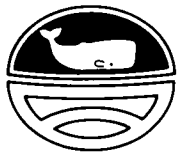

International Whaling Commission

Bibliography of Whale Killing Techniques

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Reports of the International Whaling Commission
Special Issue 7

Cambridge 1986

INTERNATIONAL WHALING COMMISSION
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ISBN 0 906975 14 X
ISSN 0255-2760

Preface

It is with some relief that I'm writing this Preface—the publication of this volume is now imminent some eight years after the idea to compile and publish it was conceived.

A lot of water has passed under and around the bridge of the vessel since then: Canada, whose scientists authored the bibliography, is no longer a member of the IWC; Japan and Norway have made some of the most important technological improvements to killing techniques since the explosive harpoon was invented; and the IWC has implemented a 'pause' in all commercial whaling.

In addition to the valuable bibliography—useful from both an historical and a 'prevention of the re-invention of the wheel' perspective, there is a fascinating Appendix on German electrical whaling which has hitherto been a mythological rather than a historical subject. The final Appendix brings up to the present the story of the humane killing debate within the IWC.

Thanks are due to Stella Bradley for help with proof reading and the indices and to Mr K. Yamamura of the Japan Whaling Association for last-minute help with some of the illustrations.

Finally I'd like to thank Ed Mitchell, Randy Reeves and Anne Evely for the wholehearted way they have fought to prevent me from having a boring life!

GREG DONOVAN (*Series Editor*)
Cambridge
1st December 1986

Cover photo: "Indiens Kodiak Chassant La Baleine. Amerique Russe". A steel engraving from *L'Artiste* Voyage de M. D. de Mofras, 1844.

Kodiak Island lies approximately 50 miles off the south coast of Alaska at the eastern end of the Aleutian chain. Until 1867, the 1,200 mile Aleutian archipelago was part of Russia. Depicted here is the Kodiak, Aleutian and Kamchatka method of hunting the right whale by using aconite poisoning, the dried root of the plant Aconitum or monkshood. The poison was attached to the lance to be implanted in the whale. It took three days for the poison to take effect, during which time the hunters could only wait, hoping the dead animal would drift ashore in their territory and not their neighbour's.

Photo courtesy of the Peabody Museum, Salem, Mass., USA.

Contents

Whale Killing Methods: an annotated bibliography

Whale Killing Methods: An Annotated Bibliography

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INTRODUCTION

Whales have been hunted by humans for more than a millennium, and whaling has occurred in virtually all parts of the world where maritime cultures have evolved near concentrations of whales. Pelagic expeditions have made it possible to exploit whales even in remote polar regions where coasts and ice-edges are uninhabited. The diversity of whale killing methods reflects the broad temporal and geographic extent of whaling enterprises.

During most of the history of whaling, concern has centered on the temporal and economic efficiency of killing techniques. More recently, due in large degree to the perception that cetaceans are intelligent mammals, concern has arisen over the humaneness of killing techniques.

To many minds there is no such thing as a 'humane' method of killing whales. The act of killing the animal—of ending its life—is in itself judged inhumane. Others would argue that there are degrees of humaneness and, given that whaling continues, that it is desirable to strive for the most humane method of killing whales, without at the same time sacrificing too much in the way of efficiency. The ideal killing method would be one which minimized the animal's suffering and at the same time allowed the killing and rendering processes to proceed safely and efficiently.

It is beyond our competence to evaluate the relative humaneness, safety, and economic efficiency of different killing techniques, and we consider it outside the scope of this volume to discuss our personal opinions about whaling. Therefore, we have limited ourselves to the task of developing a construct within which the various whale killing techniques can be understood and compared, in the hope that this effort will expedite research and development towards increasingly 'humane' methods of killing whales.

SCOPE

This work consists of two parts: an introductory essay and an annotated bibliography. In the essay we present an overview of the history of whaling and the invention or development of killing methods. It is organized according to broad categories which, incidentally, fit a more or less chronological pattern. The bibliography is an introduction to the literature on all major techniques for killing whales. Our annotations emphasize two aspects of the killing process: time to death and physiological system affected. These are two measures frequently used to evaluate humaneness. Thus, whenever possible, we have noted the quantitative evidence presented in a given reference concerning either of these criteria.

The list of references is not comprehensive. We have had neither the funds nor the time to exhaust English-language sources, and we have examined only a few Russian, Japanese and Norwegian sources. H. Omura and J. Tønnessen kindly supplied lists of pertinent Japanese and Norwegian references, respectively. Tønnessen also supplied English annotations for some of the Norwegian-language references.

Most of the methods used in the capture of small cetaceans were described by Mitchell (1975). Works concerning the technology of taking small cetaceans are not cited in our list, except for a few references overlooked in the above summary, cited in passing, or related to current methods of taking small cetaceans specifically called inhumane in print.

We have not made an extensive search of archival materials. It is clear that a wealth of such material awaits further research, as noted by Tønnessen (1967–70, vol. 4, p. 649, note 29; and *in litt.* 12 March 1978), especially in the archives of:

1. Universities Federation for Animal Welfare, London, 1948–59;
2. United Whalers Ltd, London;
3. The Association of Norwegian Whaling Companies;
4. The (Norwegian) Whale Board;
5. (The Norwegian Whaling Company) A/S Rosshavet; and
6. Christian Salvesen (Managers) Ltd, Edinburgh.

The files of the former British whaling company United Whalers Ltd, and the files of Universities Federation for Animal Welfare are especially pertinent (Tønnessen, *in litt.*, 13 January 1978).

Much of the correspondence of United Whalers Ltd relating to experiments with electrical whaling is included in the 'Bostock papers' (Bostock, 1930s–1950s). We have examined these papers; translations of published non-English articles as well as relevant unpublished reports to which an author could be ascribed have been extracted and cited in our bibliography. Many letters, memoranda, and technical reports containing specifications for whaling equipment have not been included in our list; anyone seriously interested in innovation or further practical experimentation with electrical whaling would be well advised to consult the Bostock papers directly.

There are hundreds of English-language books and articles that recount the basic procedures of modern whaling but which do not appear in this bibliography. Many of them are based on first-hand observations and thus offer insights of a primary nature. Nevertheless, in order to insure that ours is a bibliography of whale killing techniques rather than of the whaling industry as a whole, we have included only a sample of such references (see Allen, 1882; Ågård 1930; Vaucaire, 1941; Jenkins, 1948). The decision to cite a given reference was usually made because the book or article included exceptional illustrative material and/or a technical, quantitative account of some aspect of the killing process. We also tried to include books and papers that contain substantive discussions of humane issues related to whaling.

There is a very extensive literature on premodern aboriginal whaling, much of it centred on whale killing techniques. Again, we have refrained from making this a bibliography of aboriginal whaling (see Heizer, 1968). Rather, we have included only a sample of the available literature concerned specifically with aboriginal whaling, and priority has been given to those references published subsequent to Heizer.

Fig. 1. 'Natives hunting the beluga or white whale, Cook's Inlet, Alaska.' Drawing by H. W. Elliott *in* Goode, 1887, plate 201; see Clark (1887, p. 61–2).

HARPOON-LINE-FLOAT

One of the most ancient and widespread methods of capturing large whales is the harpoon-line-float technique, with usually a separate hand lance used for effecting the kill. It hinges on the principle of fastening one or more lines and buoys to the animal with harpoons to impede its progress through the water, mark its whereabouts during subsequent chasing and facilitate carcass recovery. Many variations and modifications of the primitive design have appeared. Before the development of explosive harpoons, rockets and 'bombs' of various sorts during the second half of the nineteenth century, however, the functional distinction between the harpoon, for fastening, and the lance, for killing, was essential.

The use of harpoon-line-float technology by aboriginal peoples has been well documented, and many of the references are in Heizer's (1968) very useful bibliography. Similar principles are still applied in 'transitional' whaling (see Mitchell and Reeves, 1980, for definitions) by native Alaskans and many hunters of small and medium-sized cetaceans (e.g. Sonnenfeld, 1960; Durham, 1974; Fiscus and Marquette, 1975; Marquette, 1976 *et seq*; Mitchell, 1975; Finley *et al.*, 1980; Fraker, 1980). The introduction of explosives, including rifles, shoulder guns and bomb lances, as well as outboard motors, has changed the character of 'aboriginal' whaling in most areas.

HARPOON-LINE-FAST BOAT

The Yankee sperm whalers coined the expression 'Nantucket sleighride' to describe the technique of fastening to a harpooned whale and being towed by it at high speeds. Their whaling technique involved direct fastening of the boat to the whale with a harpoon and line. Generally the harpooner would throw the harpoon from the bow of a whaleboat. Then, after much of the line had been let out, the whale either towed the boat, which acted as a drag, or threatened to pull it below the surface, at which time the fast-line might be cut. The boatsteerer would then

change places with the harpooner, coming up on the whale close enough to administer a hand lance or (later) a bomb into the surfacing whale to kill it.

Rink (1877, p. 112) stated: 'The use of harpoons, lines and lances is perfectly analogous among the European and Eskimo hunting at sea. The chief difference in their proceedings appears to be the mode of retarding the animal while running off the harpoon and lines. The Greenlander manages this by throwing out an inflated bladder attached to the other end of the line, but the European whaler still keeps this end of the line in the boat of the harpooner, only letting go so much of the line as is necessary to prevent the boat from being capsized and drawn down, while the terrified animal, being still in possession of its whole power, runs off with extraordinary quickness. The seal, or whale, having become sufficiently exhausted by dragging the boat, the mortal wounds are finally inflicted by the help of the lance.'

The basic harpoon-line-fast boat technique was used by the European and American whalers who hunted the bowhead (*Balaena mysticetus*) in the Arctic and the right whale (*Eubalaena* spp.) and sperm whale (*Physeter macrocephalus*) in temperate and tropical latitudes (Conway, 1906; Scammon, 1874; Brown, 1887). The sperm whale fishery in the Azores is the best recent and present-day example of the conventional nineteenth century technique, although it has been modified somewhat to take advantage of motor transport in traveling to and from the whaling grounds (Clarke, 1954a; Venables, 1968; Housby, 1971).

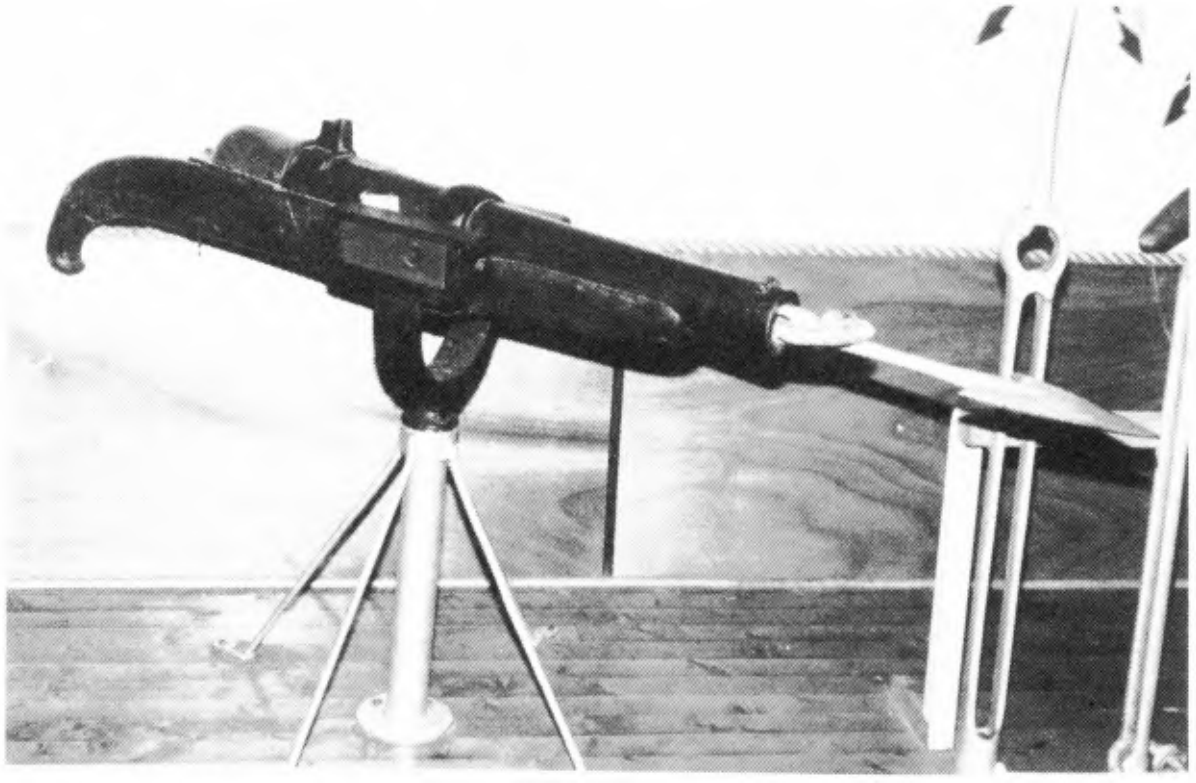

Fig. 2. Harpoon gun from S. Foyn collection, Tonsberg Museum, Norway, dated 1865. Courtesy of I. Christensen.

MECHANICALLY PROPELLED HARPOONS

Whalers were quick to realize that the range and impact of harpoon delivery could be increased if something other than the strong arm of the harpooner were used to propel the weapon. Bond (1753) sought to devise a machine along the lines of the ancient 'Balista' for hurling darts and other killing or fastening devices at whales.

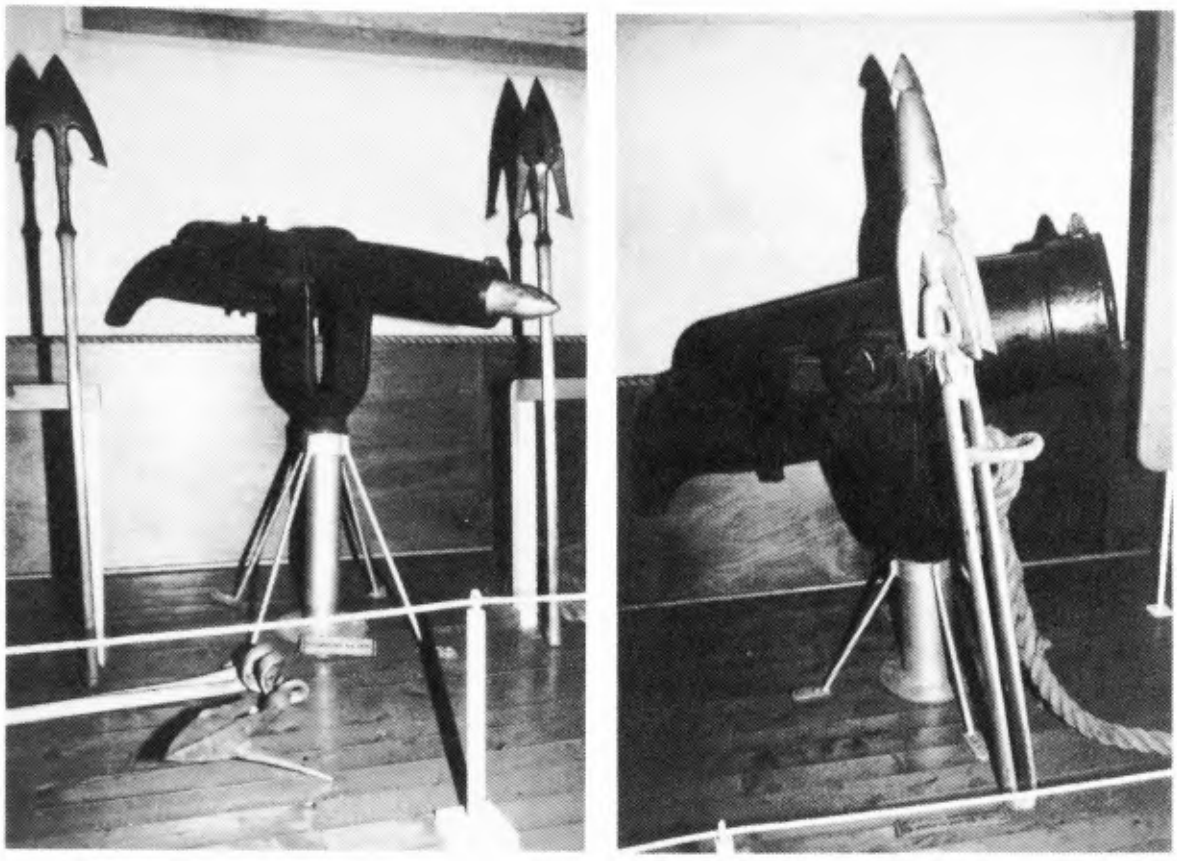

Fig. 3. Granatkanon (grenade-gun) and grenade harpoon from S. Foyn collection, Tonsberg Museum, Norway, dated 1865. Courtesy of I. Christensen.

The earliest 'bomb-gun' may have been the one used in 1731 by whalers working for the South Sea Company (Scoresby, 1820; Browne, 1846). In spite of inducements offered to experimenters by the Society of Arts, British whalers had still not adopted widely the use of gun harpoons in Scoresby's time.

There was a wide assortment of explosive whaling weapons—variously called bomb-guns, rocket-guns, darting-guns, shoulder guns, or bomb-lances—available to whalers during the second half of the nineteenth century (*Whalemen's Shipping List*; Brown, 1887; Scammon, 1874; Bodfish and Allen, 1936; Johnsen, 1959; Credland, 1978–79; Henderson, 1972), and there was much inefficiency in their use (Clark, 1887; Starks, 1922). Some locally invented explosive weapons have been impressive in their originality but of questionable efficiency and humaneness (e.g. Ommanney, 1933; Dawbin, 1967; Rathjen and Sullivan, 1970; Gaskin and Smith, 1977; Anonymous, 1981; Mitchell and Reeves, 1982).

Undoubtedly the most successful and celebrated inventor in whaling history is the Norwegian Svend Foyn, whose development of the deck-mounted cannon firing a harpoon tipped with an exploding grenade from a steam-driven catcher boat formed the basis of modern whaling technology (Johnsen, 1940, 1943, 1947, 1959; Bakken, 1964; Tønnessen, 1967–70). Other workers whose efforts in refining whaling-gun technology are well documented include Manby (1822), Roys (Schmitt *et al.*, 1980) and Greener (1967). Much experimentation and invention has taken place since Foyn's time (e.g. Johnsen, 1947; Hirata, 1951), but modern whaling continues to follow his basic techniques (e.g. Schubert, 1955; Wise 1970; Ash, 1962, 1964).

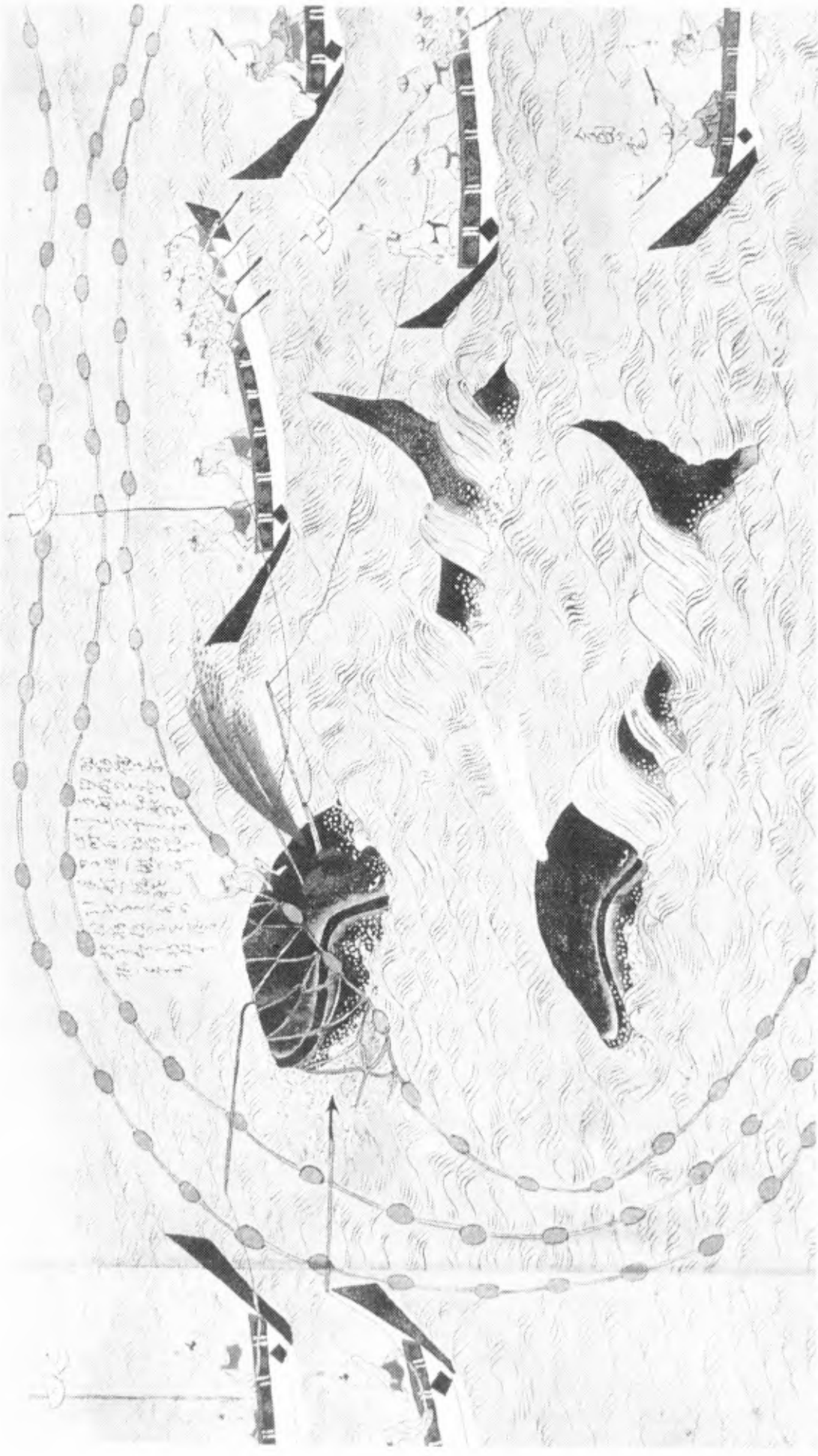

Fig. 4. Extract from picture scroll (painted *ca* 1800) showing net whaling. The picture was painted in Kyushu but no further details are known. (Reproduced from a 1984 calendar produced by the Japan Whaling Association. Original preserved at the Historical Documents Division, National Institute of Japanese Literature, Tokyo, Japan.)

ELECTROCUTION

Electrocution is the whale killing method that has come closer than any other to supplanting the now-conventional explosive grenade harpoon. Interest in electric whaling existed as early as the 1850s (Anon., 1853; Brown, 1887; Tanner, 1892; Spears, 1908) and 1860s (Anderson, 1869; Anon., 1869), and a British patent for an electric harpoon was issued in 1868 (Anon., 1952a; Jupe, 1952). Twentieth-century electric whaling technology is vastly improved over the primitive German 'magneto-electric rotation machine' of the 1850s described by Brown (1887).

Before World War II there was considerable interest in this technique in Germany, and the engineer Weber (1939) pioneered much of the technology on which subsequent experimentation was based (Anon., 1937, 1941; Clarke, 1952). In 1929, four fin whales (*Balaenoptera physalus*) were electrocuted off Norway, and 250 whales were caught by the 'Ross Clarke fleet' using Weber's apparatus in the 1932/33 season (Jupe, 1952). By 1938, just before the outbreak of World War II, about 2,000 whales are said to have been killed by electrocution during six expeditions (Sundt, 1938; Clarke, 1952). Weber supposedly committed suicide near the end of the war, and it was believed that his technical papers had been destroyed (Anon., 1952c). Nevertheless, when Lillie (1949b) raised the question after the war of the humaneness of modern whaling, experimentation with electrocution resumed (Anon., 1952b). A more detailed account of pre-World War II German electrical whaling is given in Appendix 1 of this volume.

Several British (Anon., 1952c, 1958) and Norwegian (Anon., 1960 Ms.) companies made a serious attempt to develop electric whaling beyond its experimental phase. It soon came to be viewed by some as 'the solution of the problem' (Lillie, 1949a). The advantages of electric whaling were said to include a lower sinking loss rate, improved quality of meat, and savings in time and equipment (e.g. Lillie and Hume, 1949; Reichert, 1949; Anon., 1952c; Marsden, 1952c; Clarke, 1952). Some observers were convinced that electric whaling is also much more humane than conventional shell harpoon whaling, as it supposedly reduces substantially the average time elapsed between the firing of the first harpoon and the whale's death (e.g. Marsden, 1952a, b).

The anticipated conversion from explosive harpoon to electric harpoon never occurred, however. Technical problems with stretchable conductors and current leakage, as well as apprehension concerning crew safety, have been cited as reasons for the demise of electric whaling (e.g. IWC, 1980 Ms.). At the time of writing (1983) although electric lances are used routinely by the Japanese to kill minke whales (*Balaenoptera acutorostrata*) tethered and drawn to the catcher boat with a 'cold grenade' harpoon (Hasui, 1980 Ms.; Hayashi, 1980 Ms.; IWC, 1980 Ms.), the method of capturing whales with an electric harpoon is for all intents and purposes obsolete.

NETS

The effectiveness of using nets in the capture of large whales has not been widely appreciated. Aside from the unsuccessful attempt to net a bowhead whale off Labrador mentioned by Brown (1887), nets have mainly been used in Japan, New Zealand, and Norway. The Japanese method begun in the seventeenth century involved the driving of whales into a net enclosure, then harpooning and lancing them to death (Fraser, 1937–38; Omura *et al.*, 1953; Anon., 1954a; Hawley,

1958–60; Hashiura, 1969). The large steel nets used at Whangamumu, New Zealand, beginning in 1890 appear to be the only ones of their kind employed by nineteenth and early twentieth century commercial whalers (Fagan, 1911; Ommanney, 1933; Dawbin, 1967). In Norway, herring nets were used to block off inlets and prevent the escape of whales that where shot with darts smeared in bacillus poison (Hansen, 1887; Brunchorst, 1889, 1899; Heizer, 1943a; Jonsgård, 1955).

DRUGS AND POISONS

The use of various poison substances and drugs to kill whales has long been seen as a way to increase whaling efficiency. It is not entirely clear why drugs and poisons have not been more widely adopted in the whaling industry (see Heizer, 1967), but safety concerns are probably the most significant reasons.

Native peoples of northeastern Asia and northwestern North America were probably the first poison whalers. They coated their lance tips with 'a crude but deadly concentrate of aconite rendered from the roots of the *Aconitum* plant by boiling' (Heizer, 1968, p. 345; also see Heizer, 1938a, b; Bisset, 1976).

At least one European experimenter, the Frenchman Thiercelin, attempted to use a combination of strychnine and curare (Anon., 1867b, 1872; Thiercelin, 1866). Little has been heard about this method since then, although there may have been some Soviet experiments with curare during the 1960s (Anon., 1964a).

Harpoons have been charged with small amounts of hydrocyanic (prussic) acid to paralyze the whale and facilitate its capture (Adams, 1887; Christison, 1860, 1862). Experiments were made with prussic acid whaling as early as the 1830's and the idea may have been conceived even earlier (Lewthwaite, 1833). However prussic acid lost favor with whalemen after several of their own number died from accidents during its use (Brown, 1887).

A recent experimental attempt to kill white whales (*Delphinapterus leucas*) with succinylcholine chloride was inconclusive (Anon., 1962; Flyger, 1964), but there is still some interest in this technique (cf. Baldwin and Williams, 1973 Ms.). Japan conducted ten experiments with succinylcholine since 1964 but dropped this effort for practical and safety reasons (IWC, 1979 Ms.; IWC, 1980 Ms.; Hasui, 1980 Ms.)

Efforts to immobilize gray whales (*Eschrichtius robustus*), using specially designed harpoons and syringe darts to deliver various tranquilizing drugs, resulted in the unintentional killing of two whales (Spencer, 1973). This led to a criticism of such work (Schevill *et al.*, 1967).

GAS INJECTION

The potential of gas injection as a means of killing whales, or at least immobilizing and giving buoyancy to them prior to killing, was emphasized by Ridgway and Flanigan (1981). Norwegian experiments with injection of compressed carbonic acid (CO_2) to kill whales in the 1950s were judged unsuccessful (Anon., 1952a, 1959 Ms.). An earlier test with 'carbon dioxide bombs' shot from a helicopter, although successful, did not convince gunners to adopt the method (Grierson, 1949).

In spite of the possible advantages of killing by gas embolism, enough difficulties have been experienced in experiments to date to make it unlikely that compressed gas will be used for killing whales on a wide scale during the foreseeable future (IWC, 1980 Ms.; Hasui, 1980 Ms.).

RIFLES

Rifles and other small arms have been used to shoot whales to death. This method, employed widely in fisheries for small cetaceans, sometimes in combination with harpoons and sometimes not (Mitchell, 1975; Finley *et al.*, 1980; Kemper, 1980; Fraker, 1980), has not often been practiced in fisheries for large whales, probably because it is inefficient. However, gray whales and bowheads have been killed with rifles by native hunters in high latitudes of the Northern Hemisphere (Durham, 1979 Ms.; Zimushko and Ivashin, 1980; Mitchell and Reeves, 1982), and 'Krag rifles' were used to hunt minke whales in Norway after about 1890 (Jonsgård, 1955). In recent years large caliber rifles have been used in the Norwegian small whale fishery to kill whales harpooned but not killed with the cold grenade (IWC 1980 Ms.; IWC, 1981b; Anon., 1982a). The Japanese experimented with exploding bullets in 1973/74 but abandoned these in favor of electric lances to kill whales shot with a cold grenade (IWC, 1980 Ms.).

THE INTERNATIONAL WHALING COMMISSION'S CONSIDERATION OF HUMANE KILLING UP TO 1982

At the ninth annual meeting of the International Whaling Commission, held at London in June 1957, it was noted that the Royal Society for the Prevention of Cruelty to Animals (United Kingdom) had raised with the Commission the matter of humane killing of whales (IWC, 1958, p. 18–19). The following year the World Federation for the Protection of Animals made representations to the Commission concerning the humaneness of modern whaling (IWC, 1959, p. 16). The Commission 'did not accept the charge that the present method was inhumane', noting that experiments with electric whaling had not shown conclusively that electrocution is a humane alternative to whaling with the explosive harpoon. It did, however, endorse 'the spirit' of a resolution adopted by the 1958 Geneva Convention on the Law of the Sea calling for humane killing of all marine life, particularly whales and seals.

Finally, in 1959, a working party was formed 'to examine the advantages and disadvantages of the various methods of killing whales which had so far been tried with a view to recommending a programme of research and development' (IWC, 1960, p. 19). The working party's report was presented at the Commission's eleventh meeting in 1960 (see Board, 1960 Ms.; Marsden, 1960 Ms.; Trouton, 1960 Ms.; Van Dijk, 1959 Ms.; IWC 1961a, b; Dawbin, 1960 Ms. a, b). This group identified speed of killing (i.e, death-time or time to death) as the main test of humaneness and concluded that no method was likely to prove more humane than explosive harpooning. It also stated there was no evidence of electric whaling being more humane than conventional shell harpooning. Nevertheless, the working party and the Commission recommended technical consultations between representatives of the United Kingdom and Norway to advance the 'prospect of further progress towards the development of a satisfactory electric harpoon' (IWC, 1961a, p. 19).

The results of the ensuing discussions were presented at the Commission's 1961 meeting (Marsden, 1961 Ms.). 'Recent advances in the design and technique of explosive harpooning had, it appears, reduced the time taken to kill and very often ensured instant death. This meant that explosive harpooning killed as quickly as the electrical method' (IWC, 1962, p. 22). The Commission concluded that the conventional explosive harpooning method was 'not necessarily inhumane.' No new experimentation was recommended, and the Working Party on the Humane Killing of Whales was 'dispersed'. Further experiments by Japan, Norway, and the USSR were anticipated (IWC, 1962).

The IWC took no further action on the subject of humane killing until 1975. That year the subject of humane killing returned to the Commission's agenda (IWC, 1977b). The Scientific Committee recommended to the Commission that enquiries be made concerning new developments in chemicals and explosives, as well as in whaling practices, that might improve efficiency. These enquiries did not bring to light any important new developments (IWC, 1977a, p. 18). Best's (1975) report had suggested 'that it is unlikely that death-times could be substantially reduced, at least for sperm whales, by any other method than explosive harpoon' (IWC, 1977a).

In 1976 the Scientific Committee reviewed two new documents (Ohsumi, 1977; IWC, 1977a) and made further recommendations concerning humane killing (IWC, 1977d, p. 50–51). The drug Etorphine Hydrochloride (M 99) was deemed suitable for anesthetising large cetaceans, but the need to test the floatability of anesthetised whales and to avoid contamination of the meat were cited as potential problems. The committee continued to view the rapidity of rendering unconscious and killing the whales as the most important factor in judging humaneness. Based on data presented by Best (1975) and Ohsumi (1977), it was 'uncertain' whether a drug could reduce death-times consistently below those achieved with the explosive harpoon. Consideration was given to the need for an alternative to the conventional method of killing minke whales with the 'cold grenade'.

A series of recommendations were made by the Scientific Committee and accepted by the Commission in 1976 (IWC, 1977c, p. 27). These were:

(a) The Secretary should contact health authorities in the UK, USA, Japan and other member countries to determine their regulations concerning the use of chemicals in the slaughtering process.
(b) The Secretary should contact member nations taking minke and other small whales and ask them what methods were used at present to secure and kill them.
(c) The Secretary should contact the US Government with regard to experiments on the application of CO_2 gas as a method of euthanasia.
(d) The Secretary should contact member whaling nations to enquire whether research into the use of high velocity projectiles for speeding death times is being considered.

Another review of the subject of humane killing occurred in 1977. The Scientific Committee considered several documents, including Rowsell (1978), Blunden (1978) and Anon. (1978), but in general noted a 'poor response' by member governments to the requests made the previous year (IWC, 1978b, p. 73). This was attributed to the lack of significant research and experimentation since the 'particularly comprehensive study' of the subject made in 1960–61. High velocity projectiles and drugs such as M 99 were considered the most promising avenues of

further work, and attention was again drawn to the need for monitoring use of the 'cold grenade'. Significantly, the Commission resolved to develop its own research programme to investigate humane killing methods (IWC, 1978a, p. 25).

An earlier draft of this bibliography was circulated as SC/30/Doc 38 at the IWC's thirtieth annual meeting in 1978 (IWC, 1979b, p. 54). At the same meeting, the Sub-Committee on Humane Killing Techniques of the Scientific Committee met and prepared a detailed report (IWC, 1979b). The subcommittee concluded that explosive harpooning is still 'the most reliable and efficient method of killing whales'. Hand harpooning and the whaling methods of Alaskan Eskimos were described as 'inefficient' and said to 'undeniably prolong death times'. The subcommittee's four recommendations, endorsed by the Scientific Committee and accepted by the Commission, are listed in the annotation for IWC (1979a). These recommendations led the Commission to fund the work of Rowsell (1979) at the Icelandic whaling station (summarized in IWC, 1980b, p. 59). In our view, Rowsell's study was ill-conceived in that whales observed being killed at sea were not examined ashore. Thus, there was no opportunity to correlate wounds and pathological findings with death-times and behavioural observations. Rowsell's post-mortem observations were made of carcasses for which no pre-mortem, at-sea observations had been made. At its 1978 meeting the Commission also passed a resolution requiring member states to report routinely on death-times and on information relating to the reliability of killing devices (IWC, 1979a).

At its 1979 meeting the Commission adopted a series of nine recommendations related to humane killing (IWC, 1980a; also IWC, 1979 Ms.; IWC 1980a,b). It was agreed that all whaling operations should be required to collect and report data relevant to the technological and physiological problems of measuring and minimizing death-times. A decision was made to move for prohibition of the use of the cold grenade in whaling for whales larger than minke whales, and a strong endorsement was given to efforts at shortening death-times in fisheries for small cetaceans. The Commission also called attention to the possibly 'inhumane' nature of various small cetacean and 'aboriginal' or 'subsistence' whale fisheries. Finally, an initiative was begun at this meeting for a Commission-sponsored workshop 'to consider methods of improving existing killing techniques or to suggest alternative, more humane methods'.

In 1980 the Commission's schedule was amended to include the following (see IWC, 1981a): 'The killing for commercial purposes of whales, except minke whales, using the cold grenade harpoon shall be forbidden from the beginning of the 1980/81 pelagic and 1981 coastal seasons.' It further resolved that use of the cold grenade harpoon for killing minke whales should be banned. In autumn of 1980 the Workshop on Humane Killing Techniques for Whales took place in Cambridge (IWC, 1980 Ms.).

The workshop report was reviewed at the Commission's 1981 meeting, and attention was focused on the questionable humaneness of 'aboriginal' or 'subsistence' whale fisheries (IWC, 1982). Support was given to the proposal for work by a British veterinarian at Iceland, who would document death-times at sea, then conduct post-mortem examinations of the same whales.

Two national groups have been especially responsive to the Commission's call for additional research on killing techniques and efforts to measure and minimize death-times: Japan and Norway. This, and more recent developments in the consideration of humane killing by the IWC, are discussed by Donovan in Appendix 2 of this volume.

ACKNOWLEDGEMENTS

We are pleased to acknowledge help received compiling this list. Each of the following individuals called one or more pertinent references to our attention: J. W. Anderson, J. Barzdo, R. Blunden, M. W. Cawthorn, I. Christensen, A. Collet, G. Donovan, R. Gambell, M. V. Ivashin, Å. Jonsgård, F. Kapel, D. Marchessaux, A. J. Mence, H. Omura, G. Pilleri, W. M. Scott, W. E. Schevill, J. N. Tønnessen and F. H. Winter. We are especially indebted to J. N. Tønnessen for translating much Norwegian-language literature into English for our use. Also we thank G. Horonowitsch for assisting in the translation of Russian-language materials. N. Carter of ISPA aided in obtaining a copy of the 'Bostock papers'. J. J. Seiler carried out a preliminary literature search. Initial encouragement and financial support came from N. R. Jotham, Canadian Federation of Humane Societies, Ottawa. Revision and completion from an early draft of this document was supported by a grant from the editorial office of the International Whaling Commission. Particular thanks are due to Micheline Stawski for her extensive work on an earlier draft of the Bibliography.

NOTE TO THE BIBLIOGRAPHY SECTION

The Bibliography does not include papers submitted to IWC meetings after 1982. These are extensively discussed in Appendix 2 by Donovan which examines the IWC's involvement in humane killing since 1982. Additional references on electrical whaling are included in Appendix 1 by Mitchell. References in both Appendices are included in the Index section.

Bibliography

One of a series of four prints by John Heavsiside, Edinburgh (*ca* 1770–1863) published in 1813 by Edwd. Orme, London. Photo courtesy of the Peabody Museum, Salem, Mass., USA.

1. Adams, J. E. 1970. Marine industries of the St. Vincent Grenadines, West Indies. University of Minnesota, Ph.D. Thesis, Anthropology. Ann Arbor, Michigan, University Microfilms International, pp. [i–xi] + 1–328.

Description of historic and contemporary humpback whaling in West Indies. Chapter V is called 'Whaling'; section E (pp. 109–17) describes 'The Hunt.' Hand harpoon 'could not be thrown far'. Bomb lance, shot from shoulder gun or darting gun, consisted of a brass cylinder 14 in. long with a pointed head and metal 'feather'. Time fuse made it discharge after entering whale. Bronze shoulder gun used in late 1800's and early 1900's; replaced by darting gun in early 1920's. Now 'harpooner could strike and kill the whale in one operation' (p. 116). Shoulder gun still used, and hand lance used for 'backing up' other implements.

