THE CANAL SYSTEM OF ENGLAND.

H. GORDON THOMPSON

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OF

ENGLAND:

ITS GROWTH AND PRESENT CONDITION,

WITH PARTICULAR REFERENCE TO

THE CHEAP CARRIAGE OF GOODS.

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"Of all the inventions, the alphabet and the printing press alone excepted, those inventions which abridge distance have done most for civilisation."—MACAULAY.

TO

SIR JOHN T. BRUNNER, BART., M.P.,

THIS ACCOUNT

OF THE CANAL SYSTEM OF ENGLAND

IS INSCRIBED

WITH THE WRITER'S SINCERE RESPECT.

PREFACE.

The material from which this little work has been drawn has necessarily been exceedingly various.

I had at one time thought of indicating the many authorities to whose works I am indebted for information, and as far as possible this has been done in the footnotes to the text.

So extensive, however, have been the sources from which my information has been derived, that it will hardly be surprising if some have been left unacknowledged.

May I therefore express my indebtedness to all upon whose experience I have based my argument—or from whom I have obtained facts and figures, either by direct communication or by a consultation of their works·

The object of this account of our Canal System has been, not so much to discuss each individual waterway, but to set forth in order the facts relating to our inland navigations as a whole, and to give some idea of the possibilities which lie before the method of transport.

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THE CANAL SYSTEM OF ENGLAND:

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WITH PARTICULAR REFERENCE TO THE CHEAP CARRIAGE OF GOODS.

THE subject of transport is undoubtedly one of the most important questions of the present day. The dawn of the Twentieth Century finds the great nations of the world still struggling for commercial supremacy, and there can be no doubt that one of the most important factors in this contest, is the possession of adequate means of transport. The nation having the best means of conveying her merchandise, possesses an advantage, difficult to estimate and still more difficult to reduce. **Introduction**

The utility of water as a means of transport has been apparent from a very early age, and the adaptation of the *channels* or canals, used by the ancients for irrigation, to the much wider purpose, namely as a means of transport, marked the birth of artificial inland navigations. **Utility of Water Transport.**

I.—History.

Early Canals.

From the writings of Herodotus, Aristotle, Pliny, and other ancient historians, we learn that canals existed in Egypt before the Christian era, and there is reason to believe that at the same early period, artificial inland navigation had also been introduced into China. Hardly anything, however, save their existence has been recorded of these early works. We know that the Greeks, and afterwards, three of the Roman Emperors, attempted to join the Ionian Sea and the Archipelago by a canal, but failed; and Pliny mentions that Drusus, commanding under Augustus an army which was to march into Germany, had a canal made from the now-known Rhine, to the Issel, for the sole purpose of conveying his army upon it. *

Introduction into Europe.

Canals appear to have been introduced into Europe with the advent of the Christian era, but for many centuries their employment was very gradual.

Introduction into England.

Their first introduction into this country was by the Romans, when Britain, for a period of 400 years, was a province of the Roman Empire. The canals which the Romans constructed were designed for irrigation and water supply rather than for purposes of navigation. Such was one of the most notable of their canals, the "Foss-Dyke," extending from Lincoln to the Trent, a distance of eleven miles, concerning which Cambden states in his

* Priestly. Navigable Rivers.

"Brittania" that it was made by the Romans "probably for water-supply or drainage," adding that in 1121 it was deepened and rendered in some measure navigable by Henry I. Another very notable canal constructed by the Romans during this epoch was the "Caerdike," connecting the River Nyne or Nen with the River Witham. The length of this work—stupendous for the period—was no less than forty miles, extending from the vicinity of Peterborough to three miles below Lincoln.

The progress of our waterways generally, was however, as before stated, very gradual. This was no doubt greatly owing to the need of the CANAL LOCK, the crowning improvement necessary to adapt them for routes having great alterations of level. It has been truly remarked that "To us, living in an age of steam-engines and photography, it might appear strange that an invention so simple in itself as the canal lock, and founded on properties of fluids little recondite, should have escaped the acuteness of Egypt, Greece and Rome." * Progress. The Canal Lock.

The invention had, however, escaped the notice of the ancients, and great doubts exist as to the person, and even the nation, by whom canal locks were first introduced, the discovery being claimed by both the Italians and the Dutch.† It is true that in some of the early canals of Europe, inclined planes, up which a vessel placed upon

* Quarterly Review. No. CXLVI. "Navigable Canals" by Paul Frisi.

† Canal and River Engineering—Stevenson.

a cradle could be hauled, were in use, but this contrivance in its primitive form was very inadequate, and could only be employed to a limited extent.

The lock, as now used, was not invented until the 14th century. By its introduction the construction of canals for inland navigation received a fresh impetus, and it is, in fact, only at this time that the history of modern canals may be said to have commenced.

Improvement of River Navigation.

The recognised need in these early times was that river-navigation should be rendered more efficient, and thus we find that the improvement of the navigation of the Thames was undertaken in 1423, that of the Lea in 1425, the Ouse in 1462, the Severn in 1503, the Stour in 1504, the Humber in 1531, and in 1571, the Welland

First Ship Canal.

In 1572 the first Ship Canal was constructed in England — the " Exeter "—a comparatively short waterway which had received Royal Assent in 1539, and from this date canal schemes were entered upon more extensively.

Canals 17th Century.

During the 17th century many canalisation schemes were undertaken, thus between the years 1623 and 1699, the Rivers Colne, Itchin, Wye, Avon, Medway, Wey, Bure, Witham, Fal and Vale, Aire and Calder, and Trent were all more or less canalised.

18th Century.

In the next century similar projects for river and canal navigation proceeded apace. The following examples will serve to show the nature of the canal extension during this period. Projects were entered upon for improving and canalising the following rivers :—

From 1700—1720, The Avon and Frome,
Dee,
Lark,
Derwent,
Frant,
Stour,
Weir,
Kennett,
Wear,
Weaver,
Mersey and Irwell.

In 1720 the "Leeds and Liverpool," and in 1730 the "Stroudwater" Canals were begun.

But whilst the first half of the 18th century was rich in its completion of schemes for the advancement of inland navigation, its importance in this respect was greatly increased by the construction in Lancashire of the Bridgewater Canal, for which Act of Parliament was obtained in 1759. This work, designed by Francis, Duke of Bridgewater, and Brindley, the engineer, may be said to have inaugurated another era in British Canal Navigation. Bridgewater Canal.

From 1730—1830 upwards of 90 canals were projected, bringing the total length of the Canal-System in England to 4,700 miles, and the total cost to upwards of £14,000,000. Period 1730 to 1830.

It is interesting to note that as early as 1792, the premiums of single shares in canal companies had reached such figures as £155 (Leicester), £350 (Grand Trunk and Coventry), and £1170 (Birmingham); * and in the year 1806 we find the "Times" commenting with admiration on the fact that troops were being transported by canal from London to Liverpool, *en route* for Ireland, in a period extending over "only seven days."

Pioneers of the Canal System.

Looking over the history of the development of the Canal System of England up to this time, the foremost of the pioneers of inland navigation in this country were undoubtedly—Francis, Duke of Bridgewater, and Brindley and Telford the engineers, but there must also be associated with the growth of canals such names as Smeaton, Watt, Nimmo, and Rennie—under whose guidance most of the present barge canals were constructed. † The barge canals laid out by Brindley alone, although not in every case executed by him, were as follows:—

	Miles.
The Duke's Canal—Longford Bridge to Runcorn	24
Worsley to Manchester	10
Grand Trunk—Wilden Ferry to Preston Brook...	88
Wolverhampton	46
Coventry	36
Birmingham	24
Droitwich	5

* Gazette—August, 1792.

† History of Inland Navigation particularly that of the Duke of Bridgewater, London, 1783.

Oxford	82
Chesterfield	46
	*
Total	361

It was by such men that apparently insurmountable difficulties were met, and overcome. By their indomitable perseverance and engineering skill, huge aqueducts were constructed, mountains were tunnelled, and valleys bridged, and there can be no doubt that these pioneers of the Canal System of England did much for the promotion of the true national economy and commercial prosperity of the nation.

Hindrance to trade through lack of transport.

Before the completion of these great schemes the natural increase of commerce in the middle of the 18th century was greatly hindered by the heavy expense and the lack of adequate means of conveying produce to the ports. Thus, about the year 1750, the cost of goods by road between Manchester and Liverpool was 40/- per ton, but by the Mersey and Irwell the water rate was only 12/- per ton, and after the opening of the Bridgewater Canal the cost was reduced to 6/- per ton, and a better service was given than that provided by either of the forementioned routes. Again, the cost of carriage of coal by packhorse from Worsley to Manchester, which had been from 6/- to 8/- per ton, was reduced to 2/6 per ton on the same canal.†

Freightage 1750 Manchester & Liverpool.

* Smiles—"Lives of the Engineers.' † Jeans—Waterways, p. 41.

Freightage 1760, Manchester and Nottingham.

The charges for transit from Manchester to Nottingham were over £6 per ton, and to Leicester over £8. These rates were reduced to £2 and £2 6s. 8d. respectively after the opening of the Trent and Mersey Canal, which also reduced the cost of transport from Manchester to Hull to less than £2 per ton owing to the back carriage secured from that port, together with the tide service of eighty miles up the Humber and the Trent.

Developed transport reduced rates.

To bring more vividly before the mind the way in which an increase of commerce necessitates a reduction of rates of transit, notice may be taken that in the year 1761 it was estimated that the quantity of traffic carried between Liverpool and Manchester, was about 40 tons per week, or 2000 tons per year, and the rate of carriage was 1/- per ton mile. For 1890—three years before the Manchester Ship Canal was opened—it was estimated that the traffic was not less than 10,000,000 tons, and the cost of transit from 3/- to 8/- per ton for the whole distance. *

Developed transport increased Exports.

