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D. G. TUCKER

*The History of Industries and Crafts
in Iceland*

Introduction

ICELAND is of interest to the industrial historian not only because it represents an unusual environment for the development of early industries and crafts but also, and perhaps mainly, because it is now an independent modern European country which has proceeded into twentieth-century industry without passing through the intermediate stage represented by the British Industrial Revolution and, indeed, without really even having what we may call 'pre-Revolution' industry. Iceland has virtually transferred itself to the electricity-and-jet age without having any significant development of power and machines based on waterwheels, windmills, and steam engines. Up to the twentieth century it was industrially as backward as the Faeroes, the Shetlands, the Orkneys and the Hebrides, yet while these islands have developed relatively slowly, and their population has remained static or declined, Iceland has become a state of some limited industrial and economic significance. This is very largely associated with the attainment of independence. Iceland had been under Norwegian and later Danish domination for most of its history, but in 1903 a fair degree of independence was obtained. In 1908 practically complete independence was achieved under the Danish crown. During World War II, the link with Denmark was completely broken.

In terms of area, Iceland is of course very much larger than the other island groups mentioned, having a total land area of around 103,000 sq km, ie about 20 per cent larger than Ireland. The population, which in the nineteenth century was little larger than those of the other island groups, is now growing rapidly, having risen over the last two centuries from under 40,000 in 1785 to nearly 80,000 in 1900, 120,000 in 1940, and about 200,000 today. From having been mainly

rural, the people are now mainly urban, and roughly half the population lives in the capital. Reykjavik is a spreading modern city with very few buildings surviving from the nineteenth century and having considerable charm in the older parts around the harbour and the lake (Tjörninn), but with a raw, unfinished look in the newer suburbs.

A short comparison of the early technologies of Iceland with those of the four other island groups mentioned is given in Appendix II. While there was a general similarity, there were one or two very marked differences.

Iceland is barren by English standards, and even the Icelanders accept that most of it is agriculturally useless. Even around Reykjavik one has huge stretches of rough lava-field with no vegetation except moss, but there is an extraordinary beauty about the landscape. There are good agricultural areas, especially in the southern lowlands, and the use of hot springs has enabled a glasshouse industry to develop. However, the sea around Iceland is fertile enough, and fishing has been a main occupation for centuries and is today still Iceland's dominant industry. Apart from fish, Iceland is poor in natural resources except those of hot springs and abundant water.

Iceland was first settled by colonists from Norway and elsewhere in the year 874, although there had been visits from Irish monks and others from the end of the previous century. Apart from the Scandinavian people, there were also many Celts among the original settlers. It is thought that the population of Iceland grew rapidly to about 40,000 by the year 930 and inhabited all the areas where people live today. Because the early Icelanders were great travellers and traders, they not only were in contact with other peoples but also introduced considerable foreign blood into their population.

Throughout the centuries the Icelanders have shown a great taste for writing and reading, and a strong sense of history. They have, thus, maintained their Icelandic language in which they have a vast literature and a most detailed history. The difficulty of the language produces, however, a very real obstacle to the industrial historian, who is likely to have to rely on what has been written in English, French or others of the better-known European languages, and on oral or

written communication only with those Icelanders in the upper educational crust—and while they are all interested in, and proud of, their cultural and constitutional history, few seem interested in industrial history. It has indeed been said that the Icelanders have been traditionally more interested in their literature and poetry than in practical matters, and no doubt in former times there was a great deal of truth in this. Nevertheless, they developed some industrial skills and a number of fine crafts, such as weaving and wood-carving, which still excite our admiration.

It is against this background that we shall now consider the industrial history of Iceland up to about 1914; with occasional later excursions where the topics warrant them. As there is so little literature on the industrial history of Iceland, it is hoped that this survey (the superficiality of which is only too evident to the author) will arouse interest and provide a basis for more detailed investigations.

Traditional industries and crafts

These are, naturally, those associated with agriculture, fisheries, buildings and furniture, and domestic activities. From the earliest times Icelandic agriculture has been based on sheep and cattle. By 1850 the number of sheep was 600,000 and of cattle 25,000. It was natural, therefore, that the processing and weaving of wool textiles and the preparation of skins should develop, as well as the preparation and storage of food products. Cultivation of crops was limited by the poor soil and the harsh climate; for the most part, only grass was cultivated, although in later times potatoes and turnips have been grown. There are records in the old sagas of the sowing of corn, and barley has more recently been tried, but grain will not ripen. In these circumstances it is not surprising that agricultural implements remained extremely primitive and that there was little corn-grinding.