2. Adams, J. E. 1971. Historical geography of whaling in Bequia Island, West Indies. *Caribbean Studies*, Vol. 11, No. 3, pp. 55–74.

Basically same as 'Whaling' chapter of Adams (1970).

3. Adams, J. E. 1975. Primitive whaling in the West Indies. *Sea Frontiers*, Vol. 21, No. 5, pp. 303–13.

Illustrated popular article on contemporary whaling for humpbacks at Bequia. Whales chased in open boats; hand harpoon with Manila rope used to fasten; 'bomb lance, an explosive projectile discharged from a shoulder gun [*sic*]' and hand lance used to kill.

4. Adams, W. 1887. [Communication to S. F. Baird, U.S. Commissioner for Fish and Fisheries from Capt. William Adams.] p. 249. *In:* Brown, J. T., *2.-Whalemen, Vessels and Boats, Apparatus, and Methods of the Fishery*. Section 5, Volume 2, Part 15, pp. 218–93. *In:* Goode, G. B., *The Fisheries and Fishery Industries of the United States*. Washington, Government Printing Office.

Account of whaling with prussic acid. Adams used a 'large two-grooved rifle' weighing 28 lb to shoot a shell filled with 0.5 oz concentrated prussic acid and a small charge of powder with a 10-second fuse. One bowhead killed after whalers got fast with gun harpoon. After first prussic acid shell was fired, the whale dived 4–5 minutes. A second shell was fired, and whale 'seemed quite helpless.' Shot three more times with gun harpoon.

5. Ågård, B. 1930. *Fangst Og Forskning I Sydishavet*. Annet Bind. Nye Tider. Gyldendal Norsk Forlag, Oslo. pp. [i–viii] + 419–1068 + [i–ii] + 1 folding map + 1 folding pl. [This volume is II of III.]

Emphasis on Norwegian whaling and sealing in the Antarctic during the twentieth century. Contains an extensive bibliography of whaling literature (pp. 1033–1068). [In Norwegian.]

6. Allen, J. A. 1882. Preliminary List of Works and Papers relating to the Mammalian Orders of Cete and Sirenia. Department of the Interior. *United States Geological and Geographical Survey. Bulletin of the Survey*, Vol. 6, No. 3, pp. 399–562.

Extensive, detailed and annotated; covers literature published between 1495 and 1840. Includes many titles on whaling.

7. Andersen, L. 1936. Lars Andersen does not find that the electrical method of shooting whale has any more advantages than the old one. [English] Translation. [From] Sandefjords Blad 5th March 1936 [with a covering letter from A. C. Olsen, Sandefjord 9th March 1936 to H. Charles Watt Esq., London]. 3 pp. typescript. Old Dartmouth Historical Society. Whaling Museum Library, New Bedford, Mass. Bostock Papers, IMA Microfilm #1722 and #1723.

Polemic against article by R. Sundt (1936b). Author claims 25 years of experience as a whale gunner and complains of poor performance by experimental electrical apparatus on board 'H.J. Bull' in 1936–7 season. Shortcomings said to include: failure to kill instantly; requirement to approach within 30 fathoms of whale before shooting; 'swinging' of the harpoon at long distances; and failure of system when harpoon passes through the whale, barely penetrates the blubber, or 'gets in on the legg.'

8. Anderson, G. 1947. A whale is killed. *Beaver*, Outfit 277, pp. 18–21.

Bowhead kill in 1946 using harpoon gun inherited from Dundee whalers, a shoulder gun, and hand lances. Death-time of more than 45 minutes. Two photographs, one showing Cumberland Sound Eskimos with the aforementioned equipment, the other showing whaling implements in the Hudson's Bay Company historical collection, including British harpoon gun, shoulder gun, and bomb lance.

9. Anderson, R. 1869. Capturing whales by electricity. *The Engineer*, Vol. 28 (3 Sept.), pp. 161–2.

Argument strongly supporting use of rocket gun in whaling and debunking use of electrical whaling technique proposed by 'Mr Rogers'. Rogers' apparatus supposed to paralyze whale, allowing it to be towed alongside vessel, 'when it may be easily dispatched.' Both Anderson and Rogers are concerned with developing a method for taking large rorquals.

Anderson's rocket gun harpoon is described and illustrated. It was fired from the shoulder and weighed about 30 lb. The bomb, shot from a distance of 70–90 ft or less, had a 10-second fuse.

10. Andrews, R. C. 1916. *Whale Hunting with Gun and Camera*. D. Appleton and Company, New York, pp. i–xxiv + 1–333.

Descriptions based on first-hand experience of various shore whaling operations during the early 20th century. Includes photographs of capture and processing. One chase of a blue whale is described as covering nearly 130 miles and lasting most of a day. Several harpoons were needed.

11. Anonymous. 1783. [Gun Harpoons.] *Transactions of the Society, Instituted at London, for the encouragement of Arts, Manufactures, and Commerce; with the Premiums offered in the Year 1783*. Vol. 1, pp. 42, 214–15.

According to Allen (1882, p. 473; see entry 6): 'Whale-Fishery,' p. 42 (announcement of the successful introduction of the gun harpoon). 'Gun for throwing Harpoons,' p. 215 (prize offered for improvement in its construction). 'Harpoon to be thrown by a Gun,' p. 215 (prize offered for improvements in its construction). These offers, as also a prize for the capture of Whales by use of the harpoon gun, were annually renewed by the society for many years. See the society's *Trans.*, 1784 *et seq.*'

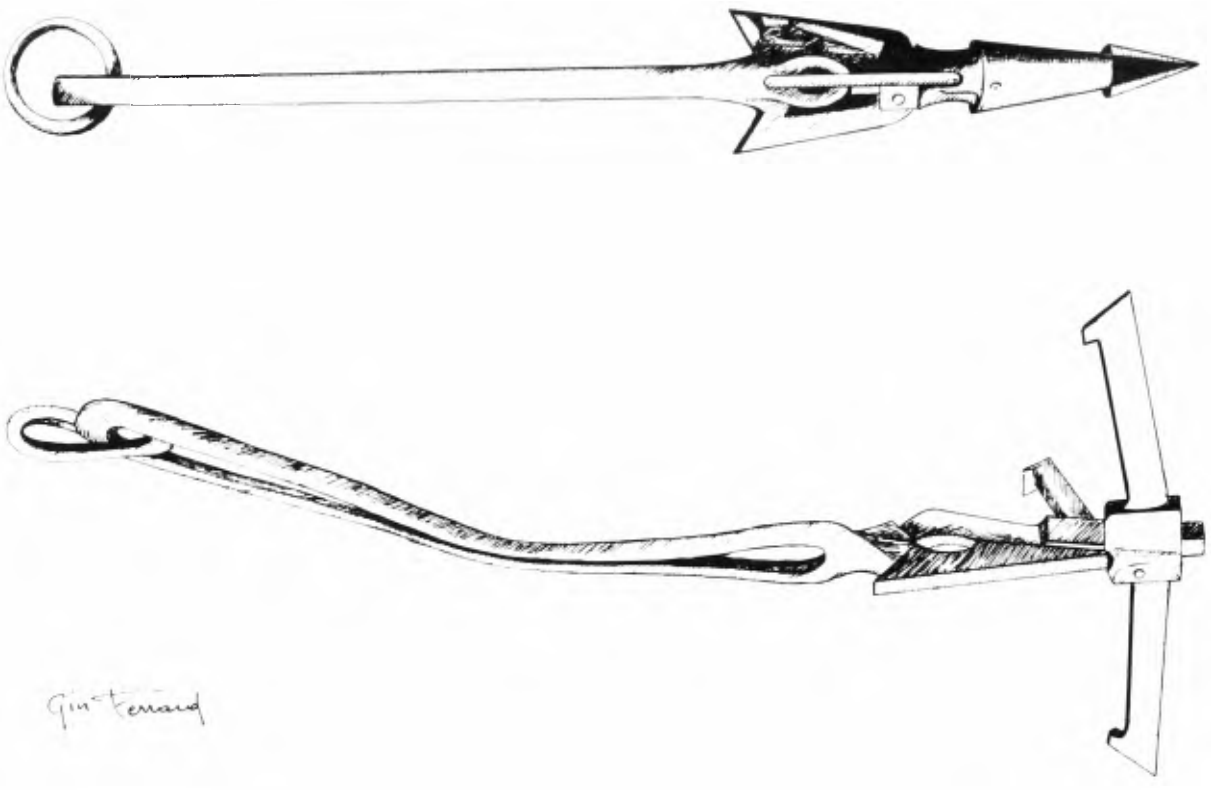

Fig. 5. Rendering by G. Ferrand of photographs *in* Andrews (1916, p. 15). Top: 'The harpoon is tipped with a hollow point called the "bomb", which is filled with powder and ignited by a time fuse. The barbs, or flukes, are tied to the shaft of the iron.' Bottom: 'The harpoon after it has been fired into the body of a whale. The bomb has exploded and the shaft is bent.'

12. Anonymous. 1784. A short account of the invention of the gun harpoon. ***Transactions of the Society, Instituted at London, for the encouragement of Arts, Manufactures, and Commerce; with the Premiums offered in the Year 1783.*** **Vol. 2, pp. 191–5.**

Account of a harpoon 'to be fired from a swivel gun' invented in 1771 by Abraham Staghold, with a plate giving figures of the harpoon and gun.

13. Anonymous. 1790. [Award of premiums for improved gun-harpoon and capture of whales by its use.] ***Transactions of the Society Instituted at London for the encouragement of Arts, Manufactures, and Commerce; with the Premiums offered in the Year 1790.*** **Vol. 8, pp. 236–7**

An announcement of rewards given for developing an 'improved Gun for throwing Harpoons' and for using a gun-harpoon to kill whales.

14. Anonymous. 1791a [Certificates of capture of whales by use of the gun-harpoon.] ***Transactions of the Society Instituted at London for the encouragement of Arts, Manufactures, and Commerce; with the Premiums offered in the Year 1791.*** **Vol. 9, pp. 158–66.**

Statements by British whaling masters certifying that various individuals harpooned whales (all or most of them bowheads) with gun-harpoons in 1790. These certificates were needed before premiums could be awarded to the harpooners. Periods of up to 2 hours from first strike to the whale's death are noted.

15. Anonymous. 1791b. [Award of premium for improved gun-harpoon.] *Transactions of the Society Instituted at London for the encouragement of Arts, Manufactures, and Commerce; with the Premiums offered in the Year 1791.* Vol. 9, p. 167–68 + pl. 4.

Testimonial for gun-harpoon invented by Charles Moore of East Smithfield, with a description and plate of 'Mr. Chas Moore's improved Harpoon Gun.'

16. Anonymous. 1792. [Certificates of capture of whales by use of the gun-harpoon.] *Transactions of the Society Instituted at London for the encouragement of Arts, Manufactures, and Commerce; with the Premiums offered in the Year 1792.* Vol. 10, pp. 238–45.

Statements by British whaling masters certifying that various individuals harpooned whales (all or most of them bowheads) with gun harpoons in 1791. These certificates were needed before premiums could be awarded to the harpooners. Periods of up to 2 hours from first strike to the whale's death are noted.

17. Anonymous. 1852. Electricity applied to the capture of whales. [Newsclipping] Coll. 58, G. W. Blunt White Library, Mystic Seaport Museum, Mystic, Connecticut. [Attributed to the 'Inquirer', June 2, 1852; article from *New Bedford Mercury*.]

An apparatus for electrocuting whales was placed aboard two whaleships from Bremen, Germany. The experiment's results are not indicated. An electro-galvanic battery was connected to the harpoon with a metallic wire, and the parts 'so arranged as to reconduct the electric current from the whale through the sea to the machine'. The idea was to 'throw' into the whale's body 'eight tremendous strokes of electricity in a second, or 950 strokes in a minute, paralyzing in an instant the muscles of the whale and depriving it of all power of motion, if not actually of life'.

18. Anonymous. 1853. Whaling by electricity. *Whalemen's Shipping List* 12 April 1853. Vol. 11, No. 6, p. 42.

Reports arrival at New Bedford of H. Rechten of Bremen, inventor of process of killing whales by electricity. Had sailed to Pacific on ship *Averick Heineken* 'for the purpose of testing his apparatus.' Experiments considered successful, and Rechten bound to New York to report details of his 'cruise upon the north-west coast' to Mr. Heineken.

19. Anonymous. 1857a. Harpoon gun for whale fishers. *The Practical Mechanic's Journal*, Vol. 2 (April 1), pp. 4–5.

Note on the use of a swivel gun for discharging harpoons. Modifications by A. Mitchell said to improve aim.

20. Anonymous. 1857b. Harpoon guns and harpoons. *The Practical Mechanic's Journal*, Vol. 2 (December 1), pp. 238–9.

Illustrations and specifications for a patent issued to R. Tindall, Jr. An expanding harpoon is shot into the whale, and a charge of powder is timed to detonate after the harpoon is embedded, filling the animal 'with gaseous matters'. A modification of the harpoon gun is supposed to improve shooting accuracy.

21. Anonymous. 1860. Novel capture of whales. *Whalemen's Shipping List* 14 August 1860. Vol. 18, No. 23.

A poisoned harpoon was used by the British in the Greenland whale fishery. At least one whale was killed with it.

22. Anonymous. 1866. [Untitled]. *Whalemen's Shipping List* 6 November 1866. Vol. 24, No. 36.

'A new kind of harpoon has been invented in France, so arranged as to contain a pound of powder which is ignited in ten seconds by means of a fuse, and instantly kills the whale without letting go its hold upon him.'

23. Anonymous. 1867a. Poisoning Whales. *Whalemen's Shipping List* 28 January 1867. Vol. 24, No. 48.

Note from London *Post* regarding humaneness of killing whales.

24. Anonymous. 1867b. [Untitled]. *Whalemen's Shipping List* 4 June 1867. Vol. 25, No. 14.

Curare and strychnine combination used as poison for whale killing. M. Thiercelin 'invented' this poison and used it in cartridge for killing whales. Ten whales were shot; all died within 4 to 18 minutes. Six were processed for blubber and bone; 2 were 'of a kind not worth fishing for'; and 2 were lost 'by one of the many accidents incident to whaling.'

25. Anonymous. 1869. [Untitled]. *Whalemen's Shipping List* 27 July 1869. Vol. 27, No. 22.

Patent obtained by London firm for electrical whaling. A 'galvanic battery' in each whaleboat, wired to the harpoon. The whale's flesh completes the circuit. Meant to paralyze the whale and allow it to be killed 'at leisure'.

Fig. 6. 'Boat fastened to whale by harpoon and line; killing the whale with bomb-lance.' From painting by J. S. Ryder *in* Goode, 1887, plate 200. The whale is actually being shot with a shoulder gun rather than a bomb-lance; see Brown (1887, p. 267).

26. Anonymous. 1872. [Untitled]. *Whalemen's Shipping List* 31 December 1872. Vol. 30, No. 45.

French chemist developed technique for poisoning whales, using 'mixture of the Indian poison called curate, or woorali, with strycnine.' Ten whales killed in 'a recent voyage', four of which were not secured 'or not thought worth cutting up.'

27. Anonymous. 1877. Improved whaling gun. *Scientific American*, Vol. 36, No. 23, (New Series), p. 354.

Note from *New Bedford Mercury* regarding Pierce and Eggers whaling gun. Weight: 18 lbs. Breech-loading. 'The whole operation of loading, fixing, and reloading can be accomplished in two minutes' time.' Range said to be over 750 ft 'when fired at a slight elevation.'

28. Anonymous. 1882. [Untitled.] *Whalemen's Shipping List* 7 February 1882. Vol. 39, No. 52.

'A whale 70 feet long grounded on the Eastern coast of Virginia a few days since, and a boat's crew of five men put off to attempt his capture. Their brutal efforts of attempting to stop his spout with a pole, driving one in three feet and breaking it off, and cutting a hole in his head with an axe, discharging ten shots into his body with a double barrelled gun, all proved to no purpose, and the tide rising, the leviathan got clear and made for the deep sea.'

29. Anonymous. 1883. *Great International Fisheries Exhibition, 1883. Official Catalogue*. London: William Clowes and Sons, Limited. pp. [i – xc + 1] – 568 + i – xxvi + 2 folding maps.

Enumeration of some contemporary whaling implements, listed under the maker's name (e.g., p. 10, 244) or nation and subject (e.g, 'Apparatus Connected with the Whaling and Sealing Industry', pp. 295 *et seq*; cf., J. T. Brown, 1883, entry 101). Some descriptions of old implements, including the bows and arrows used to poison and thus catch minke whales in Norwegian fiords (p. 505). No illustrations.

30. Anonymous. 1918. Shells kill many whales. U-boat search also leaves hundreds of porpoises dead. *New York Times*, 22 June 1918, Vol. 67, No. 22,064 p. 9, col. 4.

Article with dateline Philadelphia, 21 June, noting that ship masters report 'a number of whales, sharks, and porpoises have drifted ashore on the North Atlantic coast, between Barnegat and Cape Henry, having evidently been killed by gunfire or by the explosion of bombs or shells below the surface.' Specifically, the bodies of 7 whales lay on the beach between Cape Henlopen and Cape Henry, 'practically torn to pieces, having apparently been mistaken for submarines and fired at.'

31. Anonymous. 1922. A whale-hunt. *Blackwood's Magazine*, Vol. 211, (Jan.) pp. 91–9.

Personal account of Norwegian shore-based whaling off South Africa. An explosive harpoon was used, with a stated range of 40 yd. 'A single well-placed shot may kill a whale instantly, but sometimes three or more harpoons are necessary.' Description of chase and kill of a humpback, death-time more than 30 minutes; two harpoons needed.

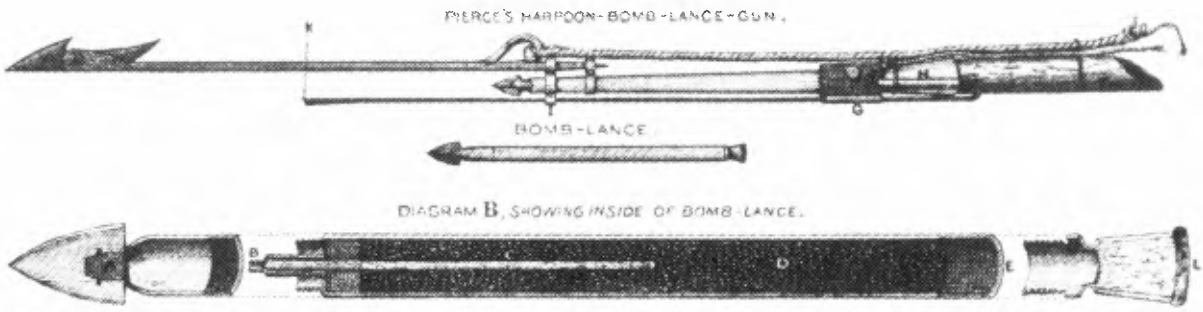

Fig. 7. Whaling apparatus illustrated in C. M. Scammon's classic book *The Marine Mammals of the North-western Coast of North America*, published in 1874 (p. 227).

32. Anonymous. 1925. De nye hvalkanoner Baklade-kanon. *Norsk Hvalfangst-Tidende*, Årg. 14, Nr. 8, pp. 92, 95–96.

Technical details are given for the new breech-loading whale-guns. There were two manufacturers of the new breech-loading gun with the glycerine recoil brake: Kongsberg Arms Manufacturing Co. (Norway) and Bofors A/B (Sweden). The former tried its new model on 15 August 1925; the latter on 19 August. The Kongsberg gun was expected to come into use during the coming Antarctic season on one of the catcher boats associated with the floating factory 'Norge'. The Bofors gun was expected to be used by British company 'The Southern Whaling & Sealing Co.' (Unilever) during its expedition to the South Shetland Islands. [In Norwegian.]

33. Anonymous. 1926a. Kongsberg Våbenfabrik. *Norsk Hvalfangst-Tidende*, Årg. 15, Nr. 8, p. 114.

34. Anonymous. 1926b. Kongsberg Våbenfabriks bakladehvalkanon. *Norsk Hvalfangst-Tidende*, Årg. 15, Nr. 1, p. 7.

35. Anonymous. 1935. Technical development of the whaling industry. *The Soap, Perfumery and Cosmetics Trade Review*, February 1935, pp. 13–19.

Primarily concerned with equipment for processing whale oil.

36. Anonymous. 1936. Difficulties with the electric whale shooting. Is the Catch going too slow with electrical killing? [English] Translation. [From] Sandefjords Blad 9th January 1936 [with a covering letter from A. C. Olsen, Sandefjord 10th January 1936]. [2]p. typescript. Old Dartmouth Historical Society, Whaling Museum Library, New Bedford, Mass. Bostock Papers, IMA Microfilm #1722 and #1723.

Indicates reluctance of Norwegian whalers to accept electrical whaling as an improvement on the familiar 'old method'.

37. Anonymous. 1937. Memorandum presented by the German Delegation. Practical experience regarding the killing of whales by the electric method. London, 27th May, 1937. ICW/1937/12, pp. 1–2 typescript. [Copy seen at] Smithsonian

Institution Archives, Washington, D.C., [File] RU 7165, IWC Conf. and IW Commn, 1930–1968. Box 3 Folder 6.

German experiments with electrical whaling continued in 1936/37 season. Whale 'seized by a convulsion and is usually dead in one-and-a-half to two minutes' when harpoon hits properly. Some float. Need for improved weight distribution in harpoon's construction. Electrical whaling considered more humane; also fewer shot whales are lost, less time is required to kill and bring whale alongside, less gear is expended, and shell splinters do not ruin machinery as carcass is processed.

Less blood supposedly is lost when whale is electrocuted, and this increases the quantity of 'fishmeal' that can be obtained.

No international regulation of electrical whaling appropriate yet.

38. Anonymous. 1938. The killing of whales by electricity. [English] Translation. [From] Sandefjords Blad 21st April, 1938. [1]p. typescript. Old Dartmouth Historical Society, Whaling Museum Library, New Bedford, Mass. Bostock Papers, IMA Microfilm #1722 and #1723.

Interview with whaler. Averaged 1.4 shots per whale captured using electricity, compared to two shots per whale using shell harpoons. Death instant with electricity, no matter where whale is hit.

39. Anonymous. 1941. Note on methods of killing whales. *The Naturalist,* No. 792, p. 156.

Quotation of note called 'Electric Killing of Whales' by A. Weber that appeared in *Science Abstracts* (Section B) *Electrical Engineering,* Vol. 43, No. 507, p. 123. Claims killing by electrocution is 'almost instantaneous' and carcasses 'always float'. A current of 40 A. is passed through whale's body with return through water and hull or propeller of boat. Alternating or direct current is acceptable. Usually alternating current of 50 cycles per second at 200 V. is used.

40. Anonymous. 1947. International Agreements for the Regulation of Whaling. International Whaling Conference in London May 24th–June 8th 1937. *International Whaling Statistics*, Vol. 17, pp. 26*–34*

Includes recommendation that governments regulate whale killing methods (p. 33). Suggests that 'suitable explosive charges' or 'a harpoon electrically charged' would cause quick death and reduce wastage. Also, 'a regulation of this character may be expected to abate something of the undoubted cruelty of present methods of whaling.'

41. Anonymous. [Abst.]. 1950. Norwegians develop new electric whale gun. *Foreign Commerce Weekly* (Government Printing Office, Washington 25, D.C., USA). Vol. 36, No. 11, p. 34, 12 September 1949. *World Fisheries Abstracts,* Vol. 1, No. 1, p. 43.

Report from arms factory in Norway said to be manufacturing electric whaling apparatus for coming season. Expects whaling efficiency to increase by 10 percent. With explosive harpoon, 20–25 percent of whales struck escaped or sank; recent introduction of tougher nylon line reduced this to 10 percent. No loss expected with electrocution, as whale supposed to float and not to struggle. Electrocution considered more humane.

42. Anonymous. 1952a. Killing of whales by chemical means. *Norsk Hvalfangst-Tidende*, Årbok 1951, p. 206.

Mentions method of killing whales with compressed carbonic acid. Harpoon shank is replaced by a tube filled with the substance. On contact with whale, a valve opens, releasing the carbonic acid into the whale, paralyzing it. Two whales shot with this harpoon off west Norway in 1950. More tests planned in upcoming Antarctic season.

43. Anonymous. 1952b. The electric harpoon in whaling. Humanitarian and commercial significance. *The Veterinary Record*, Vol. 64, No. 2, p. 30.

Description of electric whaling. Current reaches whale through conductor in forerunner and returns by sea water. Author feels Foyn harpoon should be adapted to electric whaling as interim measure until fleet can convert to new lighter harpoon shot from special gun with high muzzle velocity. Brief review of developments since 1947, when letter to *The Times* and H. Lillie's campaign brought about British initiative in electric whaling.

44. Anonymous. 1952c. Electric whaling. *Discovery*, Vol. 13, pp. 143–4.

Patent for electrical whaling equipment issued in London, 1868. Two Norwegian experiments followed. German engineer Webber (*sic*) successfully caught 4 fin whales by electrocution off Norway in 1929. Electrocution of 250 whales by *Sir James Clarke Ross* fleet in 1932–3. Webber said to have destroyed his papers before committing suicide in 1945. Post-war British research by General Electric Co. Ltd and United Whalers Ltd in conjunction with Elektrohval of Oslo. Mentions H. Lillie's campaign for more humane whaling method.

Summary of experiments by *Terje 2* of United Whalers, in Antarctic in 1948/49. Three main problems: equipment failure due to stormy weather conditions, harpoon deflection in flight due to heavy line and sheathing of harpoon leg, gunners' preference for nylon forerunners. Miniature marine enclosure designed for mounting on bridge, detachable-leg harpoon, and forerunner made of 3-cordal rope were then developed. Electric current 'with any satisfactory shot produced immediate paralysis, the whale surfacing with no struggle.' Dead within 3 minutes. Another experimental expedition to Antarctic in 1949/50, with V. Board and R. Marsden aboard. Lightweight spigot gun with lightweight conductor of high tensile strength did not bear up well under Antarctic conditions. Electric whaling by Konsberg gun resulted in catch of 51 whales. Experiments followed at São Tomé Island, using new forerunner.

Author believes electric whaling allows killing 'without undue pain' and less waste of gear, time, and whale products.

45. Anonymous. 1953. 'Economic superiority' of electric harpoon. *Fisheries Newsletter*, Vol. 12, No. 4, p. 6.

Optimistic report on development of electric whaling. Mentions 65 ft fin whale electrocuted and brought alongside within 10 minutes of firing of the harpoon. System said to kill 'nearly instantaneously, or in a minute or so at the most.' Cites savings in time, equipment, and oil and meat products with electric whaling. Also, gunner can shoot at any part of the whale's body; electrocution effective wherever harpoon head penetrates blubber.

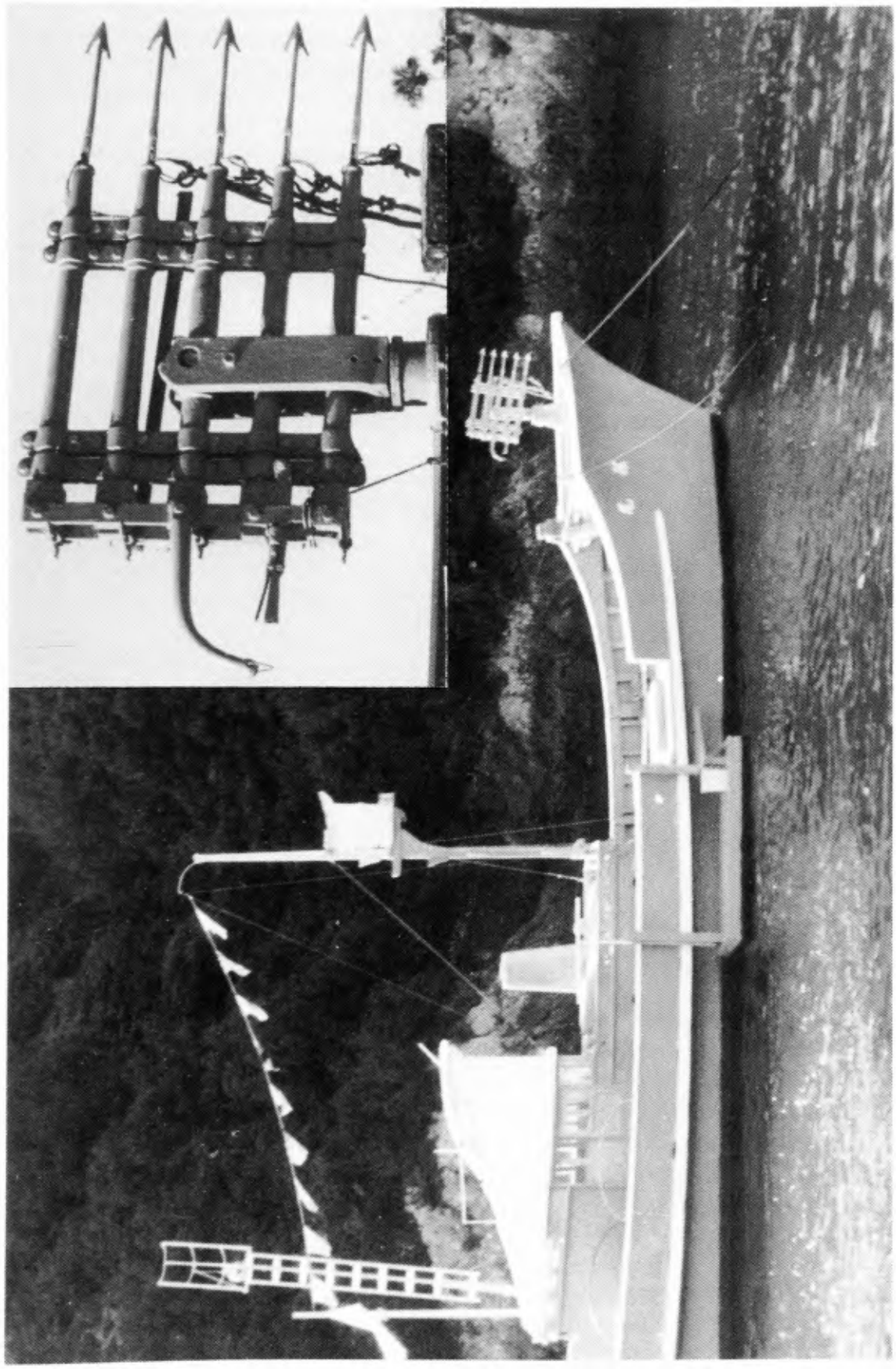

Fig. 8. The 'five harpoon gun' used in Japan especially to catch pilot whales (see Omura *et al.*, 1953). Photo courtesy Hideo Omura.

46. Anonymous. 1954a. *Japanese whaling industry*. Prepared by Fisheries Agency, Ministry of Agriculture & Forestry. Japan Whaling Association, Tokyo. pp. 1–50 + [ii] + 3 pls.

Early 17th century whaling with hand harpoon, spears, 'halberds', and 'arrows'. Replaced by net whaling in late 17th century. Netting fleet consisted of 8–12 or more boats. Whale driven toward shore, encircled with net, and harpooned. Then heavier harpoons and 'double-edged swords' employed. Swimmers tethered wounded whale by attaching lines to holes cut in nasal septum and dorsal fin. Finally, the whale was killed with a sword and towed ashore.

'Flat-head' harpoon replaced conventional 'pointed-head' harpoon, improving shots at submerged parts of the whale's body. Excellent photographs of 'five-harpoon gun' for hunting small whales (p. 20).

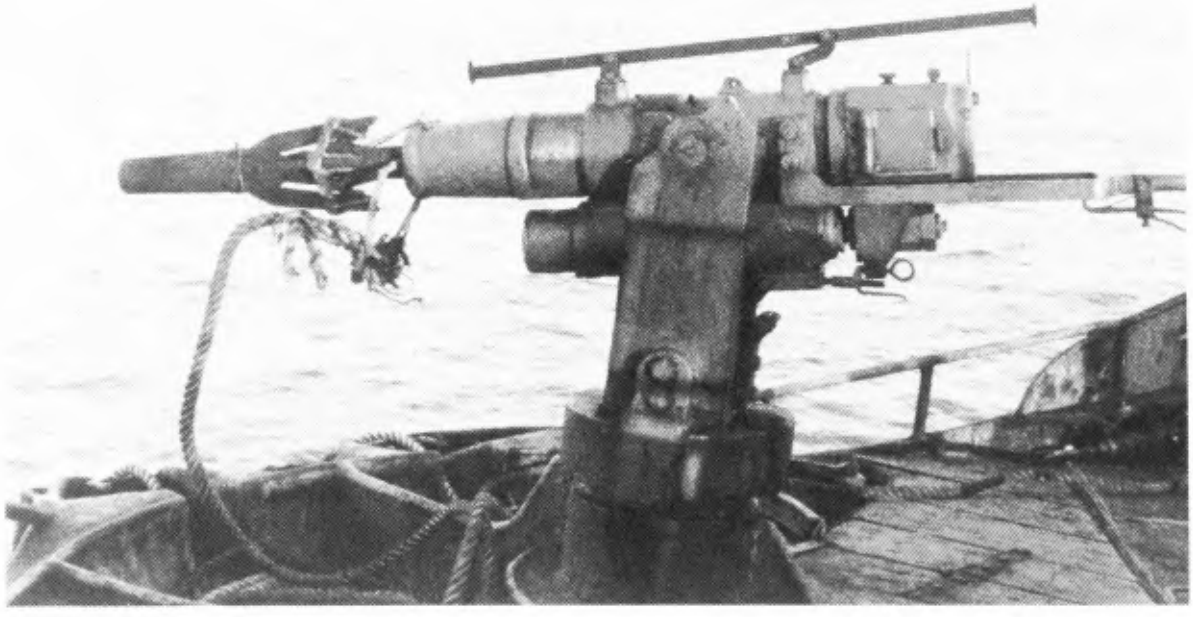

Fig. 9. A loaded harpoon used in the modern Japanese whale fishery. Photo courtesy Hideo Omura.

47. Anonymous. 1954b. Rotary whale harpoons. *Norsk Hvalfangst-Tidende*, Årg. 43, Nr. 11, pp. 410–11.

Illustrated account of two harpoon rotation devices developed by Norwegian inventors. Rotary harpoons believed to have more stability in trajectory, thus giving greater certainty of aim.

48. Anonymous. 1955. Whaling. *UFAW Twenty-Ninth Annual Report 1st July, 1954 to 30th June, 1955*. The Universities Federation for Animal Welfare. p. 2

Expresses disappointment that no electrical whaling occurred in 1954/55 Antarctic season. Main concern: Does voltage used 'produce immediate unconsciousness in the whale'?

49. Anonymous. 1956a. Killer whales destroyed. VP-7 accomplishes special task. *Naval Aviation News*, December 1956, p. 19.

Announcement of 'another successful mission' by VP-7, the airplane assigned 'the task of ridding the coastal areas (of Iceland) of killer whales.' 'Hundreds' were killed in 1955 with 'machine guns, rockets and depth charges.' More apparently were killed in 1956. [However, see entry 50.]

50. Anonymous. 1956b. War against killer whales near Iceland. *Norsk Hvalfangst-Tidende*, Årg. 45, Nr. 10, pp. 570, 573.

Bounty on killer whales near Iceland. 'Whole fleets were . . . fitted out . . . to fight the enemy (the killer whale) in veritable naval battles.' US Air Force, on request from Iceland, dropped depth charges to kill the whales. 'Not very many whales were killed, but after . . . 2–3 days the killer whales disappeared . . .' (and see entry 49).

51. Anonymous. 1956c. Whaling. *UFAW Thirtieth Annual Report 1st July, 1955 to 30th June, 1956*. The Universities Federation for Animal Welfare, London. p. 5.

Disappointment at the lack of progress toward acceptable method of killing whales by electrocution. Considers electrical whaling more humane than conventional whaling with explosive harpoon.

52. Anonymous. 1957. Electric whaling. *UFAW Thirty-First Annual Report 1st July, 1956 to 30th June, 1957*. The Universities Federation for Animal Welfare, London. p. 6.

Brief report on progress in electric whaling.

53. Anonymous. 1958. Electric whaling. *UFAW Annual Report and Accounts 1st July, 1957 to 30th June, 1958*. The Universities Federation for Animal Welfare, London. pp. 10–11.

Mentions experiments in electric whaling conducted by British companies since 1947. Resolution passed by United Nations Conference on the Law of the Sea in Geneva requesting member-states to 'prescribe, by all means available to them, those methods for the capture and killing of marine life, especially of whales and seals, which will spare them suffering to the greatest extent possible.' Debate in British House of Lords on 'Cruelty in the Whaling Industry.'

54. Anonymous. Ms. 1959. Information supplied by Messrs. Chr. Salvesen & Co: experimental work on killing whales with gas harpoons. [Submitted to] The Working Party On Humane And Expeditious Methods Of Killing Whales, International Commission on Whaling, [London,] 4 March and 9 May, 1960. HM1: Document C, [i] p. typescript.

Brief reference to unsuccessful Norwegian experiments with carbonic acid gas-harpoons in 1952/53, 1954/55, and 1958/59 in the Southern Hemisphere.

55. Anonymous. 1959. Whaling. *UFAW Annual Report and Accounts 1st July, 1958 to 30th June, 1959*. The Universities Federation for Animal Welfare, London. p. 10.

Mentions United Nations reminder to member-states 'of their obligation to find a humane method of killing whales.' Also, appointment of IWC committee 'to consider the development of whale-killing devices.'

56. Anonymous. Ms. 1960. Information supplied by the Norwegian Whaling Association. Electric harpooning of whales. [Submitted to] The Working Party On Humane And Expeditious Methods of Killing Whales, International Commission on Whaling, [London,] 4 March and 9 May, 1960: HM1: Document A, pp. 1–3 typescript.

Experimentation with electrical whaling by Norwegian factory ships from 1934 through the 1939/40 season was not considered successful. One gunner reported difficulties with the electric plant and a high loss rate compared to that experienced with the ordinary shell harpoon.

A consortium of Norwegian whaling companies resumed experimentation after World War II. Tests of electrical equipment were made off Norway in 1949 and in the Antarctic through 1953/54. The electrical method was abandoned after 1954 as it was believed to require more time for killing than the shell harpoon.

A gunner's report referred to 17 sperm whales shot with an electric harpoon. Five died momentarily; 11 required the current to remain on for 6–31 minutes before they died. The gunner believed the impact of the 130-pound harpoon may itself have killed some or all of the five that died quickly. Average time to death was 12 minutes.

Subsequently, 60 sperm whales were shot with both the electric and the shell harpoon. Average time to death was 9 min. It was impossible to determine whether a whale was alive or dead as long as the current remained on.

Later, seven sperm whales killed, with the shell harpoon only, had an average time to death of 5 min, requiring 1.6 harpoons each.

Fourteen blue whales and 3 fin whales were shot with electric harpoons. Eight died immediately; the rest required additional current or needed to be reshot. Results were inconclusive; apparently there was substantial current leakage.

Electrocution is considered less effective with baleen whales than with the sperm whale, probably because the sperm whale opens its mouth after being shot and the baleen whales do not. The open mouth of the sperm whale provides a better contact with sea water than the tightly shut mouth of baleen whales.

57. Anonymous. 1962. Whaling with hypo. needle. *Fisheries Newsletter*, Vol. 21, No. 4, p. 25.

Brief summary of experimental use of specially designed needle charged with 0.1 g succinylcholine chloride to kill a white whale in the Mackenzie delta (see Flyger, 1964, entry no. 148).

