, it is practically parallel to the coast line all the way round and high water reaches the Semaphore, which is on the shore of the Gulf alongside Port Adelaide, Black Point on the western side of the Gulf, and Port Wakefield at the head of the Gulf, all at the same time, one hour and twenty minutes after Rapid Bay. Moreover as the wave proceeds up the narrowing Gulf it increases in height, the spring range being 6 feet at Rapid Head, 8 ft. 3 in. at Port Adelaide, and at the head of the Gulf, at Port Wakefield, the range is 11 feet. Similar phenomena take place in Spencer Gulf to an even more marked degree, for it is about double the length and contracts to a narrower width. The tidal wave takes six and a half hours to go from Thistle Island, at the mouth, to Port Augusta at the head, and the spring range increases from 5 feet at Thistle Island to 12 feet at Port Augusta.

At Port Lincoln, on the western side of the entrance to Spencer Gulf, the peculiarity of the tidal behaviour was noted by Flinders. He observed there that "the tides did not exceed 3½ feet and that, as in Princess Royal Harbour, there was only one high water in 24 hours, which took place at night, about eleven hours after the moon's passage over the meridian. Yet at Thorny Passage, which is but a few leagues distant, there were two sets daily. This difference in so short a space appears extraordinary; but it may perhaps be accounted for by the direction of the entrance to the port, which is open to the north-east, from whence the ebb comes (Captain Flinders, Terra. Aus., Vol. 1, p. 150). The explanation here offered is by no means obvious as it stands, but taken in conjunction with another well-marked characteristic of our tides it gives us the solution. All round the Australian coast there is a well-marked "diurnal inequality", as it is termed; that is to say, the forenoon and afternoon tides are not of equal height, but one may be much higher than the other. At Port Lincoln the observable daily tide is simply the higher one of the two daily tides, for owing to the direction of the outlet of the harbour the water cannot escape freely, as the ebbing tide from the Gulf retards its outward flow. The

result is that the level of the water in the large area of the Port Lincoln Harbour falls very slowly, so slowly that the second and lower tide which follows in the course of the day does not appreciably raise the level of the water, and so is not apparent as a tide.

6. **Diurnal Inequality.**—This phenomenon of diurnal inequality, so evident at Port Lincoln, is a marked characteristic of Australian tides generally. Curiously enough, in the waters of the North Atlantic, where the tides were first studied, there are at most ports two approximately equal tides a day and they are at regular time intervals apart, so that when the exploration of distant seas showed in many cases that the two high waters or the two low waters or even both were unequal in height the occurence was at first thought to be something abnormal. Yet the theory as to the cause of the tides shows that diurnal inequality is something that is to be expected whenever the sun or moon is not on the equator, especially at places on the earth in high latitudes, and that the remarkable thing is, not that it occurs around the coasts of Australia and other places, but that it does not occur in the North Atlantic. When, for example, the sun is north of the equator, it tends, at a point in the southern hemisphere, to cause the evening tide to be higher than the morning tide, but when the declination of the sun is south the effect is reversed. This happens at Port Adelaide, South Australia, a place where the sun has a pronounced influence on the tides. At this port there is a definite diurnal inequality which changes sign about the equinoxes. The maximum difference in height of the two daily tides is about 3 feet, with a mean spring range of 8 ft. 2 in., and the inequality changes sign a little before the first equinox and a little after the second. That is to say from about the middle of October until about the middle of February the morning tide is the higher, the sun being then south of the equator, but from then on to the middle of October again the afternoon tide is higher than the morning tide. In this instance the sun is the dominating influence and there are few places where this is the case. At most ports the moon exerts the chief controlling force and the moon's declination changes sign about every fortnight, so that usually the changes in sign of the diurnal inequality are much more frequent. Generally for one-half of every month the sun and moon will combine to give a diurnal inequality of the same kind but their influences in this respect will be in opposition for the other half of the month.