Similarly our Export Trade was of a most restricted nature before the development of inland navigation, but with its progress the facilities for transit were greatly improved, and the exports of Great Britain soon increased to much greater proportions. This was noticed in one of the finest orations of Edmund Burke who thus describes the growth of our exports to the Colonies, which had then reached the value of £6,000,000 :—

* Jeans—Waterways, p. 42.

"When we speak of the [increase of] commerce with our Colonies, fiction lags after truth, invention is unfruitful, and imagination cold and barren."*

Developed Transport Increased Exports.

It is true that Canals did not complete this revolution, but they were important factors in its accomplishment, seeing that from the year 1760, when the canal system effectually began, to the year 1838, when this canal period closed with the advent of railways, the export trade of the country advanced in value from £14,000,000 to £50,000,000 per annum.

II.—Effect of Railway Introduction.

Introduction of Railways.

Apparently, our canal system had never before presented so brilliant a prospect, but a blow seems to have been struck at its development and progress by the invention and perfection of the steam-engine, and the corresponding introduction of railways.

Opposition to Railways.

The projectors of this new method of transit met with very strong opposition from two very powerful classes of the community,—land-owners, and canal-owners.

Popularity of Railways.

From September 30th, 1830, the day on which the first railway was opened between Manchester and Liverpool, this new method of transport proceeded almost without interruption. It gave to the country the equivalent of swiftly navigable rivers, and as its ramifications extended, land-owners found their property increasing instead of

* Present State of the Nation. Bohn's Series.

decreasing in value, while the years 1840-1846 saw the people of this country possessed by what has been aptly termed "the railway mania."

Compulsory Railway-purchase of Canals.

It is a significant fact that although in 1846 such Canals as the Trent and Mersey and the Oxford were paying dividends of 20%--30%, yet many of the Canal owners of this country, expecting that their invested capital would be rendered valueless actually attempted to coerce the Railway Companies into purchasing their Canals. The Railway Companies, realising that in buying up the canals, they were stifling future competition, were not slow to take advantage of the situation, with the result that during the years 1845-48 they were permitted, if not encouraged, to purchase nearly 1,000 miles of waterways, a total subsequently increased to 1264 miles.

Cessation of Construction

The natural consequence of this change of ownership was the complete cessation of barge canal construction, and by these means the Railway Companies almost succeeded, as Mr. Conder forcibly expressed it before the Select Committee of 1883, "in strangling the whole of the inland water traffic." *

The great difficulty in bringing home the deadly effect of this change of ownership, is due to the fact that no reliable statistics upon the subject are available—yet statistics are not necessary for the most casual observer cannot fail to note the decayed condition not only of the

* Appendix 11. Page 238.

traffic but of the antiquated locks and general structure of our inland navigations.

Parliamentary Report on Canals, 1872.

It was not until the year 1872, that the subject of Inland Navigation was again brought forward and thoroughly investigated. A joint committee of the two Houses of Parliament was appointed in that year to report upon the condition of the Canal System, and their report, which was afterwards adopted by Parliament itself, recognised that the chief difficulty in the way of improvement was the fact that the railways had bought up many of the connecting links of through routes.

III.—Manchester Ship Canal.

Manchester Ship Canal, first proposal 1877.

In the year 1877, Mr. Hamilton Fulton brought before the Manchester Chamber of Commerce a proposal to construct a large tidal ship-canal, connecting Manchester with the sea. The plan, however, was rejected, because a canal on such principles would have necessitated the docks at Manchester being at such a depth, that only the tops of a ship's masts would be level with the ground.

Manchester Ship Canal Company floated 1885

In 1881 the subject was again brought forward, when owing to the exertions of the late Mr. David Adamson, it at last assumed more practical form, and in 1885 with a capital of £10,000,000, and with Mr. Adamson as Chairman, the Manchester Ship Canal Company was established.

The contract was undertaken by Mr. Thos. A. Walker, a man of great experience, and the work was to have been completed early in 1892, at an estimated cost of £6,000,000. However, owing to the death in 1889 of Mr. Walker, and other causes, the total cost increased to £15,000,000, and the waterway was not finished until December, 1893.

Dimensions M. S. Canal.

The dimensions of the canal are remarkable :—It is 35½ miles in length, has nowhere a depth of less than 26 ft., is 170 ft. wide at surface, and 120 ft. wide at the bottom, as compared with the 72 ft. base of the Suez Canal.

Attitude of Ship-owners to M. S. Canal

The attitude of ship-owners towards the canal was shown by a statement issued by 182 of their number, possessing more than 1000 steamers, and representing an aggregate net tonnage of about one million tons, more than one-fourth of the steamship tonnage of the United Kingdom.* They said :—

(1) The Canal will be navigable without difficulty by merchant steamers of the largest class.

(2) That if the charges of the Ship Canal are not higher than those of other ports, ship-owners will at once make use of the waterway.

(3) That the additional 35½ miles to Manchester will not cause the rates to exceed those to Liverpool by a steamer, for a long voyage.

That this Canal had a future before it had been gauged by the late Sir William Fairbairn, who remarked—" Any improvement which will enable ocean-going vessels

* The Manchester Ship Canal and its Commercial Attributes, p. 6.

to discharge their cargoes in a commodious wet-dock at Manchester, would form an epoch of such magnitude in the history of Manchester as would quadruple her population, and render her the first as well as the most enterprising city in Europe."

IV.—Present Condition.

The present condition of our inland transport is a subject which calls for the close attention of all who are in any way interested in the commercial prosperity of the country at large. The enormous increase in our imports and exports demands a corresponding increase in the facilities for inland transport. **Present Condition of English Canals.**

Mr. Wells in his paper on Canals—read before the Federated Institution of Mining Engineers sitting in Conference in 1895 said :—

"The tonnage of shipping entering our ports is threefold what it was forty years ago, and during that time the population has nearly doubled in number; therefore to supply our wants, six times as much transport is needed as in 1850. These figures help us in some degree to realize the enormous additions made year by year to the movement of traffic throughout the land. This conveyance has become a necessity for our food supply and our trade generally, and as the country increases in population and wealth, its transport also must continue to grow." **Need of increased transport.**

Mr. W. H. Hunter, of the Manchester Ship Canal, at the Conference of Mining Engineers (referred to above) said that he considered that the revival of interest in the subject of inland navigation, was one of the most hopeful of the economic developments of the present day, as it was indeed one of the most important. Without a really effective canal system it was impossible to provide cheap carriage for either minerals or manufactured goods from the industrial districts of the country lying at any distance from the sea-board, and without cheap carriage, minerals must remain in their native strata, and manufactures must languish and ultimately perish.

Railway Interest. The present condition of the inland navigation of Great Britain is, however, deplorable. The introduction of the railway system produced a moribund condition of affairs on canals from which they have not yet recovered, and in addition to 415 miles which are derelict, abandoned, or converted into railways—no less than 1264 miles, or *one-third* of the total mileage, is under railway administration.

The position of these railway-owned Canals is frequently a source of difficulty to the trader, for in many cases they form links on through-routes and often have such high rates of toll that the traffic on the through-route is blocked by their charges. But the question of the position of railway-owned Canals is of such importance that a special portion of this work is devoted to its fuller consideration.

V.—Classification of English Canals.

The Canals of England have been most conveniently classified by Mr. Wells in six groups, five of which are connected with the estuaries of the Mersey, Thames, Humber, Wash and Severn, while the sixth centres around Birmingham.

The chief Canals of the Mersey group are :— I. Mersey Group.

Manchester Ship Canal	... ...	35 miles.
Bridgewater...	... ...	42 ,,
Leeds and Liverpool ...	... ...	143 ,,
Shropshire Union	.. ..	200 ,,
Trent and Mersey	... ...	130 ,,
Weaver Navigation	... ...	21 ,,

The Manchester Ship Canal as its name implies is mainly for sea-going ships, and therefore hardly comes within the scope of this paper.

The Bridgewater Canal is now owned by the Manchester Ship Canal Co , and is one of the most prosperous of the independent barge Canals.

The Leeds and Liverpool is one of the longest of our Inland Waterways, its sectional area, however, only averages 185 square feet, and the Canal is thus only able to accommodate barges of less than 6 feet draught. It does business as a Carrier and is an independent Canal.

The Shropshire Union and the *Trent and Mersey* are both owned by Railways, and form the only connection with Birmingham and the South. The Shropshire Union Co. acts as a Carrier.

The Weaver has a sectional area of 780 square feet, and a depth of 11 to 12 feet. It is one of the most up-to-date of English Canals. The result of the energetic measures taken by the Weaver Trust to keep their navigation up to modern requirements has resulted in an increase in revenue, the total receipts in 1900 being £45,500, or £625 over the previous year. Not only has the general structure been improved but a working arrangement has been entered into with the Manchester Ship Canal Co., by which all Weaver barge traffic has the free use of the Ship Canal between Weston Marsh Lock, or Weston Point and Eastham, so long as the access is less than the statutory depth called for in the Ship Canal Act of 1885.

II. Thames Group.

The chief Canals of the Thames group are:—

Grand Junction Canal...	189 miles.
Lee Navigation	41 ,,
London and Hampshire Canal	37 ,,
N'th Metropolitan Canal (late Regent's)	10½ ,,
Thames Navigation	120 ,,

The Grand Junction is now the longest independent Canal under one management. This Company recently purchased the Grand Union and the Leicester and Northamptonshire Union Canals, thus increasing its length by 43 miles.