58. Anonymous. 1964a. USSR. Scientific slaughter of whales. *New Scientist* (No. 404), 13 August 1964, p. 381.

Brief report on alternative method of whale killing with curare. Produces anesthesia and causes whale to float. 'It is expected that curare will be used on a large scale next season.'

59. Anonymous. 1964b. Whaling — end of an era. *World Fishing*, January 1964, pp. 44–45.

Announces the end of British whaling. Decries inhumaneness of 'Norwegian harpoon gun'. Average time to death stated to be 20 minutes. Mentions experiments in electrical whaling by Hector Whaling Co. and consideration of curare to be fired from a helicopter. Doubtful if incentive remains for further experimentation.

60. Anonymous. 1966. Artes de pesca (III). Los instrumentos arrojadizos. *Mar y Pesca*, 14 November 1966, pp. 28–9.

Spanish-language description of harpoons. Illustrated.

61. Anonymous. Ms. 1974. 'Euthanasia.' Report No. V.9. Produced by the Veterinary Department of the Royal Society for the Prevention of Cruelty to Animals. [Submitted to the] Workshop On Humane Killing Techniques for Whales, International Whaling Commission, Cambridge, 10–14 November 1980. Document HK 5, pp. 1–10 + Appendices [i–ii] + 1–2.

Concerns solely the euthanasia of dogs, cats, and other small animals, 'euthanasia' referring to 'painlessness' in the animal being destroyed. Inhalation of carbon dioxide and carbon monoxide and hypoxia induced by rapid decompression are reviewed. Administration of chloroform, shooting, poisoning with barbiturates, and electrocution are methods approved by the Royal Society for the Prevention of Cruelty to Animals.

62. Anonymous. 1978a. Summary of research by Japanese whaling industry on the question of humane killing. *Rep. int. Whal. Commn*, 28, p. 92.

Summary of Japanese research on whale killing methods in response to request by IWC (IWC, 1978c, see entry 206). Interest in quick death for humane and economic considerations. Meat of whales killed slowly contains blood, reducing freshness and affecting color and flavor. Industry research has focused on vital target spots, type and quantity of explosive material, type and weight of harpoon, and type of harpoon cable. Reluctance to use drugs in whale killing because meat for human consumption is main product of Japanese whaling. Refers to research into use of CO_2 and nitrogen oxide to cause rapid death by freezing. Also unsuccessful experimentation with electric whaling by Japan during 1950. 'The electric harpoon was less than 50% as effective as explosive harpoons.' Electrocution said to have burned and discolored meat. Further research on minke whales, using explosive harpoon followed by implantation of two 'electric probes'. This method presently in use.

Fig. 10. 'Makah Indians whaling at entrance to Fuca Straits.' Drawing by H. W. Elliott *in* Goode, 1887, plate 203; see p. 62 of Clark (1887).

63. Anonymous. 1979. Cruelty to small whales decried by Norwegian veterinarian. *Information Report.* Animal Welfare Institute, Vol. 28, No. 1, p. [4].

Article by A. Bryne in *Dagbladet,* December 12, 1978, called 'Whaling with Harpoon Barbaric — Would be Forbidden if Used in Slaughter House' is summarized. Statement by Norwegian veterinary inspector regarding his intention to question humaneness of 'cold harpoon' used in Norwegian minke whale fishery.

64. Anonymous. 1981. Kingdom of Tonga. Report of the preliminary survey of humpback whales in Tongan waters July-October 1979. *Rep. int. Whal. Commn,* 31, pp. 204–8.

Includes a description of the recent humpback fishery at Tonga. 'Initially, traditional hand harpooning methods were utilised in Tonga and death times were occasionally very long: up to 7 hours quoted in one instance. With the introduction of dynamite for use in major works projects, whalers were quick to seize upon a possible method of increasing their efficiency and reducing death times. It was common practice to tie a stick of explosive to the harpoon shaft, to be lit just prior to making fast. Its efficiency was debatable and at least one boat was sunk by its own explosives. The old practice of harpooning calves first to ensure retention of the cow was common in this fishery. Struck and lost rates were high.'

65. Anonymous. 1982a. Norway — Progress report on cetacean research, June 1980 to May 1981. *Rep. int. Whal. Commn,* 32, pp. 197–8.

Funding made available by Norwegian Ministry of Fisheries for 5-year study to improve killing techniques used in small whale (minke and killer) fishery. To include review of present methods and anatomical, physiological, and technological basis for more rapid and humane methods. Notes lack of data on reaction of whales and killing times according to where on whale's body the harpoon strikes. Field studies in 1981 to include correlation between point of harpoon entry and tissue or organ damage as well as evaluation of effects of high-velocity projectiles from rifles.

66. Anonymous. 1982b. Humane avlivingsmetoder for hval. [Humane methods in whale-hunting.] *Fiskets Gang,* Nr. 21 (44), pp. 651–4.

This article (in Norwegian) apparently summarizes some of the work reported by Øen (1983a,b, see entries 282 and 283).

67. Anonymous. 1982c. Hoyhastighetsprosjektil usikker avlivingsmethode. [New method for whale killing proves a failure.] *Fiskets Gang,* Nr. 22 (46), pp 693–94.

This short article apparently is based on the work of E. O. Øen (see Øen, 1983).

68. Anonymous. nd a. 'The Ahab' Harpoon Launcher. $285.00. Kodiak Manufacturing Co., P.O. Box 185, 112 Quinnipiac Avenue, North Haven, Connecticut. (4 pp. flyer, with letter dated 1966.)

69. Anonymous. nd b. The Greener Light Model Harpoon Gun. W. W. Greener Ltd., Park Lane, Handsworth, Birmingham, England. (4 pp. illustrated advertisement.)

70. Anonymous. nd c. Harpoon Gun M52. Kongsberg Vaapenfabrikk, Kongsberg, Norway. (4 pp. illustrated advertisement.)

71. Anonymous. nd d. Kongsberg Harpoon Gun 50 mm cal., Kongsberg Vaapenfabrikk, Norway. (4 pp. illustrated advertisement, with specifications.)

72. Anonymous. nd e. [Mr. Rasmussen on the electrical method of killing whales, and subsequent discussion.] [Copy seen at] Smithsonian Institution Archives, Washington, D.C., [File] RU 7165, IWC Conf. and IW Commn 1930–68, Box A, Folder 6, pp. 5–8 typescript.

Rasmussen was a representative of Norwegian company 'Rosshavet', which introduced the electric harpoon. Claims wide acceptance of electric whaling by gunners, and 'it is obvious that it is a more human [*sic*] method to use the electrical method.' Notes desirable lack of shrapnel when meat is to be used to make meal for cattle.

Main disadvantage is cost; three electrically equipped catcher boats cost the same as six conventionally equipped catcher boats. Also, just as many whales are lost with the electrical method.

Discussion of factors responsible for relatively high cost of electrical method. Some disagreement is expressed with Rasmussen's claim that as many whales are lost in electric whaling as in conventional whaling.

73. Anonymous. nd f. 90 m/m Hvalkanon M/52. Kongsberg Vaapenfabrikk, Kongsberg, Norge. (6 pp. illustrated brochure, with specifications.)

74. Anonymous. nd g. [Report on experiments in electric whaling by the 'James Clark Ross' expedition.] [Copy seen at] Smithsonian Institution Archives, [File] RU 7165, IWC Conf. and IW Commn 1930–1968. Box 4, Folder 5, pp. 60–62 typescript; Folder 6, pp. 27–29 typescript.

Successful results of experimental electric whaling by the 'James Clark Ross' expedition to Antarctic. Acceptance by gunners, but electric whaling still more expensive than conventional shell harpooning. Report from gunner: 'almost every shot [with the electric harpoon] kills instantly.' He states that the whale can be hit anywhere, 'because the electricity works practically the same wherever the harpoon hits.' His record: 229 whales with 335 shots, or 1.4 per whale compared to 2 per whale with shell harpoons.

It is noted that the Southern Whaling and Sealing Company is interested in the electric harpoon not mainly to avoid cruelty but to avoid losing whales and wasting oil.

75. Anonymous. nd h. Whaling-Equipment by Naval Company, Doylestown, Pa. (4 pp. brochure, illustrated.)

76. Ash, C. 1962. *Whaler's Eye*. The Macmillan Company. New York, pp. i–x + 1–245.

Well illustrated (black-and-white photographs), first-hand account of modern Antarctic whaling. Ash was a chemist aboard the British factory ship *Balaena*. Chapters entitled 'Catching' (pp. 75–93) and 'A Dialogue' (pp. 227–33) include a discussion of the humaneness of whaling. Ash's company, Hector Whaling, is said to have spent 'over $280,000 on experiments lasting for several years in an attempt to find an effective and humane method of killing by electrocution.' Ash expressed the belief that the time to death is decreasing with refinement of modern whaling methods. He suggests that the shock of the exploded harpoon head may

'temporarily anesthetize' the area around the wound. He presents an unfavourable evaluation of electrocution and mentions the unsatisfactory use of carbon dioxide cylinders for killing whales.

77. Ash, C. E. 1964. British whaling: final years. *Chemistry and Industry*, Vol. 38, Pt. 2, pp. 1596–601.

Includes a brief section on 'Harpoons'. Author considers many of the charges that modern, grenade harpoon whaling is inhumane to be 'grossly exaggerated' but admits 'in a fair proportion of cases considerable pain must have been inflicted.' Critique of experiments with electrical whaling. Two fallacies: that a light cable can carry enough current to kill whale instantaneously and that electrocuted whales would float. Constant modifications of electrical gear eventually led to cables, harpoons, and guns as heavy and awkward as those used before experimentation began. 'When suggestions were made that an explosive charge should be incorporated we realised that the time had come to stop [experimentation with electrical whaling].'

78. Bakken, A. 1964. One hundred years of Norwegian whaling. The start and the first year. *Norsk Hvalfangst-Tidende*, Årg. 53, Nr. 5, pp. 122–37.

Biographical information on Svend Foyn. In 1863 his steam vessel *Spes & Fides* sailed with 4–6 harpoon guns 'which fire poisoned harpoons as invented by the rural mayor Walsøe' (p. 126). Or so it was reported. Actually, this claim was based on a misunderstanding; Foyn was experimenting with different kinds of explosives. In the maiden voyage of the *Spes & Fides* she carried two types of gun, and harpoons and grenades were shot separately (p. 127). One whale received four harpoons, 'but although the whale was wounded and suffered a great loss of blood, it pulled the steamship 6½ miles in 8 hours dead against wind and sea' (pp. 129–30). It was eventually cut free. Many interesting passages from Foyn's diaries are quoted, including his statement in 1868 that it is best to fire the harpoon into a large whale at a point about a fathom behind the dorsal fin (p. 134).

Photographs of Foyn's 1865 and 1870 whaling guns (p. 128).

79. Bakken, A. and Eriksen, E. [Eds]. 1964. *Hval og hvalfangst*. Vestfold-Minne 1964. Utgitt av Vestfold Historielag, Tønsbergs Aktietrykkeri. pp. 1–188.

A compilation of papers on the history of Norwegian whaling. First chapter (p. 5 *et seq.*) by Bakken is apparently same as Bakken (1964). Other chapters include the following (titles here translated into English): 'Svend Foyn about his Lifelong Work', 'Arctic Whaling in the North in Old Days' by O. Martinsen, 'Some Problems in the History of Modern Whaling' by J. N. Tønnessen, 'Whaling Life at the Turn of the Century' by Hj. Bråvold, '*Pelagos* ex *Athenic*' (about a Norwegian floating factory) by K. Berg, 'Shortly about the Work of Deciding the Age of the Rorquals' by Å. Jonsgård, and 'Folklore and Whaling' by E. Eriksen.

80. Baldwin, H. A. and Williams, C. S., Ms. 1973. Ballistic Delivery of Biological Reagents. Final Report [To] Emergency Programs, Animal and Plant Health Inspection Service, US Department of Agriculture. Sensory Systems Laboratory, Los Alamos, NM 87544, pp. i–ii + 1–18 typescript.

Discusses feasibility of firearms to deliver biological reagents, primarily for purposes of disease control in unrestrained animal populations. Advantages and disadvantages of various drugs, drug formulations, projectiles, and administration

methods are considered. Test results are presented. Various aspects of the use of succinylcholine chloride are mentioned.

81. Bank, T. 1977. The Aleuts: clues to their origin. *Explorers Journal*, Vol. 55, No. 4, pp. 168–71.

Argues that 'aconite-poison whaling is a recent cultural transfer from Asia to America in historical, not prehistoric, times.' Centre of aconite-poison whaling in America was east of Unalaska. (See Heizer, 1938a,b entries 175 and 176).

82. Barron, W. 1970. *Old Whaling Days*. The Conway Maritime Press, Greenwich. pp. frontis + i–x + 1–211 + 5 pls.

Numerous descriptions of capturing bowheads during mid-nineteenth century. Also an attempt to kill a finner whale with a bomb lance gun said in 1859 to be 'of very recent date' and to have been in use only 'about a year' (p. 119). 'Immediately the bomb entered the body the animal appeared paralyzed, and in a few seconds the bomb exploded, and we felt the vibration. The body appeared to expand, and rolled from us in agony, giving a great flourish with its fins and tail.' Problems with misfiring and muzzle explosions discussed (p. 152).

83. Barzdo, J. 1979. *The slaughter of the whale. A summary of published information on the methods of killing whales and the possibility of cruelty in the process*. The Royal Society for the Prevention of Cruelty to Animals, Horsham, Sussex RH12 1HG. 22 unnumbered pages.

Review of some alternatives to explosive grenade whaling, based primarily on literature included in the first draft of this bibliography. Generally, modern whaling methods based on the use of explosive harpoons and cold grenade harpoons are judged to be inhumane, involving death-times of more than one minute in 50 percent or more cases. Electrical whaling is said to bring death in 'a few minutes.' Paralysis resulting from electrocution is said to facilitate killing with 'killer harpoons', 'technical and expense problems' need resolution before electrical whaling becomes feasible. Carbon dioxide requires further testing but 'may be inhumane, particularly if the shooting of the harpoon is not accurate.' Drugs and poisons do not yet offer a technically feasible and humane alternative, but 'there is a widely held view that more research should be done on the use of drugs to kill whales.' Consideration is given to the question of cetacean intelligence and the importance it may have to the issue of humane killing.

84. Bell, J. 1793. [Observations on throwing a gun-harpoon.] *Transactions of the Society Instituted at London, for the encouragement of Arts, Manufactures, and Commerce; with the Premiums offered in the Year 1793*. Vol. 11, pp. 185–92 + pl. 5.

Allen (1882, p. 481, see entry 6) states: 'The 'Observations' are preceded by a letter from Mr. Bell to the society and followed by 'Description of the Plate of Mr. Bell's improved Gun and Harpoon.' Fig. 1, the Gun fitted for firing; Fig. 2, the form of the Harpoon.'

85. Bennett, A. G. 1931. *Whaling in the Antarctic*. Edinburgh and London, Wm. Blackwood & Sons Ltd. pp. i–x + 1–222 + 24 pls.

First-hand descriptions of whale hunting and use of modern harpoon gun. See especially pp. 164–72.

86. Best, P. B. 1975. Death-times for whales killed by explosive harpoons. *Rep. int. Whal. Commn*, 25, pp. 208–14.

Author includes data on death-times, number of harpoons used per whale, and best site of entry for explosive harpoons. Observations made of 199 whales killed off South Africa in 1971 and 1973. Approximately 46 percent of the sperm whales and 86 percent of the minke whales were killed by one harpoon. For sperm whales a 50 kg grenade harpoon was used first, followed as necessary by one or more 'killers' — pipes fitted with a grenade but no line. Minke whales were shot with a 'cold grenade' harpoon, then killed either by pumping compressed air into the neck region or by further harpooning. The number of harpoons needed per whale averaged 1.6 for sperm whales; 1.1 for minke whales.

Time to death was estimated in 140 observations of three different gunners. Median death-times were 2 min 10 sec, 3 min 15 sec, and 4 min. Maximum death-time for sperm whales was 19.5 min; for minke whales, 10.5 min. For each of the three gunners, more than 70 percent of the sperm whales killed died within 5 min of the first harpooning.

In the author's opinion, the best point of entry is just behind the flipper, penetrating the heart region or the skull. Point of entry in the caudal or abdominal region can severely cripple, thus facilitating the second shot. 'It seems unlikely that the death-times recorded in this paper could be substantially reduced, at least for sperm whales, by any other method.' Drug immobilization or anesthesia present problems in dosage levels, delivery methods and drug residues left in the carcass.

87. Bisset, N. G. 1976. Hunting poisons of the North Pacific Region. *Lloydia*, Vol. 39, Nos. 2 and 3, pp. 87–124.

An important work describing various poisons used by hunting peoples of the North Pacific. Aconite poison whaling is discussed. Dosage smeared on harpoon tips is in the order of 4–5 grams, or about 0.1 mg of poison per 1 kg of body weight (p. 116). Thus whales weighing 40,000 to 50,000 kg could be hunted successfully. Suggested site of entry is where rapid circulation of poison would occur. Because of its high concentration of blood vessels, the flipper is suggested as a suitable target. Symptoms are decreased respiratory and cardiac rates, with loss of muscle power. Arrow, lance and harpoon tips were made from iron, bone, and obsidian. Extensive bibliography.

88. Blunden, R. 1978. [Comments received by the Secretary, International Whaling Commission, see entry 205] *Rep. int. Whal. Commn*, 28, p. 91.

Comments on Rowsell (1978, see entry 304). Points out difficulty of administering CO_2 gas into thoracic cavity of whale at sea. Recommends combined CO_2 gas, to inhibit diving ability, and cold grenade, to kill.

89. Board, V. Ms. 1960. Memorandum by Sir Vyvyan Board. [Submitted to] The Working Party On Humane And Expeditious Methods Of Killing Whales, International Commission on Whaling, [London,] 4 March and 9 May, 1960. HM4, p. [i] + 1–2 typescript.

Passing reference to notion of using compressed CO_2 cartridge, similar to those used in mines, to replace normal explosive grenade. Calculation showed failure of harpoon leg to carry sufficient CO_2 unless it were under high pressure, in which case it could not be contained in the whale's body.

Author's personal experience in killing 150 whales electrically was that 22 [*sic*] volts and 40–60 amp would ensure 'instantaneous' paralysis and death 'within two

minutes'. Dismisses idea that failure to kill results from shorting to the sea or through the whale's mouth; believes inadequate current most often the problem. Considers problems of generating current on the catcher boat and of crew safety to have been solved. Problem of carrying current to whale requires more research, as does the matter of developing an electric forerunner with a breaking strain equivalent to that of conventional nylon forerunner. Uncertain that electrocution can improve on the claimed present technique allowing whalers 'to tie up and pump a whale within the incredible time of 10–12 minutes.'

Fig. 11. Shoulder guns placed on the ice ready for use in the fishery for bowhead whales in Alaska. (See Marquette, 1976, p. 16.)

90. Bockstoce, J. 1977a. Eskimo whaling in Alaska. *Alaska*, Vol. 43, No. 9, pp. 4–6.

Brief mention of darting gun and 'bomb-lance shoulder gun' used since 1880's by Alaskan Eskimos for hunting bowheads.

91. Bockstoce, J. R. 1977b. An issue of survival: bowhead vs. tradition. *Audubon*, Vol. 79, No. 5, pp. 142–5.

Description of present-day Eskimo whaling for the bowhead in Alaska. Bomb lance and shoulder gun in use. Shoulder gun's accurate range said to be 10 yd.

92. Bockstoce, J. R. 1977c. *Steam Whaling in the Western Arctic.* Published at the New Bedford Whaling Museum by the Old Dartmouth Historical Society, New Bedford, Massachusetts. pp. 1–127.

A historical account mainly of sail whaling ships and steam whalers, with mention of procedures and equipment used to kill whales. After harpooning, the officer on the boat would strike the whale 'with a long lance, pumping the blade in and out through the ribs to strike a vital organ. After 1870, with the perfection of the bomb gun, he could do so more easily by firing a bomb similar to the darting gun's into the whale from a thirty-five pound brass shoulder gun' (p. 13). Excellent illustrations (see especially pp. 18–20).

93. Bockstoce, J. R. 1980. Battle of the bowheads. *Natural History,* Vol. 89, No. 5, pp. 52–61.

First-hand account of present-day Eskimo whaling for bowheads in Alaska. Stresses importance of toggle-headed harpoons and sealskin drag floats as early improvement in subsistence hunting technology. Later introduction of darting gun and shoulder gun. Concern for number of 'wounded whales — those struck and lost by darting or shoulder guns — that [are] not retrieved, many, if not most, of which are assumed to die.'

Excellent photographs.

94. Bodfish, H. H. and Allen, J. C. 1936. *Chasing the Bowhead.* Harvard University Press, Cambridge, pp. i–x + 1–281 + 9 pls.

Description of whaling technique by an experienced arctic whaleman (pp. 126–8). Attempt made to shoot whale with two darting-guns before attempting to kill with the shoulder gun. Shoulder gun, with barrel and stock made of bronze, weighed 27 lb. Time fuses on shoulder gun set at 5 seconds; on darting-gun, 3 sec.

95. Bodrov, V. A. and Grigor'ev, S. N. 1963. *Pererabotka kitovogo syryia na kitobazakh.* Pishchepromizdat, Mockba. p. 1–364.

Section on cannon and harpoon specifications (pp. 43–5). Section on hunting and killing process (pp. 52–4). Harpooner aims for area of flipper, where a hit often allows killing with one harpoon.

96. Bond, J. 1753. An account of a machine for killing of whales. *Philosophical Transactions,* Vol. 47, pp. 429–35.

An account of whaling using hand harpoons and lances. The harpoon used to secure the whale was barbed at the tip, 20 oz. in weight, and 2 ft. long. It was accurate only up to one yard. Thus, a machine was sought that would extend the throwing distance. Crossbow and gunpowder were tried but rejected due to weakness and loudness, respectively. The ancient 'Balista' was recommended over the 'Catapulta'; it could propel darts weighing up to 60 lbs horizontally. Its power depended on twisted hair ropes, favored over hemp ropes because of their elasticity. The Balista's power could be increased by multiplying the number of ropes and increasing the length of the lever. There is no evidence in this paper that such a machine was ever field-tested on whales.

97. Boone, A. R. 1935. With the whalers on the Pacific. *Travel,* Vol. 66, No. 1, pp. 28–31, 48–9.

Illustrated account of life aboard a modern catcher boat associated with a factory ship. Blue whale killed with 'perfect maneuver, perfect shot'; died in 5 minutes.

98. Bostock, B. R. 1930s–1950s. B. R. Bostock Papers. Research Re The Electrocution Of Whales. Correspondence received, printed and typescript data from other sources — diagrams, photos, etc. [collected by B. R. Bostock of United Whalers Limited, London]. Old Dartmouth Historical Society, Whaling Museum Library, New Bedford, Mass. Bostock Papers, IMA Microfilm #1722 and #1723.

99. Brandt, Andres von. 1973. Spermwalfang in der Küstenfischerei der Azoren. *Archiv Für Fischerei-Wissenschaft,* Vol. 24, Nos. 1–3, pp. 41–50.

Description of sperm whale fishery around Azores, using traditional open-boat, hand-harpoon technology. Mention made of other technologies: driving, poisoning, netting, trapping.

100. Brower, C. D. 1932. My Arctic Outpost. Chicago, *Blue Book Magazine,* (January–June, 1932): Jan., pp. 6–19; Feb., pp. 98–109; Mar., pp. 64–79; Apr., pp. 86–101; May, pp. 60–75; June, pp. 76–87.

First-hand observations of Alaskan Eskimo bowhead hunt during late 19th century (pp. 99–101). 'Stone Age' implements still in use: ivory harpoon with slate cutting edge, 7-ft shaft made of driftwood; walrus-skin line; sealskin floats; lances, with flint heads, 12 ft long; skin-covered umiak (boat). From first harpooning to lancing, considerably more than an hour. Harpooned repeatedly until 25 floats were 'fast'. Lanced in neck region, bled profusely.

101. Brown, J. T. 1883. E. The Whale Fishery and its Appliances. Great International Fisheries Exhibition. London, 1883. United States of America. Washington: Government Printing Office. *United States National Museum Bulletin* No. 27, pp. 271–386.

Includes descriptions of whaling equipment assembled by Brown for the US Fish and Fisheries Commission exhibit as well as an essay by A. H. Clark on 'Statistics of the Whale Fishery' (pp. 296–9). Of special interest is Section 3 (pp. 276 *et seq*) entitled 'Harpoons, Guns, and Lances'. In addition to the standard hand-thrown devices, prussic acid harpoons and various gun-harpoons and gun-lances are described. In the catalogue, beginning on p. 300, rockets, bombs, guns, and lances are described with reference to specimens included in the exhibit.

102. Brown, J. T. 1887. '2.-Whalemen, Vessels and Boats, Apparatus, and Methods of the Fishery.' Section 5, Volume 2, Part 15, pp. 218–93. *In:* Goode, G. B., *The Fisheries and Fishery Industries of the United States.* Washington, Government Printing Office.

Important summary of various methods of capturing whales (pp. 247–255). Attempts to entrap white whales with nets are mentioned. After netting, these whales were killed with guns and lances. Unsuccessful attempt to net a bowhead whale off Labrador, using large-mesh net 159 fathoms long and 8 deep. 'A bowhead whale entered this trap at night and carried away the entire net.'

Author implies that prussic acid whaling was widespread for a short time, but ended when 'several' men died from handling contaminated carcasses. *Susan Swain* of Nantucket purportedly sailed in 1833 with prussic acid harpoons on board, but these apparently were not used. Rumors of whalemen dying due to contact with the acid. Unclear whether American fleet ever used prussic acid, but Brown obtained two harpoons 'intended to be used with prussic acid' from a

Nantucket whaleman. Although French implicated in most accounts, Brown believes Scotland to be origin of prussic acid whaling (see Christison, 1860, entry 110).

Early apparatus for electrical whaling described from US patent issued to two Germans in 1852: 'a magneto-electric rotation machine, a metallic wire attached to the harpoon, and a coppered whale-boat constructed in such a manner that the electric current might be reconducted from the whale harpooned through the water to the machine.' Expected to give whale 8 shocks at each revolution, or 960 strokes per minute.

Reviews 'orthodox and customary methods of capture.' Harpoon, line, and hand-lance, harpoon-gun, and bomb-guns for 'discharging explosives in the vital parts of the whale.' Also, 'boat-spade' formerly used to sever tendons connecting body to flukes (i.e., 'hamstringing') of balaenids, but this practice now 'virtually displaced by the explosive lance.' During 1828–1868, there were 8–10 harpoon makers active in New Bedford; one of these sold 45,103 'old-fashioned irons' and 13,414 'improved toggle-irons' during this period. Hand lances still carried in whaleboat; one Provincetown whaler reportedly used them to kill sperm whales while reserving the bomb-lance for right and humpack whales.

Brand bomb-gun the first successfully used in American fishery. Came in three sizes, all muzzle-loaders with hickory ramrods, brass thimbles and screws. Three drams of powder recommended. Pierce & Eggers gun the 'most popular and effective.' Cunningham & Cogan gun used mainly by steam whalers in Arctic. Had gray-iron stock, steel barrel. Darting-gun developed for Arctic whaling by Pierce and Cunningham, serving both to fasten and to kill. Whaling rocket, fired not against but resting on shoulder, 'pre-eminently the most powerful and destructive agent ever used for killing whales.' Bomb-lance invented by Allen in 1846; Brand's improvements during 1850s enabled this implement to 'in part revolutionize' the process of capturing whales.

103. Brown, S. G. 1955. Modern whaling in the Antarctic. *Zoo Life*, Vol. 10, No. 2, pp. 35–40.

Brief comments on grenade harpooning, ultrasonic whale scaring devices, electric harpooning. Electric harpooning said to kill whales more quickly than grenade harpooning, but time to death not specified.

104. Browne, J. R. 1846. *Etchings Of A Whaling Cruise, with notes of a sojourn on the island of Zanzibar. To which is appended a brief History of the Whale Fishery, its past and present condition.* New York: Harper & Brothers, Publishers. pp. frontis + i–xvi + 1–580 + 1–12 + 7 pls.

Two-page essay (pp. 574–5) in appendix called 'Inventions for Killing the Whale.' Refers to conservative attitude of whalemen, i.e. their reluctance to adopt new whaling methods. Quotes 'Anderson's Historical and Chronological Deduction of the Origin of Commerce,' referring to a primitive explosive-discharged harpoon used by the South Sea Company in 1731. A novel description of an experiment with a swivel gun firing 'bomb-shells':

'All that the boats had to do was to pull up within shooting distance and fire away. A few moments after the attack the immense body of the whale was seen to explode with a grand report. But, unfortunately, before the prize could be secured it always sank beyond hope of recovery.'

Use of prussic acid judged unacceptable because of danger to crewmen handling contaminated tissue.

105. Brunchorst, J. 1887. Hvalfangst i den bergenske skjaergaard. *Naturen*, Årg. 13, pp. 160–71.

Author refers to the article in the same periodical by chief surgeon G. A. Hansen (1887, see entry 169) called 'Whaling by Bloodpoisoning'. The use of bow and arrow is said to be gradually disappearing and being replaced by the rifle. Other species in addition to the minke whale are said to be involved in this fishery — harbor porpoise (*Phocoena phocoena*), killer whale (*Orcinus orca*), pilot whale (*Globicephala melaena*), and dolphins (*Lagenorhynchus* spp.). Otherwise, this paper is almost identical to Brunchorst (1899, see entry 106).

106. Brunchorst, J. 1899. Hvalfangst med bue og pil. *Naturen*, Årg. 23, pp. 138–54.

Author claims hunting with bow and arrow continues only among 'uncivilized' tribes (aborigines) except in one field: whale hunting on the west coast of Norway near Bergen. The whale hunted in this way is the minke whale (*Balaenoptera acutorostrata*) which penetrates in summer into certain narrow fjords. When a whale is observed, the fjord is barred with a strong net, and rusty arrows charged with poison from being smeared in rotten meat are shot into the whale's blubber. After a day or two the animal is so badly infected that it is easily killed with a hand harpoon. The dead whale is pulled ashore, the contaminated meat around the arrow wounds discarded, and the rest of the meat prepared for human consumption. The average number of whales killed in this manner is 4–5 annually, the maximum in one year being 11.

107. Budker, P. 1959. *Whales and Whaling*. The Macmillan Company, New York. pp. 1–184 + pls 1–32.

Note on use of 'cold grenade' harpoon for hunting minke whales (pp. 38–9). Chapter called 'Strike the Whale' (pp. 85–121) contains a good discussion of whaling technology. Japanese net whaling — 'There was no question of killing [the whale] right away. The spears used were not enough to make a speedy end of the whale. But when the enmeshed whale was riddled with wounds, and showed signs of exhaustion, [an] extraordinary drama followed' (p. 88). Contemporary whaling in the Azores — 'During a stay at a whaling-station on the Azores it is possible to believe you have gone back a century in time' (p. 94). Poison whaling — from Norwegian bacillus (p. 100) to North Pacific aconite (p. 101) to prussic acid, strychnine, and curare (p. 102). Development of rocket- and gun-harpoons (p. 102–3) and Foyn's modern harpoon cannon (p. 103–16). Essay on improvements, from electrocution to aerial bombardment — 'A bomb released from a special device could be dropped with great precision and would be quite practicable . . . (p. 120).' Issue of 'humaneness' addressed on pp. 116–8. For example, 'Even if the first harpoon hits a vital part the whale has enough strength left to suffer a long and cruel death. Actually, the combined statistics of the whaling-fleets show that on an average three harpoons are necessary to make an end of a whale' (p. 117). Well illustrated.

108. Bullard, J. M. 1947. *The Rotches*. New Bedford. [Printed in USA by W. B. and A. B. Rotch, The Cabinet Press, Milford, New Hampshire.], pp. frontis + [i–xii] + [1]–[584] + 37 pls.

Reference is made to the invention during the early nineteenth century of 'a machine for the more certain destruction of whales, which had the approbation of our most accomplished mechanics' (p. 58). Francis Rotch, the inventor, set out on

a large schooner in *ca* 1820 to test this 'whaling gun'. One whale was taken on the cruise but 'the gun was not fired'. In fact, it apparently 'never was in the form constructed by him' (p. 65).

109. Burton, R. 1973. *The Life and Death of Whales*. London, Andre Deutsch. pp. 1–159 + 8 pls.

Includes a popular review of some changes in harpoon technology. Describes Greener's gun, 'Pierce's harpoon-bomb-lance-gun', and the modern Foyn gun. See illustrations on pp. 123, 134, 135.

110. Christison, R. 1860. On the capture of whales by means of poison. *Edinburgh, New Philosophical Journal,* n.s. Vol. 12, No. 1, pp. 72–80.

Describes 1830s experiments with hydrocyanic acid whaling. The poison was used to immobilize struck whales and thus reduce loss rate. Theory proposes that 20 oz of poison will quickly inhibit voluntary motion and probably kill a 40 ft whale. Harpoon tips, showing modification used to release the poison from vials, are diagrammed. Procedures for preparing the hydrocyanic acid are outlined.

A voyage was aborted in 1832 when the vessel, equipped with enough poison for 50 harpoons, was crushed by ice. A voyage apparently was made in 1833 in which 'strychnia' was tested, and in the same year a second attempt was made to test the effectiveness of hydrocyanic acid. In the latter voyage, muskets were used to discharge the poison-tubes, but to no effect.

In spite of the evident risks, the author views hydrocyanic (or prussic) acid poisoning as a promising method of killing whales.

111. Christison, R. 1862. On the capture of whales with the aid of poison. *Proceedings of The Royal Society of Edinburgh,* Vol. 4, pp. 270–1.

Describes hydrocyanic acid whaling attempted during the 1830s. Poison was introduced into the whale from glass tubes situated at either side of the harpoon shank. As the whale attempted to swim away, the tubes would be crushed by the barbs of the harpoon, thus releasing the poison into the animal's tissue. The aim was to paralyze the whale and allow close approach for killing. Experimentation stopped because crews feared becoming poisoned themselves while flensing the whales. An instance is mentioned in which the harpooned whale sounded and 'in a surprisingly short time came up again — dead.'

112. Clark, A. H. 1887. '1.–History and Present Condition of the Fishery.' Section 5, Volume 2, Part 15, pp. 3–218. *In:* Goode, G. B., *The Fisheries and Fishery Industries of the United States.* Washington, Government Printing Office.

Extensive review of American whale fishery, with comments throughout concerning capture methods. Of special interest are the descriptions of whaling in Provincetown for fin and humpback whales (p. 41 *et seq*). They were sometimes killed with 'bomb-lances' and allowed to sink; at other times they were bomb-lanced using a gun, then harpooned by hand. 'The bomb-lance is a most destructive weapon' (p. 44). Specifications include: 17-in. gun barrel, iron lance with 6–7 in. chamber and india-rubber 'wings' at the base, one-second fuse. 'Care must be taken not to discharge the lance at too short range, as in that case it will pass through and through the whale's carcase without exploding, and entail no serious injury.' Range said to be about 30 ft. Account given of a humpback being killed 'instantly' (p. 45) and of a finback being killed after a 2-hr struggle (p. 47).

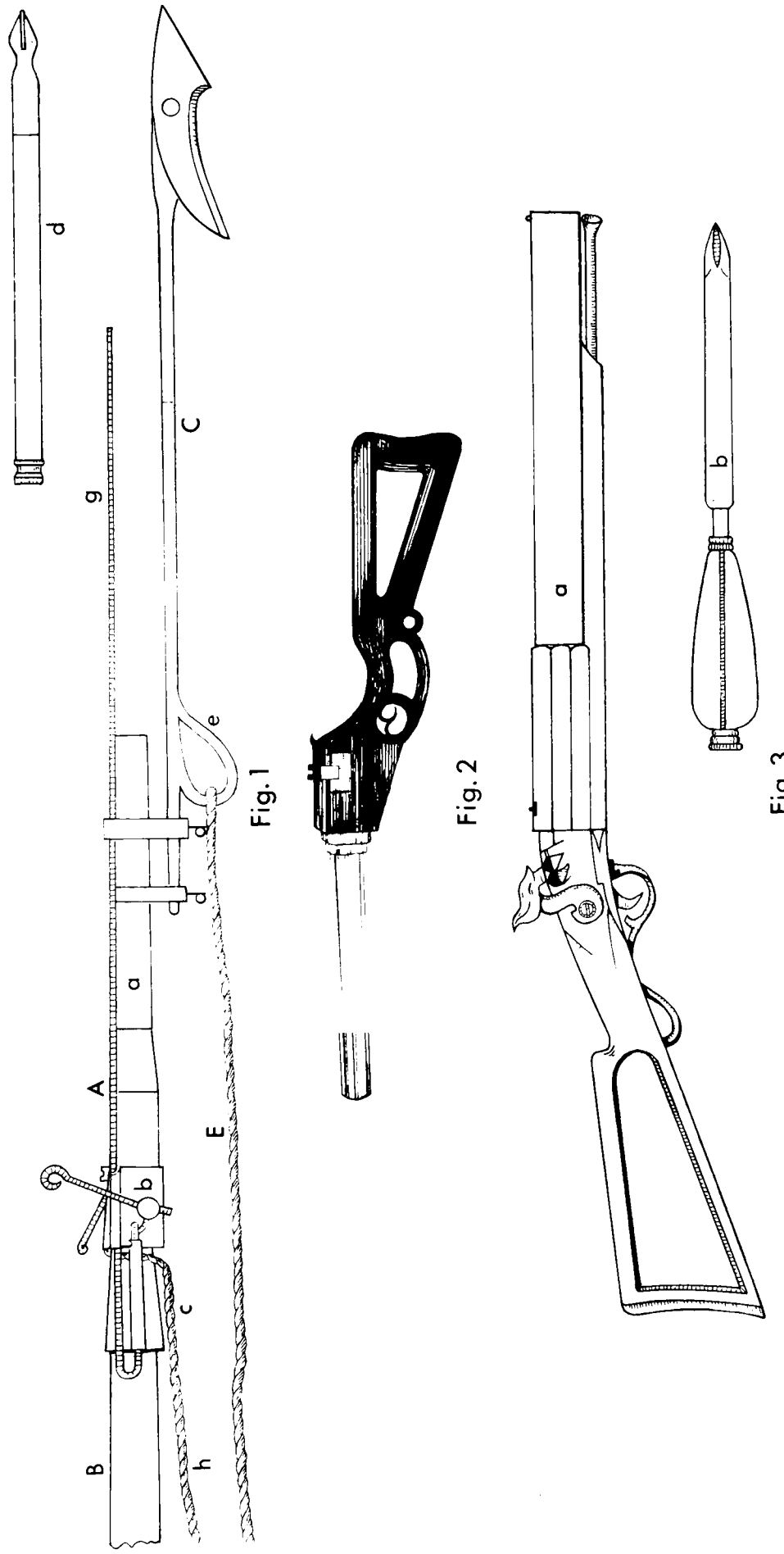

Fig. 12. Rendering of Plate 197 *in* Goode (1887), by G. Ferrand. Darting and shoulder guns.
Fig. 1 is a Pierce and Cunningham darting gun and bomb-lance, a combined harpoon and lance used largely by Arctic whalemen. The following specifications are from Goode's legend: *a*. Gun-metal barrel about 20 inches long; *B*. Ordinary harpoon hole, fitted into brass socket (*c*); *b*. Breech-pin and lock-case; *C*. harpoon with whale-line (*E*) attached; and set in projections (*d*, *d*) on the gun; *d*. Bomb-lance fired from barrel (*a*). The harpoon entering the blubber brings the long wire rod (*g*) in contact with the whale and releases the trigger; *F*. Lever for cocking the gun; *h*. Line by which the gun is hauled back to the boat.
Fig. 2. Cunningham and Gogan gun; length 33 inches; weight 27 pounds. Used by Arctic steam whalers with bomb-lance.
Fig. 3. Brand muzzle-loading whaling-gun (*a*) and bomb-lance (*b*).