7. **Harmonic Analysis.**—It is evident that the combination of a number of simple waves may result in a wave motion that is anything but simple, and it has been demonstrated mathematically that any wave motion whatever, provided that it is periodic, may be resolved into a number of simple sine waves. This is done in what is known as the Harmonic Analysis of the tides. The tide-producing forces all act over recurring periods which are definitely known. The resultant action can therefore be resolved into a number of simple waves each such as might be produced by a fictitious satellite moving round the earth in a circle on the equator. Each one of these simple waves is referred to as a "component". At most places the two principal ones are the semi-diurnal waves caused by the sun and moon as the earth revolves on its axis. They are generally known in tidal literature as S_2 and M_2, the suffix 2 indicating that they are semi-diurnal and the letters S and M indicating sun and moon. These are simple regular waves such as would be caused if the sun and moon were always at the same distance from the earth and always on the equator. The period of S_2, or the time interval between one high water and the next is twelve hours and that for M_2 is twelve hours 25 minutes. These periods are such that at intervals of about a fortnight they are both acting to produce high water at the same time, when the spring tides are the result, and midway between these times they are acting in opposition, one causing high water at the same time as the other by itself would cause low water, so that the water rises by an amount equal to their difference only and neap tides are observed.

To take account of the moon's declination we must introduce a diurnal wave to give the observed diurnal inequality. The moon's declination, however, is not constant. It varies from a maximum declination north to a maximum declination south or *vice versa* in an average period of 13.66 days. The difference between the tide-producing forces at the two daily high waters, which is the cause of diurnal inequality, is greatest when the moon has its greatest declination and gradually reduces to nothing as the moon moves on to the equator. This effect may be regarded as equivalent to that of two diurnal waves of equal height, having an average period of 24 hours 50 minutes, double

that of M_2, of such lengths that they act together at intervals of 13.66 days and are in opposition at intervals midway between, giving then the equivalent effect of the moon on the equator. Just as the combination of the lunar and solar semi-diurnal tides gives the impression of a single semi-diurnal tide that varies in height from springs to neaps, so the resultant action of these two diurnal waves would be that of a single diurnal tide varying in height from a maximum when the moon has its greatest declination to a minimum when the moon is on the equator. These two diurnal tides, which take account of the varying declination of the moon, are generally denoted by the letters K_1 and O_1, the suffix 1 denoting that the tide is diurnal. The influence of the more slowly changing declination of the sun is similarly equivalent to the combined effect of two equal diurnal waves which are in opposition at the equinoxes and act together at midsummer and midwinter when the sun is furthest from the equator. One of these has the same speed as K_1 so that the two are combined together. Thus it may be considered that the changing declinations of the sun and moon set up three diurnal waves usually denoted by the letters O_1, P_1 and K_1. O_1 is known as the lunar diurnal, P_1 as the solar diurnal, and K_1, common to both sun and moon, is known as the luni-solar diurnal. These three waves will be equivalent in effect to that of the varying declinations only to a first approximation. We should need a long series of such waves, gradually diminishing in amplitude, to make the equivalence exact. But these three will be by far the largest in the series.

Again the variation in the moon's tide-producing force by reason of its continually changing distance may be regarded as the equivalent of another component wave. The moon describes its elliptic path around the earth, with an eccentricity of about one-twentieth, in an average period of 27.55 days. When it is nearest to the earth, in perigee, its wave-producing power is greater than when it is furthest from the earth, in apogee. If now we introduce another semi-diurnal component such that at perigee its high water will synchronize with M_2 and at apogee it will produce low water at the same time as M_2 will cause low water, the effect of the new component on M_2 will be to increase its height at perigee and decrease it at apogee, corresponding to the effect of the varying distance. In other words we may regard the eccentricity of the moon's orbit as setting up this additional tidal wave. The principal component tidal waves are therefore :—

M_2	Principal lunar semi-diurnal.
S_2	Principal solar semi-diurnal.
N_2	Lunar elliptic.
K_2	Luni-solar semi-diurnal.
K_1	Luni-solar diurnal.
O_1	Lunar diurnal.
P_1	Solar diurnal.