Fisheries, although important, were also primitive for the first thousand years of settlement. Up to about 1800 only open boats were used, the fishing being confined to inshore waters, and hand-lines and long-lines were used. Fish-drying and line-making were the only industrial developments in this long period.

Buildings and furniture have been constrained by the shortage of timber in Iceland. In the early days there were some woodlands in several parts of the country, but these were irresponsibly used up without care for their future, and after that the only wood available was driftwood and occasional imports. So houses and barns were constructed as far as possible of stones and turf, with timber confined to frames and linings. Chairs and beds, etc, were made of wood, and generally highly decorated with carving showing a high standard of skill. Domestic crafts, as in other countries, were numerous, including knitting, weaving, etc. The forging of iron was common. Apart from some local iron-making in the earlier centuries, iron was imported. Other metal-working crafts also developed.

Literature covering industrial history of Iceland

This is really rather sparse. One has to look out for odd references to industry in books of a more general nature, or for references to industrial history in books or chapters dealing primarily with present-day industry. The author's inquiries at the National Library of Iceland and at the Library of the University of Iceland (both in Reykjavik) brought out nothing not already in his list. Iceland has never appeared in the indexes to the *Transactions of the Newcomen Society*. In the monumental 5 volume *History of Technology* (ed C. Singer et al, Oxford, 1954-8) the only reference to technology or crafts in Iceland appears to be that of the warp-weighted loom discussed later in the present paper, and even this does not appear in the index. Doubtless there are useful and relevant papers in learned journals, most probably in those emanating from Scandinavia, and further research will be needed to find them. There must also be a great deal of relevant manuscript material (in the Icelandic language) in the Iceland National Archives. Nevertheless, the references cited in this paper do enable a fairly comprehensive outline picture of Icelandic industrial history to be given.

Museums in Reykjavik

Relevant to the present studies are the National Museum of Iceland

and the Folk Museum. The former is now housed in a fine modern building near the centre of Reykjavik; the latter is at Arbaer on the eastern outskirts of the city, about 7km from the city centre, and easily reached by bus. There was until a year or two ago also a City Museum, but, although still mentioned in the guide-books, it has been closed.

The collections of the National Museum are very well set out, but there are a number of difficulties in getting information from the exhibits. Firstly, very seldom are dates known for the objects shown; secondly, the explanatory labels are all in the Icelandic language—reasonable enough at first sight, but perhaps a little unfortunate when it is appreciated that the majority of visitors to the museum are foreigners who would almost always know some English but hardly ever know a word of Icelandic; and thirdly, there is no detailed catalogue of the exhibits, the only printed information available being the summary guide¹ which gives very little detail. A short list of the exhibits which are relevant to industrial history is given in the Appendix and from this the coverage can be judged. There are also many paintings, lithographs, engravings, and photographs in the museum which illustrate features of Icelandic history and landscape, and several of these give useful information, eg on windmills, sulphur mines, harbour works, fish processing, and boats.

The Folk Museum is a small park containing primarily a late nineteenth-century farmhouse built mainly of timber, with outbuildings, a smithy, a church built with stone and turf and with timber lining and furniture, and a collection of domestic objects and some pictures inside the farmhouse. The industrial history interest lies more particularly in a preserved steam locomotive and a steam road-roller.

Material for field study

The scope for field study of industrial history is relatively small. Very few buildings dating from before the present century have survived, this being due to the materials and methods of construction coupled with the harsh winter climate. There are just a few industrial buildings in Reykjavik (and probably also in other towns) dating from

the early years of the present century; these were built of imported durable materials.

A windmill is said to be still in existence on the island of Vigur off the north-west coast,² but otherwise there seem to be no remains of windmills or watermills. Steam engines were used (probably only a very small number) in the second and third decades of this century to drive machinery in fish-processing plants, but it is believed that no such steam engine now remains in the country.

It is probable that furnace slag can still be found in those areas where iron-smelting was done in medieval times. Probably old implements are preserved in some farms. The ancient practice of air-drying of fish can still be seen in operation in numerous places, even on the outskirts of Reykjavik, but the demand for the dried fish (or 'stock-fish' as it is called) is diminishing rapidly, and this part of the fishing industry may soon die out.