Whaling at Cape Hatteras described (pp. 48–9). 'As soon as the whale is harpooned the 'drug' is thrown over, and when he turns to fight the fishermen, armed with guns, shoot him with explosive cartridges, and, after killing him with their lances, tow him to the shore.' The 'whaling-gun' was introduced here in 1874 by a Provincetown whaler.

California shore whaling described (p. 52 *et seq*). Of 16 gray whales taken at Cojo Viejo only one lacked scars from bomb-lances (p. 57). A large bomb-lance, holding 1 lb of powder, invented by Captain Anderson and manufactured in Norway, was fired from a swivel gun and 'usually kills the whale.' Harpoons manufactured in Cambria since 1868 considered more effective; shot from a large swivel gun. Harpoon weighs 7–9 lb, the rope 37 lb. Effective range 150 ft or less.

Description of beluga hunting in Alaska with spears 'provided with inflated bladders near the head' and a rifle (p. 61). Humpback whaling in Barbados with 'toggle-irons', lances 6 ft long on a wooden pole 5 ft long, a 'breach-loading bomb-gun', and 'explosive-bomb lances' (p. 214–5). Average death-time said to be 30 minutes, with occasional instances requiring 12 hrs. 'I have known [humpbacks to] spout thick blood at sunrise, and to get away at sunset.' In the Gulf of St. Lawrence whale fishery, 'whales are sometimes taken in fifteen minutes after they are struck with the harpoon' (p. 217).

113. Clarke, R. 1952. Electric whaling. *Nature*, Vol. 169, pp. 859–60.

Comprehensive discussion of whaling by electrocution. Experiments by German investigator Weber during 1929–38, involving 2,000 electrocuted whales. Method and research resumed by H. R. Lillie and C. W. Hume in 1946–7, with United Whalers, Ltd., of Great Britain and Electrohval of Norway. Instant death with heart/lung strike, 10 sec with dorsal muscle strike. Time spent 'securing a hit, killing the whale, heaving-to, inflating and flagging the whale, and finally resuming the chase' reduced from 45 min in grenade whaling to 10 min in electric whaling.

114. Clarke, R. 1953. Sperm whaling from open boats in the Azores. *Norsk Hvalfangst-Tidende*, Årg. 42, Nr. 7, pp. 265–77.

See Clarke (1954a, entry 115).

115. Clarke, R. 1954a. Open boat whaling in the Azores. The history and present methods of a relic industry. *Discovery Reports*, Vol. 26, pp. 281–354 + 1 folding table + pls. 13–18.

Detailed description of sperm whaling methods, past and present. Sees no essential difference between lance used by Azoreans and that used by British at Spitsbergen in early 1600s; and toggle harpoon descended from 'bone-and-sinew toggles of Eskimo whaling' (p. 317). Specifications for manufacturing and rigging the 'Temple iron' and lance, as used by the Azoreans, are given (pp. 318–21). Open whaleboats towed to and from grounds by motor-boats. 'As soon as the whale feels the harpoon, he runs away with the line, usually sounding but occasionally in headlong flight at or near the surface. What happens afterwards until the whale is killed may occupy a short or long time, sometimes as little as half an hour or an hour, and sometimes several hours' (p. 330). Chase sequence illustrated (Plate XV).

116. Clarke, R. 1954b. Whaling and the stocks of whales. *The Advancement of Science*, Vol. 11, No. 43, pp. 305–11.

Electrical whaling 'has great possibilities as a more humane and more rapid method of killing whales, and one yielding an unspoiled carcase without grenade splinters. It belongs to the future of whaling.' In author's view, however, conservative attitude of gunners must be overcome before such a radically different method replaces the grenade harpoon.

117. Clarke, R. 1967. Whaling. Reprinted from *Encyclopaedia Britannica*, 4 unnumbered pages.

Mention of grenade harpoon currently in use. Hand lance and hand harpoon, as still used in Azores, illustrated. Experiments with electric harpoon 'did not win favour with the industry.'

118. Cockrill, R. 1958. The great whales of the Antarctic. *Natural History*, Vol. 67, No. 10, pp. 538–57.

Illustrated, first-hand description of modern, Antarctic, factory ship whaling. With explosive harpoon, 'The whale's death struggle may last for some hours but is usually over in forty minutes.' Electrocution said to offer 'the possibility of eliminating the prolonged death struggle and reducing the amount of tissue damage.'

119. Cockrill, W. R. 1953. 'Antarctica revisited.' *The State Veterinary Journal*, Vol. 8, No. 24, pp. 39–53 + 1 pl.

Reference to commentaries in 'scientific and lay press' concerning 'the archaic and inhumane method of killing whales by the explosive-head harpoon' (p. 47). 'Death seldom ensues quickly.' Author also decries waste resulting from slow death. Mentions experiments with electrical whaling by Norwegian and British companies. No electric whaling in 1951/52 season, but 'in active use currently.' Death brought about 'quickly'.

Attributes invention of 'ingenious' gas harpoon to C. Wetlesen. Shank of harpoon contained 7 kg of liquid CO_2 under pressure. Death said to occur within 5 minutes; no tissue damage; whale buoyant. Author feels this invention was never given fair trial because it was used only as a 'killer' after one or two explosive harpoons already had been fired.

120. Colwell, M. 1970. *Whaling Around Australia*. Angus & Robertson (U.K.) Ltd., London. pp. [i–xii] + 1 – [178] + 20 pls.

Popular account that includes a superficial description of harpoon development (p. 109 *et seq*).

121. Conway, M. 1906. *No Man's Land. A history of Spitsbergen from its discovery in 1596 to the beginning of the scientific exploration of the country*. Cambridge: At the University Press. pp. frontis + i–xii + 1–377 + 10 pls. + 11 maps + 1 folding map in the cover.

Good description of earliest history of commercial whaling in the Arctic and of whaling techniques. Mostly hand harpoon and hand lance (e.g. p. 204), but also mention of white whale hunting at Spitsbergen, in which whales were 'driven ashore by aid of nets' (p. 212) or shot in open water (p. 257).

122. Credland, A. G. 1978 & 1979. La chasse a la baleine. *Le Musée d'Armes, Bulletin,* Liege: 6e année, No. 22, 1978 pp. 1–14; 7e année, No. 23, 1979, pp. 11–22.

Descriptions of hand harpoon whaling, evolution of the bomb lance, crossbows, etc. Photographs of harpoon guns developed in 18th and 19th centuries by Moore, Wallis, and Greener. A short but useful bibliography is included. [In French.]

123. Creisler, J. 1964. A whale of a problem. *Public Works,* Vol. 95, pp. 80–1.

Describes a variety of methods employed to dispose of a live stranded whale. Attempts to kill the whale by gunshot and by a dynamite charge placed in the blowhole proved unsuccessful. Eventually, the whale was strung from head to flukes with a 40% charge of explosives, more than 250 lbs of dynamite, and was literally blown to pieces. (The whale was still alive when this was done.)

124. Crisp, F. 1957. *The Adventure of Whaling.* London, Macmillan & Co. Ltd. pp. i–viii + 1–143.

Popular account of whaling history. Describes and illustrates vessels and gear. Considers cases of prolonged death-times exceptional in modern whaling — 'most whales are killed in a short time after the detonation of the grenade, and they probably suffer much less than a rabbit which spends a night in a gin trap' (p. 126). Mentions electrical and CO_2 gas whaling (p. 127).

125. Dalgård, S. 1962. *Dansk-Norsk Hvalfangst 1615–1660. En studie over Danmark-Norges stilling i Europaeisk merkantil expansion.* G. E. C. Gad, København. pp. 1–463.

Chapter 1 of section called 'Anden del Analyse' is entitled 'Fangstens Teknik' (pp. 239–47). Many footnote references. [In Danish]

126. Dawbin, W. H. 1952. Whales and whaling in the Southern Ocean. Chapter Six, pp. 151–194. *In:* Simpson, F. A. [Ed.], *The Antarctic today: a mid-century survey.* New Zealand Antarctic Society. Sidney, Halstead Press.

Cites S. Foyn as inventor of modern whaling, but notes that Irish whalers had tried an explosive harpoon 'off the coast of Donegal a century earlier, and in the 1850's some American whalers were regularly using shoulder guns or light swivel guns on the bows of open long-boats' (p. 155).

'After considerable experimentation, some chasers have been equipped with electric harpoons which paralyse and kill the whale much more quickly and humanely than the 165 lb. explosive harpoon' (p. 167).

127. Dawbin, W. H. 1954. Maori whaling. *Norsk Hvalfangst-Tidende,* Årg. 43, Nr. 8, pp. 269–81.

Illustrated account of whaling in New Zealand by Maoris during 19th and early 20th centuries. Techniques from 19th century, commercial, pelagic whalers: open whaleboats, hand harpoons and lances.

128. Dawbin, W. H. Ms. 1960a. Electric whaling in New Zealand. [Note of 5th April, 1960 to the Secretary of the International Whaling Commission.] [Submitted to] The Working Party On Humane And Expeditious Methods Of Killing Whales, International Commission on Whaling, [London,] 4 March and 9 May, 1960. HM5, p. [i–ii] typescript.

Author has seen many whales killed by explosive harpooning, electrocution, and hand harpoon and lance. Considers the last of these methods 'the slowest and most hazardous.' His impression was that death usually came more quickly from electrocution than from explosive harpooning. Also, he found the meat to be of consistently better quality from electrocuted whales. Saw two instances in New Zealand of inadequate application of current, resulting in 'a tremendous flurry of the whale for some 10–15 minutes before it died.' Locally designed conductor and harpoon killed 150–200 whales in New Zealand in 3 years.

129. Dawbin, W. H. Ms. 1960b. Electric whaling in New Zealand. [Further note by Dr. Dawbin.] [Submitted to] The Working Party On Humane And Expeditious Methods of Killing Whales, International Commission on Whaling, [London,] 4 March and 9 May, 1960. HM5 Addendum, p. [i] typescript.

Note that New Zealand whalers stopped electrical whaling due mainly to inability to find forerunner of suitable flex. Also, demand for meat declined. In one year, 80 percent of the New Zealand catch was made by electrocution, amounting to about 100 whales. Electric harpoon considered 100 percent effective when properly embedded.

130. Dawbin, W. H. 1967. *Whaling in New Zealand waters.* Extract from *An Encyclopaedia of New Zealand,* R. E. Owen, Government Printer, Wellington, New Zealand, pp. 1–7.

Use of 'massive steel nets' at Whangamumu to entangle and impede progress of whales so they could be approached closely for hand harpooning, begun in 1890. In 1910 a 'Norwegian-type steam chaser with a heavy explosive harpoon gun' was introduced at this station.

'Explosive-type spear' developed locally in early 20th century near Tory Channel and Campbell Island. 'The whaler-shepherds used hollow pipes containing plugs of gelignite fired by detonator after they had plunged the sharpened pipe into a whale.' In about 1911 30-ft launches and a light explosive harpoon were used to chase and fasten to the whale, improving the effectiveness of the gelignite pipe.

131. Deltager. 1927. Hvalkanon i Tenvik paa Nøtterø. *Norsk Hvalfangst-Tidende,* Årg. 16, Nr. 9, pp. 145, 148.

Description of the first trials made with a breechloading whale gun mounted on a small hill at the south end of Nøtterø, a small island on the west side of the mouth of Oslofjord. The gun was made by the Kongsberg Arms Factory. Smokeless gunpowder was used experimentally. At a distance of 30–40 fathoms a charge of 220 grams of smokeless powder proved more effective than 500 grams of the ordinary black powder. [In Norwegian.]

132. Dijk, W. H. E. van. Ms. 1959. Report on experimentation with carbonic acid-harpoons during the season 1958/59, by Netherlands Whaling Expedition. [Submitted to] The Working Party On Humane And Expeditious Methods Of Killing Whales, International Commission on Whaling, [London,] 4 March and 9 May, 1960. HM1: Document B, p. [i–ii] typescript.

Dutch experiment with carbonic acid gas-harpoons in 1958 in the Antarctic. Goal was to see whether whales could be killed immediately, whether they would be automatically inflated, and whether they could be shot and secured without a line being attached to the harpoon.

Of the 9 harpoons constructed, one misfired. Seven fin whales were shot, one of them with two harpoons. Three of the harpoons penetrated through the whale's body, the carbonic acid escaping directly into the water as the harpoon-head emerged on the far side of the animal. In the 5 other cases, the acid gas escaped from the wound. All 7 whales had to be killed with standard shell harpoons. Thus, the trials were unsuccessful.

133. Domning, D. P. 1972. Steller's sea cow and the origin of North Pacific aboriginal whaling. *Syesis*, Vol. 5, pp. 187–9.

Author speculates that harpoon hunting of the Steller's sea cow influenced development of aboriginal whaling techniques in North Pacific.

134. Duhamel Du Monceau, M. 1782. *Traité Général des Pêches, et Histoire des Poissons qu'elles fournissent, tant pour la subsistance des hommes, que pour plusieurs autres usages qui ont rapport aux Arts et au Commerce.* Suite de la Seconde Partie. Tome Quatrième. A Paris, Chez Veuve Desaint, Libraire, rue du Foin Saint-Jacques. Avec Approbation, et Privilège du Roi. [4 vols] Traité Général des Pêches et Histoire des Poissons, ou des Animaux qui Vivent dans l'eau. Suite de la Seconde Partie, Tome IV. Dixième Section. Des Poissons Cétacées, & des Amphibies. pp. 1–73 + pls. 1–15.

One of the best early encyclopedic descriptions of whaling methods and implements, including detailed accounts and accurate illustrations. Allen (1882, p. 472) states: 'His account of the whalefishery, in relation to the capture and subsequent treatment of the animals, is detailed and very fully illustrated in the plates, and forms a valuable contribution to the history of the subject.'

135. Duncan, D. W., Leung, J., Boyd, J. W., LePage, N. A. W., Muirhead, C. R. and Tarr, H. L. A. 1957. Control of post-mortem bacterial spoilage of whales with antibiotics: details of 1956 and 1957 experiments. Fisheries Research Board of Canada, Technological Station, Vancouver, B.C. Industrial Memorandum No. 20, p. 1–2 + Fig. 1 + Tables 1–9.

Tests were made by injecting whale carcasses post-mortem with Aureomycin and by inserting polyethylene bags containing 50 g portions of Aureomycin, Terramycin, or oxytetracycline into the bomb head of harpoons immediately below the charge of black powder. Bacterial count was appreciably reduced by post-mortem injection but not to a convincing degree by harpoon introduction.

136. Duncan, N. 1904. The chase of the fin-back whale. *Outing*, Vol. 44, No. 6, pp. 679–82, 684–5.

Apparently first-hand description of contemporary whaling at Newfoundland. Swivel gun, with 3-in. bore, 4-ft, 123-lb harpoon. Exploding iron bomb. Describes incident in which death-time was 3 hr; first bomb failed to explode and second was 'badly aimed.' Effective range 20 yd or less. Chase lasting 17 hr with gun being fired only once — at the end of the chase. 'It took him [the whale] a long, long time to die, frightfully torn by the bomb though he was.'

137. Durham, F. E. 1974. Ancient and Current Methods of Taking the Bowhead Whale. University of Alaska, Anchorage, Alaska Sea Grant Report No. 73–9, pp. 1–15.

Important discussion of technology changes in Alaskan Eskimo whaling for the bowhead. Traditional use of barbed harpoon, line, floats, lance, and sometimes

poison, replaced by 19th century weapons of Yankee whalers, particularly darting gun and shoulder gun. 'Hamstringing' mentioned. 'Yankee code' required quiet approach, making fast with harpoon-line-float, then killing with lance or bomb from shoulder gun. Use of shoulder gun first contributes to high loss rate. Author estimates 'good' Yankee whalers secured 2/3 to 3/4 of the whales they struck; present-day Eskimo whalers, 'one in four or five whales pursued is harvested successfully.'

Recommends return to 'older techniques, which would increase the chances of harvesting a whale.'

138. Durham, F. E. Ms. 1979. Recent trends in bowhead whaling by Eskimos in the Western Arctic with emphasis on utilization. Whale Protection Fund, Center for Environmental Education, Inc., Washington, D.C., pp. [i–vi] + 1–53 typescript.

Author discusses changing methods of hunting bowheads, based on personal experience in northern Alaska. 'Overbombing' supposedly 'often follows the mortal wounding.' Also, 'Bowheads are sometimes attacked by Eskimos using only rifles.' A 20 mm machine gun was purchased recently and set up on a tripod on the shorefast ice. Only one of several whales killed with such a gun was recovered.

139. Elking, H. 1722. *A view of the Greenland Trade and Whale-Fishery With the National and Private Advantages thereof.* London: Printed for J. Roberts, near the Oxford-Arms in Warwick-Lane. pp. 1–68.

Description of early Arctic commercial whaling. Hand harpoons and hand lances used. Blood in the whale's spout 'is a Signal of his being mortally wounded.'

140. Fabricius, O. 1962. Otto Fabricius' ethnographical works. With an introduction by William Thalbitzer, edited by Erik Holtved. *Meddelelser om Grønland,* Vol. 140, No. 2, pp. 1–138 + folding pls. 1–2.

Greenlanders used 'large lances of iron' to hunt humpback whales. Whale approached quietly and stabbed with lances, 'preferably . . . behind the flippers to strike the heart.' Lance withdrawn immediately 'in order not to lose it.' Whale followed and 'the hunters continue to stab it again until it is dead, for it can tolerate several thrusts if the heart is not hit; but sometimes they are successful in killing it by the first blow.' Whales that were not recovered immediately often died later, 'as inflammation easily appears in the wound.'

141. Fagan, D. W. O. 1911. Where whales are caught in nets. *The Wide World Magazine,* Vol. 26, No. 54, pp. 423–32.

Contemporary shore whaling in New Zealand. Nets 500–600 ft long, 200 ft deep, with 7 ft mesh, made of 3/8 inch wire rope, hung on wire cables buoyed by floats and drogues. Set at narrow channel. Whale is entangled, then attacked with harpoon guns and killed with hand lances. Whales caught are humpbacks, blue whales, and rarely sperm whales. Well illustrated.

142. Falck, R. and Falck, E. 1963. Catalogue analytique et descriptif des têtes de harpons eskimo du Musée de l'Homme. Paris, Muséum National d'Histoire Naturelle, *Catalogues du Musée de l'Homme, Série G, Arctiques* I, pp. 1–52.

Twelve plates showing Eskimo harpoon heads from various angles. A short bibliography is appended.

143. Ferguson, H. 1931. Whaling with harpoon-gun and explosive bomb. A day with Norwegian whalers in the Antarctic — industry afloat in the frozen south. *The Illustrated London News,* Jan. 3, 1931, pp. 20–21.

Modern factory-ship whaling in Antarctic. Describes capture of a fin whale, requiring two harpoons.

144. Ferguson, R. 1936. *Harpooner. A Four-Year Voyage on the Barque* Kathleen *1880–1884.* University of Pennsylvania Press: Philadelphia: 1936. pp. i–xvi + 1–316.

An edited compilation of the 'diaries' of a 19th century whaleman. Many first-hand descriptions of the capture of whales, mainly sperm whales.

145. Finley, K. J., Davis, R. A. and Silverman, H. B. 1980. Aspects of the narwhal hunt in the Eastern Canadian Arctic. *Rep. int. Whal. Commn,* 30, pp. 459–64.

Narwhal hunt analyzed according to three phases: floe-edge, ice-crack, and open-water. In the first, hunters patrol the ice-edge in snowmobiles and shoot the whales at close range, often within 20 m of the ice-edge. In the second, whales are shot in restricted ice-cracks, often at close range and from a comparatively high angle. In the third situation, whales are chased in outboard-powered canoes and boats, and harpoons are sometimes used to retrieve animals that have been shot and wounded. Medium-powered rifles, usually .303 or .3006 calibre, with full metal jacket (hard point) bullets are preferred, although appropriate ammunition is not always available. One instance is recorded in which soft-point ammunition was used, requiring 36 rounds to kill a large male. Loss rates are discussed in detail, and estimates are made for the floe-edge and open-water phases of the hunt.

146. Fiscus, C. H. and Marquette, W. M. 1975. National Marine Fisheries Service Field Studies Relating to the Bowhead Whale Harvest in Alaska, 1974. Seattle, NOAA, Northwest Fisheries Center Processed Report January 1975, pp. [i–iv] + 1–23.

Brief report on subsistence hunt by natives, using skin boats, plastic floats, shoulder gun, and bomb lance (see Table 3). Failure of bomb to explode cited as important reason for struck whales not being recovered. Recommends that darting gun with harpoon and attached float be used first to reduce loss rate. Photographs.

147. Fjeld-Andersen, A. 1961. *Oversiktskatalog i Bøker, Periodiske Skrifter og Saertrykk ved Hvalfangstmuseets Bibliotek.* Kommandør Chr. Christensens Hvalfangstmuseum, Sandefjord. A/S Handelstrykkeriet. ii + 264 pp.

A miscellaneous bibliography.

148. Flyger, V. 1964. Succinylcholine chloride for killing or capturing whales. *Norsk Hvalfangst-Tidende,* Årg. 53, Nr. 4, pp. 88–90.

Commentary on possible use of succinylcholine chloride projectile syringe for killing whales. Aluminum syringe containing 1000 mg of succinylcholine chloride in aqueous solution fired into a white whale in Mackenzie Delta. Experiment inconclusive because whale was shot by Eskimos after being darted. Immobilization and buoyancy apparently effected. Author calculates dosage of 0.55 mg per kg of body weight required for immobilization and killing of white whales. Considers method humane and efficient.

149. Foord, H. 1784. [Certificate of capture of whales by use of the gun-harpoon.] *Transactions of the Society, Instituted at London, for the encouragement of Arts, Manufactures, and Commerce; with the Premiums offered in the Year 1784.* Vol. 2, pp. 197–222

A series of letters from Humphrey Foord, a resourceful whaling master, concerning his attempts to kill whales, mainly bowheads, with gun-harpoons. An interesting comment: 'The greatest disadvantage we labour under, which prevents the gun harpoon from being one of the noblest contrivances that ever was invented for killing whales, is, the want of experienced persons to fire the guns. As for the harpooners, they are like a parcel of old gin-horses, that cannot be drove out of their pace; and notwithstanding all the encouragment they have met with from the Society of Arts, Manufactures, and Commerce, yet there is not one in ten of them that will use the gun harpoon, unless compelled. . . .'

150. Foote, D. C. 1975. Investigation of small whale hunting in northern Norway, 1964. *Journal of the Fisheries Research Board of Canada,* Vol. 32, No. 7, pp. 1163–89.

Detailed description of equipment and types of harpoons used in Norwegian small whale hunting. 'Although the Kongsberg 50-mm cannon can be fitted with a grenade-carrying harpoon, the Norwegian small whale hunters do not use this added killing device.' Harpoon usually passes completely through whale's body. Usually shot at 20–30 yd. 'Death is seldom instantaneous and the whalers must pay out lines and floats while the dying animal expends its last energy.'

151. Fowler, G. H. and Allen, E. J. [Eds.] 1928. Science Of The Sea: an elementary handbook of practical oceanography for travellers, sailors, and yachtsmen prepared by The Challenger Society for the promotion of the study of oceanography. [Second Edition]. Oxford at the Clarendon Press. p. frontis + [i]–xxiii + 1–502 + 3 charts.

Chapter 12, 'Whales, Seals, and Sea-Serpents' by D'Arcy Wentworth Thompson, includes a description of the hunted whale species and an excellent historical overview of the whale fishery. Thompson recounts from Captain Thomas Brown's edition of Goldsmith's *History of Animated Nature* (1835, vol. 3, p. 469) that 'the harpoon-gun was invented a hundred years before Svend Foyn's time, by an Irishman in Donegal'. Two brothers, Andrew and Thomas Nesbit, of Killibegs, fished for whales on that coast about the year 1759 . . . and Thomas, we are told, 'in order to give force to the harpoon, and also to the lances which are discharged at the fish every time he rises after the harpoon has entered, contrived to discharge both the harpoon and the lance from a swivel-gun; which succeeded so well, that in the year 1762 the company killed three whales, two of which were between 60 and 70 ft long, and the other above 50; and in 1763, they have killed two whales of a large size, which is more than many have done that have been fitted out for Greenland, at a vast expense'. This venture failed at length, and was forgotten; the fact is, it was the explosive bullet combined with the harpoon-gun which made Svend Foyn's invention a success'.

152. Fraker, M. A. 1980. Status and harvest of the Mackenzie stock of white whales (*Delphinapterus leucas*). *Rep. int. Whal. Commn,* 30, pp. 451–8.

Detailed discussions of hunting methods. Two approaches are used: 'He may shoot the whale in order to wound and slow it, so that it can be harpooned more easily, after which it is killed. Or he may first harpoon the whale and then shoot to kill the

animal. In either case, the harpoon is connected to a line to which a large float (up to 1 m in diameter) is attached (p. 453).' Tables 3 and 4 (p. 454) list reasons for whales being killed-and-lost and specifications of typical cartridges used in the hunt, respectively. Instances are noted in which 40 rounds were fired at a large male before it was killed and 60 rounds were fired at a whale that was not secured. In the former case, 27 wounds could be discerned within 30 cm of the eye. Author cites need for non-expanding, hard-point ammunition to kill efficiently in this fishery. He considers the .30/.30 Winchester rifle less suitable, especially with currently available ammunition, than the .30/.06 Springfield and the .270 Winchester.

153. Fraser, F. C. 1937–38. Early Japanese Whaling. *Proceedings of The Linnean Society of London, 150th Session,* 11 Nov. 1937. pp. 19–20 + pl. 2.

Lecture with 'lantern-slides' showing Japanese whaling in late 18th and early 19th centuries. 'Nets played an important part in the capture of the animals, whilst harpoons, lances, and knives were used in their dispatch.'

154. Frost, S. [chmn]. 1979. *The Whaling Question.* (The Inquiry by Sir Sydney Frost of Australia). Friends of the Earth, San Francisco, and The Whale Coalition: distributed by Friends of the Earth, 124 Spear Street, San Francisco, CA 94105. pp. [i–xviii] + v–xii + 3–341 + [i–iii].

Report of an independent inquiry into whales and whaling sponsored by the Australian government. Terms of reference included examination of 'methods used in taking whales and whether better methods are possible' (p. viii). Chapter 10 (pp. 172–182) covers 'Techniques Used to Kill Whales.' Includes brief but comprehensive summary of past and present techniques. Good review of recent IWC actions regarding humane killing.

New data presented from Cheynes Beach whaling station in Australia. Of 420 sperm whales killed in 1978, 195 (46.4%) required one harpoon; 47.4 percent died within 1 min, 27.4 percent within 2–4 min, 19.3 within 5–7, 4.8 within 8–10, and 1.2 in more than 11 min (p. 178–9). An 'extreme case' required 4 harpoons and a death-time of 15 min. Average death-time was about 3 min.

Humaneness of whaling is discussed. Conclusion: 'Although death is brought about by a most horrible method, in the cases where it occurs instantaneously, the act of killing may be said to be not inhumane. But if the death is not instantaneous, or does not happen quickly, the animal is required to suffer from these truly horrible injuries for at least three minutes and more usually up to five or seven minutes until a killer harpoon can be fired.' In the latter cases, 'death is caused most inhumanely' (p. 182).

It is stated (p. 205) that whaling cannot be expected to achieve standards of humane killing equivalent to those in slaughterhouses, 'and for this reason we believe that the killing should stop.' The principal recommendation of the inquiry is that Australia establish a national policy opposed to whaling.

155. Fujita, I. Ms. 1959. [Letter from the Japanese Commissioner on the effects of electric killing of whales. Tokyo, 17th November, 1959.] [Submitted to] The Working Party On Humane And Expeditious Methods Of Killing Whales, International Commission on Whaling, [London,] 4 March and 9 May, 1960. HM1: Document G, [i] p. typescript.

Short letter complaining that Japanese experience with electrical whaling was that it reduced marketability of meat. No further initiative contemplated to develop humane killing method.

156. Gaskin, D. E. and Smith, G. J. D. 1977. The small whale fishery of St. Lucia, W.I. *Rep. int. Whal. Commn,* 27, p. 493.

Using various craft, from a 50 ft inter-island trader to dugout canoes powered by outboard motors, small cetaceans are caught with 'the most primitive level of hand-thrown harpoons' as well as 'hand-made harpoon guns consisting of mounted 12 gauge shotguns powered by hand-loaded shells.'

157. Gilmore, R. M. 1951. The Whaling Industry. Whales, Dolphins, and Porpoises. Chapter 33, pp. 680–715 *In:* Tressler, D. K. and J. McW. Lemon [Eds.], *Marine Products Of Commerce. Their Acquisition, Handling, Biological Aspects and the Science and Technology of Their Preparation and Preservation.* Book Division, Reinhold Publishing Corporation, New York.

Brief description of modern whaling methods (p. 689), little changed for 75 years except that ships have become more powerful and guns more accurate and long-ranged. Explosive harpoon fired from muzzle-loading cannon most common, but breechloading cannon 'recently perfected and applied.' Diesel just beginning to replace steam in propulsion, and nylon replacing hemp in forerunners and lines. ASDIC and aircraft beginning to be used in spotting and tracking whales.

Mentions recent appearance of electric harpoon. Experiments with liquid CO_2 harpoon unsuccessful.

Specifications given for 'standard harpoon gun'.

158. Golovlev, I. F. 1955. Ob uboinykh mestakh u kitov. *Rybnoe Khoziaistvo,* Vol. 31, No. 7, pp. 20–21.

Discussion of target areas on fin whales. In diagram, '+"s indicate spots where the first harpoon was fatal; 'o"s indicate spots which required at least one additional harpoon to kill. Quantitative results based on 31 observations. Nineteen whales killed with one harpoon; 12 required a second harpoon. Of 18 whales first shot in the right side, 11 were killed by the first harpoon (61%). Of 13 first shot in the left side, 8 proved fatal (62%). Average death-time for whales killed with one harpoon was 5–6 minutes; those requiring two or more harpoons, 16.7 minutes. For the entire sample, the average death-time was 10 minutes. Author believes a well-placed shot can reduce the time to death by 50 percent. An ideal shot would be about 2–3 m behind the center of the chest. [In Russian.]

159. Golovlev, I. F. 1956. *Tekhnika Kitoboinogo Promysla.* (Technique of the Whaling Industry.) Pishchepromizdat, pp. [1]–[112].

Contains good illustrations of harpoons and other modern whalecraft used by the whaling industry of the USSR. [In Russian].

160. Goode, G. B. 1887. *The Fisheries and Fishery Industries of the United States.* United States Commission of Fish and Fisheries, Washington, Government Printing Office. (5 Sections in 7 Volumes). Section V, History and Methods of the Fisheries, in two volumes, with an atlas of two hundred and fifty-five plates. Plates. pp. (i) – xvi + pls. 1–255.

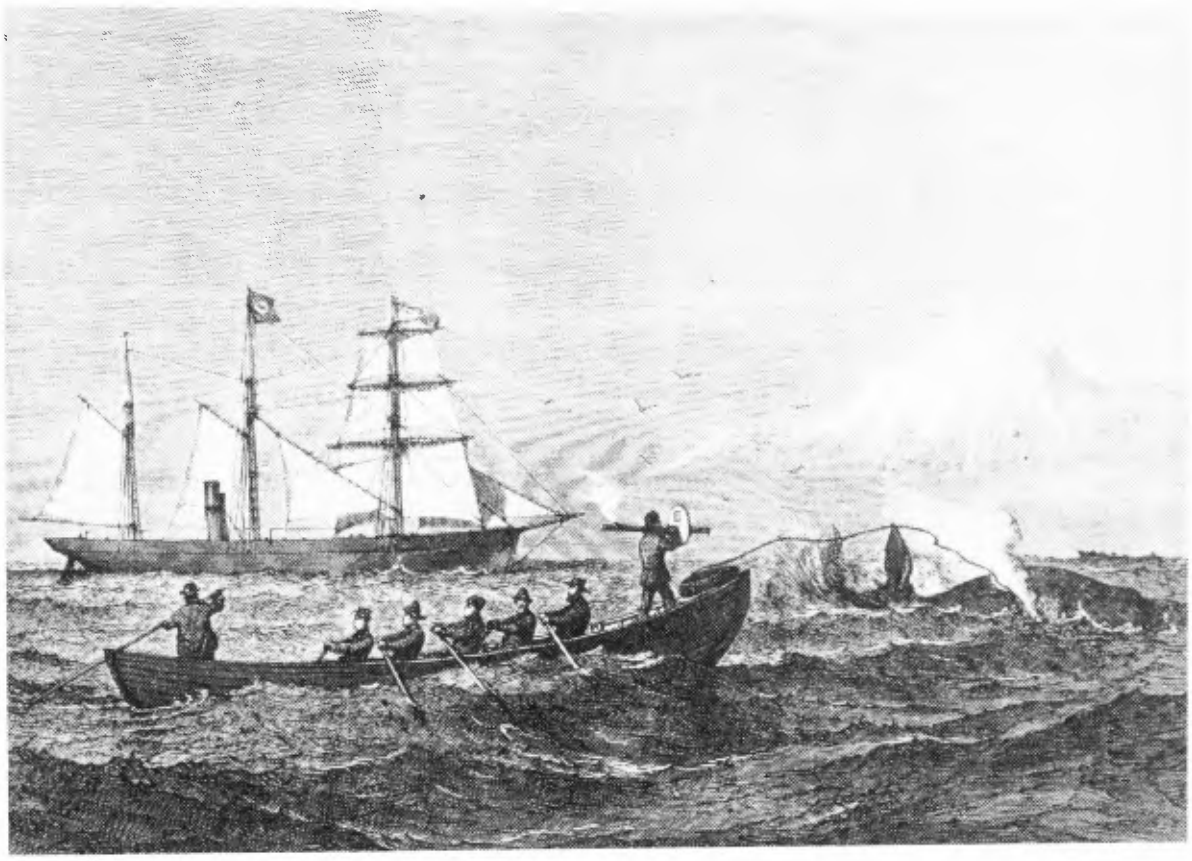

Fig. 13. Captain, Thomas Welcome Roys developed the Rocket harpoon, here shown in use in a competing Danish-backed venture carried out from the 297-ton steamer *Thomas Roys* off the coast of Iceland. (Photo courtesy of the Kendall Whaling Museum.)

161. Gordon, J. 1982. One whale less. *Oceans*, Vol. 15, No. 1, pp. 30–1.

First-hand description of sperm whaling at the Azores. 'This whale has taken just over an hour to die, a typical time in the Azores, though times of five or six hours are not uncommon.'

162. Granöe, C. R., Berntsen, H., Blydt, C. B. and Langfeldt, E. 1934. [English translation of a letter from Hvalfangerforeningen, The Association of Whaling Companies, to The Whaling Council, with a covering letter by A. C. Olsen, Sandefjord, 28th April 1933 [1934]]. pp. 1–20 + [1] typescript. Old Dartmouth Historical Society, Whaling Museum Library, New Bedford, Mass. Bostock Papers, IMA Microfilm #1722 and #1723.

Detailed technical description and comparison of two systems, one developed by German engineer Weber and the other by Norwegian engineer A. I. Foyn. Weber's system is judged preferable to Foyn's. The primary advantage of electrical whaling over shell harpoon whaling is considered the reduction in the percentage of lost whales. Savings due to elimination of problems associated with shell splintering in the flesh of whales killed by 'ordinary' methods are also mentioned. A controlled experiment in the Antarctic is recommended.

163. Gray, R. 1889. Whale Fisheries. *Encyclopaedia Britannica*, 9th edition, Vol. 24, pp. 526–8.

Detailed descriptions by an experienced whaleman of steam whalers, whale boats, harpoons, lances, and whale lines as well as killing and processing procedures. 'Under favourable circumstances the capture of a full-grown whale from the time of first harpooning until its death occupies from one to one and a half hours.' Emphasis on British bowhead fishery.

164. Gray, R. W. 1939. Harpoons and the capture of whales. *The Naturalist,* No. 992, (Sept.), pp. 245–9.

Description by an experienced Arctic whaler of equipment and methods. Fixed head and moveable, jointed, or 'toggle' head harpoons distinguished. Three methods: (1) 'Eskimo' use of drogues or buoys (made of sealskin) to exhaust and follow the whale; (2) getting fast to the whale and using the attack boat itself as a kind of drogue; and (3) modern or Norwegian use of small, steam-propelled catcher boats to fasten to and kill the whale with a grenade harpoon. Arctic whaling for bowheads and bottlenose whales (sometimes with a small swivel gun, 30–36 inches long and 1.5–2 inches in diameter, mounted on the ship's bow) and sperm and right whale fishery in the Pacific and South Seas. Tables give specifications for boats and harpoons, according to species.

165. Greener, W. W. 1967? *The Gun and its development.* Ninth Edition. Rewritten, and with many Additional Illustrations. Bonanza Books, New York. [Reprint of 1910, Ninth Edition.]

The author was a well-known gun-maker and inventor in his own right, although in whaling history his father W. Greener was more prominent. The section titled 'Harpoon Guns' (pp. 514–17) gives a concise description of nineteenth century harpoon guns; the 'mortar projecting an explosive ball, or bomb-lance' used by the Norwegians; and harpoons 'with an exploding bomb in front.' Thiercelin's experimental use of 'a shell filled with poison and burst by an explosive' is recounted: ten whales were killed with a soluble salt of strychnine and a twentieth part of curare. Four of the ten were 'lost by sinking.'

166. Grierson, J. 1949. *Air Whaler.* Sampson Low, Marston & Co., Ltd., London. pp. frontis + i–xii + 1–243 + pls. i–xliv.

Author was involved in early use of aircraft to assist Antarctic whaling fleet in ice, weather, and whale reconnaissance. Discusses possible use of helicopters for shooting whales with rocket harpoon (pp. 233–6). Carbon dioxide would need to be used to ensure buoyancy. Author decries conservatism of Norwegian whalers and supposes their reluctance to accept innovation would stand in the way of development of airborne whaling. Mentions electrocution of 200 whales by *Star XIV* in 1934/35, of which only two were lost. *Balaena* expedition in which author was involved experimented with harpoon heads filled with liquid carbon dioxide under high pressure. Two of these 'carbon dioxide bombs' were shot at a whale and killed it. 'Tests later showed that this method resulted in better preservation of the meat, but it was impossible to persuade the gunners to use any more of these bombs' (p. 235).

167. Haley, D. 1974. The bloody business of whaling. *Defenders of Wildlife International,* Vol. 49, No. 4, pp. 261–5.

Popular account, critical of modern whaling.

168. Halmond, A. 1919. Electrocuting whales. *Illustrated World,* Vol. 31, pp. 505–6.

Optimistic description of proposed method for electrocuting whales. Main arguments for development of electric whaling are crew safety and the elimination of product wastage resulting from use of grenade harpoon.

169. Hansen, G. A. 1887. Hvalfangst ved blodforgiftning. *Naturen,* Årg. 11, pp. 1–4.

Hansen, famous discoverer of the lepra bacillus in 1873, states that the whales killed in the Norwegian bacillus whaling are infected by bacilli from rotten whale meat, the arrows having been dipped in the wound of a killed whale. The arrow is not cleaned from one year to another and may still be infected from a previous year's contamination. See Brunchorst (1887, entry 105, 1899, entry 106).