To get complete mathematical equivalence we require a very long series of components, but these seven are the most important ones, and the character of the tides at any place is determined by their relative magnitudes and phases.

The period of each one of these component waves is known from the movements of the sun and moon. With this knowledge it becomes possible, by the method of "harmonic analysis", given the records of a self-registering tide gauge over a considerable period, to determine the magnitudes of all the component waves and their relative phases at the beginning of the period. The length of time over which the records must extend for successful analysis may be a month or even a fortnight but more accurate results are obtained if the observations are complete over a full year. Once the magnitudes of the components are found and their phases at any particular time, it is a simple matter to compute their combined effect at any time afterwards. This is the only system of tidal prediction that is of any value for the Australian tides. Before it was introduced by Lord Kelvin, then Sir William Thomson, in 1867, the tides at Australian ports were a hopeless puzzle. Now at the principal ports predictions are issued for a year ahead by using the constants determined by harmonic analysis. Lord Kelvin made the first application to Australian tides by analysing records of the Fremantle tides in 1878 (*Nature*, Oct., 1878). At Port Adelaide the tides are still being predicted with success from constants found from the analysis of two separate year's records made over 40 years ago.

Of recent years our knowledge of Australian tides, particularly along the northern coast, has been greatly extended by investigations made by the Hydrographic Department of the Australian Navy. The following table gives the amplitude in feet, that is half the wave height, of each of the seven principal components at a selected number of places round the coast where analyses have been made. The places are ranged in order, beginning near Cape York and going round Australia anti-clockwise. Authorities are given by references at the end of table.

Place.	Amplitudes of Component Waves in Feet.						
	M_2	S_2	N_2	K_2	K_1	O_1	P_1
Frederick Point[1] .. .. 10° 43′ S, 142° 35′ E	1.8	1.6	0.8	0.4	1.6	0.7	0.5
Tuesday Island[1] .. .. 10° 33′ S, 142° 21′ E	1.6	1.6	0.7	0.4	2.0	0.7	0.7
Thursday Island[1] .. .. 10° 35′ S, 142° 13′ E	1.2	1.1	0.5	0.3	1.9	1.0	0.5
Proudfoot Shoal[1] .. .. 10° 31′ S, 141° 29′ E	2.2	0.5	0.4	0.1	1.7	1.0	0.6
Port Langdon, Groote Eylandt[2] .. 13° 52′ S, 136° 50′ E	0.85	0.41	0.28	0.11	0.50	0.56	0.16
Cape Don, Coburg Peninsula[2] .. 11° 18′ S, 131° 46′ E	1.98	0.85	0.38	0.23	0.82	0.65	0.27
Camp Point, Melville Island[2] .. 11° 36′ S, 131° 25′ E	3.39	1.50	1.12	0.40	1.52	1.00	0.5
Cape Hotham[2] .. .. 12° 03′ S, 131° 17′ E	3.97	1.61	0.84	0.43	1.15	0.75	0.38
Tower Beach, Bynoe Harbour[2] .. 12° 35.2′ S, 130° 34′ E	5.64	2.95	1.06	0.80	2.03	1.02	0.68
Port Darwin[3] .. .. .. 12° 38′ S, 130° 51′ E	6.56	3.44	1.04	1.02	1.91	1.14	0.44
Port Hedland[4] .. .. 20° 22′ S, 118° 36′ E	5.51	3.35	0.87	0.80	0.79	0.50	0.19
Beadon Point[2] .. .. 21° 38′ S, 114° 06.5′ E	1.88	0.98	0.30	0.27	0.62	0.40	0.21
Fremantle[4] .. .. .. 32° 03′ S, 115° 45′ E	0.12	0.11	0.03	0.03	0.42	0.32	0.12
Princess Royal Harbour[5] .. 35° 08′ S, 118° 00′ E	0.16	0.26	0.07	0.07	0.62	0.42	0.17
Adelaide[6] .. .. .. 34° 51′ S, 138° 30′ E	1.70	1.68	0.09	0.46	0.83	0.52	0.22
Williamstown, Victoria[5] .. 37° 52′ S, 144° 54′ E	0.81	0.10	0.09	0.03	0.29	0.22	0.10
Sydney, Fort Denison[5] .. 33° 52′ S, 151° 12′ E	1.62	0.40	0.35	0.12	0.47	0.30	0.13
Newcastle[5] .. .. .. 32° 57′ S, 151° 44′ E	1.60	0.39	0.35	0.13	0.51	0.29	0.15
Ballina, Richmond River[5] .. 28° 52′ S, 153° 33′ E	1.08	0.28	0.20	0.07	0.45	0.31	0.14
Brisbane[5] .. .. .. 27° 20′ S, 153° 10′ E	2.22	0.62	0.42	0.18	0.70	0.39	0.21
Cairns[5] .. .. .. 16° 55′ S, 145° 47′ E	1.96	1.12	0.66	0.30	0.87	0.41	0.29
Cooktown[5] .. .. .. 15° 28′ S, 145° 10′ E	1.87	0.79	0.45	0.21	0.29	0.30	0.10