Bridges (as indeed roads themselves) were a rarity until the last decade of the nineteenth century. The old bridges were of timber and it is thought that none of them still remains. There has been very little use of railways in Iceland, and probably the preserved locomotive at the Folk Museum is the only important relic. How many steam rollers were used in roadmaking is not known to the author, and the specimen preserved at the Folk Museum may well be the only remaining example.

Fishing, whaling, agriculture, food processing, eider-down

From the first colonisation in 874 up to about 1800, fishing was done only in inshore waters from open boats with hand-line or long-line. During the nineteenth century the use of decked sailing vessels led to fishing in more distant waters.³ Steam trawlers were introduced just before 1900, motor boats just after 1900. The last decked sailing vessel disappeared by 1928.⁴ Many models of old fishing boats may be seen in the National Museum.

The air-drying of fish in special structures was practised from ancient times, and salting was introduced around the end of the eighteenth century.⁵ The export of fish represented about 60 per cent

of Iceland's total exports in 1900,⁶ but this proportion has risen steadily and was 95 per cent in 1961.⁷ Even nowadays a great deal of fish is dried in the open air, on huge drying-frames constructed of timber; 13,000 tons of this stock fish were produced in 1957 and were exported mainly to Italy and Nigeria.⁸ An Icelander engaged in this business told the author that the juices which dripped from the fish when first hung up fertilised the thin soil under the drying-frames so that excellent grass grew there. The frames were, therefore, moved every few years to develop good grazing over an area. Whereas drying was the main process for treating fish up to the beginning of the twentieth century, it is now relatively unimportant.⁹ Hundreds of thousands of tons of other fish products are now produced annually, such as frozen fish, salted fish, fishmeal, and fish oil. Large factories have been built since the early years of this century for fish processing. The first indoor drying was in 1905; the first fish freezing plant was set up in the Westmann Islands in 1907.¹⁰ The first fishmeal-processing plant was set up by a Norwegian firm at Siglufjörður in 1910, using steam power.¹¹

Whaling was not a traditional industry in Iceland, and was really developed by Norwegians from 1880 to 1915 based on twelve whaling stations in various parts of Iceland—seven in the north-west and five in the east.¹² The shore stations were abandoned in 1915. In 1935 another Norwegian whaling station was established at Sudureyri in Tálknafjörður in the north-west, but presumably abandoned during the war. There is now a whaling station at Hvalfjörður on the south-west coast, north of Reykjavik, at which about 500 whales are processed each year.¹³

We have already discussed agriculture briefly, and need only add that the use of ploughs, harrows, etc is quite recent in Iceland, probably dating from early in the present century.¹⁴ A good collection of hand cultivating implements is on show in the National Museum. Although Icelandic-grown grain does not ripen and could only, therefore, be used for fodder, some corn-mills were built shortly after 1770 'so that the people could grind their own flour'.¹⁵ Nothing more seems to be known about these mills, however. Corn-grinding was usually

done as a domestic activity using querns made of lava, specimens of which may be inspected in the National Museum. Grasslands were in ancient times watered by irrigation or by a type of water-meadow, and more modern systems have also been tried.¹⁶

Of course, the production of various drinks had been a domestic 'craft' over a long period, but a brewery was set up in Reykjavik in 1913 to produce drink on a commercial scale,¹⁷ and the old brewery buildings at 19 and 21 Njalsgata (in central Reykjavik) are probably the original ones.

The production of eider-down is an ancient industry of Iceland, and it was certainly being done on a commercial basis by the seventeenth century. At the end of the nineteenth century, over 3,000kg were being produced each year, and this represented about 1 per cent by value of Iceland's exports.¹⁸ The industry still continues, but the output is down to about 2,000kg.¹⁹ There is no real mechanisation in the industry, and the down is normally cleaned by a hand process after being air-dried. This cleaning process is, however, interesting and involves what could be regarded as a machine—a frame with parallel taut strings about 1 or 2cm apart.²⁰ With a heap of down placed on the strings, the latter are vibrated by drawing a stick across them; the dirt and coarse feathers fall through, leaving clean down still on the strings. A down-cleaning works was set up earlier this century at Stykkishólmur on the west coast in which artificial heating was used for drying, but no additional mechanical aids were used for cleaning.