The Lee Navigation connects Hertford with the Thames, and is used for barge traffic.

The London and Hampshire is one of the few Canals which act as Carriers—in fact its revenue is almost entirely derived from Carrying Freights.

The North Metropolitan (late Regent's) is only a short Canal of 10½ miles length, and runs from East to West of London.

The Thames Navigation has a connection with the Severn by two routes but part of each route is owned by the Gt. Western Railway Co.

The Humber group is composed entirely of barge Canals. The chief being :— III. Humber Group.

Aire and Calder Canal	... ...	93 miles.
Don Navigation	... ...	60 ,,
Ouse ,,	... ...	60 ,,
Trent ,,	... ...	68 ,,

The Aire and Calder is one of the most successful of our barge Canals, both as a Carrier and a Toll-taker. Excluding the Manchester Ship Canal—the revenue per mile of the Aire and Calder Navigation, from freights as

Carriers and from tolls, averages double that of any other English waterway; and it is this Navigation which has the lowest freight rates in the kingdom. Surely no further demonstration is necessary that where a Canal is kept up to modern requirements not only does its traffic increase but a diminution in freight rate results.

The Don Navigation forms the only connection by water between Sheffield and the Humber. It only accommodates barges under 6 feet draught and is owned by a Railway Company.

The Ouse Navigation is an independent waterway, connecting York with Goole and the Humber.

The Trent Navigation is an independent Canal which derives 90% of its Revenue from Carrying Freights and only 10% from Tolls. It forms with the Loughborough and Leicester Navigations and the Grand Junction Canal a through-route from the Humber to the Thames.

IV. Wash Group.

The group connected with the Wash are all river navigations. The most important being

The Ouse and its Tributaries ... ... 150 miles.

This Navigation has no less than nine toll taking bodies, having power to exact tolls on different parts of its length.

V. Severn Group.

The Severn Group contains among others :—

Gloucester and Berkeley Ship Canal 16½ miles.

Avon Navigation	... ...	11 miles.
Severn ,,	... ...	94 ,,
Stroudwater Canal	... ...	8 ,,

The Gloucester and Berkeley is a Ship Canal and will not be further described.

The Avon Navigation is owned by the Gt. Western Railway Co., and forms part of one of the two routes from the Severn to the Thames.

The Severn Navigation is an independent Canal, but 40 miles of waterway above Stourport have become derelict, and thus only about 54 miles remain in use.

The Stroudwater Navigation forms part of the second through route from the Severn to the Thames. It is an independent Canal and is connected with the Thames Navigation by the Thames and Severn Canal, which is in the hands of the Gt. Western Railway Co.

VI. Birmingham Group.

Around Birmingham the canals are all narrow, and to a great extent owned by railway companies, but there is one independent through route to the Severn.

Connection of Birmingham with the Sea.

The connection of Birmingham with the Sea by a new waterway has attracted much attention. In 1882 a special committee to consider this subject was appointed by the House of Commons, and a lengthy report was issued by the commission.

The Birmingham Town Council also in 1888 appointed a Committee to examine the different Canal routes between Birmingham and the Sea.

Several schemes were brought before the Committee —and the four routes discussed were those *via* the

Severn,
Thames,
Mersey,
Humber,

After carefully considering the whole matter, the Committee reported that in their opinion, it was in the highest degree important that canal communication with the larger ports of the country should be greatly improved so as to provide carriage at much lower rates.

Birmingham and the sea (continued).

The Committee believed, however, that the ports of London and Liverpool were of far greater importance to Birmingham traders than the Severn ports, because of the constant and efficient service of steamers regularly leaving those ports. They found that Birmingham and the neighbourhood despatched 40% of its exports and received 19% of its imports *via* London, and despatched 43% of its exports and received 24% of its imports *via* Liverpool. The Committee therefore inclined towards the Liverpool route.

Although so narrow, the Birmingham Canal Navigations are among the most extensive in the whole country, and carry altogether nearly eight millions of tons of traffic. But there are also points of Engineering interest; several of the waterways are led through long tunnels—the Netherton Tunnel, 9,081 feet, the Dudley, 9,516 feet, and the Lappal Tunnel, 11,385 feet in length, in many places cut through the solid rock. The great reservoirs which feed the system are the largest in England, they are six in number and the largest has a capacity of 105,000,00 cubic feet.

VI.—Structural Conditions.

The present structural conditions of the English Barge Canal System are deplorable. The few exceptions mentioned above, such as the Weaver, and the Aire and Calder, still continue to prove the wisdom of their management.

On no important through route, as far as the writer has been able to ascertain, is it possible for anything but small barges to travel the entire length, whilst many have become so shallow for want of dredging that they form an impassible block to all through traffic; such for example is the case on the Kennet and Avon, a long canal on the most direct Thames-to-Severn through-route.

It might be expected that, at the least, those Canals helping to form important through routes would have been kept in good working order and repair—but such is not the case.

The Ouse and its tributaries were investigated in 1890 by the Board of Trade, and it was then reported that on this navigation from St. Neots to Louth, the timber-work had become rotten and decayed, the masonry was falling to pieces, whilst the locks were almost useless; yet on this navigation there are *nine toll-taking bodies*, all having a voice in its administration.

Canal Transport.

The Birmingham Canals, according to the Board of Trade returns for 1888, conveyed by far the greatest tonnage of all the inland navigations of Great Britain, amounting to 7,713,000 tons in that year, and yet nothing has been done to bring them up to modern requirements. There are still the small locks, shallow water and horse haulage as in former days, and all attempts to open up an improved waterway to the seaports have proved abortive.

The difference in the dimensions of the English canals is perhaps their greatest disadvantage. Two examples will suffice.

Dimensions.

(1) The sectional area of the Trent and Mersey Canal averages 136 square feet, while that of the Aire and Calder is 475 square feet, and the Weaver Canal 780 square feet. The smaller canal locks have an average width of 7 feet, while that of the Aire and Calder reaches 18 feet.

(2) There are three through routes from the Mersey to the Humber. The shortest runs from the Mersey *via* the Bridgewater, Rochdale, Aston, Huddersfield, Sir John Ramsden's, and the Calder and Hebble, to the Aire and Calder Canal. The control of this through route system

between the Mersey and the Humber, excluding navigation authorities, is in the hands of no less than eight different companies amongst whom there is the keenest competition ; and a consignment of goods has to traverse ten distinct waterways—the gauges of locks on which range through various grades from 50 feet by 14 feet by 4·6 feet on Sir John Ramsden's canal to 212 feet by 22 feet by 9·6 feet on the Aire and Calder.*

Standard Dimensions.

With such instances as these it is clearly essential, that an effort should be made to arrive at some standard minimum sectional area of canal and lock, height of quay, radius of curve, headway of bridge, &c., which shall be adhered to in future operations, whether in the re-construction of old, or in the laying out of new canals.

Mr. Saner, speaking before the Liverpool Engineering Society in 1893, advocated the adoption of an English Canal Standard as follows :—

Bottom width	40 feet.
Surface width...	64 ,,
Depth of water	8 ,,
Sectional area...	416 ,,

Other Standard dimensions were proposed in the evidence before the Select Committee of 1883, but *none have been adopted* and no minimum fixed.

* Progress of Railways and Waterways. Forbes.

French Standard Dimensions.

If examination is made of the dimensions of Continental Canals—a striking difference is observable. France for example has done a great deal to improve and extend her Canal System. In 1877 extensive improvements on the dimensions of the existing waterways were begun, at a cost of more than 30 millions sterling; with the result that main through-routes were widened and deepened, and thus in many cases the capacity of the boats could be more than doubled.

On the Haute Colne Canal, the carrying capacity of the boats has been increased from 115 to 275 tons, whilst the Roubaix Canal will now take boats of 250 instead of 80 tons. Two years after these improvements were begun, standard dimensions for canals of the first class were laid down by law. The locks were to be at least 130 feet long, 17 feet wide, and 6·5 feet deep over the sills.

The result has been that within fifteen years the total length of canals of the first class has been almost trebled, and the traffic on the improved waterways has increased over 100%, thus enabling the charges to be reduced in some cases by as much as 40%.

The growth of traffic has indeed been remarkable.

In 1876 the total traffic was 1953 million ton kilometres.
In 1884 ,, ,, ,, 2451 ,, ,,
In 1893 ,, ,, ,, 3609 ,, ,,
In 1899 ,, ,, ,, 4950 ,, ,,

Germany.

But France has not stood alone in such matters.

Germany also has not been lacking in the improvement and development of her waterways. Between 1880 and 1894 over eleven millions were voted by the Government for inland navigation improvement.

Improved English Canals.

In England there has been no general or Government scheme for Canal improvement, yet the enterprise of a few individual Companies such as the Aire and Calder and Weaver Navigations has shewn, that an up-to-date system will command success. Such success as is seen in the Board of Trade returns for 1890, when these navigations together carried over 10% of the total freight on English Canals, or 3,750,000 tons out of a total of 34,325,000 tons transported on our Canals.

The improvements made in these canals have not only brought about an increase of traffic, but also a diminution in the rates charged for carriage, and it is notable that the cheapest rates in England for coal, are found on the Aire and Calder.

Effect of Dimensions on Freight.

Messrs. Fellows, Morton & Co., the great canal carriers, once stated at a meeting in Nottingham, that with a 6 ft. deep waterway from Nottingham to the Humber, they could carry goods over that route for 4/- per ton, as against the present rate of 8/- to 10/- per ton, according to the classification. Nothing could better illustrate the fact that the cheap carriage of goods on canals depends upon the dimensions of the waterway itself.