Authorities.—(1) Report on the Tides, Currents and Tidal Streams in the southern part of Torres Strait, 1931, Hydrographic Department, Admiralty. (2) Supplied by the Hydrographic Department, Australian Navy. (3) R. W. Chapman and Captain Inglis, A.A.A.S. Reports, Vol. 9, p. 67, 1902. (4) H. B. Curlewis, Proc. R.S. of W.A., Vol, 1, p. 28, 1915. (5) Admiralty Tide Tables, Part 2 and also Special Publication No. 98 of the U.S. Coast and Geodetic Survey. (6) R. W. Chapman and Captain Inglis, A.A.A.S. Reports, Vol. 7, 1898.

8. **Explanation of Peculiarities of Tides from Results of Harmonic Analysis.**—A study of the preceding table will give a better understanding of the nature of the tides around the Australian coastline than any general description can possibly do, for it is on the relative magnitudes of the component waves that the idiosyncrasies of the tides depend. Consider for example the two principal semi-diurnal components M_2 and S_2, due respectively to the moon and the sun. As we have seen we might expect from a comparison of the tide-producing forces that M_2 would be more than twice as great as S_2. This is so in a number of cases but the ratio between the two is anything but constant, and there are six instances on the list, Frederick Point, Tuesday and Thursday Islands, in the north, and Fremantle, Princess Royal Harbour and Port Adelaide, in the south, where the two are practically equal. At Princess Royal Harbour, S^2 is even greater than M_2. At spring tides the range, due to the semi-diurnal waves, is 2 ($M_2 + S_2$), and at neaps, if the two are equal or nearly equal, they practically neutralize one another and cause no rise nor fall at all. This is what happens at Port Adelaide where at this period the recording gauge shows frequently little or nothing in the way of tide, in some cases the level of the water remaining almost constant for a whole day; in other cases one small tide occurs during the day. On each side of this the tide is markedly irregular both as regards time and height, and the apparent impossibility of saying when the tide will be at this particular period has presumably gained for it its name as "The Dodger". The further we get away from the neaps the more regular is the tide, until at spring tide it is fairly normal. The reason for this is that at the neaps the semi-diurnal tides are practically eliminated and the rise and fall of the water is then controlled by the diurnal tides which give only one tide a day and are here relatively large, K_1 having an amplitude about half that of M_2 or S_2. At Princess Royal Harbour and at Fremantle similarly the sun has as great an effect as the moon and the semi-diurnal waves balance one another out at the neaps. The range of tide at both places is small and the diurnal tides are relatively large compared to S_2 and M_2. Thus at Fremantle the amplitude of K_1 is 0.42 and O_1 is 0.32 compared with 0.12 for M_2, and at Princess Royal Harbour K_1 is about four times as big as M_2 and O_1 is more than twice as great. The consequence is that over most of the month the diurnal components dominate the situation and there is evident only one observable tide in the 24 hours.