170. Harrold, C. G. 1929. 'Big-game hunting' in the Bering Sea. *Country Life,* Vol. 65, pp. 160–2.

Modern whaling from a shore station in the Aleutian Islands, described from first-hand observation. The range of the deck-mounted cannon said to be about 150 ft, 'although shots may occasionally be taken at greater distances.' A second explosive harpoon used when 'the first bomb failed in its work.'

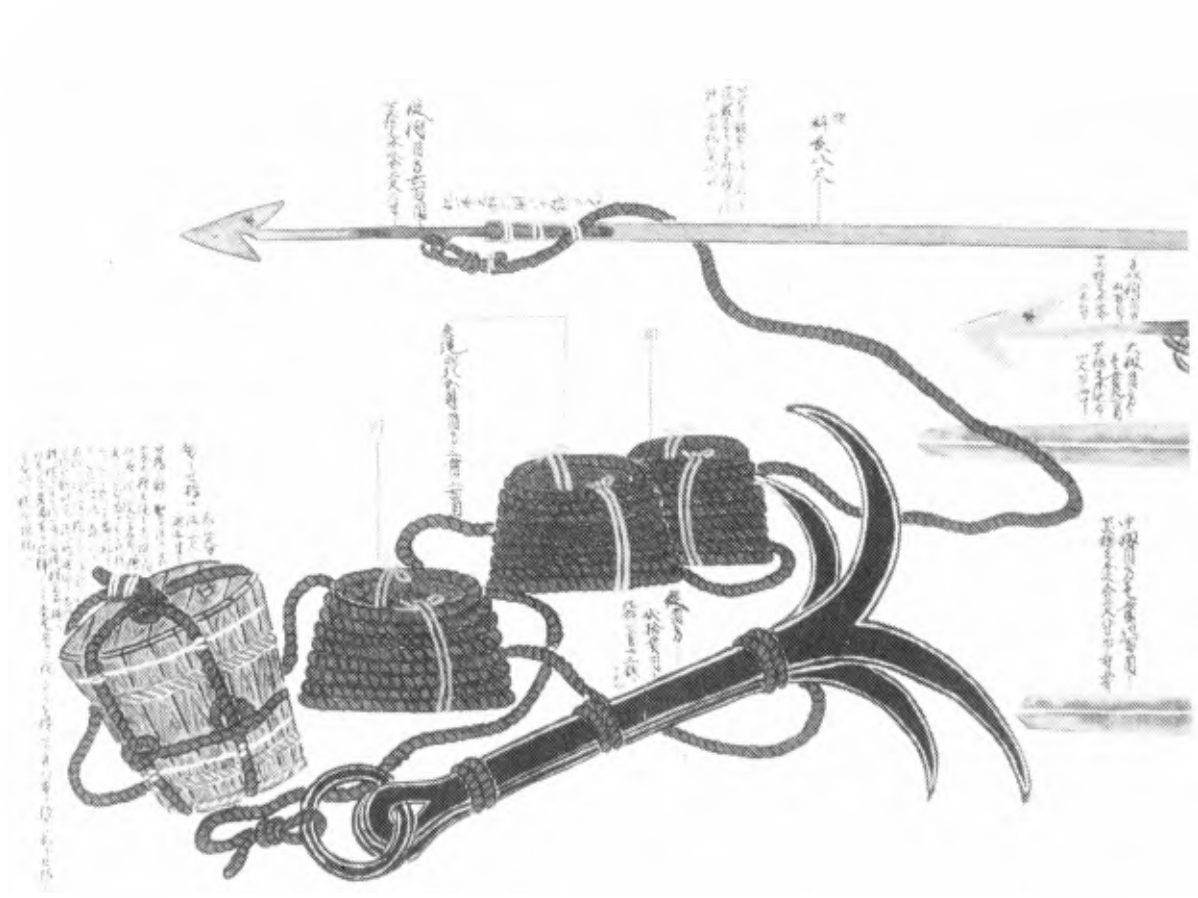

Fig. 14a and b. Detail from part of a picture scroll on Taiji Ura (1847). 14a—equipment used in net whaling. 14b—top, a right whale, and bottom, a humpback whale, entrapped in nets. (Reproduced from a 1984 calendar produced by the Japan Whaling Association. Original preserved at the Historical Documents Division, National Institute of Japanese Literature, Tokyo, Japan.)

Fig. 14b

171. Hashiura, Y. 1969. Whaling at Taijiura, a series of scrolls. Explanatory notes on the scrolls. pp. 1–9. Appendix to: *A History of Whaling at Taijiura*, Kumano. Heibonsha Ltd., Publishers, Tokyo, p. [1]–663 + Scrolls 1–6 + Appendix p. 1–9.

Illustrated records of ancient whaling in Japan. Japan's first whaling operation began at Taiji in 1606. Harpooning and netting are said to have been first used in 1789–1800. Both methods are illustrated. Humpback and right whales clearly were involved.

172. Hasui, S. Ms. 1980. Research and development on whaling methods. [Submitted to the] Workshop On Humane Killing Techniques For Whales, International Whaling Commission, Cambridge, 10–14 November 1980. Document IWC/32/32, pp. 1–6 typescript.

Japanese whaling methods are intended to 'kill whales as promptly as possible without giving them pain, increase supplies of fresh meat (the primary purpose of Japan's whaling) and improve the efficiency of catching operations.'

Japanese experiments in electric harpooning were carried out in 1941–42 and 1949–53. For various reasons, these were considered unsuccessful.

Two methods of carbon dioxide injection were tested: one by charging the harpoon with liquefied CO_2, the other by forcing CO_2 into the whale with a compressed air lance after conventional harpooning. This approach was abandoned due to blackening of meat.

Anesthetization with succinylcholine chloride was used on 5 sperm whales and a sei whale in 1964, 3 Baird's beaked whales in 1970, and a minke whale in 1977/78. The muscle relaxation leading to death occurred only after 'the whole amount of the liquid medicine was injected into the whale's body,' and there was concern about residues in the meat.

Explosive bullets, containing 10–15 g of black powder and fired with a 12-caliber gun, were used to kill minke whales during the 1973/74 and 1976/77 Antarctic seasons. It proved difficult to hit the 'spinal bulb' at sea, and 50–100 kg of meat per whale was destroyed by metal fragments and gas from the explosion.

Explosive harpoons have been used in Japan since 1899. They are unacceptable for killing minke whales, however, because 300–500 kg of meat per whale is ruined. Use of electric lances for finishing off whales first struck with the cold grenade harpoon began in 1973 and is now a standard procedure in the Japanese minke whale fishery. A 110 V AC 60-cycle power source is preferred. The whale usually dies within 4 to 5 minutes 'after the start of electrocution.' [N.B. – Death-time would be calculated by adding the 4–5 minute period to the time between first harpooning with the cold grenade and the start of electrocution.] During the 1979/80 season experiments were carried out with 'pulse-type power sources of 200 V and improvements in lances.'

A team of Japanese specialists began work in 1979 'to develop and improve whaling gear.' Experiments with a detonation device designed to kill the whale 'instantaneously' with shock waves were conducted on Bryde's whales in 1980. The first of these tests were unsuccessful. After some improvements were made experiments were conducted on three more Bryde's whales. One 'died instantly,' detonation having occurred near the lung and liver. In the second whale 'complete cessation of movement and death were confirmed 5 minutes after the harpoon strike,' detonation having occurred around the ribs. The third whale was struck behind the dorsal fin, and the harpoon passed completely through the body. Detonation apparently did not occur. Because both killed whales were struck by the harpoon in vital parts, it was unclear whether detonation caused their deaths. Further experimentation was anticipated.

Work began on development of an electric harpoon with no electric wires. The power source is to be located in the head of the harpoon. Experiments were planned for the 1980/81 whaling season.

Since August 1979, many Japanese whalers and 35 Japanese specialists and engineers had become involved in development and field trials concerned with improved whaling methods. Total expenses amounted to $50,000 U.S., and 1,050 man-days were expended.

173. Hawley, F. 1958–60. *Miscellanea Japonica: being Occasional Contributions to Japanese Studies.* Kyôto: Printed for the Author. Printed by the Kawakita Printing Co. Miscellanea Japonica, *II. Whales & Whaling in Japan.* In Three Volumes. Volume 1, Part 1, pp. 6 unn. ff. + [1]–354 + [I]–X + one errata-slip + 18 pls.

A laborious work that includes a chapter called 'Japanese Books on Whales and Whaling' (pp. 176–354).

174. Hayashi, Y. Ms. 1980. Report on method of catching minke whales—assessments made mainly from the viewpoint of humane killing. [Submitted to the]

Scientific Committee, International Whaling Commission, Cambridge June/July 1980. SC/32/O 24, p. 1–69 + 6 illustrations.

Results of observations made on 52 minke whales killed in the Antarctic in 1979. All whales struck were ultimately secured. Ten whales were judged 'instantaneously unconscious' due to harpooning, with time to unconsciousness averaging 4 minutes. Five of the 'unconscious' whales had continued heart beat, according to ECG. One's heart ceased beating after 8 min; another's after 33 min 30 sec. The remaining three were electrically lanced, and their hearts stopped beating within less than a minute.

Forty-two whales were drawn directly to the bow after being shot with the cold-grenade harpoon, then immediately lanced with electricity. Heart beat was found to have ceased in 27 of these whales. Of the 15 others, 3 continued to move and 6 to breathe, while 6 showed a heart beat on the ECG but did not move or breathe. If unconsciousness is indicated by termination of voluntary breathing, then average time to unconsciousness in the 42 whales was 4 min 19 sec; if by cessation of heart beat, 5 min 11 sec.

For the 15 whales that continued to show signs of life after electrocution, repositioning of the electrode to nearer the heart proved effective in stopping the heart beat.

The gunner's judgment was supported by results of ECG and post-mortem examination in most cases, but it was found that slackening of the jaw (i.e. opening of the mouth) denoted only unconsciousness and not necessarily termination of heart beat.

Electrodes currently used in the Japanese minke whale fishery are 550 mm long, 50 mm thick, and 'pencil shaped'. Author recommends use of longer (more than 800 mm) and 'stick-shaped' electrodes. Standard electrodes deliver 100 V and 5 A of alternating current; changes in these values would involve tradeoffs in risks associated with operations and quality of meat.

Resumption of experiments with electrical harpoons is recommended. It is suggested that batteries be built into the harpoon, thus eliminating need for wires.

Well illustrated.

175. Heizer, R. F. 1938a. Aconite arrow poison in the Old and New World. *Journal of the Washington Academy of Sciences,* Vol. 28, No. 8, pp. 358–64.

Author postulates aconite poison hunting originated in Himalaya region and spread northeastwards eventually reaching North America *via* the Aleutian chain.

176. Heizer, R. F. 1938b. Aconite Poison Whaling in Asia and America; an Aleutian Transfer to the New World. Smithsonian Institution, *Bureau of American Ethnology Bulletin 133, Anthropological Papers,* No. 24, pp. 415–468 + 7 pls.

A valuable review of whaling techniques employed along the coasts of East Asia and western North America. Long quotations from earlier works describing, for instance, whale netting in Japan and by Koryaks north of Kamchatka, use of harpoon-line-float method by Chukchee in northeast Asia and Eskimo of the Bering Sea and Alaska, and aconite poison whaling in the Aleutians and the Kodiak Island region. Detailed discussion of aconite poisoning. A useful table (p. 446) compares various elements of whaling methods (e.g. large nets, stone-headed dart or lance, poisoned with aconitine) in different geographic or cultural areas (e.g. Japan, Chukchee, Kodiak Island).

Appendix 1 called 'The Use of Poison Harpoons and Nets in the Modern Whale Fishery.' Summarizes information from Christison (1860) and Thiercelin (1866)

concerning experiments with hydrocyanic (prussic) acid and a strychnine/curare mixture, respectively. Short essay on netting methods. Important bibliography.

177. Heizer, R. F. 1943a. Catching whales with pathogenic bacilli. *Ciba Symposia.* Vol. 5, Nos. 1 & 2, pp. 1486–8.

Description of a method for killing small, mainly minke, whales along coast of Norway. Whales entrapped in bays by herring nets, then shot with crossbow darts, 40–50 cm long, attached to wooden floats. Barbed tip of dart covered with bacilli that cause septicemia. Weakened whale easily killed with ordinary hand harpoon about 36 hr later. Meat of whale still edible, except in and around the wound. Crossbow, iron darts, and the rod-shaped bacilli are illustrated.

178. Heizer, R. F. 1943b. A Pacific Eskimo invention in whale hunting in historic times. *American Anthropologist, New Series,* Vol. 45, pp. 120–2 + 1 pl.

Author states and defends hypothesis that Aleut immigrants to California coast developed a 'communal' whale hunting procedure that differed significantly from the aconite poison whaling used in the Aleutians. Large numbers of vessels surrounded the whale, many small harpoons with bladders attached were thrown at it, and the whalers finally killed the whale with long lances. In Heizer's view, 'the California coast whale hunt is attributable to historic origin through transference to the sea otter hunting pattern.'

179. Heizer, R. F. 1952. Notes on Koniag material culture. *Anthropological Papers of the University of Alaska,* Vol. I, No. 1, pp. 11–24.

Includes description of whaling lance. Illustrated.

180. Heizer, R. F. 1967. Early day whale hunting with poison. *Alaska Sportsman,* Vol. 33, No. 7, pp. 19–20.

Good popular summary of early whaling techniques, especially those involving poison. Mentions 'impoundment'/bacillus poison whaling in Norway, Aleut and Koniag aconite poisoning, and Japanese netting/lancing method. Summarizes Christison's (1860) account of hydrocyanic (prussic) acid poisoning. Refers to cruise by *Susan Swain* of Nantucket in 1833, carrying poison harpoons that crew refused to use. French navy surgeon Ackerman developed prussic acid *harpoon inoculateur* in 1840's; no record that it was field tested. A whale was killed by French experimenters in 1862 with 28 lb gun firing shells charged with 0.5 oz prussic acid released by small explosive after 10-sec delay. Summarizes Thiercelin's (1866) experimental results from 1863 to 1865 using 30 g of strychnine and curare mixed in the powder charge of ordinary bomb lance. He used soluble salts of strychnine mixed with 1/20 part of curare. With this apparatus he killed 10 whales, including a rorqual, killer whales, gray whales, and bowheads. Six were tried out in ordinary method without ill effects on crew. Time to death varied from 'almost immediately' to 18 minutes. Author wonders why poison methods were never widely adopted. Good illustrations.

181. Heizer, R. F. 1968. A bibliography of aboriginal whaling. *Journal of the Society for the Bibliography of Natural History,* Vol. 4, Pt. 7, pp. 344–62.

Author comments on primitive whaling methods: use of pathogenic bacilli, aconite poison, and boat-line-harpoon method. Excellent bibliography.

182. Henderson, D. S. 1972. *Fishing for the Whale. A guide-catalogue to the collection of Whaling Relics in Dundee Museum.* A Dundee Museum and Art Gallery Publication, Catalogue No. 2, pp. 1–62.

Includes an illustrated catalogue of whaling implements and other artifacts in Dundee Museum (pp. 37–62). Photos of Greener harpoon guns, various hand harpoons, darting gun, bombs, and darts.

183. Hindle, E. [chmn]. 1947. Whaling today: the search for a humane method of killing [Notes from a meeting held at University College, London, on 17 October 1947, under the auspices of UFAW (The Universities Federation for Animal Welfare)]. pp. 1–7 typescript. Old Dartmouth Historical Society, Whaling Museum Library, New Bedford, Mass. Bostock Papers, IMA Microfilm #1722 and #1723.

Critique of 'customary' (shell harpoon) whaling method. Potential use of projectile charged with curare, liquid HCN, or various curare-like substances is discussed. Possibility of using projectile charged with nitrous oxide or carbon dioxide is considered, and an instance is mentioned of a whale being killed 'fairly smoothly in a short time' with a cylinder containing 1.9 kg of liquid CO_2. Use of high-velocity solid shot is regarded as worth testing. Extensive and favorable review of electrical whaling, including summary of work by Weber and Foyn (see Granöe *et al.*, 1934, entry 162). List of British patents related to electrical whaling. Calculation by Maj. Hume that approximately 200 amp would be needed to kill a 125-ton whale and that 100 volts would give such a charge. Cites need for better information on conductivity of whale blubber. Abstract of Schjold (1936, see entry 313). Call for experimental work.

184. Hirata, M. 1951. Experimental investigation on flattened head harpoon an attempt for restraining ricochet. *The Scientific Reports of The Whales Research Institute,* No. 6, pp. 199–207.

Reference is made to electrical whaling experiments made off Hokkaido in 1949 by catcher boat *Taiheimaru No. 1,* under auspices of Committee for the Improvement of Equipments of Whaling Vessels.

Author experimented in 1949 with a modified 'ordinary grenade of harpoon' with a flattened head. He also fitted an electric harpoon with a thick circular disc of steel at the tip. The purpose of these experiments was to reduce or eliminate 'ricochet' when the harpoon strikes the water surface.

The modified electric harpoon was tested on a sei whale and a sperm whale, and the modified grenade harpoon was tested extensively both in the North Pacific and the Antarctic.

Useful diagrams and photographs.

185. Holder, C. F. 1901. Running down whales. *Scientific American,* Vol. 84, No. 8, p. 121.

Note on steamships accidentally colliding with — and killing — large whales off California coast.

186. Holder, C. F. 1903. Trapping big game of the sea. *Scientific American,* Vol. 89, No. 22, p. 391.

Account of pilot whale drive fishery at Provincetown, Cape Cod. Also, the driving ashore of a fin whale is described.

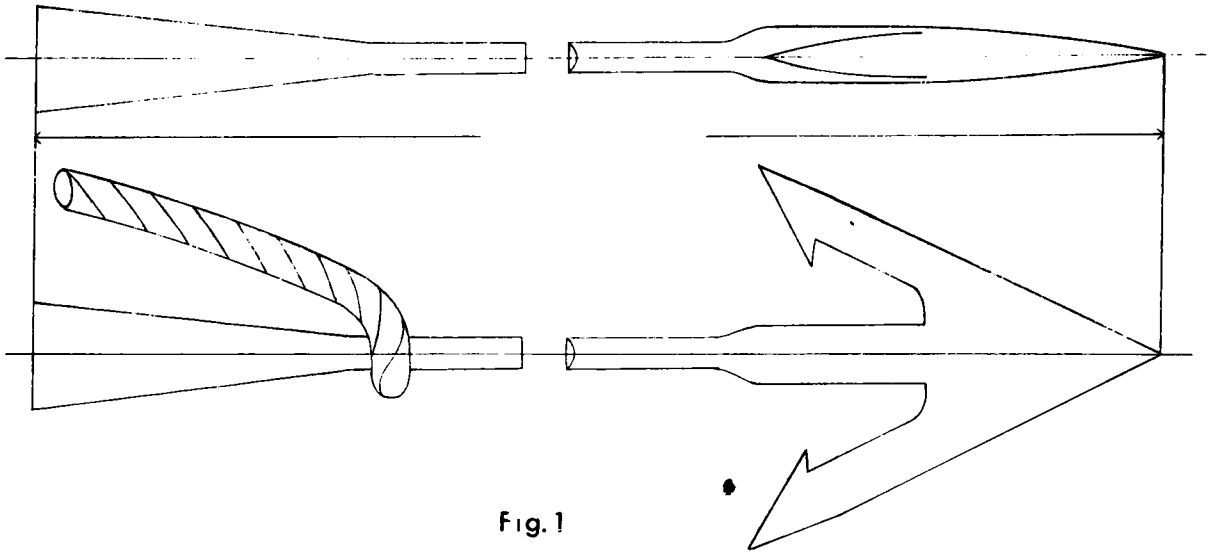

Fig. 1

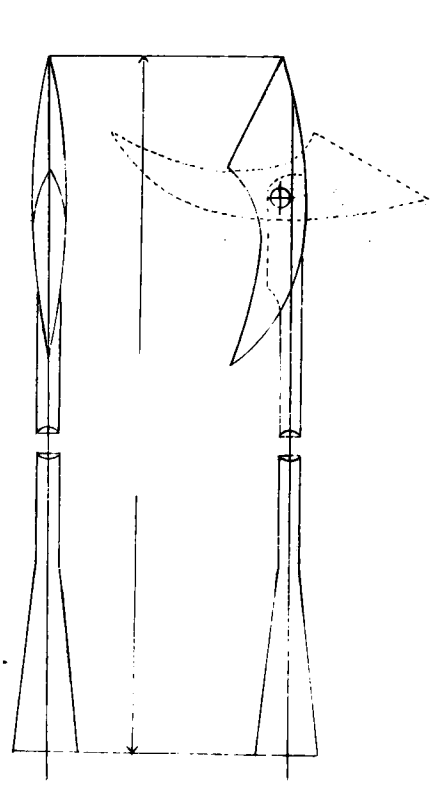

Fig. 2

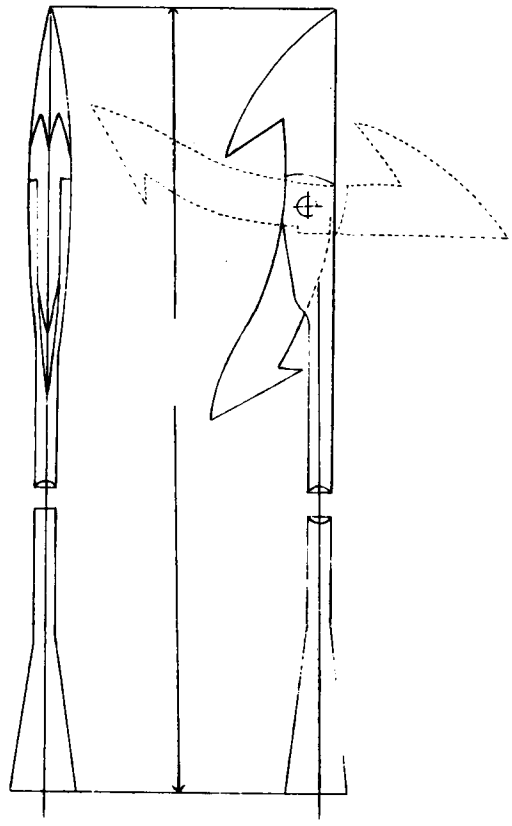

Fig. 3

Fig. 15. Rendering of Plate 195 *in* Goode (1887), by G. Ferrand. English harpoons drawn by Capt. William Adams of Dundee, Scotland. Fig. 1. Old style of hand-harpoon little used by the 1880s. Fig. 2. Hand-harpoon in general use about 1857. Fig. 3. Hand-harpoon most in use on Scottish steam whalers during the 1880s.

187. Holt, S. J. Ms. 1980. An approach to the question of defining 'humane killing' in the context of the IWC Workshop. [Submitted to the] Workshop On Humane Killing Techniques For Whales, International Whaling Commission, Cambridge, 10–14 November 1980. Document HK 6, p. 1–2 typescript.

Urges that 'humane killing' procedures take account of the 'distress, stress, pain' caused by 'awareness' of being chased and by 'grief' on the part of surviving members of a social group whose companion has been killed. A moral/philosophical essay.

188. Housby, T. 1971. *The Hand of God. Whaling in the Azores.* Abelard–Schuman, London, New York, Toronto, pp. 1–96.

Popularized, well illustrated account of open-boat, hand-harpoon whaling for sperm whales and dolphins in the Azores. 'Harpoon guns of one sort or another have been introduced to the Azorean whaling industry on several occasions but the islanders never became proficient with them and soon reverted to the traditional hand harpoons' (pp. 22–3). Although sperm whales are harpooned from vessels propelled by sail or oar, they are herded with motor boats during the chase (pp. 58–9). An instance is described in which the harpoon line was cut by the whalers for safety reasons (p. 59). A large sperm whale 'fought for over two hours before finally succumbing' (p. 63). Illustration of cow, accompanied by a calf, being harpooned (p. 69).

189. Housby, T. R. 1975. Shore-whaling in the Azores. *Ships Monthly*, Vol. 10, No. 7, pp. 12–5.

A condensed, popular account of Housby (1971).

190. Hume, C. W. 1948. The methods of killing whales. pp. 1–16 typescript. Old Dartmouth Historical Society, Whaling Museum Library, New Bedford, Mass. Bostock Papers, IMA Microfilm #1722 and #1723.

Incorporates information from Hindle (1947, see entry 183), a report by B. R. Bostock, technical adviser of United Whalers Ltd, and 'articles' by J. Grierson, Antarctic factory ship *Balaena*. Critical of Foyn harpoon gun. Claims whales 'occasionally' killed within 5 minutes or immediately, but 'usually' killing takes up to an hour. Specifications of modern steel harpoon: 4 ft long, 3.5 inches diameter, 150 lb. Forerunner: 4.25 inches circumference, 65 fathoms long, 2 cwt (1.75 lb per yd), tows 6-inch whale rope. Fired at range of 30–50 yd. Gun barrel 45 inches long. Harpoon completes trajectory of 30 yd in about 3 seconds.

Contemporary whaling in Cook Strait, New Zealand, (*fide* F. B. Sharland) involves technique after harpooning 'to quieten the whale by skillful placing of explosives, taking care not to kill and let the whale sink. The whale is then inflated.'

Brief critique of CO_2 gas, poison, high explosive and solid shot as killing agents. Summary of Schjold (1936, see entry 313).

Records of German engineer Weber, believed lost after his suicide at War's end, reportedly recovered by Bostock. Lethal current-density '100mA. per 45,000 sq. mm.' Death due mainly to action on respiratory and circulatory centres in medulla oblongata. If heart beat is stopped by direct action, it may resume when the current is turned off. Harpoon connected to electric conductor in forerunner, which is in turn connected to conductor in one of 5 ropes attached to 'hither' end of forerunner. This rope connected by switch to one pole of AC generator whose other pole is sea-earthed. Current passed through whale, with sea-earth return,

until lower jaw slackens. Hand spear with 25 m long electric cable used if auxiliary current needed to complete kill.

Field trials by factory ship *Sir J. C. Ross* in 1936/37 season indicated favorable comparison of electrical and explosive harpoon whaling in number of whales caught per week. Relative humaneness and reduction in sinking loss rate attributed to electrical method. Also, fewer forerunners consumed, no whale ropes consumed, no meat spoilage or risk of bacterial contamination from electrical. Whales said to float more often when electrocuted.

Detailed specifications given for electrical magnitude, cables, 'prime mover', ballistics, harpoon, operation and indicators, strength of shock, and desiderata relating to future developments.

191. Hume, C. W. 1951. A progress report on humane electric whaling. The Universities Federation for Animal Welfare, London. *UFAW Courier*, No. 5, Autumn, pp. 21–2.

Promising results in electric whaling were obtained in the 1948/49 season using a heavy-duty nylon forerunner with an insulated conductor. Experiments with a redesigned harpoon and improved forerunner in the 1949/50 season were equally promising. In subsequent years a new, lightweight harpoon was developed: 'The harpoon itself is a tube, the rear half of which forms a combustion chamber and is slipped over the spigot which supports and aims it. The propellant is interposed between the end of the spigot and a partition which closes the tube half way down and seals off the forward end of the combustion chamber. The projectile, which has a high velocity, draws the cable after it, and the switch gear is arranged so that the cable does not come alive until the harpoon has lodged in the whale.' A 60-amp alternating current would paralyze the whale on impact, then kill the animal if kept on for 3 minutes. The positive aspects include: savings in time, less suffering for the whale, reduction of costs, and 'improved quality of meat.'

192. Hume, C. W. 1958. *Expanding Justice. A conspectus of problems relating to man's treatment of animals.* UFAW (The Universities Federation for Animal Welfare), London. 1st October, 1958, pp. 1–16.

Overview of inhumane treatment of animals. Describes present method of killing whales as 'excessively cruel', involving a half hour, on average, of the harpooned whale towing the catcher boat. Accuses Norwegian whaling gunners of 'obstruction' in development of 'relatively humane' electrical whaling method and complains that more money needs to be allocated to research.

193. International Whaling Commission. 1958. Appendix III. Chairman's report of the ninth meeting. *Rep. int. Whal. Commn*, 9, pp. 13–20.

Reference is made to correspondence from the Royal Society for the Prevention of Cruelty to Animals (pp. 18–19) but no details given.

194. International Whaling Commission. 1959. Appendix III. Chairman's report of tenth meeting at The Hague. *Rep. int. Whal. Commn*, 10, pp. 12–18.

The Commission's response to representations by the World Federation for the Protection of Animals concerning humane killing was to point out that experimental work with electric harpoons had not demonstrated that electrocution is more humane than explosive harpooning (p. 16). Also, 'the Commission did not accept the charge that the present method was inhumane,' pointing to the 'high percentage of whales killed instantly.' While the Commission endorsed the

resolution on humane killing by the Geneva Conference on the Law of the Sea, it considered that statements made by the Federation were 'based on inadequate evidence and a lack of knowledge and were of a damaging nature.'

195. International Whaling Commission. 1960. Appendix III. Chairman's report of the eleventh meeting. *Rep. int. Whal. Commn*, 11, pp. 15–22.

Section 17 on 'The Humane Killing of Whales' (p. 19) notes the Netherlands and UK requested that the question of humane killing be put on the Commission's agenda. A proposal by the Canadian Commissioner to convene an investigation was adopted. A small group of experts, charged 'to examine the advantages and disadvantages of the various methods of killing whales which had so far been tried, with a view to recommending a programme of research and development for the improvement of existing methods and the development of new ones,' would be asked to report at the next Commission meeting.

196. International Whaling Commission. 1961a. Appendix III. Chairman's report of the twelfth meeting. *Rep. int. Whal. Commn*, 12, pp. 14–22.

Section 16 (pp. 18–19) called 'The Humane Killing of Whales' includes a short review of the Report of the Expert Working Party (IWC, 1961b, see entry 197). The recommendation of British and Norwegian consultation regarding refinement of electric harpoon technology was accepted by the UK Commissioner. It was agreed that the working party's report could be circulated to interested organizations, 'but that an accompanying letter should point out to them that at the moment there was no conclusive evidence that electrical killing was more humane than the existing means.'

197. International Whaling Commission. 1961b. Appendix V. Report of the Working Party on humane and expeditious methods of killing whales. *Rep. int. Whal. Commn*, 12, pp. 32–5.

Working party's mandate was to review results of various experiments at developing more humane and efficient whaling methods and to recommend a program of further research for improving current methods and developing new ones. Participants and background documents are listed. It was agreed that the suffering experienced by whales could only be measured by time to death and not according to the actual method of killing. A decision was made to use death-time as the measure of humaneness, considering that pain could not be quantified.

Poisoning and anesthetization were dismissed as unpromising approaches because: (1) appropriate dosage levels are not known and the effects on individual animals may vary, (2) products handled or consumed by people may be contaminated, and (3) the drugs are expensive and large quantities would be required.

CO_2 gas harpooning was ruled out due to problems with a harpoon to administer the gas and the 'practically insuperable problem' of hitting the whale in the right place and at the proper angle consistently.

Review of results of electrical whaling experiments. British found 220 volts, 40–60 amperes, and 50 cycles to be most effective for killing within 2–5 minutes. Norwegians were not satisfied that electrical methods reduced death-times or were more humane than conventional shell harpooning. Although British and Norwegian experiments with electrical whaling produced different results, it was agreed that a cooperative effort by the two countries' engineers held enough promise to justify further development. If British generating equipment were combined with

the superior Norwegian forerunners and harpoons, it should be possible to kill whales electrically in 2–5 minutes. Working party resolved to bring companies from the two countries together for discussion along these lines.

198. International Whaling Commission. 1962. Appendix III. Chairman's report of the thirteenth meeting. *Rep. int. Whal. Commn*, 13, pp. 15–24.

Section 19 (p. 22) refers to 'The Humane Killing of Whales.' Agreed by Working Party on the Humane Killing of Whales that 'recent advances' in explosive harpooning technology ensured that 'present methods [of killing whales] were not necessarily inhumane.' Continuing experiments by Japanese, Norwegian, and USSR governments noted. Working Party 'dispersed' with no further reviews or recommendations anticipated.

199. International Whaling Commission. 1977a. International Whaling Commission Report 1975–76. *Rep. int. Whal. Commn*, 27, pp. 16–19.

Section on 'Humane Killing of Whales' (p. 18) notes that little additional work on development of more efficient killing techniques has occurred since 1959. It is considered unlikely that death-times of sperm whales can be reduced below those achieved with the explosive harpoon.

200. International Whaling Commission. 1977b. Chairman's report of the twenty-seventh meeting. *Rep. int. Whal. Commn*, 27, pp. 6–15.

Section 14, 'Humane Killing of Whales' (p. 10). US Commissioner raised the issue, which was referred to the Scientific Committee. The committee accepted the conclusion of the IUCN Survival Service Commission Whale Specialist Group that 'the explosive harpoon technique when used by expert whaling gunners was still the best available for killing large whales in as short a time as possible.' Recommendation for further enquiry into new developments in chemicals and explosives.

201. International Whaling Commission. 1977c. Chairman's report of the Twenty-Eighth Meeting. *Rep. int. Whal. Commn*, 27, pp. 22–9.

Section 19, 'Humane Killing of Whales', refers to four recommendations accepted by the Commission: (1) that health authorities be contacted in the UK, USA, Japan, and other countries to determine regulations pertaining to use of chemicals in slaughtering operations, (2) that the Secretary inventory methods used to kill minke and other small whales, (3) that the US government be asked to report on experimental use of CO_2 gas in euthanasia, and (4) that inquiries be made concerning use of high velocity projectiles for shortening death-times. The USA and UK delegations expressed concern about whale killing methods.

202. International Whaling Commission. 1977d. Report of the Scientific Committee. *Rep. int. Whal. Commn*, 27, pp. 36–60.

Section 18 on 'Humane Killing of Whales' (pp. 50–1) refers to work presented in IWC (1977) and Ohsumi (1977). Although not yet field-tested, the drug Etorphine Hydrochloride (M 99) is considered 'potent enough and has a wide enough therapeutic index to be suitable for anesthetising large cetaceans.' Questions about the buoyancy of anesthetised whales and the acceptability to health authorities of products from drugged whales remained.

It was agreed that the rapidity with which the whale is rendered unconscious and killed is the most important factor, both from the humane and a commercial point of view.

Consideration was given to the possibility that CO_2 gas injection might provide an alternative to the cold harpoon in killing minke whales. Committee members were doubtful of this technique's efficacy and wondered whether CO_2 gas would damage the meat.

The Committee recommended that health authorities be approached to determine regulations used in UK, USA, and Japan to control the quality of meat from animals killed by chemical means. Also, that member nations be asked to report on methods used to kill minke whales. Experiments with gas injection for euthanasia were done in the US. The possibility was raised that high velocity projectiles might help reduce death-times. Lack of response from Japan and the USSR to the Secretary's inquiries was noted.

203. International Whaling Commission. 1977e. Humane killing of whales. *Rep. int. Whal. Commn*, 27, pp. 61–2.

Summary of replies to Commission's request for information from whaling countries on new developments in 'chemicals and explosives suitable for killing whales.' No recent work in this regard was reported by Australia, Canada, Iceland, Norway, Japan, or the USSR. South Africa experimented with various drugs 'around 1963' but found that 'doses required were so large that they had to be delivered by a normal whaling harpoon, rather defeating the humane aspects of the exercise.'

Possibility of using etorphine hydrochloride (M99 or Immobilon) raised by C. Stevens of Animal Welfare Institute. A 0.1–1.0 gram dose contained in a specially designed bullet would probably be sufficient for analgesia, but not death, of a 100-ton whale. Effect would likely be relaxation of the blowholes, loss of air from the lungs, and sinking. Question of residue in meat is another drawback of using this drug.

Dr. de Jager indicated that etorphine hydrochloride has considerable promise, as it is extremely powerful and an adequate dose can be delivered with a dart gun. However, he cited safety hazards associated with its use, the likelihood that killed whales would sink, and skepticism on the part of health authorities concerned with possible contamination of the meat, as major disadvantages.

Suggestion made by Swiss drug firm that fish-anesthetic and tranquilizer MS222 Sandoz be tested for anesthetizing whales.

Suggestion made that attention in future be given to ballistics rather than drugs in search for more humane and efficient whale killing method.

204. International Whaling Commission. 1978a. Chairman's Report of the Twenty-Ninth Meeting. *Rep. int. Whal. Commn*, 28, pp. 18–37.

Section 22 on 'Humane Killing' (p. 25), after summarizing IWC (1978b, see entry 205), asks all members to send relevant references to EDM for inclusion in this bibliography. It was noted that Australia and Iceland offered to participate in experimental trials with new killing methods. Japan expressed the opinion that use of drugs would need to take account of the utilization of whale meat as human food.

Immediate initiation of data gathering was recommended. The number of whales struck and lost in native fisheries and death-times and 'consistency of force generated' in commercial fisheries were identified as the most important kinds of information.

205. International Whaling Commission. 1978b. Report of the Scientific Committee. *Rep. int. Whal. Commn*, 28, pp. 38–89.

Section 19 on 'Humane Killing of Whales' (p. 73) refers to IWC (1978a, see entry 204), Rowsell (1978, entry 304), Blunden (1978, entry 88), and Anon. (1978, entry 62). The poor response from member countries to the Secretary's request for information was noted and attributed to the 'lack of promising alternatives at present to the explosive harpoon.'

Little research on killing methods had been done since 'the particularly comprehensive study by an IWC Special Committee in 1960–61' (see IWC, 1961a, b, entries 196, 197). 'Practical difficulties' have been encountered with electric harpoons and CO_2. High velocity projectiles and drugs were considered the most promising avenues for future research.

The Committee considered a proposal before the Commission 'to make it statutory to report the number of harpoons used to kill each whale.' It was noted that number of harpoons is 'an unsatisfactory measure of humaneness because it might encourage gunners to use less harpoons and finish off the animal by other means (e.g. compressed air).' Rather, the Committee felt attention should be given to monitoring the use of cold grenades.

206. International Whaling Commission. 1978c. Humane Killing. *Rep. int. Whal. Commn*, 28, p. 90.

Summary of responses by member governments to IWC requests for information concerning: national health regulations pertaining to use of chemicals in slaughtering, methods used to capture minke and other small whales, experimental use of CO_2 gas in US for euthanasia, and possible use of high velocity projectiles to shorten death-times.

South Africa: Although use of M99 (Etorphine hydrochloride) is circumscribed, obstacles to its use in whaling 'would probably not be insurmountable.' UK: Use of CO_2 gas or nitrous oxide for euthanasia acceptable. Law requires slaughter 'to be carried out without the infliction of unnecessary suffering.'

For summary of other responses see Anonymous (1978, entry 62), Blunden (1978, entry 88) and Rowsell (1978, entry 304).

207. International Whaling Commission. Ms. 1979. [Report of the] Technical Committee Working Group on Humane Killing, International Whaling Commission, Cambridge, 4–5 July 1979. IWC/31/5 WG, p. 1–4 typescript.

Rowsell defined a humane death as 'one in which there is no panic and fear and in which the animal is rendered unconscious (and so insensitive to pain) rapidly.' He discussed the difficulty of estimating the time at which whales attain unconsciousness or death during normal whaling operations, and he remarked on the need for more study of whale physiology in order to allow evaluation of this group's sensitivity to pain and susceptibility to unconsciousness. Rowsell defined a 'rapid' death by harpooning to be one that occurs within 3 minutes. He indicated that cervical dislocation, a pierced heart, and massive thoracic haemorrhage would probably ensure rapid unconsciousness.