Mining and metals

Of all the activities in Iceland the production of iron must be regarded as the most interesting. It is certainly very ancient; the famous Icelandic Sagas make it quite clear that iron was produced in Iceland in the first part of the eleventh century. Bog iron ore was the sole source of this iron; it occurs in the valleys, particularly in the north and west, and can have an iron content around 50 per cent. There are other iron-containing minerals in Iceland, but they have not so far been successfully worked.²¹ The definitive account of iron production in Iceland is the paper by Nielsen published originally in

1926,²² but more usefully in a French translation by Philipot in 1929.²³ The remainder of our summary of the topic is based on this work.

Iron was usually produced, as in other countries, in open furnaces by burning the broken ore with charcoal to produce a mixture of iron and slag which could be forged into wrought iron. Examination of remains of the charcoal indicate that it was produced from local wood. Forest was formerly present in Iceland on a sufficient scale for this, and the localities where iron furnaces existed were naturally those where the trees grew. There was also in Iceland a technique of producing iron in clay pots which was practised on a more limited scale.

Knowledge of the sites of ancient iron furnaces and forges is based on literary sources, oral tradition, and on field investigation. Nielsen lists (and describes as far as possible) forty-six sites, but suggests there may well be more. The greatest concentration is just to the east of Akureyri, the chief town of northern Iceland. The remainder is scattered over western districts. Detectable remains consist mainly of slag and sometimes charcoal; there are very few structural remains. There are some pieces of slag in the National Museum, together with tools and other remains, and a large quantity of old iron objects, most of which would have been forged in Iceland.

Metalworking has been an important craft in Iceland, also from early times, and the National Museum has collections which demonstrate this. Apart from the making of swords, knives, etc in iron, there was fine work by silversmiths. The silver was presumably imported, although mining for silver is said to have been tried in 1754.²⁴ Examples of such work are some twelfth-century silver chalices in the National Museum.

Metalwork grew into a small industry in the nineteenth century with the establishment of workshops,²⁵ and there has since developed a sizeable metal industry to serve local needs, comprising foundries, forges, boiler making, and machining and fabrication.

Minerals other than iron ore have also played some part in Icelandic life and trade.²⁶ Sulphur was commercially important in the thirteenth century, and reached its peak in the sixteenth century with a production of 400 tons per year. There is a watercolour painting in the National

Museum showing a sulphur mine at Krysvik in the eighteenth century.²⁷ This place (about 30km south of Reykjavik) has hot springs and natural steam, and the sulphur is still very evident to both sight and smell.

There is some coal in Iceland in the form of lignite, and it has been dug for local use; attempts to work it commercially have failed. There is also some peat which is similarly used locally. During the heyday of steamships, large quantities of coal were imported from England, and stocks of from 2,000 to 10,000 tons were held at each of the main ports.²⁸

There are deposits of china clay at Thrudardalur in the north-west peninsula and these were worked for the Danish Royal Porcelain factory in the eighteenth century. Iceland spar—a transparent variety of calcite used in optical instruments—is a mineral produced almost exclusively in Iceland, from one mine at Helgustadir in the eastern coastal region. Mining began in 1850, but the deposit was practically exhausted by 1914. A more recent discovery is that of diatomaceous earth on the bottom of Lake Mývatn, and in 1965 work commenced on the exploitation of this for filter-aids; this promises to be an important export industry.²⁹

Apart from these rather sparse mineral deposits, Iceland is poor in mineral resources. There is no limestone, and to avoid importing cement for building (practically all modern building in Iceland is in concrete), a cement works has been established since the late 1950s at Akranes in the west using as its raw material a shell-sand which occurs there. Its annual capacity is about 110,000 tons.³⁰

The use of stone for building in Iceland is, of course, ancient, but only in a crude form. Stone-working as a craft was brought by Swedish tradesmen in 1878, and the firm of Gudnason was established in Reykjavik before the end of the century.³¹

An interesting mineral activity not based on deposits is the extraction of salt from sea water.³² This was done in ancient times, but in 1773 a plant was started, at Reykjanes in Ísafjardarsýsla in the north-west, to evaporate sea water using the heat from hot springs; unfortunately it was worked for only thirteen years as it was not profitable.