The peculiarity that the sun has a much bigger effect upon the tides in comparison with that of the moon than would be expected from the calculation of the relative tide-producing forces seems to hold good right round the coastline from Adelaide to Fremantle. The explanation given by Rollin A. Harris was that this was due to the fact that the body of water to the south of Australia, lying between it and Antarctica, has a depth such that its natural period of swing, about a line running east and west through the middle of it, is exactly twelve solar hours. A standing wave or continuous oscillation of this ocean is thus set up, keeping time with the sun, producing thus a much greater effect than other periodic forces that meet with no such harmonious response. More recent work has shown that this kind of oscillation of the water is not the way in which the water is likely to swing on a rotating earth, but nevertheless in a general way the explanation probably remains good, that the effect is due to the resonance of the Southern Ocean to these particular periodic forces.

At the time when this dominating influence of the sun was first made known by the analysis of the tides at Port Adelaide nothing corresponding was known elsewhere except at a port in the Gulf of Mexico. But since then the work of the Hydrographic Department of the Admiralty has shown that at the opposite corner of Australia, at Tuesday and Thursday Islands in the south of Torres Strait the same phenomenon occurs. There again the diurnal tides are greater than the semi-diurnals with the result that diurnal inequality is always very marked and there is apparently extraordinary irregularity at and near the period of neaps. Tidal curves for successive days on Tuesday Island illustrate how the sun controls the situation, for high water comes at almost the same hour day after day; at Thursday Island similarly there is nothing approaching the advance in time of 50 minutes a day common in other places. Our Australian sun certainly has a great influence on the land but few would expect this to extend to the surrounding waters.

At Port Hedland, on the north-west coast, we have a very different state of things. The table shows that the amplitude of the lunar semi-diurnal wave is 5.51 and that of the corresponding solar wave is 3.35, more in accordance with the tidal forces, and the amplitude of the largest of the diurnal waves, K_1, is only 0.79. The spring range is here over 19 feet and as the neap range is generally over 4 feet it follows that the diurnal waves, the total range of which when all three are acting in unison is less than 3 feet, can never have the effect of changing the semi-diurnal character of the tide. All that the diurnal waves do is to cause an inequality in the two daily tides that amounts to a maximum of about 2 feet when the moon has its greatest declination. Here undoubtedly it is the moon that is the more potent influence and not the sun. Each day high water occurs about 50 minutes later than it did on the day before as is the normal behaviour where the tide follows the moon, and it is one of the few ports in Australia where the old method of predicting the time of high water, from a knowledge of the interval of time that elapses between high water and the last transit of the moon across the meridian, can be applied with even approximate accuracy. The "establishment" at Port Hedland, that is the interval of time between high water and the moon's transit, ranges between nine and one-quarter and twelve hours, following a very regular curve depending on the time of the moon's transit. No such regular curve applies however at places like Port Adelaide and Thursday Island where there are not the same number of tides in a month as there are transits of the moon.

Further along the northern coast, at Port Darwin, where there is a spring range of 24 feet, it will be seen from the table that the analysis is very similar to that for Port Hedland, the dominant waves are M_2 and S_2, and M_2 is nearly twice as great as S_2 so that again the moon is in control, but in this case the diurnal tides are relatively more important. If we add together K_1, O_1 and P_1 we get 3.49 as the amplitude or, say, 7 feet as the range of the resultant wave when all are acting in unison, which may be greater than the neap range due to the semi-diurnals M_2 and S_2, so that we might expect occasional strange behaviour at this period. There are two tides a day, however, throughout the month but the diurnal inequality is very great, especially in the low waters. The greatest effect occurs in December and January; when the two high waters may differ by 4½ feet and the two low waters by as much as 9 or 10 feet. But sometimes in March and April, when the moon is from 8 to 10 or from 20 to 24 days old, two tides amalgamate to form one long high water. When approaching this stage the two high waters get more and more nearly equal, and the two low waters more unequal, until at last the H.L.W. is equal in height to the two high waters on each side of it. At other times occasionally in September and early October the low high and the high low become of the same height and merge into one.