VII.—Changes of Level.

Attention must now be given to the different methods of effecting changes of level, with their economic aspect.

There are three chief methods of altering a boat's level on a waterway.

Canal-Lock.

I. The first, and by far the most common, is by means of the lock, which has been in use for so many centuries. This method is so cheap as regards first cost and so easily worked, that for moderate falls of 15 to 18 feet, where water is plentiful, it is undoubtedly the most advantageous.

Disadvantages of the Lock.

But the great disadvantages of the lock system are :—

First—that for large falls the boats in the lock are apt to be damaged by the rush of water, or by striking against the walls or gates.

Second—that in deep locks the loss of water is excessive, especially where the traffic is going chiefly in one direction. *

The latter is a most important factor where water is scarce.

Large-fall Lock.

At the Fourth International Congress on Inland Navigation, a scheme was submitted for a lock of French standard size but having a 66 ft. fall, the total cost of which was estimated at £65,000. The difficulty of the rush of the water was overcome by side chambers at different levels storing most of the water, but the depth used at each operation was over 25 ft., and this would require a very copious supply, where there was much traffic.

* Saner on Canals.

On the Manchester Ship Canal and the Weaver, the culvert-openings are distributed along the side walls, but even then, with only a fall of 16 ft., great care is necessary to prevent damage to small craft during the filling of the lock.

The only way of meeting the difficulty of water supply for the use of the lock, is by pumping. An efficient pump will raise 1,000,000 gallons of water 100 feet for 20/-. Now, assuming for the traffic from South Staffordshire to London, or *vice versa*, that water had to be raised by pumps to an aggregate height of 900 feet (which would doubtless be more than would be required, the water for the supply at the present time not being raised one quarter of that height, the balance being obtained from gravitation-supplies), this would give an expenditure for pumping water for the whole journey to London of about 4d. per ton, and if double locks were used the cost would be 2d. per ton of cargo, or 3d. per ton of cargo, assuming that half of the boats returned empty.*

Pumping for Locks.

The variation in the dimensions of locks on our different canals is a great disadvantage, and it is to be regretted that this variation in size is not tabulated or even mentioned, in the returns in the Blue Book of the Board of Trade.

II. Another method of effecting changes of level is by the use of inclined planes. The most extensive use of

Inclined planes.

* Salt. Canals and their Improvements —Rept. Conf. of Mining Engineers.

planes,* is on the Oberland Canal in Germany, where there are five in succession, with lifts varying from 45 to 80 feet. The boats are only of 60 to 70 tons burthen, with flat bottoms, and are not kept afloat, but rest on a grid for nearly their whole length. This system does not appear to be applicable for larger craft, as the weight of the cargo, especially if in bulk, would set up severe strains upon the sides of the boats when taken out of the water. The cost of these inclines averages £5,140 each.

At the Fourth International Congress referred to previously, a design was brought forward for an incline of about 100 feet to take French Standard boats, and the cost was estimated at £60,000, an expense quite out of proportion to the comparatively small outlay for the lock.

Disadvantages of inclined planes.

Other disadvantages of inclined planes are briefly—

(1) The large amount of space necessary.

(2) The great wear and tear of the chains and ropes.

(3) The damage done to the boats by striking the sides of the trough.

Advantages

The one important advantage is doubtless the great saving of water.

Hydraulic Lifts

III. Vertical Hydraulic Lifts are also in use. The first of these was built in 1875 at Anderton, between the River Weaver and the Trent and Mersey Canal, under the direction of Mr. (now Sir) E. Leader Williams. The boats remain afloat in a water-tight trough, and are raised 50 feet with a loss of only 6 inches of water, one trough ascending as the other descends.

* Saner-Canals.

The great objection to such lifts is their first outlay and the cost of maintenance; the Anderton lift with troughs 75 feet by 14·5 feet cost £5,000, and the maintenance averages £500 per annum. The great advantage of this method, however, is the great saving of time and water, and as this latter is a matter of the most vital importance in a district where the water supply is poor, this method is one which bids fair to be adopted, in order to effect the changes of level in future canal construction.

Disadvantages of Lifts.

Advantages.

The question of the economy of the different systems for effecting changes of level points to the lock system as the cheapest. Assuming that 30 hydraulic lifts could be made to take the place of the proposed locks on the route from South Staffordshire to London, and that they could be worked @ 0·20d. per ton (the figure given by Mr. Saner who had over 10 years experience of the Anderton lift), this would represent 6d. per ton for lifts to London as against 3d. per ton for pumping.* The lift system also requires the attention of several skilled men, entailing extra expense. Whilst it may be said that locks are wasteful of water, and that this waste must be made up by pumping, there is this advantage over a mechanical arrangement, that in times of large rainfall no cost is incurred in supply. Locks are infinitely less likely to be stopped by any defect in the arrangements for their working, than are hydraulic lifts or inclined planes, they are less costly to construct, no skilled labour is required to

Economy of Systems for changes of level.

* Salt, Canals—Rept. Conf. of Mining Engineers, p. 114.

work them, and some authorities declare that they can be worked as expeditiously or more so, than any mechanical appliance.

VIII.—Haulage.

Horse-haulage.

The old method of horse-haulage is still in use on most of the English Canals, and indeed it is the only one which can be used on many of our waterways. The state of dis-repair into which the banks have fallen, the want of dredging and consequent shallowness of the water, the small dimensions of locks and of the canals themselves, all combine to forbid the use of steam, except upon those routes that have not these disadvantages.

Steam-haulage.

The economy of steam haulage, where it is possible, is beyond dispute, but to the actual cost by steamer must also be added an amount for the depreciation and injury done to the banks of the canal. Mr. Clegram, of the Gloucester and Berkeley Canal, found that after allowing 15% for interest and depreciation, the cost of steam haulage amounted to ·091d. per ton per mile, being a saving of over 60% as compared with horse power.

With a heavier trade, however, allowing the barges to be more generally employed, the work was done for ·063d. per ton per mile.*

The average cost of horse-haulage is 0·33d. per ton per mile.

Assuming that 100 tons are to be transported 100 miles—the total cost of haulage would be £13 15 0

* Jeans—Waterways and Water Transport.

Whereas by steam haulage at the rate ruling on the Aire and Calder the cost would be	1	5	0
A difference per trip of	£12	10	0

From this, must be deducted the small amount for the excess of deterioration of property due to the use of steam, and the net saving would allow for a decrease in toll, and a substantial profit.

Mr. Alderman Bailey, of Salford, estimated the cost of working a steamer for twenty-four hours and towing two barges fully loaded on the Leeds and Liverpool Canal; his figures are as follows:—

Cost of Steamer.	£	s.	d.	£	s.	d.
Wages, Captain...	0	4	8			
do. Mate	0	4	8			
Two ordinary hands...	0	8	0			
Gas coke for engines, 24 cwt. at 6/8 per ton	0	8	0			
Tallow, 2 lbs. at 5d....	0	0	10			
Oil, 2 qts. at 10d.	0	1	8			
Stores, waste and lights	0	1	0			
				1	8	10
Cost of two Barges.						
Wages, two Captains at 4/4	0	8	8			
do. two ordinary hands	0	8	0			
5% Interest and 10% Depreciation on 1st cost of Steamer and Barges (£1000) for 1 day	0	8	3			

15% of Steamer and Barges for repairs per day	0 8 3	
		1 13 2
		£3 2 0

The average distance covered (including locks) in twenty-four hours was 40 miles. The weight carried was :—

By the Steamer	35 tons.
By the two Barges, each 40 tons ...	80 ,,
Total	115 ,,

This brings the cost to about 0·165d. per ton per mile.

Aire and Calder train of boats system.

On the Aire and Calder Navigation, a unique system was introduced, many years ago, for the carriage of coal. This consisted in a train of boats or floating tanks, each of 40 tons capacity, and the whole hauled by a steam tug.

The cost was given before the Select Committee on Canals in 1883 as 0·0087d. per ton per mile.

This system has been eminently successful, and a great increase in the coal traffic on the canal has been the result.

Steam *v.* horse-haulage.

It has also been shown that on a movement of 4,000,000 tons of merchandise by cargo-carrying-tugs, the cost was 0·03d. per ton per mile. Horse-haulage on the same route costs 0·14d. per ton per mile, nearly five times as much, and on the smaller section of the Leeds and Liverpool Canal, on which boats are taken from the Aire and Calder, horse-haulage is at 0·33d. per ton per mile, or nearly ten times as much as steam-haulage, and more than twice as much as horse-haulage on the larger canal.

That steam haulage is more economical than horse-haulage cannot be doubted, and Mr. Peake, of Walsall, speaking at the Conference on Inland Navigation of 1895, said that he had been sending coal by canal since about 1860 between Cannock Chase and Birmingham, a distance of about 20 miles. The canal over which the coal was borne, owned by the London and North-Western Railway Company, had not been improved for fifty years. There were the same small locks, necessitating the use of narrow barges, the same series of locks, and the same heavy expenditure. He (Mr. Peake) had tried to work a steam tug on the Birmingham Canal from Walsall Wood to Wolverhampton, a length of 16 miles. The haulage cost 8d. per ton with horses, but the steam tug was worked for some twelve to eighteen months at a cost of about 4d. per ton. He believed that although public opinion was not yet ripe for steam haulage, a steam tug could be built for £250, which would draw five barges each containing 150 tons of coal, at a speed, regulated in a narrow canal by the wash of the boats, of 2½ to 2¾ miles per hour.