Textiles, rope-making, etc

The spinning and weaving of wool textiles was a most important domestic craft in Iceland, and some very beautiful examples of the woven product may be seen in the National Museum; so also may a variety of spinning wheels (all with flyers) and some looms. The spinning wheel appears to have been little used (if at all) in Iceland before the nineteenth century, and then the pattern of wheel introduced was similar to the Scottish wheel of the same period.³³ Two examples of warp-weighted looms are of especial interest, one in Room 2 and one in Room 13. The former, in particular, is described as 'a vertical warp-weighted loom of a very ancient type'.³⁴ A warp-weighted loom has the warp threads held taut by weights attached to their ends, and the type dates from around 2500 BC or earlier in the Near East.³⁵ It survived in use in Iceland until later than almost anywhere else. Pile weaving was also practised in Iceland, examples being on show in the museum, together with a small pile-weaving loom of horizontal type (Room 3).

Native dyes were originally used, but these were supplanted in the later nineteenth century by imported chemical dyes.³⁶ Knitting was also common, and both woven and knitted textiles were important articles of trade, especially overseas. The history of Icelandic trade in the centuries before independence is too complicated a matter to discuss in this paper,³⁷ but an interesting aspect of it is that in the middle of the eighteenth century the quality of the woollen goods became too poor to be acceptable, and merchants made many complaints. The Icelandic leader of that time, Skuli Magnusson, was much concerned by this, 'as the greater part of the people made their living by home manufacture of woollen goods'.³⁸ He pushed forward several measures, including the building of a woollen mill at Reykjavik and the bringing of German weavers to Iceland. Besides the woollen mill, a fulling mill, a ropery and a tannery were built at Reykjavik. Whether these were powered by waterwheels is not known. They lasted less than two decades owing to commercial opposition.

Rope-making was practised in Iceland on at least a small scale, and

examples of the wooden machines used to twist a three-strand rope are in the National Museum. In this case the ropes were quite fine and were used as hand-lines in fishing. Annandale gave in 1905 a full, illustrated description of the machines and the process as used in the Faeroe Islands,³⁹ and these seem identical with those involved in the Icelandic rope-making illustrated in the museum. However, Annandale was concerned with the ropes used in bird-catching, ie for climbing up and down cliffs, and these were usually made of horse-hair. He discussed their use in Iceland only with reference to the Westmann Islands, and said that there the ropes were all imported. He did also discuss the making of fishing lines in the Faeroes, but apparently these were made of wool, twisted with the aid of spindles.⁴⁰ There is, thus, still some doubt, as far as the present author is concerned, as to the extent to which rope-making was practised in Iceland.

Basketry was not widespread in Iceland, and the roots of a shrub were known to have been used as the material of construction in at least one example.⁴¹

Food containers, utensils, and the absence of pottery

It is interesting that there appears to have been no manufacture of pottery in Iceland even on the domestic scale. No reference to it has been found in the literature, and there is no Icelandic pottery among the exhibits in the National Museum. (Equally, however, the author has found no definite statement that pottery was not made.) All domestic utensils and containers were of wood, stone or metal apart from a few imported ceramics for special or 'best' use. Numerous fine examples of wooden jugs, etc are shown in the National Museum; their making was a domestic craft. Some iron cooking vessels are shown in the Folk Museum.

In recent times a small industry has been established to make what are called 'lava ceramics', but the products, which are attractive in appearance, seem primarily ornamental and are probably intended as much for sale to tourists as for local use.

Building

The common style of building in Iceland was that already mentioned, namely, stone bases for the walls, with turf walls and roofs over a timber framing. Such buildings may still be seen at the Folk Museum, and exist at many places in the country. A later style was the timber house (built from imported timber); a very fine example of a larger timber building is the Senior Grammar School in Reykjavik, built as the Latin School in 1846. Since it has become available, corrugated iron has been used very widely to cover and protect the timber of buildings. A significant proportion of buildings in the towns, even the Government Hospitality House in Reykjavik, is faced and roofed with this material, and when it is kept properly painted, it looks smart and colourful.

Buildings of dressed stone are rare in Iceland. A notable one is the Parliament Building (Althing) in Reykjavik, built in 1881.