Speaking generally, as we proceed along the north coast from west to east, the range of the semi-diurnal components gets less and less while the range of the diurnal waves remains more nearly constant. The result is that at the eastern end the tides, as at Tuesday Island, are chiefly diurnal but at the western end of the coast the semi-diurnal components are the controlling forces and there are two tides a day throughout the month.

Along the east coast, at Sydney, Newcastle, Ballina and Brisbane, M_2 is about four times as great as S_2, so that along this part of the coast the moon has a greater effect, relative to the sun, than might have been expected. The diurnal tides are sufficient all the way along the coast to give a pronounced diurnal inequality to the daily tides but they are not big enough, relative to M_2 and S_2, to change the semi-diurnal character of the tides even at neaps, except at Cairns.

9. **Tidal Records.**—The responsibility for the keeping of tidal records lies with the State Governments who have generally vested it in the local Harbours and Marine Board Authorities. Unless a special series of observations is taken for the purpose, as is often done by the Hydrographic Department of the Australian Navy, it is only the records of self-recording tide gauges, which give a continuous trace of the level of the

water, that are of any value for tidal analysis in these waters where the diurnal elements play such a prominent part. Such gauges have so far been set up only at important ports, as will be seen from the following table :—

NUMBER OF SELF-RECORDING TIDE GAUGES.

State.	Number of Gauges.	Places where Fixed.
Queensland	2	Brisbane, Cairns
New South Wales ..	6	Ballina (Richmond River), Clarence River, Newcastle, Sydney (2), Wollongong*
Victoria	2	Williamstown and Point Lonsdale
Tasmania	1	Hobart
South Australia ..	5	Port Adelaide, Port Pirie, Thevenard, Franklin Harbour (Cowell) and Whyalla*
Western Australia ..	4	Albany, Bunbury, Fremantle and Port Hedland
Northern Territory ..	1	Port Darwin

* At Wollongong and Whyalla gauges are established temporarily and will be moved on to other places when a sufficient length of record has been obtained to determine the tidal constants.

10. **Tidal Predictions.**—For ports where the tidal records have been subjected to harmonic analysis the Harbours Boards of Australia find it most convenient and economical to have their predictions made out on one of the tide-predicting machines of England or America. Tidal predictions made out in this way are published in the Admiralty Tide Tables for each year for the ports of Thursday Island, Port Darwin, Port Hedland, Port Adelaide, Port Phillip (Point Lonsdale), Sydney (Fort Denison), Newcastle and Brisbane Bar and the United States Coast and Geodetic Survey in their annual tide tables for the Pacific and Indian Ocean give predictions for Sydney, Melbourne (Williamstown), Port Adelaide and Port Hedland. In addition the Harbours Authorities in Victoria issue an annual pamphlet giving tidal predictions for the year for Williamstown and Port Phillip Heads, South Australia does the same for Port Adelaide, Western Australia for Port Hedland, and Queensland for Brisbane. In each of these cases tidal differences are given to permit of a reasonable estimate of the times of high water at other ports in the State. In Tasmania tide tables are issued by the Mersey and Launceston Marine Boards for their respective ports, but these are not based upon harmonic analysis.

The author wishes to express his obligations to the Hydrographic Department of the Australian Navy, to Mr. Curlewis, Government Astronomer at Perth, and to the various Marine Boards and Harbours Authorities for generous assistance in gathering information.