Hasui reviewed Japanese efforts to develop new whale killing methods. Experiments with the electric harpoon were considered unsuccessful and abandoned 20 years ago. Carbon dioxide gas injection was tried. The drug succinylcholine chloride was used to kill 5 sperm, one sei, three beaked, and one minke whale, but residues left in the meat were considered too dangerous to justify

further experimentation. Explosive bullets were used to kill minke whales that had been tethered by the cold harpoon, but this method was discontinued in 1976/77 in favor of electric lancing. Average death-time in the Japanese whale fishery is said to be 4–6 minutes.

Some discussion of why earlier German, British and Norwegian experimentation with electric harpooning was not successful. Rowsell claimed electrocution could be inhumane if the current did not initially pass through the brain.

Rowsell deemed use of narcotic drugs unpromising because of legal, safety, and health considerations.

Group concluded that 'at present the best available method for killing large whales is the explosive harpoon, but . . . from a humane point of view . . . it leaves much to be desired.' An alternative to the cold harpoon for killing minke and other small whales is desirable.

208. International Whaling Commission. 1979a. Chairman's Report of the Thirtieth Annual Meeting. *Rep. int. Whal. Commn*, 29, pp. 21–37.

The Commission recommended that: (1) a veterinarian or other qualified person investigate and evaluate the killing procedures in at least one fishery for large whales and one small-type whaling operation; (2) a 'report-back meeting' be held after this study to plan further action; (3) further research on electrical, pharmacological, and explosive methods be encouraged; (4) 'standard criteria' of death and unconsciousness be formulated; and (5) relevant data continue to be collected from whaling operations.

It was agreed that Professor H. C. Rowsell would be given support to carry out a study of whaling operations in Iceland.

An amended proposal concerning a requirement to report information on the number of harpoons used to kill each whale was adopted. This proposal requires that all catcher boats report, for each whale killed, the methods used, other than a harpoon, and in particular compressed air. It made a similar requirement of all small-type whaling operations and those by native peoples.

209. International Whaling Commission. 1979b. Report of the Scientific Committee. *Rep. int. Whal. Commn*, 29, pp. 38–105.

A sub-committee was set up to examine the question of humane killing and its report is given on pp. 90–2.

Conventional large whale catching operations involve '90 mm harpoon cannons firing a 60 kg, 4 fluked harpoon, armed with a flat-topped, cast iron explosive grenade of approximately 8 kg weight, charged with 400 gm of black powder'. The Japanese began using 75 mm cannons firing 45 kg harpoons during the mid-1960s because of a change in emphasis to smaller species (e.g., sei and minke) and a desire to conserve meat. Coastal whaling in the Northern Hemisphere involves 40–60 mm cannons firing 2 or 4 fluked harpoons tipped with a 'cold' (non-explosive) grenade. The Japanese kill minke whales that have first been harpooned with a cold grenade by application of a 100 V, 25 amp electric lance. The Soviet Union takes minke whales in the Southern Hemisphere with 90 mm, cold grenade harpoons propelled by 'a reduced charge'. Fisheries in the Azores (sperm whales) and Tonga and Bequia (humpbacks) involve open boats and hand-harpooning methods. Eskimos in Alaska use 19th century bomb lances and shoulder guns to kill bowheads.

Data on death-times from Best (1975, see entry 86) and Ohsumi (1977, see entry 286) are summarized. In addition, 'preliminary data' from the Australian sperm

whale fishery are given. For 61 whales killed, 20.6 per cent 'died instantly', 55.1 per cent 'within 5 mins.', and 24.3 per cent in 'over 5 mins.'. The geometric mean of number of harpoons used per whale was 1.9.

Use of drugs considered impractical and unsafe 'for the present'. Problems with electric harpooning outlined. Japanese said to have found it '50% less effective than explosive harpooning'. Difference between Norwegian explosive harpoon, made of iron and designed to fragment and damage major organs, and Japanese explosive harpoon, made of steel and designed to split in two and kill by shock.

Explosive harpoon considered 'most reliable and efficient method of killing whales practised today'. Hand-harpooning (Azores, Tonga, Bequia) and method used by Alaskan Eskimos 'are both inefficient and undeniably prolong death times'.

Four recommendations for research were made which were adopted by the full Committee. (Section 20 on 'Humane Killing of Whales', p. 51). These include that: (1) 'suitably qualified veterinarians and other personnel be asked to evaluate death-times and injuries in at least one whaling operation for large whales and one small-type whaling operation, (2) there be a 'report-back meeting' to decide on future action, (3) further research into electrical, pharmacological, and explosive methods be encouraged, and (4) 'standard criteria' be developed for judging unconsciousness and death.

There was discussion concerning the ethics of killing cetaceans, and the substance of this discussion is summarized in subsection 20.2, 'Ethics of killing cetacea' (p. 51).

210. International Whaling Commission. Ms. 1980. Report of the Workshop On Humane Killing Techniques For Whales. Cambridge, 10–14 November 1980. IWC/33/15, pp. 1–18 typescript.

Working definition of 'humane killing of an animal': death brought about 'without pain, stress or distress perceptible to the animal.' Humane killing is expected to increase 'efficiency' of whaling operations and improve quality of meat.

Conventional capture techniques for large and small whales reviewed. 'Flat-headed' grenade introduced in Japan in 1949 has replaced 'pointed head' grenade in all present-day commercial operations. Gunner aims just behind flipper, at about the horizontal midline, hoping harpoon will pierce the heart.

'Cold' (non-explosive) harpoon used in modern whaling for minke whales. Shock waves rather than hemorrhaging expected to cause unconsciousness and death. Japanese use an electric lance, Norwegians a large caliber rifle, to finish killing when necessary.

CO_2 gas injection reviewed. Advantages are rapid death and large target area, flotation of the carcass, and reduced tainting of meat. Experimental results ca. 1959 with liquid CO_2 cylinder attached to harpoon and lance for injecting CO_2 into whale struck by conventional harpoon were not encouraging.

Explosive bullets, charged with 10–15 g of black powder, were used experimentally by Japan in 1973/74 Antarctic season.

Review of attempts to use drugs, poisons and electrocution. Japan carried out ten experiments since 1964 with succinylcholine; abandoned for safety and practical considerations.

Discussion of five means of depressing central nervous system or cerebral

cortex, thus ensuring insensitivity to pain: (1) shock from pressure waves or concussion, (2) interference with blood supply to brain, (3) passage of electric current through brain, (4) interference to neurological pathways with chemicals, and (5) cervical dislocation or severance of spinal cord.

Discussion of possible new developments. Summary of Kano and Hasui (1980 Ms., see entry 232). Because 70–80 percent of the harpoons shot at minke whales pass completely through the animal, it is difficult to ensure that an explosive harpoon will detonate inside the whale. Harpoons that explode on impact with the body surface cause an unacceptably large amount of meat damage. A detonator/counter spring/firing pin system developed by the Japanese, using penthrite in place of the conventional black powder, was tested on two Bryde's whales. One appeared to lose consciousness immediately, began moving after about 30 seconds, blew 2–3 times, and finally became immobile after about 5 minutes. The other whale moved slightly but completely stopped after about one minute. More tests were planned for the 1980/81 Antarctic season. It was agreed that slackening of the jaw or flippers rather than cessation of motion is 'probably the most reliable evidence of death or unconsciousness at sea.' It was also agreed that harpooners should continue to aim for the thoracic cavity in hopes of damaging the heart or the thoracic *rete mirabile* to bring unconsciousness.

Depth charges were considered unpromising. It was recommended that 7 mm rifles, as used in the Norwegian fishery, be fired first or simultaneously with the cold grenade harpoon to achieve a short death-time.

Japan is said to be making progress in development of a harpoon carrying a high-voltage electric power source in the grenade. The humaneness of electrocution was questioned, particularly inasmuch as it is not possible to ensure that a stunning current passes immediately through the brain of a whale harpooned at sea.

Two types of drugs were identified: paralysing or neuromuscular blocking drugs and anaesthetising drugs. The former (such as succinylcholine, curare, and gallamine compounds) 'should be regarded as inhumane when used alone for catching or killing cetaceans.' No anaesthetising drug is known presently that allows safe, practical use in whale killing. Etorphine chloride (M99), anaesthetising steroids, and insulin were considered in turn by the workshop.

The work of Ridgway and Flanigan (1981, see entry 300) with compressed air injection to kill swine was considered. Whaling by aborigines was judged 'likely to result in slow deaths by bleeding' and this matter was referred for attention to the IWC *ad hoc* Working Group on Management Principles for Subsistence Whaling. Shooting with a heavy caliber rifle and drug administration were deemed acceptable methods of euthanising stranded cetaceans.

Nine recommendations were made, as follows: (1) Experimentation with penthrite explosive harpoons used on an anaesthetised and monitored cetacean 'above the dolphin size.' (2) Further research into use of high velocity projectiles for killing minke whales. (3) Controlled experimentation with electrocution. (4) Observation of whales killed at sea to determine behavioural indicators of unconsciousness and death. (5) Consideration of using drugs — especially etorphine hydrochloride and possibly insulin — to euthanise stranded cetaceans and to kill whales not used for human consumption. (6) Collection of information on rates of and reasons for grenade failure. (7) Urgent attention to improvements in technology used in 'aboriginal/subsistence fisheries.' (8) Paralysing drugs should not be used to catch or kill cetaceans because they do not produce unconsciousness. (9) Continued evaluation by experts, under IWC aegis, of ongoing field studies and research on humane killing methods.

211. International Whaling Commission. 1980a. Chairman's Report of the Thirty-First Annual Meeting. *Rep. int. Whal. Commn* 30, pp. 25–41.

Section 16 is called 'Humane Killing' (p. 31). Reference is made to the Technical Committee Working Group's detailed review of Rowsell's work at Iceland as well as of Japanese use of electric harpoons, electric lances, and drugs. The Commission adopted nine recommendations. 1. All whaling operations should be asked to supply data on times harpoons are fired, time of death, and position of harpoon wounds. 2. Observations similar to those by Rowsell at Iceland in 1978 should be made at representative operations where cold harpoons are used for small-type whaling. 3. Call for review of Rowsell's report by pathologists and physiologists. 4. Call for IWC-sponsored workshop on improved killing techniques. 5. Whaling with cold grenades should be limited to species of minke whale size or smaller. 6. Development of techniques for reducing time to death is desirable. 7. In 'some primitive whale fisheries' the killing power of the darting-gun or 'first-fixing device' should be increased, and use of the shoulder gun should be investigated and possibly banned. 8. Efforts should be made to ensure methods for killing small cetaceans are as humane as possible. 9. Attention is drawn to the continued killing of lactating females at Tonga and Bequia and by non-member whalers, resulting in 'protracted death for the dependent calf.'

212. International Whaling Commission. 1980b. Report of the Scientific Committee. *Rep. int. Whal. Commn*, 30, pp. 42–137.

Section 19 on 'Humane Killing' (p. 59) summarizes the findings of Rowsell (1979, see entry 305).

Five recommendations were made to the Technical Committee that: (1) observers and inspectors at whaling operations record time and location of harpooning, time of cessation of breathing and of locomotor activities, and nature of wounds; (2) an investigation similar to Rowsell's be carried out for at least one whaling operation in which the cold harpoon is being used; (3) Rowsell's report be reviewed by a panel of pathologists or physiologists; and (4) research on 'improved killing techniques' be sponsored.

213. International Whaling Commission. 1981a. Chairman's Report of the Thirty-Second Annual Meeting. *Rep. int. Whal. Commn*, 31, pp. 17–40.

Australian view that recent emphasis on catching of minke whales has resulted in longer death-times and greater pain for whales (p. 25). IWC position accused of being 'morally indefensible' in this respect. United Kingdom considered death-times in Norwegian minke whale fishery 'unacceptably long.' Spain noted loss of meat resulting from use of explosive harpoons to kill fin whales.

The Commission agreed to ban use of the cold grenade harpoon from commercial whaling, except for minke whales, beginning with 1980/81 pelagic and 1981 coastal seasons. Also resolved to consider at 1981 meeting a schedule amendment to include minke whales (p. 32): 'The Commission resolves that the use of the cold grenade harpoon for killing minke whales for commercial purposes should cease as from the beginning of the 1981/82 pelagic and 1982 coastal seasons.'

214. International Whaling Commission. 1981b. Report of the Scientific Committee. *Rep. int. Whal. Commn*, 31, pp. 51–77.

In section 14, 'Behavioural Studies and Humane Killing' (pp. 69–70), reference is made to the Report of the Meeting on Cetacean Behaviour and Intelligence and

the Ethics of Killing Cetaceans (IWC/32/15). Two documents regarding humane killing of minke whales are summarized. That by Hayashi (1980ms, see entry 174) reports results of examination of 52 killed minke whales using ECG equipment to determine time of death. He calls for improvements in the 'shape of electrode used in electric lancing,' tests with batteries built into the harpoon, and experiments with the position of electrodes. Committee members suggested that a modified explosive harpoon be developed that would not damage meat.

Yamamura reported experiments conducted on Bryde's whales and described Japanese plans for further research using ballistics and electrical engineering experts.

Øritsland (IWC/32/30) reported that Norway now requires whales not killed with the first harpoon to be killed as soon as possible by rifle shot. Also, Norwegian whalers are required to complete forms detailing death-times in the small cetacean fishery.

215. International Whaling Commission. 1982. Report of the Scientific Committee. *Rep. int. Whal. Commn*, 32, pp. 43–149.

Section 13 called 'Behavioural Studies and Humane Killing' (pp. 61–2). The report of the Workshop on Humane Killing Techniques for Whales (IWC, 1980 Ms, see entry 210) was reviewed by the committee. The need for a 'full treatment of the humane killing issue' as it pertains to 'aboriginal' or 'subsistence' fisheries was noted.

Yamamura reported results of Japanese experiments with penthrite. He stated that an improved electric lance was responsible for reducing average death-time in the Japanese minke whale fishery from 5.2 minutes to 3.4 minutes.

Best queried the workshop report's statement that M 99 would remain as toxic residue in whale carcasses, and it was noted that this statement was not based on experimental evidence. Best also noted that stranded killer whales in Australia had been despatched by placing an explosive charge on the neck.

The committee supported the proposal that a British veterinarian be sent to Iceland to extend the work of Rowsell (1979, see entry 305) but stressed that whales for which death-times were recorded at sea should be autopsied on shore.

Fig. 16. A catcher boat supplied by the United Nations Food and Agriculture Organization to the village of Lamalera, Lomblen Island, Indonesia, during 1974, equipped with a deck-mounted harpoon gun. FAO photo no. 9215/C/18, by Paul Fjeldstad, courtesy J. Goodman.

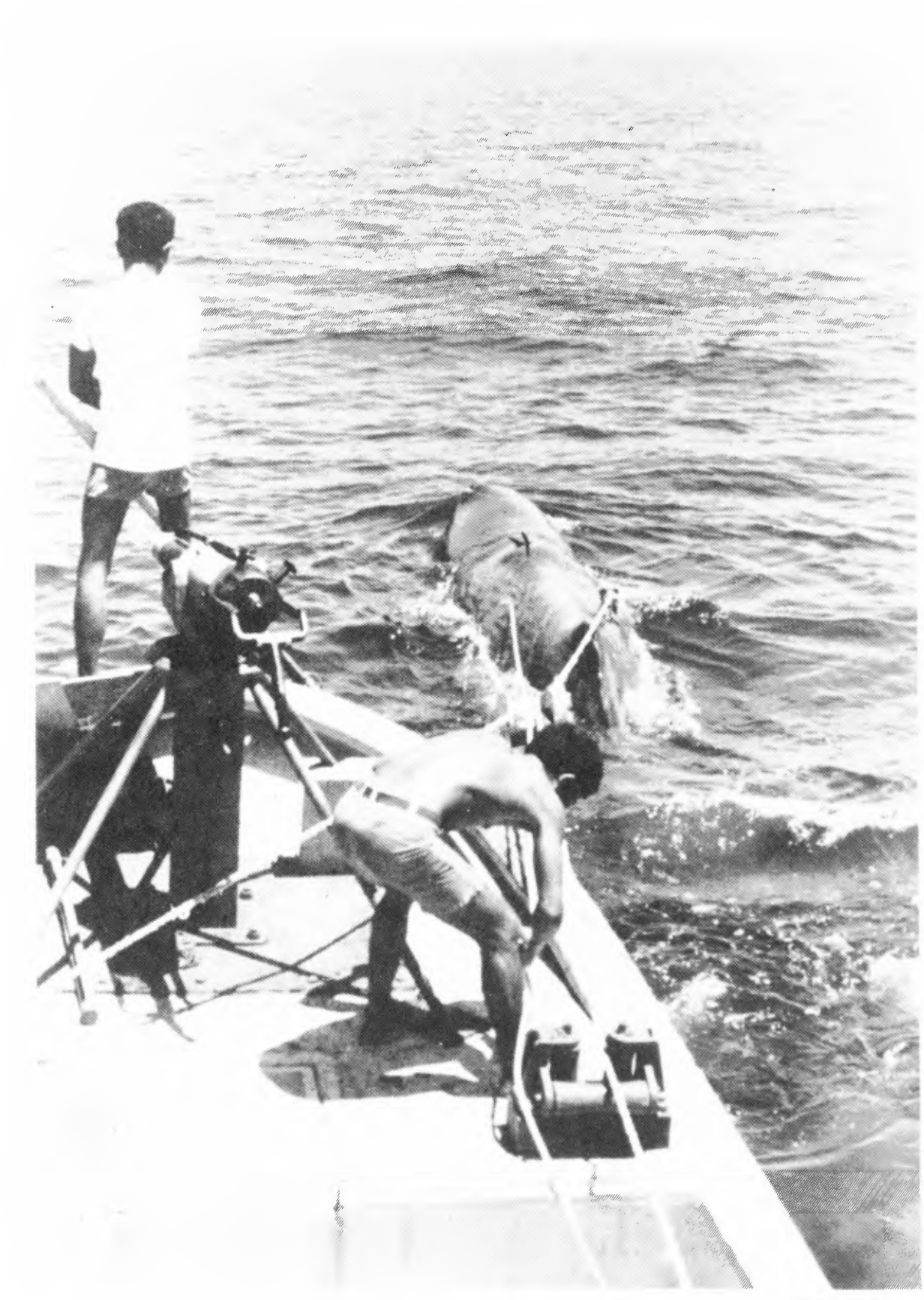

Fig. 17. The capture of a 9.5 m, 2.5 ton sperm whale in July 1974 by the whalers of Lamalera, Lomblen Island, Indonesia. Three harpoons had been made fast to the animal thus far. FAO photo no. 9302/D/1, by Paul Fjeldstad, courtesy J. Goodman.

216. Japan Whaling Association. n.d. [1980]. *Whaling Review*. Japan Whaling Association, 3–2–4, Kasumigaseki, Chiyoda-ku, Tokyo, Japan. pp. 1–40.

Includes chapter titled 'Humane Taking of Whales' (pp. 20–2). Reviews recent initiative by IWC to find more humane killing techniques. The Japanese whaling industry 'is now practising the use of explosive harpoons and the use of conventional (non-explosive) harpoons in conjunction with electricity.' Average death-time with former said to be 3–7 minutes. The latter used for minke whales primarily, with the kill made when 'two electric probes are implanted on both sides of the heart or hindbrain and an electric shock administered.'

Research on electric harpoons said to be 'continuous'.

Field research by Japan planned in 1979/80 Antarctic season. Also, industry will 'establish separate expert groups on the type and weight of harpoon, type and quantity of explosive material, type of harpoon cable, and so on.'

217. Jenkins, J. T. 1921. *A History of the Whale Fisheries. From the Basque Fisheries of the Tenth Century to the Hunting of the Finner Whale at the present date.* H. F. & G. Witherby, London, pp. 1–336 + 12 pls.

Early harpoon guns after Foyn model said to be muzzle loaders made of steel with steel coils and mounted on swivels (p. 264). Range was 25–50 yd, and gunner attempted to hit whale 'between the ribs as near the spinal column as possible.' Gun harpoon consisted of shell with charge, the barb-holster, and pole. Shell contained 'a glass filled with sulphuric acid'. Rope of 400 fathoms, weighing 3,000 lb attached. When harpoon hit whale, barbs turned and crushed glass tube, causing sulphuric acid to escape and detonate shell.

218. Jenkins, J. T. 1948. Bibliography of whaling. *The Journal of the Society for the Bibliography of Natural History*, Vol. 2, Pt. 4, pp. 71–166.

An extremely useful reference, including hundreds of titles.

219. Joensen, J. P. 1976. Pilot Whaling in the Faroe Islands. [Reprint of] *Ethnologia Scandinavica 1976. A Journal for Nordic Ethnology*. pp. [1]–[42].

A detailed account of the customs and techniques involved in the Faroese pilot whale hunt, an activity at least several centuries old. The whales are herded and driven to shore and killed either on the beach or in shallow embayments. 'One puts a whale to death with the whaling knife by making a deep cut a hand's breadth from the blow-hole down towards the spinal marrow which is sliced through. The whale thrashes so mightily as a result that it breaks its own spinal cord' (p. 15). The killing process in which all or most members of a pod are taken can last a half-hour to four hours. 'Formerly' a kill could last several days (p. 18). The Faroese whalers have experimented with rifles and explosives but these have proven 'highly dangerous for the participating hunters and unnecessarily painful for the whales' (p. 19–20). Now the use of implements other than the traditional whaling lance (for stabbing and wounding), iron hook or harpoon (for fastening), and knife (for killing) is forbidden.

220. Johnsen, A. O. 1940. The shell harpoon. *Norsk Hvalfangst-Tidende*, Årg. 29, Nr. 9, pp. 222–41.

An attempt to trace the origins of Foyn's invention. J. N. Walsøe's experiments during 1850 with an 'exploding arrow' said to constitute Foyn's greatest debt.

Walsøe's projectile, armed with a charge of 'fine, strong powder' fitted to a time fuse, was shot by a 'specially constructed, very thick and solid smooth-bored gun.' The chief difference between his invention and Foyn's was that the latter used a cannon rather than a solid gun. Walsøe's arrow was not strong enough to catch balaenopterids consistently. Another Norwegian, Captain Dahl of Bergen, improved on Walsøe's inventions during the 1850's, furnishing the harpoon with a rope for fastening to the whale, and replacing Walsøe's rifle with a deck-mounted cannon. Author believes Foyn learned little from German gunmaker Cordes, whose apparatus simultaneously used a harpoon and a shell lance, fired sequentially from a specially designed 'double cannon'. Also, author acknowledges no special contribution by the Americans — e.g. Roys, Lilliendahl, etc. He concludes: 'We are entitled to maintain that Walsøe's and Dahl's inventions or plans are the nearest presuppositions of Foyn's patented shell harpoon, and that this invention therefore both in its first origin and in its final and decisive shape is a Norwegian product.'

Three multipaneled plates show specifications for Foyn's 'patents on instruments for whaling', 'the shell construction', and 'the shell harpoon and a harpoon for the catching of Greenland whales.'

221. Johnsen, A. O. 1943. *Svend Foyn og hans dagbok.* I kommisjon hos Fabritius & Sønner, Oslo. pp. 1–251.

Biography of Foyn, inventor of modern Norwegian whaling method. Also, reproduction of notes from his logbook. [In Norwegian].

222. Johnsen, A. O. 1947. *Norwegian patents relating to whaling and the whaling industry. A statistical and historical analysis.* Oslo, A. W. Brøggers Boktrykkeri A/S. pp. 1–212.

A register of the patents issued in relation to the whaling industry during the years 1842–1940. There were 533 Norwegian patents, of which 406 were taken out by Norwegians and 127 by foreigners. Of the 314 patentees, 214 were Norwegian and 100 were foreigners (p. 16–20). Patents refer to shooting implements, whaling vessels, flensing equipment, cookers, oil extraction processes, etc.

Modern whaling developed during three periods: 1860–1904, 'Northern Whaling' off North Norway and Iceland: 1905–1922, 'World Whaling' centered on the Antarctic; and 1923–1940, 'Pelagic Whaling' carried on wherever whale stocks of harvestable size could still be found (p. 24–6). The most patents (326) were filed in the period of Pelagic Whaling; the least (90), during Northern Whaling (p. 27). More patents regarding shooting implements were issued during Northern Whaling than during World Whaling, but experiments with electrical whaling after 1923 contributed to a dramatic increase in such patents during the period 1923–1940 (p. 38).

There are sketches of the lives of prominent inventors, including descriptions and diagrams of their main inventions (pp. 44–105). The patents are classified in nine groups, of which one is 'shooting implements' and another is 'electrical whaling appliances' (p. 111). They are indexed in the table beginning on p. 124, allowing the reader to identify those patents pertaining to a given group (subject). The patents are also indexed by name of patentee and patent number (p. 195 *et seq*).

Including patents registered since 1940, there were as of 1978, 54 Norwegian patents on electrocuting whales, 12 on carbon dioxide whaling, one on carbide whaling, and six on curare whaling (J. N. Tønnessen, *in litt.*, 3 March 1978).

223. Johnsen, A. O. 1959. *Den Moderne Hvalfangsts Historie. Opprinnelse Og Utvikling.* Første Bind. Finnmarksfangstens Historie 1864–1905. Oslo, H. Aschehoug & Co. (W. Nygård). pp. 1–714. [See Tønnessen, J. N., 1967–1970.]

Chapter on whaling methods (pp. 279–366) includes excellent illustrations of harpoons and guns of various sorts. Also see notes on pp. 666–673 for important commentary and references. [In Norwegian, and see entry 334.]

224. Johnson, B. 1981–1983. The Barbara Johnson Whaling Collection. Sotheby Parke Bernet Inc., New York Galleries, New York. Part I: December 11 and 12, 1981, p. [i–vi] + [1–220] + [i–ii]; Part II: September 24 and 25, 1982, p. [i–vi] + [1–137] + [i–v]; Part III: April 29 and 30, 1983, p. [i–v] + [1–178] + [i–vii]; Part IV: December 16 and 17, 1983, p. [i–vi] + [1–196] + [i–ii]. [Exhibtion and Auction Catalogues.]

Series of catalogues of a large private collection of whaling artifacts. Illustrations of various kinds of harpoons are included. For example, in Part I are photographs of Grudchos & Eggers Bomb Gun, C. C. Brand Bomb Lance Gun, and C. C. Brand Bomb Gun (all *ca* 1850–60; item no. 435) as well as 'Humpback' Toggle Harpoon ('used for raising sunk whales'), Charles Freeman Explosive Bomb Head Harpoon (patented 1872), and a nineteenth century toggle harpoon (item no. 436).

225. Jones, P., Barzdo, J. and Gordon Clark, J. 1978. *Whale Manual '78.* Friends of the Earth Ltd., London. pp. [i–ii] + i–iv + 1–153.

Chapter 8 (pp. 74–6) titled 'The Cruelty Aspects of Whaling.' States modern harpoons weigh 160 lb, measure 6 ft in length, and reach over 60 mph on impact. Authors consider estimated average minimum death-time of 3 minutes to be inhumane. Reference to IWC initiatives regarding new killing techniques in 1959 and 1975.

Mention of US research on etrophine hydrochloride, marketed in UK as 'Immobilon' by Reckett and Colman. Authors question its appropriateness in whaling as it takes at least 2 minutes to become effective. They also mention dangers to those handling the drug and possibility that meat and oil would be contaminated.

Suggest chemical tranquilizer MS222 SANDOZ, presently used as fish anesthetic, for experimentation in whaling. Also refer to work of Baldwin and Williams (1973, see entry 80). Investment of over £280,000 by Hector Whaling Co. in electrical whaling experiments deemed 'not successful'. Push for more research and development of humane killing techniques.

226. Jong, C. de 1972. *Geschiedenis van de oude Nederlandse walvisvaart. Deel een, Grondslagen, ontstaan en opkomst, 1612–1642.* Pretoria, gedrukt bij de Universiteit van Suid-Afrika. p. i–xii + 1–430 + 6 pls.

In Dutch, with an English summary (pp. 335–9). Chapter V, 'Het Materiaal en de walvissloep' (pp. 123–57) includes information on whaling methods. In the English summary, reference is made to 'unsuccessful Dutch inventions,' including 'a rocket harpoon or rocket lance' (p. 337). The footnotes and bibliography are extensive and provide a useful entry to the Dutch literature on whaling.

227. Jonsgård, Å. 1955. Development of the modern Norwegian small whale industry. *Norsk Hvalfangst-Tidende*, Årg. 44, Nr. 12, pp. 409–30.

Description of small whale hunting, both historical and modern, in Norway. Historically, nets were used to block inlets, thereby trapping whales. Smaller species were killed by hand harpoons; larger species (e.g. minke whales), by poisoned iron-tipped arrows shot from rowboats. Poisoned whales weakened after several days due to blood poisoning, and thus became easy to harpoon. New poisoned arrows made by dipping them into inflamed wound of dead whale. This combination of net entrapment/bacillus poisoning continued until about 1890. 'Krag rifles' were then used to hunt minke whales. Harpoon guns came into use by the 1880s in the bottlenose whale fishery. Modern small whale fishery involves use of 'normal 'claw' harpoon without a shell.'

228. Jordan, W. J. Ms. 1979. The suffering of whales during killing. Submitted to the Scientific Committee, International Whaling Commission, Cambridge, June 1979. SC/31/DOC 17, p. 1–7 typescript.

Discussion of the morality of inflicting pain on nonhuman animals, of the nature and physiology of pain and awareness, and of the significance of death-times in judging the humaneness of whaling. Author discounts as a measure of humaneness the number of harpoons needed to kill a whale, noting 'we would not like to discourage the use of more than one harpoon' and citing Frost's (1979, see entry 154) statement that use of only one harpoon does not necessarily mean a whale died 'instantaneously' or 'free from pain'. Quotes extensively from Scarff (1977, see entry 311), Best (1975, see entry 86), Ohsumi (1977, see entry 286), and Frost (1979, see entry 154).

229. Jörgensen, L., Olsen, O. and Andresen, W. 1937 [1938]. Electrical Killing Of Whales. A general introduction in the method with report of catchings from Fl. f. 'Sir James Clark Ross' in the season 1937/38. A/S. Elektrisk Hvalskytning. p. [i–ii] + 1–8 typescript + 1 illust. Old Dartmouth Historical Society, Whaling Museum Library, New Bedford, Mass. Bostock Papers, IMA Microfilm #1722 and #1723.

A simple, straightforward explanation of electrical whaling. A single phase AC generator with 200 volts, 50 c.p.s. is used. The current is transmitted to the whale by way of an insulated cable and the harpoon. As the whale's skin acts as an effective insulator, the current flows through the whale to the mucus membrane of the mouth. A 'prolonged' forerunner allows the whalers to operate within 250 yards of the whale without disconnecting the killing circuit.

Death of the whale can only be determined with certainty when the lower jaw relaxes and sinks down. If this condition is observed within 10–30 seconds after shooting, it can be assumed that the whale died 'momentarily'. At other times the whale becomes unconscious as indicated by its lying on the side, not blowing, and shutting the eyes.

Shots near the backbone are most effective, but shots to the heart or lung cause instant death. A 'hand-spear' can be used to electrocute whales that have only been paralyzed by the current from the harpoon.

Advantages of electrical whaling are listed, including reduction in loss rate, time savings due to 8–15 minute average between shooting and bringing the whale alongside, reduction in expense associated with catching and processing, and greater humaneness.

A report is given of the catching operations by the floating factory *Sir James Clark Ross* in the Antarctic in 1937/38, with three of nine catchers whaling by electricity. Average catch by the three boats using electricity was 210.66; that of the other six boats using standard shell harpoons, 203.5.

230. Jørgensen, A. 1926. Gasharpun. *Norsk Hvalfangst-Tidende*. Årg. 15, Nr. 2, pp. 23, 26.

Includes schematic diagrams of harpoon heads fitted for gas injection.

231. Jupe, J. H. 1952. The electrocution of whales. *The New Zealand Electrical Journal*, July 25, 1952. pp. 564–5.

First mention of electric harpooning said to be British patent issued in 1868. No practical results recorded. Two later Norwegian experiments. First recorded success was Weber's electrocution of 4 fin whales off Norway in 1929. 'Ross Clarke fleet' electrocuted 250 whales in association with Weber in 1932/33. This line of research ended in 1945 when Weber destroyed his papers and committed suicide.

Experimentation resumed after the War by United Whalers Ltd (England), Elektrohval (Norway), and General Electric Co. Ltd (England). Lillie's call for inquiry into humane methods led to field tests by United Whalers in 1948/49 Antarctic season. A 250 V single-phase alternator and electric manila forerunner used aboard *Terje 2*. After these tests, the G.E.C. developed miniature marine enclosure for gear; Konsberg Gun Co. and Elektrohval developed the 'detachable leg harpoon'; Pirelli-General Cable Works and British Ropes Ltd developed flexible conductor with 3-cordal rope equivalent to nylon for forerunner cable. Whale expected to die within 3 minutes of shooting. More tests in 1949/50 season, with 'spigot gun' firing lightweight harpoon — developed by Westley Richards Ltd — and an 'ultra-lightweight conductor of very high tensile strength.' Catch by the experimental equipment using the Konsberg gun was 51 whales. More development followed. Wright's Ropes Ltd developed a lighter manila forerunner for use with a newly designed Westley Richards gun. In 1950 these were tested at Sao Thome Island, where a large sei whale (sic) was killed, allowed to sink to a depth of 300 ft, and successfully hauled in with the new forerunner. Author optimistic about eventual replacement of grenade harpoon whaling with electrical whaling.

232. Kano, H. and Hasui, S. Ms. 1980 Progress of research, development and experiments on humane methods of catching whales during 1979/80 and research program for 1980/81. [Submitted to the] Workshop On Humane Killing Techniques For Whales, International Whaling Commission, Cambridge, 10–14 November 1980. Document HK3, p. 1–[42] typescript.

With 75 mm cold grenade harpoon used in Japanese minke whale fishery, 'instantaneous death' caused by striking a vital part (e.g. heart or spinal bulb) occurs in 10–30 percent of cases. Otherwise, the whale is towed to the bow and electrocuted.

Team working in Japan since 1979 to develop improved whaling methods includes experts in explosives, electrical engineering, artillery, precision machinery, ballistics, and ropes as well as whaling. Production of high-quality meat is high priority in Japanese whaling. The compatibility between whaling efficiency, i.e. ensuring a quick kill and retrieval and full utilization of all killed whales, and humane killing of whales noted.

Development of detonation grenade using penthrite is discussed. Also, an electric harpoon with the power source housed in the grenade (or harpoon head).

Specifications for black powder and penthrite are presented and compared.
Separate reports of the various experiments, on land and at sea, are given.

233. Kapel, F. O. Ms. 1979. Supplementary list of literature on the occurrence and exploitation of white whale and narwhal in Greenland. Cambridge, International Whaling Commission, Document SC/31/SM 22. 3 pp. typescript + Figs. 1–2.

234. Kapel, F. O., and Petersen, R. 1982. Subsistence hunting – the Greenland case. *Rep. int. Whal. Commn* (special issue 4), pp. 51–74.

Mainly about hunting of marine mammals other than large whales, but includes two photographs (plates 6 and 7) of fishing vessels with mounted harpoon cannons used in hunting minke whales.

235. Kemper, J. B. 1980. History of use of narwhal and beluga by Inuit in the Canadian Eastern Arctic including changes in hunting methods and regulations. *Rep. int. Whal. Commn,* 30, pp. 481–92.

Critique of 'rifle-first technology' which results in unacceptably high loss rates. Cultural and technological changes required for a reduction in loss rate are discussed.

236. Kleinenberg, S. E., and Makarova, T. I. (eds.) 1968. *The Whaling Industry of the Soviet Union.* Israel Program for Scientific Translations, Jerusalem. IPST 5299, TT 68–50459. pp. (i–iv) + 1–20 typescript. (Translation of Kleinenberg, S. E. Makarova, T. I. (eds.) 1955. *Kitoboinyi Promysel Sovetskogo Soyuza.* Ministerstvo Rybnoi Promyshlennosti SSSR. Vsesoyuznyi Nauchno- Issledovatel'skii Institut Morskogo Rybnogo Khozyaistava i Okeanigrafii VNIRO. Izdatelstov Zhurnala 'Rybnoe Khozyaistvo', Moskva. pp. (1)–(118) + (i).

237. Kristensen, S. 1926. Krudt for hvalkanoner. *Norsk Hvalfangst-Tidende.* Årg. 15, Nr. 8, pp. 119, 122 and 125.

238. Kristof, E. 1973. The Last U.S. Whale Hunters. *National Geographic,* Vol. 143, No. 3, pp. 346–53.

First-hand description of present-day Alaskan Eskimo hunt for bowhead whale. Calls shoulder gun 'the Eskimos' main whale-hunting weapon.' Photographs.

239. Lake, P. A. 1975. Harvesting. *Oceans,* Vol. 8, No. 3, pp. 40–3.

Author describes the killing of a sperm whale off South Africa with an explosive harpoon weighing 80 kg, shot from a 75 mm cannon. A second, smaller killer harpoon is used should the explosive harpoon not be effective. Photographs of a rorqual being harpooned.

240. Legendre, R. 1926. La chasse aux 'Bélugas' et l'utilisation des petits cétacés. *La Nature,* 1926 — Premier Semestre, pp. 380–84.

Review of the development of small cetacean fisheries along the coasts of France. Hunting began during the late 19th century as a predator control measure. Among the killing methods contemplated or tried were: poisoning, aerial bombardment,

netting, explosives discharged underwater, and baited steel needles set to spring open and perforate the intestine once swallowed. Cannons, torpedos, and other explosive devices were tried. The harpoon, and eventually the bomb-lance harpoon, proved most effective for capturing small cetaceans. In spite of a bounty paid by the French government for the heads of small cetaceans, the author believed attempts to reduce populations would be futile unless an industrial, commercial fishery were established. Photographs of bomb-lance harpoon and sketch of baited needles.

241. Legendre, R. 1929. Les Bélugas. *Bulletin de l'Institut Océanographique*, Monaco, No. 538, pp. 1–16.

Essentially the same as Legendre (1926, see entry 240).

242. Lewthwaite, J. 1833. Prussic acid first employed for killing whales. *The Nautical Magazine*, 1832–1870, Vol. 3, pp. 48–9.

A brief description of use of prussic acid in whaling. Author claims to have invented the idea in 1828. In an experiment carried out with 6 specially rigged harpoons in 1828–9, one whale 'was paralysed for a few minutes, and when opened; the blood about the harpoon was white and partially curdled.'

243. Lillie, H. R. 1949a. With whales and seals. *British Medical Journal*, Vol. 2, pp. 1467–1468.

Includes a polemic against grenade harpoon whaling. 'Killing with the explosive harpoon is more cruel and economically unsound than was the original iron harpoon.' Claims that in a whale, 'wound shock gives no relief.' Takes 'anything up to an hour' for wounded whale to die, but sometimes 2–3 hr and 3 or more harpoons are required. Author observed blue whale kill lasting 5 hr and involving 9 harpoons. Calls for development of more humane killing methods.

244. Lillie, H. R. 1949b. Whaling and its Antarctic problems today. *Canadian Geographical Journal*, Vol. 38, No. 3, pp. 104–13.

Reviews 4 alternatives to explosive harpoon whaling. Curare poisoning ruled out because adequate supplies unavailable; hydrogen cyanide poisoning, because of risks to humans eating the meat. Compressed gas (carbon dioxide or nitrous oxide) would require too large a container for fitting an ordinary harpoon, assuming 150 cu ft of expanded gas is necessary to float a large whale. Replacement of black powder charge with high explosive considered too dangerous due to possibility of misfires becoming embedded in carcasses later handled by people. Electrocution viewed as 'the solution of the problem.' A 200 volt, 30 amp current conveyed through flexible copper cable said to be adequate. Norwegians electrocuted 200 whales in 1934. Anticipates British experimentation with electrical whaling in 1948/49 Antarctic season and cooperative efforts by New Zealand and Australia.