Brick has occasionally been used, but as far as can be ascertained bricks have not been made in Iceland, and the few that have been used have been imported. Two very interesting uses of brick in industrial buildings in Reykjavik are in a fish-processing factory near the eastern breakwater of the harbour, and in the timber works of the firm called Timburverzlunin Volundur Ltd, on the sea-front nearby.⁴² In the former there are brick edgings and one brick wall, and in the latter there is a brick chimney stack; both buildings date from the early years of the present century. The timber works were indeed the first mechanised timber works in Iceland, being set up in 1905.

Occasionally a slated roof is seen, and there is at least one house in Reykjavik with slate-hung walls. There is also occasional use of asbestos board. All modern buildings are of concrete; and cement, as previously stated, is now an Icelandic product.

Boats and navigation

The open wooden fishing boats used exclusively until 1800 were made locally, and the larger decked vessels that have since been built have been the product of small Icelandic shipyards, which have grown

up in numerous places around the coast. No iron vessels were made, however, until 1955, and up to that time were ordered overseas.⁴³ The building of steel ships is now an important part of modern Icelandic industry, and many are exported.

Numerous repair shops have developed to meet the needs of the fishing and coastal fleets, and a full history of them and their facilities was prepared during World War II,⁴⁴ together with particulars of all the harbours. The first railway dry dock was opened at Reykjavik in 1902.⁴⁵

As winter fishing and trading developed, a need was found for lighthouses, and the first was built in 1878 on the Reykjanes peninsula.⁴⁶ Although there is a small peninsula of this name just outside Reykjavik harbour (as well as at numerous other places), it is almost certain that the Reykjanes at the south-west tip of Iceland was the site of this first lighthouse. Three more lighthouses were opened in 1897, and by 1936 there were 110.

Internal transport

Until the later part of the nineteenth century, Iceland was virtually without roads, ponies forming the main means of inland transport. There were practically no bridges, and the few that had been built were of timber. The first bridge of the new era was a steel bridge of 75m length, built by British engineers across the Ölfusá river (in the south-west, near Selfoss, south-east of Reykjavik) in 1890.⁴⁷ The following years saw a number of other steel bridges built, but since 1907 nearly all bridges have been of reinforced concrete. By 1929 there were 159 bridges of length exceeding 10m, and of these only thirty-five were not of concrete.

Roads were built and improved, but to this day they are all untarred with the exception of a few tens of kilometres. Except in high summer, a fair proportion of the road system is difficult or impossible to use. A small Aveling & Porter steam roller is preserved at the Folk Museum at Reykjavik. It was presumably used in road construction in Iceland. Nowadays modern diesel road-making equipment is used.

There have never been any public railways in Iceland, although two

routes in the south-west were proposed in the 1920s.⁴⁸ There have been a few industrial uses of railways, however, and the 3ft gauge locomotive *Pionér*, built by Jung in 1910 and now preserved at the Folk Museum, was used on a railway system serving the construction works when Reykjavik Harbour was modernised and extended in 1913–17. A fuller (but still short) discussion of the railway history of Iceland is given in a separate article by the author.⁴⁹

Motor vehicles first appeared in Iceland in 1913, being of course imported.⁵⁰ Most motor vehicles are still imported, but bus bodies and chassis have been built in Iceland since 1941.⁵¹ Bicycles were repaired in Reykjavik from 1904 by the founder of the firm now known as Falkinn Ltd, and the manufacture of bicycles was soon embarked upon, 13,000 having been built.⁵²

Printing and bookbinding

Writing and reading have always been a strong interest of the Icelanders, so it seems natural that printing should have been adopted in Iceland well within a century of its first introduction in Europe. The first press was set up at Hólar in the north (headquarters of an ancient bishopric) around 1530.⁵³ This was, however, the only press for over two centuries. There has been a rapid growth in printing since the mid-nineteenth century. Paper has always been imported. Old printing blocks for illustrations in books have survived, and a collection can be seen in Room 8 of the National Museum, mostly dating from around 1680 to 1695 or later; but there is one as early as 1589. Bookbinding has been done in Iceland since around 1300.⁵⁴

Power

There is little evidence of any machinery being used in Iceland up to the nineteenth century which required any power to drive it other than that of human beings as used, for example, in looms and spinning wheels. We have already mentioned the possibility that the few corn and textile mills which were built in the eighteenth century might have been powered by waterwheels. Early in the twentieth century two woollen mills were built using water power,⁵⁵ but details are not to

hand. The only certain evidence is of three stream-operated horizontal watermills and a tide-mill in the middle of the nineteenth century.