Other methods of haulage besides horse and steam are Chain and wire-rope haulage.

in use. The chain and wire rope systems used on the Continent have met with little success on English Canals, no doubt owing to peculiar local circumstances. The wire rope was tried on the Bridgewater Canal, but could not be properly adapted on account of the large number of bends and turns, and the difficulty of working the traffic in opposite directions.

Oil & gas engines

Another system of haulage makes use of motors in the shape of oil or compressed gas engines—the advantage over steam being that less room is required for machinery, and thus more is available for goods.

Electric haulage. Recent experiments.

Messrs. Siemens and Halske, of Berlin, have recently been making some experiments on behalf of the Prussian Government on the subject of boat traction by means of electric locomotives. The scene of operations, says "Engineering," was a short length of the Finow Canal, which forms a portion of the waterway between Berlin and Stettin, and is traversed every year by about 25,000 to 26,000 boats each way. The craft used are in the main tow barges, about 132 ft. long by 15 ft. 6 in. beam, carrying about 150 to 175 tons. There are also a few steam barges employed which carry about 150 tons and can tow a second barge. The traffic to Berlin is much heavier than towards Stettin, and as a consequence three-quarters of the barges return light from the metropolis. Traction is generally effected by horses, there being a tow-path on each bank, but on the down journey man traction is not infrequently relied on. In any case the speed is slow, and, including stops, does not average more than about $1\frac{1}{4}$ miles per hour.

The section of canal chosen for the experiments above referred to, was selected owing to the physical difficulties presented by several reverse curves, in one case of but 328 ft. radius the waterway at this point being spanned by a railway bridge. Electric Haulage (Continued).

The line laid down for the towing engine was 1 metre (3·28 ft.) gauge. The rails, which were of the flange type, were laid partly on sleepers, ballasted with gravel, and in part on blocks of concrete, weighing 220 lbs. each in the case of the heavier principal rail, and half this for the other rail. This arrangement cost £50 to £80 more per mile than the arrangement with sleepers, but proved less expensive to maintain. A steel rack, bolted to the web of this principal rail, provided the resistance necessary for haulage, the weight of the locomotive used being insufficient to give this by adhesion.

Though no wharf actually existed on the length of canal used for experiment, the arrangements necessary, had such wharf existed, were fully tested. At one point the line was raised to a height of 9 ft. 6 in. above the level of the tow-path, being carried on posts and brackets; this elevated portion being connected with the level line on each side of it by gradients of 1 in $8\frac{1}{2}$. The carrying posts were 12 in. in diameter, and were spaced at 18 ft. 8 in. centres. A cap piece 8 in. by 10 in. in section spanned the gap between consecutive posts. The principal rail was laid directly on this cap piece, whilst the other was carried by a stringer, supported at each post on brackets.

The conductor for the current was supported on pine posts, 23 ft. long, spaced at 35 to 44 yards apart. It consisted of 8-millimetre wire, carried by porcelain insulators. The potential used was 500 volts and the principal rail served as conductor for the return current. The source of power was a 15-horse-power portable engine, driving a 9-kilowatt dynamo, and a large storage battery was also provided. The extreme dimensions of the towing locomotive were 6 ft. 10 in. in length by 4 ft. 10 in. wide. It was mounted on four wheels, spaced at 3 ft. 6 in. centres. The total weight of the locomotive was two tons; but the motor was so placed that only one-fifth of this total came on the accessory rail. The latter, however, had to take the vertical component of the tension of the tow-rope. The motor provided was much more powerful than necessary for the work in hand, as it was capable of working up to 14 to 15 horse-power.

Since, however, these experiments were merely preliminary ones intended to test the possibilities of electric traction for large barges, this excess power was supplied intentionally, and the requisite resistance to call forth the full powers of the motor was in some of the experiments provided by rafts.

The report drawn up as the result of these experiments showed the system to be "capable of meeting all needs, and of working, with safety and economy."

Somewhat similar experiments are being made on the Lee Navigation, a canal about 41 miles in length, running from Hertford through Tottenham, Enfield, and numerous other districts to the Thames.

Mr. Chas. Tween, the Engineer of the Lee Conservancy, is actively interesting himself in the matter, and has kindly supplied the author with particulars. The experiments are to be conducted on M. Leond Gèrard's system—an electric motor running along a track on the towing path—and supplied with current from overhead wires, on the trolley system. One man is required to drive the motor, and the barge which is merely connected by a tow-rope with the motor would have the usual two hands aboard. The estimated cost of haulage ranges from 9·5d. to 12d. per barge mile and the speed would be from 2·5 to 3 miles per hour.

Should it facilitate navigation and cheapen transport to the extent anticipated, this system will doubtless be introduced on most of the canals of this country, as the aggregate saving on the volume of canal traffic would be very large.

Thwaite-Cawley System—Cost.

The Thwaite-Cawley is another form of electric haulage. In this system an aerial railway is provided at an elevation of 9 ft. or 10 ft. above the towing path, supported by cast-iron or wooden posts placed at 30 ft. intervals. Along this elevated track run a number of four-wheeled electric motors, with two of the wheels on the upper and two on the lower surface of the rail, the axles being proportioned so as to regulate the pressure of the wheels upon the track. The tow-rope is attached to a link at the back of each motor.

Two rails are provided forming an "up" and a "down" line, so that when two barges are passing in opposite directions the one connected with the motor on the upper rail steers wide and its tow-rope passing clear over the first, no stoppage is necessary.

No driver is required for the locomotive is controlled entirely from the barge and the power is supplied from one or more generating stations at suitable points on or near the canal.

Further, as canal traffic with electric haulage can be carried on both by night and day, the average speed per day can be greatly increased, while the generating and distributing plant are constantly in use.

Statistics have been prepared showing the cost of haulage (i.) by horses, (ii.) by electric locomotives at the same running speed as with horses, and (iii.) by electric locomotives at a higher speed (four miles per hour).

A length of 30 miles of level canal has been taken with an annual traffic of 100,000 tons per mile. The details of the estimates cannot be given in this paper, but the results in brief, are as follows :—

	Cost per Ton per mile.	Time occupied in Transit.
Haulage with horses at $2\frac{1}{2}$ miles per hour	0·077	15 hours.
Electric Haulage at $2\frac{1}{2}$ miles per hour	0·032	12 ,,
,, ,, 4 ,, ,,	0·041	$7\frac{1}{2}$,,

If the figures given are anything like correct for regular working, then the electric is undoubtedly the haulage of the future. For the present, the adoption of steam haulage is slowly on the increase, especially by those Canal Companies which are most enterprising, and which are consequently carrying the most traffic.

Speed on Canals.

The greatest drawback to Inland Navigation is the slow rate of speed at which goods can be carried. The speed of boats on canals is regulated by several conditions, such as—the sectional area of the canal, radius of curve, changes of level, &c.—and thus even where locks and other obstructions are absent, a greater speed than 4·5 to 5 miles per hour is impossible without great damage being done to the banks. Hence the dimensions of the canal are of the first importance, since they not only fix the size of the boats, but also to a very great extent regulate the speed and economy with which they may be navigated.

Dimensions and Speed.

The number of locks naturally forms a most important factor in determining the speed at which a boat will traverse a given distance. It has been estimated that on the English canal system there is one lock to every 1·37 miles of waterway, and that a delay of at least six minutes is incurred at each change of level.* All these small losses of time reduce the total speed, and it is on the claim of quicker delivery that the chief advantage of the railway over the canal rests, a claim which we propose to consider for a short space.

Between Gloucester and Birmingham the goods despatched by river and canal are delivered as expeditiously as those sent by railway.† Sir James Allport, in his evidence before the Select Committee of 1883, said that the railway engine would do in an hour, what would occupy a day on a canal. This may be quite true without the speed of delivery being greater, for railways as a whole cater in the first place for passengers, and goods are shunted, delayed, and given a secondary place to the passenger traffic.

Canals have no such causes for delay, and thus we find that Mr. F. Morton, representing the firm of Messrs. Fellows, Morton & Co., Railway and Canal Carriers, before the same Committee, declared that in conveying limestone from the Froghall Quarries, and ironstone from North Staffordshire to the Blast Furnaces in South Staffordshire, railway waggons and canal boats averaged about the same time, viz.: from seven to eight days.‡

Of course on such a railway as the Taff Vale, which caters primarily for carriage of mineral goods, and second-

*Report of Select Committee on Canals, 1883.

†Minutes of proceedings of the Inst. of Civil Engineers. Vol. lxxvi. p. 171.

‡ Report of Select Committee on Canals, 1883. Q. 1620—1622.

arily for passengers, the transit of goods is very expeditious, but this case is the exception and not the rule, and the rate of transit on Railways and Canals alike, rests very much with the administration of the owners; and the administration of the canals of England is very largely responsible for the comparatively small amount of traffic on our waterways.

IX.—Administration.

As matters stand at present, no trader can make use of a through canal route in England without negotiating with a number of small companies, every one of which has its own rate of toll, and none of which is disposed to give too much facility to the other companies.

To such an extent does this difficulty prevail that Mr. Morton told the Select Committee of 1883 that so long a time is spent in correspondence and arranging a suitable rate of toll, that very frequently the traffic passes away before a suitable rate can be arranged for it.

Numerous examples might be given to illustrate the way in which different routes are broken up into pieces of greater or lesser size, some owned by independent companies and some controlled by railways. Through Routes.