245. Lillie, H. R. and Hume, C. W. 1949. The electrocution of whales. *Polar Record*, Vol. 5, Nos. 37, 38, pp. 362–3.

Reviews advantages and disadvantages of four experimental methods of whale killing in addition to conventional shell harpooning: (1) curare or hydrogen cyanide poisoning, (2) delivery of compressed carbon dioxide or nitrous oxide gas into whale to produce embolism or buoyancy, (3) replacement of 1 lb charge of black powder with more lethal high explosive, and (4) electrocution. Electrocution

considered 'an efficient substitute for the explosive harpoon, and . . . far more humane.' Several hundred whales electrocuted and killed to date by German, Norwegian, and British experimenters. Advantages claimed for electrocution, in addition to humanitarian, are: fewer sinking losses, savings in hunting time, improved quality of meat, and saving of cordage. Further development of lighter gear expected to increase accuracy of fire and killing range.

246. Low, A. P. 1906. *Report on the Dominion Government Expedition to Hudson Bay And The Arctic Islands on board the D.G.S. Neptune 1903–1904.* Ottawa, Government Printing Bureau. p. frontis + i–xviii + 1–355 + 62 pls.

Includes descriptions of whaling methods used by Scottish and American bowhead whalers in Hudson Bay. Harpoon used by Scots had single barb and was fired by a swivel gun mounted on the bow of the whaleboat (p. 264). Lines were manila, 3 inches in circumference. Bomb gun, with one-inch diameter bore and an explosive shell detonated shortly after penetration through the blubber, was 'rarely used before the whale makes its first plunge, and frequently several dives are made before the boat can get close enough to give this *coup de grace.*'

The Americans used a 'very heavy' hand harpoon with 'a gun attached to it' (p. 270). It was necessary to approach 'within a few feet of the whale before [the harpoon] can be thrown with any certainty of success.'

247. Lowenstein, T. n.d. [1981]. Some aspects of sea ice subsistence hunting in Point Hope, Alaska. A report for the North Slope Borough's Coastal Zone Management Plan. pp. 1–84.

The hunt for bowhead whales at Point Hope is described on pp. 43–61. Reference is made to the 'death spot' at which the harpooner aims, apparently in the neck region (p. 59). A properly placed blow is said to 'kill the whale outright.' A shot in the heart with a darting gun 'will also kill the whale quickly.' Use of the shoulder gun is decried. Whales are said to be shot and lost 'more frequently today than would have been acceptable in the pre-contact era, and in my view the use of the shoulder gun should be restricted to whales that have been secured by drag float already.'

248. Lubbock, B. 1937. *The Arctic Whalers.* Glasgow, Brown, Son and Ferguson, Ltd., pp. i–xii + 1–483 + 51 unnumbered pls.

A review of Arctic whaling, with emphasis on the Greenland Sea and Davis Strait/Baffin Bay bowhead fisheries. Author describes methods used by commercial whalers to capture bowheads (p. 15 *et seq.*), based on published accounts and unpublished logbooks and journals. Various descriptions of prolonged chases and exceptionally long death-times. A 'rocket apparatus' used by *Fame* to kill a fin whale and 9 bowheads, all dying 'in less that 15 minutes' (p. 227). Mention of early use of bomb lance (*ca.* 1859; pp. 372, 378). Author's account of 1821 season refers to monetary award offered by Society of Arts for whaling master who killed most whales in a season with a harpoon gun (p. 220). That year Scoresby, Sen., sailed with supply of 'Congreve's rocket appliances and harpoon guns' for experimental use; Scoresby, Jun., with Manby (1822, see entry 251). Svend Foyn's invention of explosive harpoon in 1860's is described briefly (p. 383). Use of Greener's harpoon gun in 1876 (p. 406). Differences between Peterhead and Dundee harpoon heads.

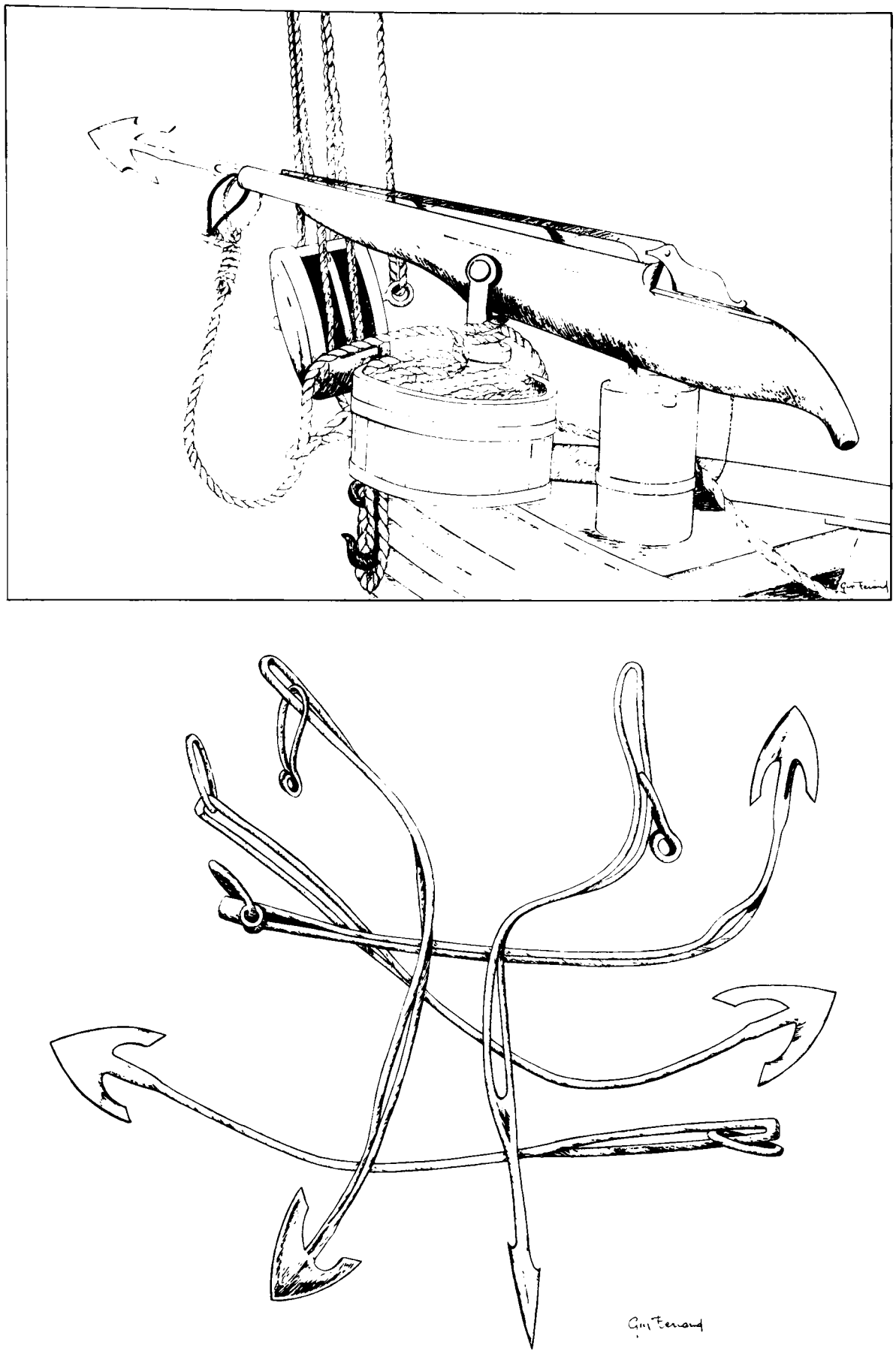

Fig. 18. Rendering by G. Ferrand of photographs *in* Lubbock (1937). Top: harpoon gun 'lent by' Capt. William Adams, a Scottish whaling captain. Bottom: 'Twisted harpoons taken from the dead body of a whale', 'lent by' Capt. Milne, a Scottish whaling captain.

249. Lytle, T. G. 1984. *Harpoons and other whalecraft.* The Old Dartmouth Historical Society Whaling Museum, New Bedford, Massachusetts, pp. [1]–xii + 1–256.

The authoritative source for hand-darted harpoons, darting guns, swivel guns, shoulder guns, rocket guns, lances, spades and other American whalecraft, omitting only the bomb lances. The text is clear and informative, setting the implements firmly in the context of the historical development of the whale fishery. As might be expected of a mechanical engineer, the author provides good descriptions of the structure and function of the implements. The illustrations are mainly photographs of examples in the New Bedford Whaling Museum's collections. The short bibliography cites few specialized technical articles on whaling implements. The book includes a short glossary, and a lengthy, well illustrated catalogue of the museum's whalecraft collection.

250. Mackintosh, N. A. 1965. *The Stocks of Whales.* Fishing News (Books) Ltd., pp. [i–iv] + 5–232 + 20 pls.

Overview of whaling history, written by a biologist. In Chapter 8: 'The Whaling Industry and its Regulation' (pp. 137–59), estimates range of modern grenade harpoon cannons as about 30 yd. 'The harpoon kills quickly with a well-placed shot, but the gun is reloaded without delay since a second harpoon is sometimes needed' (p. 138). See Plates XV and XVI.

251. Manby, G. W. 1822. *Journal of a Voyage To Greenland, in the year 1821. With graphic illustrations.* London: Printed for G. and W. B. Whittaker. pp. frontis + i–viii + 1–143 + 1 folding map + 19 pls. (1 folding).

In addition to excellent first-hand descriptions of the bowhead hunt, including observations of whale behavior and the reaction of whales to harpooning, Manby discusses extensively the subject of harpoon gun technology. Manby's purpose for joining Scoresby's cruise to the Spitsbergen area was to test a hand harpoon he had devised 'on a new principle' and a 'gun-harpoon possessing such combined mechanical strength, and singular principles to defy retraction' (p. 16). He defends his new techniques on humane grounds as well as on their alleged relative efficiency (p. 16).

Manby wanted to test his exploding shell on a finner whale but did not have the opportunity (p. 77).

The appendix (pp. 123–43) consists of a well illustrated essay on harpoon technology, from the hand harpoon and 3 types of gun-harpoons to Manby's own invention, for which he claims a 'point blank' range of 30 yd. Manby was puzzled that the British whalers were critical of gun-harpoons and reluctant to adopt them even though it was admitted that whales were never '*instantly* killed by the stroke of a hand harpoon' while this 'frequently' occurred with gun-harpoons (p. 133). Captain Scoresby is quoted as saying: 'a hundred superficial wounds received by harpoons, could not have the effect of a single lance penetrating the vitals.' According to Scoresby (quoted by Manby, p. 137), 'Captain Manby's gun-harpoon is on an *entirely* new principle, both in its construction, and in the manner of firing it.' He goes on to describe and illustrate Manby's inventions.

252. Marquette, W. M. 1976. Bowhead whale field studies in Alaska, 1975. *Marine Fisheries Review,* Vol. 38, No. 8, MFR Paper 1195, pp. 9–17.

(See Fiscus and Marquette, 1975, entry 146). Reasons for hunting loss: line breaking after whales shot with darting gun and shoulder gun bomb failing to explode.

253. Marquette, W. M. 1977. The 1976 catch of bowhead whales (*Balaena mysticetus*) by Alaskan Eskimos, with a review of the fishery, 1973–1976, and a biological summary of the species. Seattle, U.S. Department of Commerce, NOAA, National Marine Fisheries Service, Northwest and Alaska Fisheries Center Processed Report, pp. [i–ii] + 1–80 typescript + [15 pp. figs & tables].

Whaling methods described and illustrated. Photographs of darting gun and shoulder gun used in present-day hunt. Struck-but-lost rate a major problem. Autumn whaling allows persistent chase — e.g. one captain shot 17 bombs at one whale and finally killed it with a lance (p. 23). Bombs used are about the size of Discovery tags, with 100 g of powder. Shoulder gun bombs are 46 cm long; darting gun bombs, 38 cm. Both are 2 cm in diameter. Misfiring is important cause of struck whales being lost. Guns and bombs manufactured by Naval Gun Co., Doylestown, Pennsylvania, under contract to Alaska Native Industries Cooperative Association. They are almost unchanged since late 19th century. Financial costs of whaling equipment given (pp. 9–10).

254. Marquette, W. M. 1978. The 1976 catch of bowhead whales, *Balaena mysticetus*, by Alaskan Eskimos. *Marine Fisheries Review*, Vol. 40, No. 11, pp. 18–27.

(See Marquette, 1976, 1977, entries 252 and 253). Useful photographs of darting guns, shoulder gun, bombs, and toggle-head harpoon.

Record of narwhal being shot with a rifle.

255. Marsden, R. 1952a. The electrocution of whales. *G.E.C. Journal*, Vol. 19, No. 2, pp. 122–23.

Claims electrocution reduces death time from 2 hr to 3 min. Kongsberg standard gun used to launch 150 lb electric harpoon in 1949/50 Antarctic tests. On a different vessel, a new spigot gun and lighter weight electric harpoon were tried. Electrical whaling will reduce time spent catching whales and improve quality of meat. Author believes it will eventually replace the conventional shell harpoon method entirely.

256. Marsden, R. 1952b. Electrical method of killing whales (1). *World Fishing*, Vol. 1, June, pp. 97–100.

Describes post-War developments in electrical whaling. Author observed blue whale towing a modern catcher boat for over 2 hr despite having been shot with 8 explosive harpoons. Dr. Lillie's Antarctic voyage in 1946/47 led to initiative by United Whalers Ltd in cooperation with General Electric Co. Conservatism of whalemen and their fear of handling electrical equipment had to be overcome. Elektrohval Co. of Norway adapted Foyn harpoon for use with electrical conductors carried in 3-cordal manila forerunner rope. Nine whales killed 'with speedy despatch' in first Antarctic trials. Results indicated need for further modifications of gun and replacement of manila line with nylon. An extensible conductor was developed to match the qualities of nylon yarn, resulting in a forerunner rope that 'behaved as one unit'. New, patented 'Detachable Leg' harpoon solved problem of current leakage. 'The harpoon having penetrated, the pull on the forerunner causes the barbs to open. This releases the leg portion, which, already spliced to the fore-runner, is withdrawn, so leaving the head and barbs firmly embedded in the whale. The leg, being disconnected, cannot then conduct electricity; and being withdrawn, it is not bent and consequently is recoverable undamaged, to be used again with a new head and barbs.'

257. Marsden, R. 1952c. Electrical method of killing whales (2). *World Fishing*, Vol. 1, July, pp. 127–33.

Detailed, well illustrated, but perhaps overly optimistic account of British experiments with electrical whaling in the Antarctic in approximately 1950. On this expedition 45 whales were shot, including sperm, humpback, blue, and fin. Problems experienced with individual whales are mentioned, from snapped conductors and broken harpoons to shots penetrating through the animal resulting in current being discharged directly into the sea. The rigors of Antarctic conditions make exceptional demands on equipment. Three-minute rule developed by which current is left on for that period regardless of whale's stiffness, slack jaw, and other signs of death. Post-mortem examination indicated high-quality meat, rarely any burning supposedly because whales were dead or paralyzed before releasing large quantities of adrenalin from pain and fright reaction.

258. Marsden, R. Ms. 1958. Information supplied by the General Electric Co. Ltd. of England in cooperation with Messrs. Hector Whaling Ltd. Outline of experiments into the use of electric harpoons for whale killing. [Submitted to] The Working Party On Humane And Expeditious Methods Of Killing Whales, International Commission on Whaling, [London,] 4 March and 9 May, 1960. HM1: Document F, p. 1–5 typescript.

Experiments with electrical whaling were made in the Antarctic in 1948 by General Electric Co. Ltd in cooperation with Hector Whaling Ltd. The forerunner consisted of manila yarn with an electrical conductor as its core. Only 3 whales were killed before mechanical damage to the gear caused the experiment to end.

Modifications were made before the following season to accommodate the gunners' criticisms. United Whalers Ltd fit two catchers for experimentation in the 1949/50 Antarctic season: one with a standard whaling gun, a new detached shaft harpoon, and nylon electric forerunner ropes; the other with a 7–8 lb lightweight spigot gun, special conductors 'to ascertain fundamental data', and a small bore harpoon gun to retrieve killed whales. Forty-one whales were taken with the former, and the latter proved successful after alterations were made in the field. 'Instantaneous unconsciousness followed by death' supposedly occurred in 'a minute or less'.

A new spigot gun capable of firing a 30–40 lb harpoon became available so that a single shot could both kill and retrieve. Problems continued to arise with respect to the conductor breaking through its nylon yarn covering. An unsuccessful experiment took place at Sao Thome Island in 1951. After additional development of forerunner ropes and spigot guns, further tests were conducted from a Norwegian land station in 1952. A large fin whale was electrocuted and brought alongside in 10 minutes. Subsequent field trials in the Antarctic were less successful. Author unable to decide if problems are due to equipment inadequacy or to reluctance of whalers to adopt the method.

Electric harpoon weighing 170 lb, with simple forerunner rope attachment and capable of use with existing guns, was tried in 1956/57 Antarctic season. Results inconclusive. 'Electric System has successfully killed whales of all types, humanely and speedily,' but before a commercially viable system is to be available for Antarctic whaling, more experimental work is needed. Funding for such work an obstacle, but author believes electrical method more humane and less wasteful than conventional shell harpooning.

259. Marsden, R. Ms. 1960. [Notes on Documents A–G already circulated as HM1, February 1960.] [Submitted to] The Working Party On Humane And Expeditious Methods Of Killing Whales, International Commission on Whaling, [London,] 4 March and 9 May, 1960. HM2, p. [i] + 1–5 typescript.

Generally a defense of electrical whaling by this representative of General Electric Co. Author takes issue, in turn, with Norwegian (Anon., 1960, see entry 56), Dutch (Van Dijk, 1959, see entry 132), British (Trouton, 1958, 1960, see entry 339 and 340), and Japanese (Fujita, 1950, see entry 155), reports, insisting that electrical whaling was condemned without an unprejudiced trial and that it deserves further consideration.

260. Marsden, R. Ms. 1961. Report on discussions with members of the Norwegian Whaling Association and its Associates at Sandefjord, Norway, 11th–13th April, 1961. [Submitted to] International Commission on Whaling, Thirteenth Meeting, London, 19–23 June, 1961. Paper IWC/13/7, 1 p. typescript.

Author is finally persuaded that little improvement in 'humane and expeditious killing of whales' can be expected from further experimentation with electrical whaling. Refers to new technique developed by Norway, using explosive shell harpoon fired below water line with combined time-delayed and instantaneous trigger-off fusing when hitting the whale. Said to result in 'practically immediate killing'.

261. Martin, K. R. 1979. Whalemen of letters. *Oceans*, Vol. 12, No. 1, pp. 20–29.

Excerpts from three exceptional, unpublished whaling journals are used to help describe nineteenth-century American whaling. From a June 1843 account by Joseph Hersey of a sperm whale capture: 'At this time Mr. Turner darted his lance with such exact precision that it entered his life [i.e., vitals] . . . That is he has received a wound which in the end will prove mortal, though he may live for some hours after it is inflicted. In this instance the whale had about 40 minutes from the time he was first lanced until he expired'.

262. Matthews, L. H. 1968. *The Whale*. George Allen & Unwin, London. pp. 1–287.

Colorfully illustrated, popular history of whaling. Chapter called 'Whaling with Boats and Hand Harpoons' (pp. 94–129) includes reproduction of many old engravings, woodcuts, paintings, and photographs: e.g. Japanese 'scroll' paintings of early net/harpoon fishery (p. 100), use of a 'swivel gun' by Yankee whalers of the 1870's (p. 121), and 'Greener's patent bomb lance of 1850' (p. 126).

Chapter on 'Modern Whaling' (pp. 188–219) has useful color photographs and diagrams. Account of pursuit and kill (p. 203). 'If, as often happens, the whale does not die quickly from the first shot, it must be hove-in short and killed with a second.'

Electric harpoons used in 1950/51 'but did not prove to be effective' (p. 217). Norwegians killed 'a few thousand whales' with electricity during the 1930's but found the equipment 'too expensive'. British companies 'wasted' much time and money trying, unsuccessfully, to develop electric whaling 'for humanitarian reasons.' Flat-headed harpoon, invented in Norway, patented in 1938, and first used by Japanese in 1951, said to have 'brought about a quick increase in whaling efficiency.' A device that forms 'a net of ultrasonic impulses which keep the whales grouped' used by British in 1945/46. Also, a 'rocket-launching device' was tested for hastening the delivery of a second harpoon into the whale when necessary.

263. McCracken, D. R. 1948. *Four Months on a Jap Whaler.* Robert M. McBride & Company, New York. pp. i–x + 1–228 + 8 pls.

Includes description of the killing of a blue whale, from a modern catcher boat (pp. 93–4). A second harpoon was needed. 'This killed him immediately.'

264. McGaffin, W. 1953. New harpoon electrocutes whale in two minutes. *Popular Science,* Vol. 162, No. 1, pp. 146–150,242.

A well illustrated popular account of electrical whaling. Summarizes contemporary experimental work by United Whalers. Electrical whaling considered more humane than grenade harpoon whaling, as time required to kill and bring whale alongside expected to be reduced from 50 minutes to 10 minutes. Refers to Antarctic expedition and six additional experimental cruises by V. Board and R. Marsden to test electrical whaling apparatus. Death times are said to be 'about two minutes' compared to 40 minutes to 2 hours with the conventional grenade harpoon. The electric harpoon is said to travel 40 ft per second and to have an effective range 20 yds longer than the grenade harpoon. 'The Kongsberg, Bofors or any other gun now used to fire the grenade harpoon can be switched over without modification to firing the electric harpoon.' The traditional Kongsberg harpoon gun and the 'newly developed' spigot gun are illustrated.

265. McIntyre, J. [Ed.] 1974. *Mind In The Waters. A Book to Celebrate the Consciousness of Whales and Dolphins.* McClelland and Stewart, Limited, Toronto. pp. 1–240.

A collection of papers on whales in mythology; whale intelligence, communication, and social behavior; and personal reminiscences. For references to whale killing techniques, see for example pp. 21–4, 123, 210–16, 225–31.

266. McLaughlin, W. R. D. 1962. *Call to the South. A story of British whaling in Antarctica.* London, George G. Harrap & Co. Ltd. pp. 1–188 + 8 pls.

Written by the 'senior deck executive officer of a modern whale-factory ship' (p. 19). The chapter called 'The Temperamental Gunners' (pp. 92–99) is of particular interest. 'Many whales will kill easily, others will fight hard for survival . . .' Sometimes as many as seven harpoons are fired before the mammal dies, and it has been known for a whale to be still alive as it was held fast alongside the whaleboat. The compressed air soon finished the job — a cruel, a painful death' (p. 94). Electric harpoons deemed unsuccessful 'because the whale-gunners will not use them' (p. 98).

267. McVay, S. 1973. Stalking the Arctic whale. *American Scientist,* Vol. 61, No. 1, pp. 24–37.

Mention of 'fairly modern equipment' used by present-day Alaskan Eskimos to hunt bowhead whales. Estimates whalers 'fatally wounded and lost perhaps five times as many whales as they actually capture.' Describes equipment maintenance as 'a somewhat casual affair', and considers theirs a 'buckshot' approach to whaling.

Extensive quotation from Scoresby (1820, see entry 317) under section titled 'How a whale dies'.

268. Mielche, H. 1952. *There She Blows!* London, Edinburgh, Glasgow, William Hodge and Company, Limited. pp. [i–viii] + 1–227 + 12 pls.

An illustrated account of modern Antarctic whaling. Foyn's inventions discussed (pp. 54–8). Description of modern harpoon and cannon (p. 114).

269. Mitchell, E. 1975. Porpoise, Dolphin and Small Whale Fisheries of the World. Status and problems. *IUCN Monograph No. 3.* Morges, Switzerland, International Union for Conservation of Nature and Natural Resources, pp. 1–129.

Past and present techniques for capturing and killing smaller cetaceans. Fisheries using drive techniques, nets, and hand harpoons, shoulder harpoon guns, conventional firearms, and vessel-mounted cannons. Also live-capture fisheries using hoop nets, driving, or traps. Extensive bibliography to aid entry into diverse and scattered literature.

270. Mitchell, E. [Ed.] 1975. Special Issue — Review of Biology and Fisheries for Smaller Cetaceans. *Journal of the Fisheries Research Board of Canada,* Vol. 32, No. 7, pp. 875–1242.

Discussion of types of small cetacean fisheries, and relationships between cetaceans and other fisheries (pp. 952–8). Bibliography.

271. Mitchell, E. and Reeves, R. R. 1980. The Alaska bowhead problem: a commentary. *Arctic,* Vol. 33, No. 4, pp. 686–723.

Table 1 (pp. 694–5) gives proposed definitions of different kinds of whaling: aboriginal, non-aboriginal, local, regional, primitive, 19th century, modern, subsistence, commercial, traditional, transitional, and mechanical. Also, Table 2 (pp. 696–7) gives classification of current fisheries as aboriginal, local, primitive, subsistence, or traditional.

272. Mitchell, E. and Reeves, R. R. 1982. Factors affecting abundance of bowhead whales *Balaena mysticetus* in the Eastern Arctic of North America, 1915–1980. *Biological Conservation,* Vol. 22, No. 1, pp. 59–78.

Summarizes kills and attempted kills of bowhead whales in Eastern Arctic since 1915. Table 1 shows that rifles, in addition to old Yankee or Scottish equipment, have been used for killing.

273. Möbius, K. 1893. Über den Fang und die Verwerthung der Walfische in Japan. Sitzungsberichte der Königlich Preussischen. *Akademie der Wissenschaften zu Berlin,* Jahrg. 1893, No. 52, pp. 1053–72.

274. Mörch, J. A. 1908. Improvements in whaling methods. *Scientific American,* Vol. 99, No. 5, p. 75.

Note on development of 'floating factory'.

275. Morgan, L. 1974. We got a whale! *Alaska,* Vol. 40, No. 9, pp. 33–8.

First-hand account of present-day bowhead whaling at Barrow, Alaska. 'Our whaling guns and harpoons were relics from the late 1800's and not very efficient.' Mentions wounded whales that were lost, and guns jamming. 'The trick was to try and shoot a black powder bomb into a whale where it would do the most damage.' Photo of shoulder gun being shot while hunter stands at ice edge.

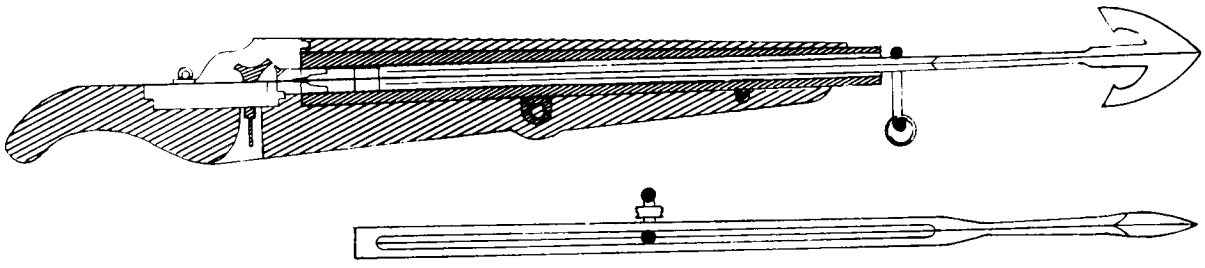

Fig. 1.

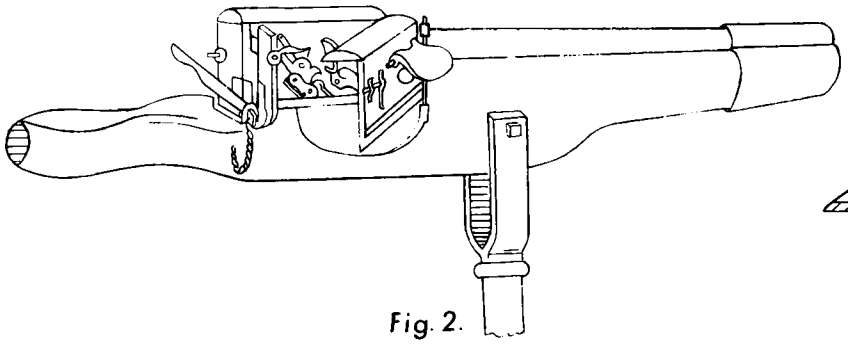

Fig. 2.

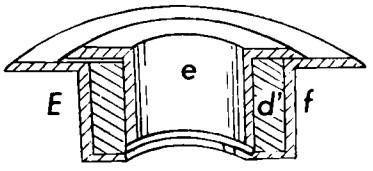

Fig. 5.

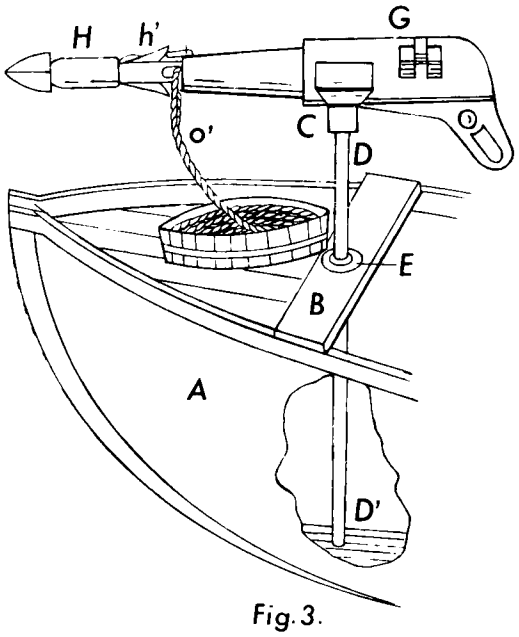

Fig. 3.

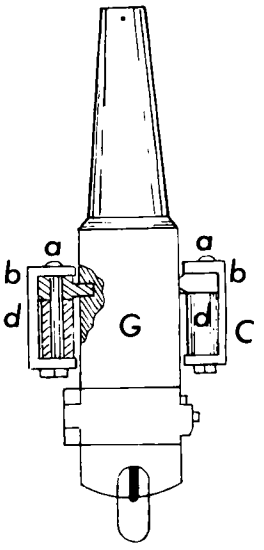

Fig. 4.

Fig. 19. Rendering of Plate 196 *in* Goode (1887), by G. Ferrand. English and American Swivel guns.

Fig. 1. English harpoon-gun and gun-harpoon used by Scottish whalers during the 1880s.

Fig. 2. An early form of English whaling-gun.

Fig. 3–5. Mason and Cunningham mounting boat-gun. The following specifications are from Goode's legend:

Fig. 3. is a perspective of the gun mounted in the bow of the whale-boat, ready for use; Fig. 4. is a top view of the gun and the casting (*C*) and trunnions; and Fig. 5. is a sectional view of the box (*E*), which is fixed in the clumsy cleat (*B*) of the boat (*A*), at *E*. In Fig. 5 the parts *e* and *f* are of metal, and *d'* is of some elastic substance. The gun is mounted at *C* on the standard (*D*), which passes through the cushion-blocks (*E*) and enters the floor at *D'*. In Fig. 4, *b* and *b* are the trunnions, which are supported by the slides (*a*, *a*). Rubber cushions (*d*, *d*) are placed around the slides (*a*, *a*) and at the rear of the trunnions (*d*, *d*). The operation of the apparatus is as follows: the harpoon (*H*), with the line (*o'*) attached, is loaded into the muzzle. When the gun is fired, the force of the recoil is caught on the cushions (*d*, *d*) shown in Fig. 4, and partially by the cushion in box *E*, Fig. 5, thus converting the sudden flow of a recoil into a push.

276. Morley, F. V. and Hodgson, J. S. 1926. *Whaling North And South.* The Century Co., New York, London. pp. frontis + i–xviii + 1–235 + 31 pls.

Illustrated, first-hand (Hodgson was a professional whaler) description of modern whaling.

277. Mowat, F. 1972. *A Whale for the Killing.* McClelland and Stewart Limited, Toronto/Montreal. pp. 1–240.

A polemic describing the death of a fin whale near a Newfoundland outport. After becoming trapped in a small embayment, the whale sustained many hundreds of rounds of small arms ammunition before dying. Unquestionably, this is an inhumane method of killing a whale.

278. Münzing, J. von. 1978. *Die Jagd auf den Wal: Schleswig-Holsteins und Hamburgs Grönlandfahrt.* Westholsteinische Verlagsanstalt Boyens and Co., Heide in Holstein, pp. [1]–[43] + pls. 1–48.

A well illustrated, short account of the history of bowhead whaling out of Schleswig-Holstein and Hamburg, with details of implements and vessels, and extended explanatory text and legends.

279. Myers, F. Ms. 1959. [Letter from The Humane Society of the United States to the Secretary of the International Whaling Commission, 25th September, 1959.] [Submitted to] The Working Party On Humane And Expeditious Methods Of Killing Whales, International Commission on Whaling, [London,] 4 March and 9 May, 1960. HM3, p. [i–ii] typescript.

Suggestion that modification of pneumatic rifle used by researchers and zoos to immobilize large mammals be applied to whaling. Curare derivatives, coupled with a barbiturate, might be used to induce paralysis and/or anesthesia.

280. Nakai, T. and Ono, H. 1951. The effects of electric shock and fatigue on post-mortem changes in muscle. *The Scientific Reports of the Whales Research Institute,* No. 6, pp. 177–85.

Albino rats were used to test possible effects of electrical whaling methods on the freshness of whale meat. Reference is made to Japanese experimentation with electrical whaling. It is assumed that there is no long 'struggle' preceding death when a whale is killed by electrocution rather than by harpooning. Mechanically shocked rats (that is, those killed with a wooden hammer) decomposed earlier than electrocuted rats. A dramatic rise in lactic acid levels of muscles apparently was caused by electrical shock.

281. Nakashima, L. 1977. Fall whaling in Barrow. *Alaska,* Vol. 43, No. 9, p. 97.

Present-day Eskimo hunt for bowhead whale in Alaska. Bomb from darting gun 'doesn't kill whale, . . . additional bombs (up to 20) must be fired from a shoulder gun into the whale before it dies.' Death-time said to be as long as 4–6 hr.

282. Øen, E. O. 1983a. Killing times of minke whales in the Norwegian coastal whaling in the 1981 and 1982 seasons. *Nordisk Veterinaer Medicin,* Vol. 35, Nos. 7–9, pp. 314–18.

Quantitative data are presented for killing times and locations of hits on 125 minke whales killed in 1981 and 78 in 1982. In 1981 reshooting with harpoons was needed in 16% of the cases, while rifle shots were fired into the brains of 54% of the

whales. In 1982 the respective percentages were 29.5 and 50. In both seasons the harpoon penetrated completely through the body in 87% of the cases. Average killing times were 11 min 50 sec in 1981 and 12 min 40 sec in 1982. Killing times were measured with a stopwatch, starting when the first harpoon was fired and hit the whale, ending when flipper movement ceased, the mandible relaxed, the whale sank, or a rifle shot hit the brain. The data indicate that hits in the central nervous system or the heart are the most effective for ensuring a short killing time. 'Improved shooting accuracy therefore would result in more immediate kills and could reduce killing times significantly, regardless of harpoon type.'

283. Øen, E. O. 1983b. Electrical whaling – a review. *Nordisk Veterinaer Medicin*, Vol. 35, Nos. 7–9, pp. 319–23.

A short review of some of the literature on electric whaling, including a description of the physiological effects of the electric current (the author is a veterinarian) and of the equipment needed. Electrocution 'was probably more rapid and humane than the use of the detonating grenade harpoon' for killing large whales. The author, however, finally concludes that because of 'difficulties in controlling the effect on whales it is doubtful if the method is more humane than the method now being used and it will hardly be more widely used in whaling than is the case at present.'

284. Øen, E. O. Ms. 1984. The use of drugs in whaling. Cambridge, International Whaling Commission, Technical Committee Document TC/36/HK2, p. 1–16 typescript.

A brief review of some of the literature on the use of drugs to kill whales (and other animals). The author points out some of the practical difficulties involved in whaling with drugs, and concludes that 'the use of drugs to catch whales [is] a very doubtful proposition'. Not only is it not practical, but if it were 'it would scarcely lead to any improvement as compared with current whaling methods, with regard to humane killing, but rather prolong death time and result in whales being lost to no purpose'.

285. Ohsumi, S. 1975. Review of Japanese small-type whaling. *The Journal of the Fisheries Research Board of Canada*, Vol. 32, No. 7, pp. 1111–21.

From early 17th century to end of 19th century Baird's beaked whale and other medium-sized cetaceans hunted in Japan with small boats and hand harpoons. Norwegian methods introduced in 1908. Special 'five-harpooned gun' used mainly for pilot whales introduced from US in 1910. 'Miniature types of ordinary modern whaling guns' used since 1935. In 1947 a '40 mm bore gun' was permitted; in 1952, a 50 mm gun. Grenade harpoons used at present. The five-harpooned gun changed to 'a 25-mm bore, three-harpooned gun' in 1971.

286. Ohsumi, S. 1977. A preliminary note on Japanese records on death-times for whales killed by whaling harpoon. *Rep. int. Whal. Commn*, 27, pp. 204–5.

Data from 3 catcher boats in 1973/74 Antarctic season. Use of 75 mm cannon, 45 kg harpoon, 'flat-topped' 3 kg grenade. Whalemen prefer 75 mm rather than 90 mm cannon due to change in hunted species from large (blue and fin) to smaller (sei and minke) whales, problem of harpoons going through whale, desire to avoid ruining meat, and relative ease of handling lighter equipment.

Fin whale death-times (n = 122): 0–27 minutes, average 5.52 min. Sei (n = 282): 3.91 min. average. Minke (n = 946): 3.72 min. average. 'Cold' grenade used for catching minke whales. Evidence of different efficiencies among gunners. Use of drugs ruled out because of potential danger to consumers of meat.

287. Ommanney, F. D. 1933. Whaling in the Dominion of New Zealand. *Discovery Reports,* Vol. 7, pp. 239–252 + pls. 11–13.

Illustrated description of net whaling for humpbacks at Whangamumu. 'Sections of net were suspended from the cable and the whales became entangled in them . . .' In their struggles to free themselves they used to carry away sections of the net, so that their progress was impeded and they became an easy prey for the harpooner.' This technique was abandoned in 1910 when a steam whaler became available. Two fast motorboats with mounted light harpoon guns were also used.

Illustrated description of whaling in Tory Channel and around Queen Charlotte Sound with fast motor launches and specially developed, 1¼ inch bore, light harpoon guns. 'The explosion of the grenade stuns but does not kill the whale. After the shot the launch is brought up close to the whale and the body is inflated with air in the Norwegian manner. After inflation the whale is finally despatched by inserting into the thorax ventrally a long lance with a hollow cast iron head. The head is filled with a pound and a half of gelignite which is exploded within the whale's thorax by means of an electric detonator.'

288. Omura, H., Maeda, K. and Miyazaki, I. 1953. Whaling in the adjacent waters of Japan. *Norsk Hvalfangst-Tidende,* Årg. 42, Nr. 4, pp. 175–88.