In the nineteenth century there were certainly a few windmills in Iceland. This matter, together with that of the watermills, has been more fully discussed in a separate paper by the author than we can afford to do here.⁵⁶ Briefly, the evidence is of certainly one windmill, and possibly as many as three, in Reykjavik and certainly one on the island of Vigur, the latter being probably still in existence. A smock mill in Reykjavik is shown in a photograph in Bennett and Elton's book;⁵⁷ the evidence (such as it is) for the other mills comes from paintings and engravings in the National Museum. The Vigur mill is a post mill, and is illustrated by a small sketch in a guide-book.⁵⁸ It is certain, however, that windmills were not extensively used in Iceland. Wind power has, in more recent times, been used for the generation of electricity on a small scale. In 1940 there were 177 wind-driven generators with a total capacity of 35kW.⁵⁹

Steam engines were used in Iceland to supply power to the fishmeal factories that were set up from 1910 onwards. The author has found no evidence of any earlier use of steam power except, of course, for the propulsion of ships. Indeed, great difficulty has been found in getting *any* evidence of the use of steam power on land in Iceland. Inquiries at both the National Library of Iceland and the Library of the University of Iceland brought forth no evidence at all, and only oral statements have been obtained.⁶⁰ Apparently the first steam engine was in the factory of Siglufjörður, set up by the Norwegians in 1910, but steam did not long survive 1930 because electricity took over. Steam cranes were used in Iceland, for there were six of them at Siglufjörður around 1940.⁶¹

Steam turbines were used in one electricity power station according to one informant,⁶² and steam as a prime-mover in generating electricity in Iceland is substantiated by an entry showing a 7.5MW steam power station at Ellidaár in a table of power stations.⁶³

Natural steam and hot water are, of course, a source of power in Iceland, but so far they have not been greatly exploited (if at all) for this purpose. They are, however, extensively exploited for heating.

The houses and buildings of Reykjavik are centrally heated by natural hot water brought in insulated ducts from springs many kilometres away and stored in insulated tanks on a small hill in the town. A greenhouse industry based on the heat of natural hot water was developed in the last few decades, notably at Hveragerði (about 30km south-east of Reykjavik), where tomatoes and other fruit and vegetables and also flowers, are grown in considerable quantities.

Hydro-electric power was, of course, a natural development for Iceland when it started to enter its industrial era at the beginning of the twentieth century. Its potential in this respect is enormous, variously estimated at 2½ million hp⁶⁴ to 4 million hp,⁶⁵ or say 3,000 megawatts. This would provide 30,000 million units (kWh) of electricity per year.

The first hydro-electric power station was commissioned in 1902 according to one source,⁶⁶ in 1904 according to another.⁶⁷ The latter states that it was a 9kW station at Hafnarfjörður, near Reykjavik. The main development of hydro-electricity has, however, taken place since 1918. In 1961 the total installed capacity was 141MW.

Electrical communications

A submarine telegraph cable linking Iceland to Europe via Scotland was proposed in 1854.⁶⁸ This was very early, as the first successful telegraph cable across any stretch of sea was that laid across the Straits of Dover in 1851.⁶⁹ In view of Iceland's state of development at that time, it is not surprising that the project did not proceed. The first submarine cable actually laid to Iceland was that from the Shetland Isles to Seydisfjörður in 1906.⁷⁰ This terminal on the east coast was not linked to Reykjavik until 1911 when a line was opened via Akureyri in the north. Connection via the south coast was not opened until 1929.

Telephones were introduced in Reykjavik in about 1900 and a telephone line to Hafnarfjörður (11km) was opened soon after. The system was extended slowly, and in 1930 carrier and teleprinter working was introduced. Now Iceland has a modern integrated telephone system with through automatic working in a large area.