Mr. Lloyd, speaking before the same Committee, gave the following particulars as to the number of distinct Canal Companies upon the principal through routes :—

I. London to Liverpool (3 Canal Routes).

Via Shropshire Union	9 different Canals & Navigations
Via N. Staffs. and Bridgewater	9 Companies.*
Via Warwick and N. Staffs. ...	10 Companies.

II. London to Bristol (4 Canal Routes).

Via Kennet and Avon	3 Companies.
Via Wilts and Berks	5 Companies.
Via Stroudwater	3 Companies.
Via Warwick...	9 Companies.

III. Birmingham to Bristol (3 Canal Routes).

Via Worcester	3 Companies.
Via Stourbridge	5 Companies.
Via Wolverhampton Locks...	4 Companies.

IV. Hull to Liverpool (3 Canal Routes).

Via Leeds and Liverpool ...	4 Companies.
Via Rochdale...	7 Companies.
Via Huddersfield	9 Companies.

V. London to Hull (2 Canal Routes).

Via Leicester Navigation ...	8 Companies.
Via Coventry...	9 Companies.

Variation of Freights on through routes.

Thus a trader desirous of sending iron-work from London to Liverpool, or *vice versa,* would have to deal

* The Grand Junction Canal Co. in 1894 purchased the Grand Union and the Leicestershire and Northamptonshire Union Canals—thus reducing to seven the number of companies on this route.

with no fewer than six or seven canals, who charge tolls varying from 2d. to 1s. 9d. per ton to Preston Brook, within 20 miles of Liverpool. If, however, the traffic is to be carried 20 miles further, it has to be transhipped into larger craft and carried on the Bridgewater Canal, the owners of which charge 7s. 6d. per ton, or more by 2s. 4d. than the other six companies charged for the whole distance of 220¼ miles over which they had carried the goods.*

Amalgamation.

Railway Companies long since recognised the advantages to be gained by amalgamation. All the large Railway Companies are the products of the amalgamation of smaller ones which have united and thus extended their influence and equalised their rates. But if Railway Companies recognised the advantage of their own amalgamation, they were also not slow to realise that by purchasing canals forming links in through water routes, they were stifling future competition with themselves. Thus it came about that one-third of the canal-mileage was allowed to pass into their hands, and at the present time 1,264 out of 3,520 miles of navigation are in their possession.

Parliamentary report on Railway control.

Freedom from railway control and amalgamation on through-routes are the first essentials for our Canal System, and this necessity was recognised when the report of the Joint Committee of the two Houses of Parliament appointed in 1872 was adopted.

* Jeans—Waterways and Water Transport. Since Mr. Jeans' book was published the Manchester Ship Canal Co. has purchased the Bridgewater Canal.

It stated *inter alia* :—

(*a*) The most important method by which the railways have defeated the competition of canals has been the purchase of important links in the system of navigation and the discouragement of through traffic.

(*b*) That no inland navigation now in the hands of a public trust shall be transferred to or placed under the control of a Railway Company, and that if the trustees of an inland navigation or of a canal, apply to Parliament for power to purchase compulsorily a canal from a Railway Company, such purchase shall be favourably regarded by Parliament.

(*c*) That the utmost facilities shall be given for the amalgamation of adjoining canals with one another or with adjoining inland navigations.

(*d*) That no canal shall be transferred to, or placed directly or indirectly under the control of any Railway Company, nor shall any temporary lease of any canal to a railway company be renewed, until it has been conclusively ascertained that the canal cannot be amalgamated with or worked by adjacent canals, or by a trust owning an adjacent inland navigation.

Effect of Railway control on Tolls

The following example which was given in evidence before the Select Committee of 1883 serves to show the way in which the possession of important links of the Canal System by Railway Companies, affects the toll of the through route. The Birmingham Canal Company, guaranteed by the North-Western Railway Company, owns 12 out of 160 miles, the total length of the route, and they have heretofore taken 33 per cent. of the whole recoverable toll on the entire route.

Tolls on bricks.

With regard to the carriage of bricks a still more glaring instance was given. The Birmingham Canal Company's charge upon bricks on a length of 7 miles was 11¼d. per ton, whilst the adjoining canal—the Warwick—for a distance of 37½ miles charged 6½d., and the Grand Junction for 101 miles only charged 1s. 4½d.

The only remedy for this defect in our Canal System is the amalgamation of the Companies on through routes. In 1894 the Grand Junction Canal Company purchased the Grand Union, the Leicestershire and Northamptonshire Union Canals, and this was the first real step taken for the union of independent links of a through route.

Canal Co.'s as Toll-takers and Carriers.

The subject of administration raises the question as to whether Canal Companies should act as carriers or only as toll-takers. Of the English canals only fourteen act as carriers, six of which are independent, and the remaining eight owned by railways.

This same question was formerly raised with reference to Railway Companies, for at their first construction railways were regarded as "land canals," and by Act of Parliament any person who paid the tolls was allowed to run his trains over the lines.

The Companies themselves declared that it was against their wish and their interests to carry goods and passengers and that they desired to be toll-takers only. Even up to 1840, private carriers were still found competing with the Companies on the Gt. Western and Grand Junction Lines.

Canal Co.'s as Carriers.

Though the mileage of the seven independent canals in England and Wales is 200 miles less than that of the eight owned by Railway Companies, the revenue earned as carriers by the former is more than double that earned by the latter, £433,006 as against £199,042.

An examination of the individual earnings of the canals in the two classes shows that while, the revenue earned by the Railway-owned canals as toll-takers, is with only two exceptions, considerably *above* that earned by them as carriers, exactly the *reverse* is the case, with one exception, with the independent canals.* Thus the Aire and Calder earned £121,775 as carriers, and only £67,835 from tolls; the Leeds and Liverpool £94,464 as carriers, as against £43,367 from tolls; and the Trent Navigation £14,115 as carriers, and only £1,492 from tolls; whereas the total revenue of the seven independent canals from freight as carriers is £433,000, and that earned by tolls £212,551. Finally, if we compare the profits earned by canals acting as carriers with those (whether acting as carriers or not), taking tolls, we find that the total earnings of the eighteen carrying canals of the United Kingdom

*Jeans—The progress of Railways and Waterways Report of Conference on Inland Navigation. 1895. P. 11.

amount to more than two-thirds of those earned by one hundred and twenty-six toll-taking canals, *i.e.*, £685,240 as against £998,844, though the mileage of the former is only 1,380 miles and that of the latter 3,811 miles.

The above facts seem to show that where a Canal Company controls an important through route, the carrying trade may be made as remunerative on canals as on railways.

It may be convenient here to sum up the important *advantages*, *defects*, and *points requiring attention* in the English Canal System.*

General advantages of Canals.

The chief *advantages* of canals, apart from the question of economy are:—

(*i.*) They admit of a class of goods being carried in the manner and at the speed which proves to be most economical and suitable for it, without interference from any other class.

(*ii.*) Goods can be carried in greater bulk.

(*iii.*) The landing or shipment of cargo is not necessarily confined to certain fixed stations, as is obligatory on railways, but boats can stop at any point on their journey to load and unload, and discharge their cargoes direct over the ship's side.

(*iv.*) The dead weight to be moved in proportion to the load is much less.

* Canals and Inland Navigation. A paper read before the Society of Arts, by Gen. Rundle, R.E., C.S.I.

(*v.*) The capacity for traffic is practically unlimited provided the locks are properly designed.

(*vi.*) There is no obligation to maintain enormous or expensive plant or establishments, as all these can, and would, be provided by separate agencies and distinct capital. Thus a large outlay in first cost and subsequent maintenance is avoided.

General disadvantages and defects.

The *disadvantages and defects,* besides those of original construction, in existing British Canals are :—

(*i.*) A total absence of unity of management.

(*ii.*) A want of uniformity of gauge in the locks as well as in the canals themselves.

(*iii.*) The difficulty in the use of steam power which cannot be adopted except in a few notable instances.

(*iv.*) The lack of a uniform system of tolls.

(*v.*) The fact that so many links are in the hands of the Railway Companies which paralyses any unity of action, and renders any scheme of amalgamation between the several parts of a through-route impossible.

(*vi.*) The liability of canals being frozen up in winter and a consequent dis-organisation of traffic.

Points requiring attention.

The chief *points requiring attention* are :—

(*i.*) The dimensions to be given to the main lines, with the best relative proportion of width to depth.

(*ii.*) Uniformity of gauge in locks or lifts, which should be of a size suited to the maintenance of the most effectual steam traffic.

(*iii.*) Remodelment of the cargo boats, so as to obtain the largest carrying capacity, with the least amount of sectional and frictional resistance.

(*iv.*) Provision for working the canals night and day, with the help of the electric light, the power for maintaining which would be easily and economically obtained at the various changes of level.

(*v.*) A uniform rate of toll.

(*vi.*) A careful revision of the administration, and the establishment of special effective supervision over the whole system.

(7) A uniformity of headways under bridges.*

Capacity for Traffic.

In spite of these numerous defects and disadvantages, the capacity of the English canals for traffic is very great. This is readily proved by the traffic returns, in which we find that for 1888—the Birmingham canals alone carried nearly 8,000,000 tons of traffic or 48,500 tons per mile of canal. Even these figures give but a poor idea of the carrying capacity of our waterways, for on the 21 miles of the Weaver during the same year, no less than one

* It is to be regretted that there is no reference to the "headway under bridges" in the Board of Trade returns for 1888 although this is a most important point in canal navigation.

and a half million tons or 75,000 tons per mile, were transported, and on the busiest portion of this navigation at least 1,200,000 tons per mile must have been carried.

From the above figures it will be seen that the possibilities of canals for traffic are very large, and with better conditions, the traffic on the existing waterways might be greatly increased.

Railways and Canals in conjunction.

It has often been urged that the Canal and the Railway should be combined under one management and that were the canals of sufficient size, with uniform gauge and capacity, they could be worked side by side with the railway to their mutual advantage, thus largely replacing the goods train with its consequent risk of both accident and delay caused by the shunting, etc., incidental to goods traffic. An attempt is made to show that the canal would take the bulky and heavy goods, such as coal, iron, stone, etc., and the railway the passengers and perishable and light articles. This, however, seems quite impracticable, taking into account the present relations between the Canal and Railway Companies, and the manner in which the latter have acted in cases where canals have been acquired.

Judging from past experience—the inevitable result of such universal combination would be an increase of freights at present in vogue, and the transfer of traffic as much as possible to the railway, leaving the trader entirely at the mercy of one carrier.

In 1882 the Railway Rates and Fares Committee reported as follows:— Railway Rates & Fares Committees Report on Railway Control of Canals.

"Cases have been adduced where Railway Companies, having acquired possesion or control of a canal, have ceased to work it, or allowed it to fall into disrepair, or charged excessive tolls, especially in the case of through routes, and that in consequence traffic is diverted to the railways where higher rates are exacted, to the injury of traders and the public generally. Your Committee are of opinion that these complaints are not unfounded."

In 1888 the Railway and Canal Traffic Act was passed, Railway and Canal Traffic Act. which, recognising the report of the 1882 Committee, contained provision for the protection of the trader using railway-owned canals. As regards *railway control*, section 38 empowered the Railway and Canal Commissioners to make orders for the alteration and adjustment of tolls, rates, and charges levied on the traffic of, or for the conveyance of merchandize on the canals controlled by Railway Companies, where it was proved to their satisfaction that such tolls, rates, or charges were calculated to divert the traffic from the canal to the railway, to the detriment of the canal or of persons sending traffic over the canal or other canals adjacent to it; and if the alterations required by the order were not made by the company within such time as it prescribed, the Commissioners might themselves make them. Section 42 also provided that in the event of the misapplication of a Railway Company's funds for the acquisition of any unauthorized interest in a canal, the canal interest purchased in contravention of its provisions should be forfeited to the Crown, the officers who permitted such application of the Company's funds being made liable for their repayment to the Company.

Parliamentary recognition of the danger of Railway control of Canals.

That Parliament has also shewn its appreciation of the dis-advantage of railway-owned canals is seen by the fact that in 1889 the Manchester, Sheffield and Lincolnshire Railway Company was compelled by Act of Parliament to sell the canals between Sheffield and the Trent to an independent canal company, to be formed after the passing of the Act.

X.—Cost and Freight Rates.

Railway Transport Cost.

The cost of transport by Railway differs considerably from that by Canal. It has often been argued that the actual charge imposed by the Railway Companies is a likely criterion of the cost of the service, but this is distinctly a fallacy. In the United Kingdom the Railway Companies have openly proclaimed that the amount of traffic that a particular route will *bear*, and not the cost of the services rendered, is their basis of charge.*

Water Transport Cost.

In water transport the question of cost as in railway transport is affected by many elements, such as the size of the canal and of the vessels employed, the number of locks with their mechanical appliances, the rate of speed, the system of traction, and other obvious factors previously

* Report of Conference of Society of Arts on Inland Navigation.

mentioned. But if the cost depends upon these items, the freightage charged also depends in its turn upon the cost, and this subject of cost and freightage we now propose to consider.

Railways and Waterways Chicago to New York. Grain Traffic.

In the annals of transportation there is no more interesting chapter than that which deals with the contest that has been waged for about fifty years between the railways and the waterways for the grain traffic between Chicago and New York.

Freight Rates Chicago to New York.

The following extract on the subject is from an address by Mr. E. R. Johnson, Instructor in Political and Social Science, Haverford College, U.S.A.

"The cheapest freight rates by rail to be found in the world are those for grain between Chicago and New York. And why? Because the cheapest inland water transportation rates in the world are between the same points. The following table shewing the wheat rates per bushel from Chicago to New York for the years 1868, 1870, 1880, and 1891 by water, by water and rail combined, and by rail, indicates very plainly how Freight Rates have fallen, and how this movement has been led by the waterways."

	By Lake and Canal. Cents.	By Lake and Rail. Cents.	By Rail. Cents.
1868	22·79	29·0	42·6
1870	17·10	22·0	33·3
1880	12·27	15·7	19·9
1891	5·96	8·53	15·0

The distances traversed by the two routes are as follows :—

By RAIL	From 912 to 990 miles, say 950 miles.	
By WATER	Lakes 985 ,,	
	River & Canal 420 ,,	
		1405 miles.

Thus, although the water route is 50 per cent. longer than the railway, the water route rules the rate, because the cost of the water transport is 0·125d. per ton per mile, while that of the railway transport is 0·2d. per ton per mile, resulting in the total rate by water between Chicago and New York being two-thirds of the rate by rail. So far there appears to be a *prima facie* case in favour of canals, but it is well to notice that if the cost of this transport by water be taken separately for the lakes and the Erie Canal it appears that the cost on the lakes is 0·083d. per ton per mile, and the cost on the Erie Canal is 0·167d. per ton per mile, so that the cost of transport on the Canal is double that on the Lakes, and more nearly approaches the transport by railway.*

Cost of Transporf on English Waterways.

On English waterways the actual cost of transport in 1883 was stated to be seldom more than 0·3d. per ton per mile. In the case of steam colliers it was given at 0·15d. and for steam barges on the River Lea it was 0·33d.†

* Report of the Conference of the Society of Arts on Canal Navigation, 1888.

† Appendix to Report of Select Committee on Canals.

In Germany* the rate varies from 0·18d. to 0·48d. per ton per mile, thus :— German Freight Rates.

	Per ton per mile.
Goods in bulk loaded in boats and towed in trains	0·18d. to 0·29d.
Goods in bales, towed in trains	0·24d. to 0·38d.
Goods in bales carried by steam carriers...	0·39d. to 1·0d.

Hence it is not surprising that in Germany "for valuable goods a preference is shown for water over railway transport."

"There," we are told, "artificial waterways carry the mass of cheap goods for two-thirds of the regular railway tariff, and valuable goods for from one-third to two-thirds of this tariff.†

This competition by water transport has not only been successful, but it has also effected a reduction of Railway Freights.

Decrease of Continental Freight Rates.

The average German ton-mileage has undergone remarkable modifications. About the year 1885 the average ton-mile rate in the German Railroad Union was nearly 1d., whereas in 1893 it had fallen to 0·67d.

In both France and Belgium also the railway rates have been considerably lowered during recent years.

Carrying-load.

The great secret of cheap transportation is to handle and carry large quantities ; for example, in the United

* Journal of Statistical Society.

† Bulletin du Ministere de travaux publics, Nov. 1887.

States in 1850, the capacity of trains carrying grain from Chicago to New York was only 25 cars or waggons of 8 tons each—a total trainload of 200 tons. At the present day train loads of from 1000 to 1200 tons, between Buffalo and New York, are not uncommon. In 1850 the largest craft employed for transporting traffic on the lakes and rivers between Chicago and New York did not exceed 600 tons, whereas now the maximum is not less than 3,000 tons.*

These facts shew the result of competition between Railways and Waterways abroad—and the way in which this competition has brought about an improvement of structure and a reduction of rates on both systems.

English Freight Rates.

Turning to our own Railway rates we find a marked difference. The late Sir James Allport, for many years Manager of the Midland Railway Company, stated in 1883 that the cost of transporting mineral traffic on that system, assuming 42 trucks or 336 tons of minerals to a train, was 2s. 6d. per train mile.†

Freight Rates 1865-1889. No decrease.

Now it is a remarkable thing that on three of the principal English Railways, as far back as 1865, the ascertained cost of working mineral traffic varied from 2s. 6·6d. to 2s. 10·7d. per train mile, ‡ the cost per ton

* Proceedings of the American Society of Civil Engineers, Vol. XIV., p. 55

† Select Committee on Canals, 1883, p. 83.

‡ Report of the Duke of Devonshire's Commission on Railway Working.

mile varying with the paying load, while in the year 1889 the same figure was accepted by the late Sir George Findlay and other railway experts in giving evidence before the Board of Trade Commission on Railway Rates and Classification. Thus from 1865 to 1889 there has been practically no reduction made in English railway rates, in spite of the greater economy that more scientific and intelligent methods have enabled railway managers to exercise.

Thus it is evident that where there has been competition between waterways and railways, as in the case of America and the Continent, the result has been to reduce the rates on both Railways and Canals, but where, as in our own country, there has been practically no competition, the rates have remained abnormally high.

Manchester Ship Canal and Railway Freights.

There is, however, one important English waterway which has been able to successfully compete with the railway, with the inevitable result that the freightage by rail has been very considerably reduced. The MANCHESTER SHIP CANAL was constructed to enable ocean-going vessels to discharge their cargoes at Manchester instead of unloading at Liverpool and thence by railway.

Liverpool to Manchester by Canal and by Rail.

The economic effects of the Canal on freights are shewn by the following table. In every case the cost is given per ton—delivered in Manchester.

	Cost via Liverpool.	Cost via Canal.
Cotton	13s. 8d.	7s. 0d.
Wool	16s. 5d.	7s. 9d.
Sugar (loaves)	17s. 11d.	6s. 8d.
Sugar (raw)	12s. 2d.	4s. 11d.
Wheat	9s. 11d.	4s. 10d.
Petroleum	14s. 5d.	5s. 11d.
Tallow	13s. 6d.	5s. 10d.
Timber...	9s. 5d.	4s. 9d.