Radio was introduced to Iceland in 1918 when a coast radio station

- 30 IT, 71. 31 IT, 240.
 32 NI, 67-9. 33 NA, 193-4.
 34 Information from Summary Guide to National Museum.
 35 G. M. Crowfoot, 'Textiles, Basketry, and Mats', in C. Singer et al (eds), *A History of Technology*, vol 1, Oxford (1954), 426-8.
 36 NA, 195. 37 KG, 335-67. 38 KG, 340-1.
 39 NA, 57-9. 40 NA, 59. 41 NA, 207-8.
 42 IT, 230-1. 43 IT, 62-3. 44 NI, 250-86.
 45 IT, 229. 46 NI, 86-7.
 47 NI, 369-70. 48 NI, 383.
 49 D. G. Tucker, 'Railways in Iceland', *Industrial Railway Record* (forthcoming).
 50 NI, 382. 51 IT, 223. 52 IT, 292-3.
 53 NI, 149. 54 IT, 64. 55 IT, 73.
 56 D. G. Tucker, 'Windmills and watermills in Iceland', *Industrial Archaeology* (forthcoming).
 57 R. Bennett and J. Elton, *History of Corn Milling*, vol II, *Watermills and Windmills* (1899), 297.
 58 Peter Kidson, *Iceland in a Nutshell*, Reykjavik (1968), 194.
 59 NI, 327.
 60 Especially personal communication from Mr Páll Ólafsson.
 61 NI, 268.
 62 Personal communication from Mr Björn Kristinsson.
 63 IT, 97. 64 KG, 455-6. 65 TT, 163.
 66 NI, 327. 67 IT, 94. 68 NI, 398.
 69 P. Dunsheath, *A History of Electrical Engineering* (1962), 211.
 70 HL, 82-3. 71 NI, 398. 72 HL, 83.
 73 *Facts about Iceland*, Publishing Dept of the Cultural Fund, Reykjavik (1970), 58.

For plates, provided by the author, see pp 97-9

Appendix I

ITEMS RELATING TO INDUSTRIAL HISTORY IN THE NATIONAL MUSEUM OF ICELAND

- Iron** Numerous objects in iron throughout the museum, and many must have been made in Iceland. Swords of great age, knives, axes—some were found in pagan burials of nearly 1,000 years ago (especially Room 1).
 Some very old smith's tools (eg tongs) (Case 9).
 Some pieces of slag, stated to be from the working of bog iron (Case 9).
 Reconstruction of a smith's forge with bellows, but from what period is not stated (Room 14).
- Other metals** Bronze axe from pagan burial } not clear whether made in
 Numerous bronze ornaments } Iceland (especially Room 1).

- Silver chalices of twelfth century. Icelandic workmanship (Case 27) (presumably silver imported).
- Querns** Numerous, using lava.
Stone mill (small) with original stone 'bullet'—used for grinding 'tuff-stone dyes'. (Also other stone vessels) (Room 1).
- Lathe** for wood-turning. Scale-model of lathe where mandrel is given alternating rotation by means of rope wound round it with handles at each end (Room 14).
- Wood-carving** Some fine examples of domestic and church carving.
Textiles Stone-weighted looms (of very ancient type) (Rooms 2 and 13).
 Pile-weaving loom.
 Numerous spinning wheels, all with flyers (Room 2).
 Numerous specimens of woven fabrics.
- Rope-spinning** (Actually 3 strand lines for hand-line fishing.) Machine with two separate end-devices and a sort of slug to tighten up the twist. One end holds 3 strands widely spaced and rotates. The other holds 3 strands as finished line and also rotates. Large stones act as weights to hold each end in place, but there are small wheels at one end for movement as rope lengthens. (Room 13).
- Fishing hooks** }
Fishing boats } mostly nineteenth century.
 (mostly models)
Harpoons, etc for shark and whale-fishing (Room 13).
Printing blocks (wood) dating from 1589 (Room 9).
 Numerous *pictures* covering varied aspects of Icelandic life and activities.

Appendix II

TECHNOLOGY IN THE FAEROES, SHETLANDS, ORKNEYS AND HEBRIDES COMPARED WITH THAT IN ICELAND

Since the circumstances of these five island groups in the North Atlantic region were similar for so long a time, it is useful to compare their technologies. In the centuries before 1900, their populations were comparable, being of the order of 30,000 to 50,000; their climates were not very dissimilar; they all had meagre natural resources; they all had Scandinavian and Celtic racial origins; and all were minor dependencies of a much more prosperous country. It is thus not surprising that their technologies were, for the most part, rather similar. However, less seems to be generally known about the technologies of Iceland than of the other groups.

One of the differences in agriculture is that much less grain has been grown in Iceland than in the other groups. Admittedly the more northerly situation