The greater part of this difference in freights may be explained by the fact that goods passing through Liverpool must be unloaded at a dock, transferred to train, unloaded from train and so to the warehouse of the purchaser—whereas goods going direct by canal require only one unloading at the docks at Manchester, and thus both labour and expense are saved. The result of the competition, however, has been that the Railway Companies between Liverpool and Manchester have been forced, as before mentioned, to considerably reduce their freight rates. The Ship-Canal is slowly but surely gaining the confidence of the trader—and the last half-yearly report is of an encouraging nature. The total receipts were £20,095 in excess of the corresponding period of 1901, and the directors were thus enabled to pay the interest on the first and second mortgage debentures, amounting to £44,742, the interest due on the mortgage of surplus bonds, amounting to £1,000, and the rent of new transit sheds

Result on Railway-rates of the competition by water between Liverpool and Manchester.

amounting to £3,179, leaving a balance of £24,955 to pay over as interest on debentures to the Manchester Corporation.

Attempts have frequently been made to draw up an average traffic ton-mile rate for the different countries of the world, but it should not be forgotten that for England there is no record of the average distance over which mineral traffic is carried on either railways or canals, nor yet are there any available English Railway Statistics as to the ton mile rates (the railways themselves professing that they had not the information) and thus the English average can only be roughly estimated.

Average Traffic ton-mile rates.

The report of the Interstate Commerce Commission of the United States shews that whereas the average ton mile rate in the United States is under ½d. per ton per mile for all descriptions of traffic, the average rate for the United Kingdom is not less than 1¼d. per ton per mile.

Interstate Commerce Commission Report.

With the growth of close competition both home and foreign it is natural that traders and merchants should, by every means in their power, endeavour to reduce the cost of transit, and yet there is still great difficulty experienced in reaching some of the principal markets.

How was it that in 1895 the railway rates for coal from the Midlands to London were higher than the value of the coal at the pit?

English Coal Freights.

How is it that at the present time the average cost of coal and coke at iron-works on the west coast is nearly twice as much as the cost at pits and ovens in South Durham? It is for want of adequate means of transport.

Freight Rates on Salt.

How is it that brine shafts in the centre of Germany having water communication with Holland, Belgium and Hamburg, have to a great extent cut out English salt from Holland and Belgium, and actually send salt to Newcastle-upon-Tyne? The reason is, that though the cost at the place of production is within a fraction of what it is in Cheshire, the expense of transit by inland navigations to Hamburg, and by sea from Hamburg to Newcastle-upon-Tyne, is actually less than that from the Cheshire brine-shafts.

How was it that in the year 1888 our traders could submit several lists of rates and charges to the Committee of the Board of Trade shewing that sometimes the rates for a short distance traffic rose to 1·5d. per ton per mile, and that even the London coal traffic was seldom carried for less than ·5d. per ton per mile, although the cost of the service, excluding interest on capital was considerably less than one-half that amount? *

French Canal Traffic.

How is it—on the other hand—that six million tons of goods are annually carried into Paris by water, this traffic being 41% of the total entering the city by railway

* Jeans on Transport by Railway and Canal. Conference of Federated Mining Engineers, 1895.

and water, one million tons being carried from Rouen in direct competition with a railway?

How is it that Berlin is supplied to the extent of one half of its imports by canal? German Canal Traffic.

How is it that over 27% of the traffic of the United States is water borne, in spite of the cheap railway rates of that country? U.S.A. Canal Traffic.

How is it that in France water borne traffic forms 30%, and in Germany 23%, while in the United Kingdom it is less than 11% of the total traffic?

It is because *inland navigation has been improved and kept up to date in these countries*—whereas in our own case our waterways have stagnated in most and retrograded in many instances.

Sir John T. Brunner, M.P., writing to the Secretary of the Conference on Inland Navigation of 1895 gave it as his opinion that one could not study the figures relating to our waterways without coming to the conclusion that "the making of canals, the improvement of existing canals, the amalgamation of existing Canal Companies and the acquisition by independent companies of canals now owned or controlled by Railway Companies, was of infinitely greater and more urgent importance to agriculturists and other traders than the making of light railways."

The question now arises as to whether Canal is cheaper than Railway Transport in this country. The late Mr. E. R. Conder had no doubt as to the small cost with which Economy of Water-transport.

traffic could be carried by the canal as compared with the railway. In a calculation which he submitted to the Select Committee on Canals,* he contended that the cost of railway traffic in the United Kingdom was not less than 0·53d. per ton per mile, and this together with 0·78d. per ton per mile in respect of interest on invested capital, made a total of 1·31d. per ton per mile for both items, and a total cost of £587 per 100,000 units. In the case of canals he contended that with a similar volume of traffic, the cost of transport in England would only be 0·37d., including 0·11d. for interest on investment, or £154 per 100,000 units. In other words, he estimated that the cost of railway transport would be at least three and a quarter times as much as the cost of transport by canal. †

Freight rates of various countries.

A list drawn up by the Journal des Economistes shewing the freight charges on the railways of different countries is given below :—

	Per ton per mile.
United States	0·40d.
Holland	0·78d.
Belgium	0·80d.
Germany	0·82d.
France	1·10d.
Russia	1·20d.
Italy	1·25d.
Great Britain...	1·40d.

This table gives an average of 0·97d. per ton per mile.

* "Select Committee on Canals," 1883, p. 83.

† Jeans. Transport by Railway and Canal.

Railway Receipts of various countries.

The net railway receipts are given as :—

The world average	3·2d.
France	3·8d.
Egypt	4·1d.
Great Britain	4·1d.
Belgium	4·6d.
Germany	5·1d.

Net Receipts—Vol. of traffic & Income on Railways & Canals.

Thus our net railway receipts are among the highest, and as the volume of traffic is greater than in any other country, the income ought to be proportionately large, but the want of system in laying out the lines, the great cost of land and preliminary expenses, and the large sums spent in railway construction, have so acted on the capital accounts that no considerable cheapening of the cost of transportation can be expected from the Railway Companies. In fact, in order to pay a 5% dividend on the capital of the English Railways, a sum of £2,600 would have to be earned per mile per annum, whereas a sum of less than £500 per mile would suffice to pay a like dividend on canal expenditure.

Maintenance.

There are other features of primary importance in which the economy of transport by canal differs from that by railway, and perhaps the most evident is the expense of maintenance. As soon as anything like an adequate amount of traffic is brought on a line, the cost of maintenance of a railway is remarkably steady, rising and falling with the increase or diminution in the volume of the trans-

Economy of Maintenance of Canals with increase of traffic

ports. On canals, on the other hand, the fixed expenses demand in any case a certain cost, but this cost is very little increased by a large increase of traffic. The annual cost of maintenance of the Suez Canal was actually less from 1876 to 1881 than it had been from 1871 to 1876, although the traffic had considerably more than doubled, and thus the cost of maintenence *per ton per mile* fell from 0·35d. to 0·134d. * Again, the last half-yearly report of the Manchester Ship Canal shews that the weight of toll paying merchandise which passed over the waterway was nearly 200,000 tons in excess of that of the corresponding period of 1901 when the tonnage was 1.391,149. This has been accomplished with an increased expenditure of only £1,658, while the increase in the receipts amounted to £20,095.

Economy of increase of haulage on Canals.

Not only does an increase of traffic diminish the proportionate cost of maintenance, but the cost of haulage is also proportionately less: thus on the Weaver Navigation, a single horse hauls a cargo of 100 tons whereas a load of 250 to 300 tons only requires two horses.

Economy of lesser cost of plant on Canals.

But the economy does not stop at haulage—it is also assisted by the lesser cost of plant. A railway train loaded with 220 tons costs for the locomotive and trucks £3,360. A steam barge to carry the same quantity will cost £1,600, and this barge is frequently used to tow three other barges of 260 tons capacity, costing £1000 each.

* Report of the Conference on Canals, 1888—Society of Arts.

Thus it can readily be seen that the economy of transport by water is assisted by the increase of traffic and the lesser cost of plant.

Rapid increase of English transport

The inland transport of England is rapidly increasing, and already it is over six times what it was fifty years ago; the goal to be attempted is the moving of this enormous traffic with greater economy than is at present practised, and this would inevitably tend to the increased prosperity of the nation. In the commercial world there is no question of greater importance than the cost of transit. Other things being equal, the nation possessing the cheapest means of conveyance *must* gain the day in the struggle for industrial supremacy.

The rapid increase in commerce of the Nineteenth, and the still more rapid increase already experienced in the Twentieth Century, must be met, in this country, by a corresponding increase in facility of transport, in order that England may retain her position of commercial pre-eminence; a position which can only be maintained by the constant and careful investigation of the economy of each contributory factor.

In the briefest possible manner, the growth of our Canal System has thus been traced, the important features of its present condition have been outlined, and the great possibilities which lie before this method of transit have been pointed out.

Conclusion.

In conclusion, to quote the oft-repeated words of Alderman Bailey, of Manchester, addressed to the Manchester Association of Engineers:—

"Make England to the world what London is to England—make every part of the verge, fringe, shore, creek, bay, river and inlet of our map as equal as possible in relation to distance from the shores of foreign countries,—double the coast line—resuscitate the ancient ports,—extend some more inland,—make Britain narrower—shorten the distance from coast to coast—from sea to sea, and increase the setting of Shakespeare's lines:—

'Fortress built by nature for herself
This little world—
This precious stone set in a silver sea.'"

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Abbreviations—C. Canal. N. Navigation.