Includes a brief section on early Japanese whaling with nets, begun in 1674. Right, humpback and fin whales were taken. 'Beater boats' used to drive whale into netting, where it was harpooned by hand. A fisherman jumped onto the whale and attacked it with a knife, cutting a hole in the nasal septum through which a rope was attached. He then lanced the whale in the heart to kill it, and the carcass was towed to shore by tug boats. Norwegian-type steam ship whaling did not begin in Japan until 1899. Japanese small-type whaling restricted to vessels of 30 tons and whale gun caliber of 50 mm or less. Photograph of 'five harpoons gun' used in capture of pilot whales (p. 187).

289. Omura, H., Matsuura, Y. and Miyazaki, I. 1942. Kujira-sono kwagaku to hogei no jissai. (Whales, their science and whaling operations.) Tokyo, Suisan-sho. pp. frontis + 8 pls. + 1–319 + (i–ii). [In Japanese.]

290. Peters, N. (Ed.) 1938. *Der neue deutsche Walfang. Ein praktisches Handbuch seiner geschichtlichen, rechtlichen, naturwissenschaftlichen und technischen Grundlagen.* Verlag 'Hansa' Deutsche Nautische Zeitschrift Carl Schroedter, Hamburg. pp. (i)–viii + 1–263.

Good overall description and illustration of German whaling technology, including only published photograph we have found of Weber electric whaling harpoon (Abb. 51). [In German]

291. Pethick-Lawrence, Lord. 1958. Cruelty in the whaling industry. *House of Lords Official Report,* Vol. 210, No. 82, pp. 258–88.

Extracts from debate in British House of Lords, led by Lord Pethick-Lawrence, concerning the need for development of a more humane method of killing whales.

Refers to resolution of U.N. Conference on the Law of the Sea (Anon., 1958). Indicates average death-time with explosive harpoon to be about 30 minutes. Electric whaling said to 'stun' the whale immediately, kill it in 'a short time', and lead to contamination of relatively little of the meat. Salutes V. Board of Hector Whaling Co. for spending £100,000 on experimentation in electric whaling. Resistance to innovation within the industry, but R. Marsden insists electric whaling feasible and preferable to conventional explosive harpooning. Pethick-Lawrence moves that British government should contribute necessary £10,000 to further research in electric whaling.

Lord Bishop of Portsmouth refers to death-times with grenade whaling ranging from 'instantly' in the case of heart, brain, or back-breaking shots to 30–40 min, an hour, or even 4–5 hr in the case of a 'stomach' shot. Claims 'highly-skilled' individual Norwegian gunners may have average death-times as low as 5 min. Discusses anatomical/physiological basis for pain and suffering in whales. Considers necessary refinements to electrical method of killing whales. Recommends further research with carbonic acid gas injection. Fitting out a catcher boat with state-of-the-art electrical apparatus would cost ca £3–4000. High cost at least partly offset by time savings and reduced wastage of meat. Estimates more than £10,000 needed for research to perfect electric whaling.

Lord Geddes describes modern whaling from first-hand experience. Maintains that 30 percent of whales shot with grenade harpoon 'are killed immediately', that average death-time is 15 minutes, and that rarely do more than 30 minutes pass between harpooning and having the whale alongside. Questions relative humaneness and efficiency of electric whaling.

Lord Winster points out 'strong economic pressure in favour of swift killing.' Reviews recent history of electric whaling and concludes that 'no satisfactory electric whaling equipment is available for sale to the whaling companies.' Mentions 'harpoon using gas' to be used experimentally at Iceland.

Lord Dowding raises technical question about current circuitry in electric whaling and expresses belief that gas and curare hold more promise in whaling than does electricity.

In response to the debate, government spokesman states that UK commissioner to IWC 'has instructions' to raise the matter of the U.N. resolution 'and to invoke its full consideration by the Commission.' No commitment of government funds for more research on electric whaling. Pethick-Lawrence disappointed, withdraws his motion.

292. Pilleri, G. 1969. Eine unmenschliche methode zum fangen kleiner zahnwale in Japan. *Schweizer Naturschutz* (Basel), Vol. 35, No. 2, p. 31 + 1 pl.

(see Pilleri, 1971, entry 293). [In German.]

293. Pilleri, G. 1971. An inhuman method of capturing small odontocetes in Japan. *In:* Pilleri, G. [ed.], *Investigations On Cetacea,* Brain Anatomy Institute, Berne (Switzerland), Vol. 3, Pt. 2, pp. 347–8 + 3 pls.

Author objects strongly to 'barbaric method' used by Japanese to kill small odontocetes, specifically *Phocoenoides truei* [sic]. Porpoises are harpooned with long wooden poles with barbed iron spikes on the end, attached to wooden floats. Gaff hooks are used to haul the tethered porpoises on board, where they bleed to death.

294. Pilleri, G. and Brenner, G. 1976a. Man — the butcher of the seas. From fifty-millions to fifty. ***In:*** **Pilleri, G. [Ed.],** ***Investigations On Cetacea,*** **Brain Anatomy Institute, Berne (Switzerland), Vol. 7, pp. 211–17.**

Uncritical diatribe against killing of cetaceans.

295. Pilleri, G. and Brenner, G. 1976b. Der mensch-mörder der meere. ***Neue Zürcher Zeitung,*** **21 April 1976, Nr. 92, (reprint, 4 unnumbered pages).**

(see Pilleri and Brenner, 1976a, entry 294) [In German.]

296. Rainey, F. 1941. Eskimo method of capturing bowhead whales. ***Journal of Mammalogy,*** **Vol. 21, No. 3, p. 362.**

Eskimo whale killing methods at Tigara (Point Hope) in 1940. Skin boats propelled by paddles; darting gun administered by hand; and 'a regular 1860 'shoulder gun'.' Misfires and injurious accidents are mentioned.

297. Rankin, N. 1951. ***Antarctic Isle. Wild Life in South Georgia.*** **Collins, London. pp. frontis + 1–383 + 94 pls.**

Observations at South Georgia by a naturalist. Chapter XI is called 'Modern Whaling Methods' (pp. 330–55). Photographs of gun platform, foredeck, and harpoon on a modern catcher boat (opposite p. 356 and 357). In addition to specifications and illustration of explosive harpoon (pp. 334–8), author gives first-hand description of the capture of a sei whale (pp. 342–5).

298. Rathjen, W. F. and Sullivan, J. R. 1970. West Indies Whaling. ***Sea Frontiers,*** **Vol. 16, No. 3, pp. 130–7.**

Capture of sperm whales and blackfish (pilot whales) at St. Vincent, West Indies, in open boats under sail. Harpoon propelled by 'modified shotgun, from which a portion of the barrel has been cut and partly replaced by a 1½-inch diameter pipe.' Said to have effective firing range of over 50 yd. This 'shotgun harpoon' replaced the hand harpoon in 1962. In 1968 a boat equipped with an engine was introduced to the fishery. Mention made of a small sperm whale which 'was harpooned and was fast (on the line) for over two hours before it was eventually lanced and killed.'

299. Reichert, W. 1949. Zur Praxis der elektrischen Waltoetung. ***Fischereiwelt,*** **Bremerhaven, Vol. 1, No. 1, pp. 36–7.**

Compares electrical whaling and explosive grenade whaling, respectively, as follows: time to death from first shot, 10 versus 45 minutes; consumption of forerunners per season, 8 versus 25; consumption of whale lines, none or one versus 6 or more; consumption of grenades per season, none versus 400; and loss of whales, none versus 2–6 per season. [In German].

300. Ridgway, S. H. and Flanigan, W. F. Jr. 1981. An investigation of a potential method for the humane taking of certain whales and seals used for food. Final Report to the U.S. Marine Mammal Commission in Fulfillment of Contract MM 6ACO30. Report No. MMC-76/20. National Technical Information Service, U.S. Department of Commerce, Springfield, Va 22151, p. i–iv + 1–12.

Eight domestic pigs were used as experimental subjects in an effort to evaluate gas injection as 'a more humane and less wasteful method of taking marine mammals.'

The main objective was to learn 'whether gas under high pressure could be given in dosages high enough to cause rapid loss of consciousness.' Measures of consciousness were the EEG (electroencephalogram), the cortical evoked response, the EEG spectrum, and muscular reflexes.

High pressure gas injection caused EEG and EP (auditory evoked potential) changes indicative of unconsciousness in as little as seven seconds. Effects were dosage dependent. On the basis of 2,000 ml at 150 atm required for a 60 kg pig, it is estimated that 20 litres for an average-sized walrus and 200 litres or more for a medium-sized whale would be required. There is some doubt about the practicality of delivering such doses under hunting conditions.

The authors recommend the auxiliary use of a drug with gas injection for the capture of specimens for research. However, drugs should not be used when any part of the carcass is to be used for food.

Curare and succinyl choline are considered unacceptable because they 'produce paralysis but do not prevent pain.'

An alternate approach would be to use sublethal administration of high pressure gas to immobilize the animal and give it buoyancy, then shoot it through the brain with a high-velocity bullet 'to render it totally unconscious and insensitive to pain.'

The authors recommend the use of anesthetized swine with physiological monitoring to test the penthrite harpoon method of Kano and Hasui (1980, see entry 232).

301. Rink, H. 1877. *Danish Greenland. Its People And Its Products.* Henry S. King & Co., London. pp. i–xviii + 1–468 + 1 folding map + pls. 1–16.

Methods used by West Greenlanders for capturing whales (p. 111 *et seq*). Comparison of European and Eskimo technologies. Large whales hunted by Greenlanders mainly from 'whale-boats or open boats', while belugas and narwhals hunted from kayaks. Kayak hunters sometimes used rifles. Hunting of large whales (i.e. bowheads) with 'harpoons and bladders' no longer done in West Greenland. The humpback 'is simply pursued by stealing upon it when it is found asleep, and stabbing it with a lance. Sometimes a harpoon is also entered with good effect after the strength of the animal has been reduced by the stroke of the lance' (p. 122).

302. Risting, S. 1922. *Av Hvalfangstens Historie.* [Publikation Nr. 2 Fra Kommandør Chr. Christensens Hvalfangstmuseum i Sandefjord.] Kristiania, J. W. Cappelens Forlag. pp. [i–xvi] + [1] – 625 + [i–v].

See pp. 107–30 for photographs of harpoon guns invented for whaling along the coast of Finnmark during the late nineteenth century. [In Norwegian]

303. Robertson, R. B. 1954. *Of Whales And Men.* New York: Alfred A. Knopf. pp. i–xii + 1–300 + [i] + 16 pls.

A fictional account by a physician, 'based on my actual experiences during a whaling expedition' (p. vii). 'Sometimes the whale is killed outright, but more often it either races away on the surface or dives deep . . .' (p. 125). In the latter case, a 'killer' harpoon is used to finish off the wounded and tethered animal.

304. Rowsell, H. C. 1978. [Comments received by the Secretary, International Whaling Commission.] *Rep. int. Whal. Commn,* 28, pp. 90–1.

A veterinary pathologist's comments on recent developments concerning humane killing of whales. Notes failure of Ohsumi (1977) to indicate criteria used in his

study to signify death and lack of information on post mortem findings. Considers chemical agents unacceptable due to risks to human health and possibility of meat becoming tainted. Especially critical of barbiturates, Phenycyclidine, and Etorphine Hydrochloride or Immobilon (M99). Considers shark dart containing CO_2 gas administered to the thoracic cavity as promising. Eye reflex helpful in determining 'time of complete depression of the central nervous system.'

Post mortem signs to be looked for with cold grenade killing: penetration of thoracic cavity, massive hemorrhage in the cavity, or rupture of heart or aorta. With shark dart, post mortem changes difficult to ascertain because release of pressure upon opening thoracic cavity may confound appearance of heart and aorta. Post mortem examination deemed best means of evaluating death-times of whales. Use of 'time at which all physical activity of the whale ceased' is considered unreliable for establishing death-time.

305. Rowsell, H. C. 1979. Assessment of harpooning as a humane killing method in whales. A Report to the International Whaling Commission. pp. [i–iv] + i–ii + 1–31.

Report by a veterinary pathologist on observations at Iceland in 1978. Emphasis on post-mortem findings. Time to unconsciousness considered most significant measure of humaneness. Of 19 whales examined (16 sperm, 3 fin), onset of unconsciousness deemed 'rapid' in 8; 'slow' in 7. Other 4 required second harpoon so no judgment possible.

'Good' strikes result in fracture of brain cavity, massive hemorrhage into brain, destruction of brain, damage to heart, hemorrhage into and around brain, rapid massive hemorrhaging, or severance of spinal cord behind skull (cervical dislocation). Strikes of 'questionable value' include those rupturing the liver or spleen, hitting the skull without adequate hemorrhaging, or cutting the spinal cord in the thoracic or abdominal region.

Recommendations: (1) further study, (2) regular reporting by observers at whaling stations of positions and number of harpoons in carcases, (3) possible use of grenade 'whose metal would fragment, producing cutting surfaces' for killing sperm whales, (4) addition of auxiliary harpoon line to reduce loss rate, (5) study of pain physiology in whales, and (6) assessment of cardiopulmonary function in whales.

Description of whaling operations, log of 3 days at sea, post-mortem results for each whale examined, and 6 photographic plates, 4 of which show post-mortem features.

306. Saebjørnsen, S. 1936. Svend Foyn, hans opfinnelser og hans første hvalbaater 'Spes & Fides', 'Marta' og 'Providentia'. *Norsk Hvalfangst-Tidende*, Årg. 25, Nr. 6, pp. 141–4, 146, 149–150, 152, 154, 165–171, 173–4.

307. Sbrodov, A. A. 1950. Sovietskii kitoboinyi promysel. *Rybnoe Khoziaistvo*, Vol. 4, pp. 12–15.

Popularised history of Soviet whaling. Grenade harpoon introduced in 1863–68. [In Russian.]

308. Scammon, C. M. 1871a. Coast whaling. *Overland Monthly*, Vol. 6, No. 2, pp. 118–125.

Hunting of gray whales by Yankee whalers along west coast of North America. Mainly females are killed in the lagoons. Darting distance for hand harpoon is

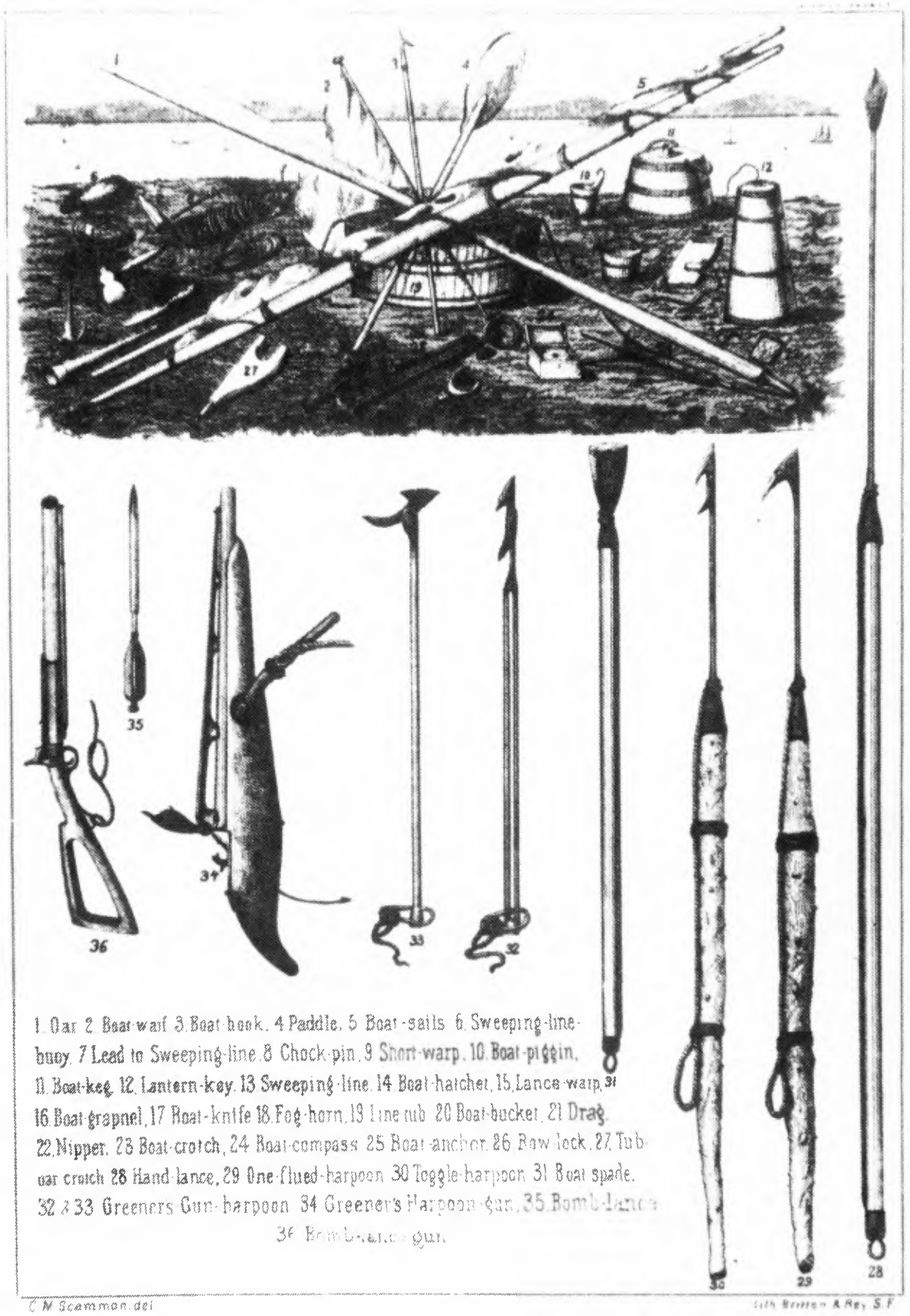

Fig. 20. 'Implements belonging to a whale boat' (Scammon, 1874, Plate XXIV).

16–18 ft. Bomb-lance used after harpooning. Infrequently it explodes in a vital spot and kills 'instantly'. More often 2–3 bombs are needed, 'which paralyze the animal to some extent,' and the hand-lance is used to finish the whale. When hunting along the open coast, whales are sometimes shot with the bomb-lance first, then harpooned by hand if possible. 'Greener's Harpoon Gun', mounted on the bow, said to be accurate up to 84 yds. Aboriginal whaling with 'primitive weapons' described as well.

309. Scammon, C. M. 1871b. Northern whaling. *Overland Monthly*, Vol. 6, No. 6, pp. 548–54.

Hunting of balaenids by Yankee whalers in the Pacific and Western Arctic. After harpooning, some whalemen attempt to 'hamstring' the whale by severing its peduncle. Others throw several harpoons without lines into the peduncle in order to slow down the harpooned whale. A bomb-lance, hand lance, or 'Greener's Gun' was used to finish the whale. Sometimes 'hamstrung' whales bled to death from the severance of blood vessels in the peduncle.

Fig. 21. 'Aleutian islanders whale harpoon' from Scammon (1874).

310. Scammon, C. M. 1874. *The Marine Mammals of the north-western coast of North America, described and illustrated: Together with an account of the American whale-fishery*. J. H. Carmany & Co., San Francisco. pp. 1–320 + i–v + pls. 1–27.

Authoritative account of nineteenth century Yankee whaling by a noted whaleman. Although descriptions of whaling methods occur throughout the book, Chapters I, 'Origin and Ancient Mode of Whale-Fishery' (pp. 185–201), and II, 'Ships, Outfits, and Manner of Taking the Whale' (pp. 216–239), of Part III, 'The American Whale-Fishery', are especially relevant.

The former consists primarily of long quotations from Martens' 1671 account of bowhead whaling near Spitsbergen. A hand-thrown harpoon was used to get fast to the whale. The harpooner attempted to strike the whale 'just behind the spout-hole' or 'in the thick fat of his back, where they also do launce him, for that maketh him spout blood sooner than if wounded in any other place and die sooner than if you should launce them into their belly, or through the guts.' Martens went on: 'They also launce the whales near their privy-parts, if they can come at it; for if they are run in there, it doth pain them very much; nay even when they are almost dead, if you run in your launce thereabout, it causes the whole body to tremble.' The whalers avoided striking the head because the harpoon was not likely to remain imbedded there for long. The harpoon, the purpose of which was 'to tye, as it were, the whales with them, that they may not run away', was made of 'well-temper'd' steel. Detailed description of capture process follows.

Chapter III gives a detailed description of the whaling equipment and how it was used. Scammon was particularly impressed by 'Pierce's bomb-lance', which he described as an 'ingenious invention for killing whales' (p. 228). It is diagrammed whole and in lengthwise cross-section (p. 227), and detailed specifications are given (p. 228 *n*). The harpoon was still administered by hand, although often the bomb-lance shot an 'explosive missile' into the whale simultaneously. The bomb-lance 'usually' killed the whale 'instantly'.

311. Scarff, J. E. 1977. The International Management of Whales, Dolphins, and Porpoises: An Interdisciplinary Assessment. *Ecology Law Quarterly*, Vol. 6, No. 2, (Part One), pp. 323–427; Vol. 6, No. 3, (Part Two), pp. 571–638.

312. Schevill, W. E., Ray, C., Kenyon, K. W., Orr, R. T. and Van Gelder, R. G. 1967. Immobilizing drugs lethal to swimming mammals. *Science*, Vol. 157, No. 3789, pp. 630–1.

Brief report on the use of immobilizing drugs as a central nervous system depressant. Immobilization of whales results in suffocation or termination of the voluntary breathing response.

313. Schjold, E. 1936. Elektrisk hvalskytning. Harpungranaten–eletrisk drepning. *Norsk Hvalfangst-Tidende*, Årg. 25, Nr. 1, pp. 8–9.

English abstract from Hindle (1947, see entry 183), quoted here in full: 'Smokeless powder replaced black powder from 1926 onwards, and experiments made during 1928–1933 related to a high-explosive head ('difficulties with detonation and other matters . . . in the end it was not taken up'); to poison ('once there was a small and wonderful bottle with poison enough to kill 100 whales, but then it was feared that the oil would be spoilt by the poison'); to carbide or the like for producing gas ('one had to produce 2 or 3 cu. metres of gas inside the whale to prevent it from sinking; it was no good'); to a harpoon head filled with compressed air, carbonic acid, liquid air, or the like ('the same trouble, that of keeping the whale afloat, arose again. It did not work'); and to electrocution.

'Experiments on electrocution were made at the Kongsberg arms firm with cable in or on the foregoer, or fired separately from the same gun, or fired from a separate smaller gun. The whale usually floats, but can sink; 'apparently it depends on the time of year and where and when the harpoon hits. . . . The greatest advantage gained by electrocution is that the percentage of sinkings — loss on account of gear giving way — can be reduced considerably. It is very difficult to work out loss percentages. Some give 0, others 10% and others 20%, but with present equipment it must be round 10% and should be brought down to 2–3%. The experiments made by Star XIV last year (1934) would seem to indicate this — 200 whales with the loss of two.' (This sentence seems to me that the old method involves a wastage of 10% of the whales killed, and electrocution should reduce this to about 2%). Six boats fitted with electrocution gear went out in the season 1935/1936.'

314. Schmitt, F. P., de Jong, C. and Winter, F. H. 1980. *Thomas Welcome Roys. America's Pioneer of Modern Whaling*. Published For The Mariners Museum, Newport News, Virginia, By The University Press of Virginia, Charlottesville, pp. i–xvi + 1–253.

Valuable biography of an inventor and experimenter, based mainly on primary sources. Roys was 'among the first to apply methods of the machine age to the whaling trade' (p. ix). Experiments with bombs and guns in 1856 resulted in the shooting of 'about sixty' rorquals, only one of which was secured (p. 68). Later that year Roys lost one of his own hands in an accident with a whaling gun (p. 71). By 1859 Roys had patented a 16-pound rocket launcher which fired, from the shoulder, charges weighing 16, 18, and 21 pounds that exploded in eight seconds (p. 78). Roys's whaling guns (pp. 74, 83, 101, 158–9), his ingenious 'whale-raiser' for retrieving whales that had sunk (p. 86), and his 'whale compensator', of which the modern equivalent is the accumulator (p. 132), are illustrated.

The successful retrieval of a large blue whale killed off Iceland in 1863 — 'the first that Roys had been able to pluck from the depths and to salvage out of the hundreds killed and wasted in seven years of experiments' — was regarded as a milestone (p. 101). Eleven of 20 killed whales were recovered in 1864 (p. 103). Among the problems encountered in 1864 off Iceland was that some of the whales 'did not die quickly and towed the boats so fast or far away that the harpoon lines had to be severed' (p. 113).

Problems in performance of Roy's rockets during 1866 included the fact that 80 out of 100 misfired (p. 125) and that trajectory and penetration were often flawed (pp. 126–33). About half of the 90 whales killed this season were secured. Efforts by so-called imitators and competitors of Roys and his collaborator Lilliendahl are discussed in Chapter 11 (p. 140 *et seq.*). By 1868 the improved rocket gun supposedly 'worked perfectly'; nevertheless, three of every four whales shot off British Columbia were lost, 'through lines and harpoons breaking' (p. 170). After Roys's death in 1887, his work was carried on by Fletcher and Suits, developers of the California Whaling Rocket, which was used principally in the North Pacific and Arctic (p. 182 *et seq.*).

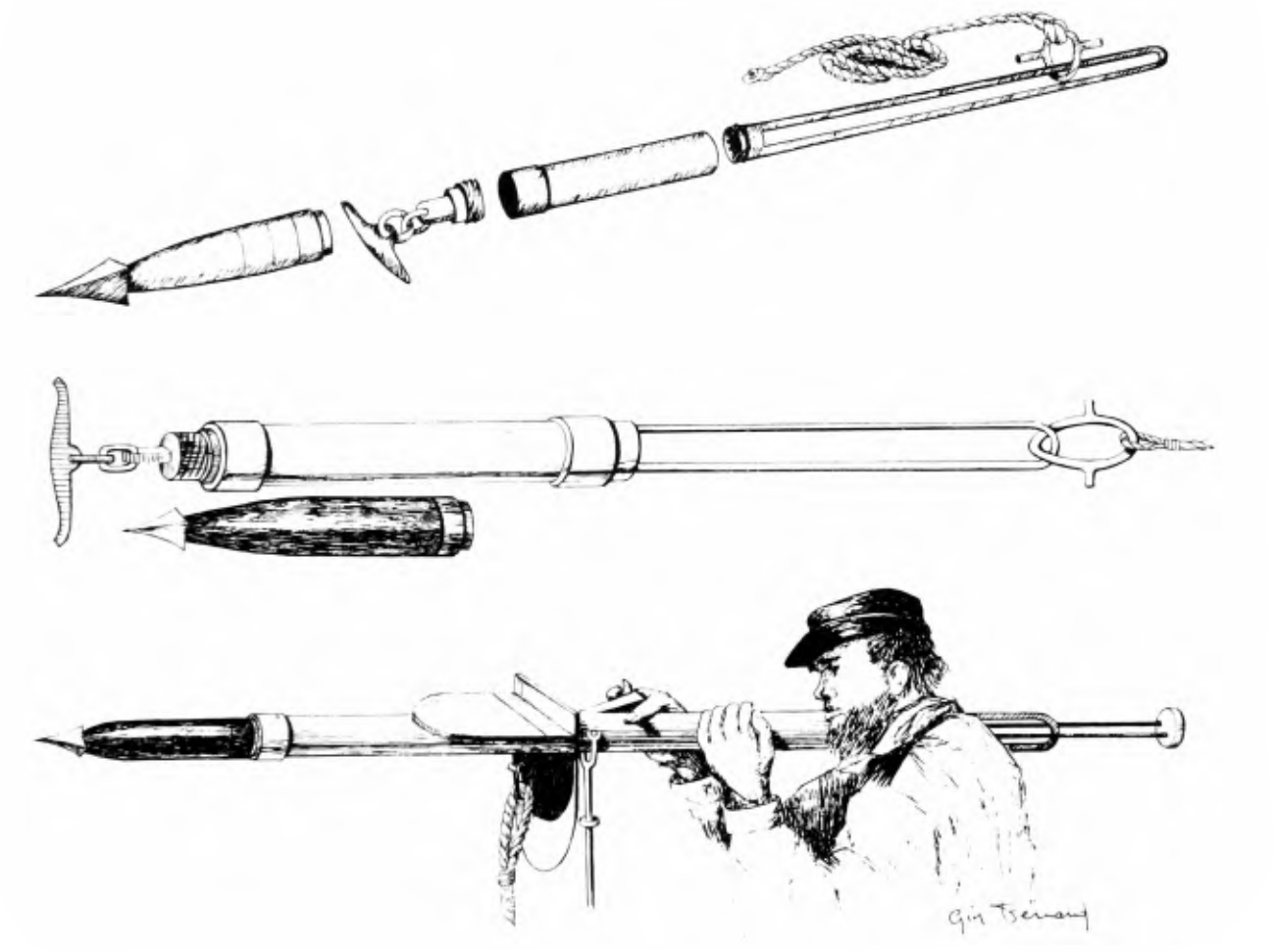

Fig. 22. Renderings by G. Ferrand of Figs 22 (top) and 33 (bottom) *in* Schmitt *et al.* (1980). Top: Said to be the last surviving example of the original California whaling rocket, *ca* 1881, shown here disassembled [displayed at the National Air and Space Museum, Smithsonian Institution, Washington, D.C.]. Bottom: An example of the rocket in use *ca.* 1880. The movable flap automatically protected the face of the operator after the rocket-harpoon was fired. The original photograph from the Smithsonian is a wood engraving by Smeeton-Tilly, after a sketch by Gilbert, published in *La Nature* (Paris) 9 (December 1880): 36, according to Schmitt *et al.* (1980, p. 188).

Although Roys 'was never able to perfect the weapon [his rocket-harpoon] completely, . . . other methods which evolved in the course of its development became Roys' contribution to modern whaling' (p. ix).

315. Schubert, K. 1949. Elektrische Waltötung. *Fischereiwelt,* Bremerhaven, Vol. 1, No. 1, pp. 35–6.

316. Schubert, K. 1955. Der walfang der gegenwart. *Handbuch der seefischerei Nordeuropas,* Vol. 11, No. 6, pp. i–iv + 1–206 + 9 pls. + 13 tables (11 folding).

Detailed account of modern whale catching and processing technology, with useful illustrations. See especially section called 'Fangtechnik' (pp. 94–103). Extensive reference list, but citation incomplete and often incorrect. [In German.]

317. Scoresby, W. Jun. 1820. *An Account of the Arctic Regions, with a history and description of the Northern Whale-Fishery.* In Two Volumes. Edinburgh: Printed for Archibald Constable and Co. Edinburgh: and Hurst, Robinson and Co. Cheapside, London. Vol. 1, pp. frontis + i–xx + 1–552 + 1 folding Table + Appendix, p. (1)–(82) + 1 folding Table. Vol. 2, pp. i–viii + 1–574 + 2 folding Tables + pls. 1–22 + [i–ii].

South Sea Company provided with harpoon gun in 1731, but Dutch harpooners accused of being too conservative to adopt its use (Vol. 2, pp. 70–1). Vessel sent out in 1733 did use harpoon gun, and two of the three whales taken were shot with this implement.

Whaling method used by Europeans during early 1600s 'was usually by means of the harpoon and lance, though the Dutch inform us that the English made use of nets made of strong ropes for the purpose (Vol. 2, p. 173)'. Harpoon was a 'barbed or arrow-shaped iron dart', 2–3 ft long, with a wood handle, attached to 300 fathoms of rope. The lance used to kill the whale was 'an iron spear, with a wooden handle', 10–12 ft long.

Description of harpoon used in contemporary Arctic fishery, little changed over 200 years. Barbed tip made of soft iron; thus, easily sharpened. Shank also made of soft, pliable iron to withstand twisting and bending. Steel-tipped iron lance used for killing. Discussion of harpoon gun development, beginning in 1731. Improvements in harpoon gun technology stimulated by premiums offered by Society of Arts. State-of-the-art in Scoresby's time allowed harpoon to be thrown 'near forty yards with effect', but still the gun was not widely adopted (see Vol. 2, pp. 223–9, Plates 18 and 19).

318. Skerrett, R. G. 1930. Modern whaling methods differ greatly from those of the past. *Compressed Air Magazine,* Vol. 35, pp. 3274–80.

A popular description of modern whaling, from steam-powered vessels using a deck-mounted cannon firing an explosive-tipped harpoon. 'If the gun has been well aimed, the shock of the explosion is commonly sufficient to kill the whale well-nigh instantly; but on occasions the wounded animal will survive long enough to pull a hunting boat a matter of miles before becoming exhausted.'

319. Skjold, E. 1927. Litt om røksvakt hvalkanonkrudt. *Norsk Hvalfangst-Tidende,* Årg. 16, Nr. 9, pp. 148, 150 & 153.

On 8 July 1926 the Norwegian Explosive Industry, in collaboration with the Kongsberg Arms Factory, began experiments with smokeless powder for

whale-guns. The advantages of the smokeless powder proved to be: (1) a more even pressure throughout the gun barrel, compared to the one violent jerk resulting from the explosion of black powder (this reduces the strain on the carriage), (2) greater ease of cleaning the gun after the shot, and (3) ability of the gunner to watch the harpoon on its way to the target due to the lack of smoke.

320. Slijper, E. J. 1962. *Whales*. Hutchinson of London. pp. 1–475.

'Historical Introduction' (pp. 1–57) reviews history of whaling and mentions various methods of killing large and small cetaceans. 'From 1732 British whalers in the Arctic, in particular, had begun to experiment with all sorts of harpoon guns and even with bomb lances, but with no noticeable success' (p. 31). Electrical whaling's humaneness is questioned due to possibility of paralyzing 'an otherwise conscious animal' (p. 34). Same possibility attributed to curare poisoning. Trials with compressed CO_2 in 1956/57 deemed unsuccessful. Refers to special committee formed by IWC to discuss humane killing. 'Some progress with regard to electrocution was made by exchange of information and W. H. Dawbin reported successful electrocution by New Zealand's Humpback whalers' (p. 35*n*).

In 1796 the Dutch Academy of Science held a competition for 'the best biological description and natural history of whales, such as would help to discover their habitat and the best methods of killing or catching them' (p. 48). The gold medal was given to J. A. Bennett for, among other things, describing 'a new kind of harpoon.'

321. Smidth, J. K. 1876. I.–Historical observations on the condition of the fisheries among the ancient Greeks and Romans, and on their mode of salting and pickling fish. pp. 3–20 *In:* Part III. *Report of the Commissioner for 1873–4 and 1874–5. A–Inquiry into the decrease of the food-fishes. B.–The propagation of food-fishes in the waters of the United States*. U.S. Commission of Fish and Fisheries. Washington: Gov. Print. Off. pp. i–li + 1–777. [Nogle historiske Bemaerkninger om Fiskeriernes Tilstand paa Graekernes og Romernes Tid samt om de dengang brugte Tilberedelsesmaader af saltet og marineret Fisk.] Af J. K. Smidth. Tidsskrift for Fiskeri. Udgivet af H. V. Fiedler, og Arthur Feddersen. — 6te Aargang. Kjøbenhavn. Jacob Erslevs Boghandel. 1871. pp. 34–62.

Includes account by Oppianus regarding whaling by ancient Romans in the Mediterranean Sea. Harpoons were used with 'two large leather bags filled with air, precisely like those which the Greenlanders and the inhabitants of Kamschatka use.' The whales were lanced with 'double-hooked spears.'

322. Sonnenfeld, J. 1960. Changes in an Eskimo hunting technology, an introduction to implement geography. *Annals of the Association of American Geographers,* Vol. 50, No. 2, pp. 172–86.

Description and evaluation of whaling technology used by Barrow Eskimos, early and recent. Harpoon and lance had separate functions and were replaced in these functions by darting gun (= bomb lance) and shoulder gun, respectively. Well placed shot with darting gun 'was able to kill the whale outright, or so maim it as to make unnecessary the long and potentially dangerous chase' (p. 175). Effective approach distance for hand harpoon and darting gun was similar, but shoulder gun's range of 100 ft or more was much greater than that of hand lance. Misuse of shoulder gun seen as cause of high loss rate. Increased killing efficiency of new

Fig. 23. 'Aleuts planting glass, obsidian, and jade darts in a school of humpback whales, Akoon Island, Bering Sea.' Drawing by H. W. Elliott *in* Goode, 1887, plate 202.

technology did not necessarily ensure a greater or more consistent whale catch by Eskimos. Important distinction made between an implement's 'efficiency' and its 'effectiveness' in a given cultural context.

323. Spears, J. R. 1908. *The Story Of The New England Whalers*. New York, The Macmillan Company. pp. frontis + i–x + 1–418 + [i–iv] + 9 pls.

Chapter IX of this popular account is called 'Harpoons, Lances, Guns, and Boats' (pp. 203–43). Describes Norwegian bacillus whaling; one-flued, two-flued, and toggle irons; use of boat spade for 'spading flukes' ('hamstringing'). Swivel gun used as early as 1731. Mentions Greener gun, Brand gun, Pierce and Eggers gun, etc. Description, including photo of entangled humpback, of net in Wangamumu, New Zealand. Experiments in early 1860s with prussic acid and in 1850s with electrocution. Description of a 'reel' used on Norwegian steam whale boats for 'playing' harpooned whale.

324. Spencer, M. P. 1973. Scientific studies on the gray whales of Laguna Ojo de Liebre (Scammon's Lagoon), Baja California, Mexico. *National Geographic Society. Research Reports, during the year 1966,* pp. 235–53.

Description of experimental attempts to immobilize gray whales for research. Tranquilizing drugs were delivered from a helicopter using a specially designed, shoulder-fired Greener Light Harpoon Gun and a syringe dart. 'The injected animal usually turned immediately upchannel under encouragement of the boats and aircraft, while the pharmacologic effects were observed.' The syringe dart, 16 inches long, was fired with a 15-grain black-powder shell. The 1.6-pound stainless steel harpoon, 30 inches long, was fitted for automatic injection and tagging of the target animal.

Two gray whales were injected and tagged. Both died as a result. The drugs used were morphine derivatives; no antidote was administered.

325. Starbuck, A. 1878. *History of the American Whale Fishery from its earliest inception to the year 1876. Report of the U.S. Commission on Fish and Fisheries, Part 4.* Washington, Government Printing Office. pp. 1–768 + pls. 1–6,

Remark on 1833 voyage of sloop *Fame* of Nantucket (p. 301): 'Sailed in search of whales, *sea-serpents,* &c; was armed with a patent harpoon charged with poison.' Also, a discussion of prior invention of poison whaling by English in 1831 (pp. 300–01 *n*).

326. Starks, E. C. 1922. A history of California shore whaling. *State of California Fish and Game Commission, Fish Bulletin* No. 6. California State Printing Office, Sacramento. pp. 1–38.

Excellent review of historical and modern shore whaling and the development of harpoon guns and bomb guns. Remarks on inefficiency of early bomb-lances; one observer at San Diego in 1860–61 stated that two-thirds of whales shot 'were lost on account of failure of bomb.' In 1881 one right whale was shot with 25 bomb lances and several harpoons but was lost. Whales that were harpooned were sometimes killed 'instantly' by the first bomb lance, but more often 2–3 bombs were required. Modern steam whaling much more efficient.

327. Stevens, C. 1974. Battle for the whales. *Defenders of Wildlife International,* Vol. 49, No. 4, pp. 307–9.

Author discusses inhumane whale killing, citing H. Lillie's (1949a, see entry 243) description of 150 lb, explosive harpoon and an instance in which 9 harpoons were needed during 5 hours to kill a female blue whale.

328. Sundt, R. 1936a. Electrical whale shooting. [English] Translation. [From] Tønsbergs Blad 15.1.1936 [with covering letter from A. C. Olsen, Sandefjord, 16 January 1936]. [2 pp.] typescript. Old Dartmouth Historical Society, Whaling Museum Library, New Bedford Mass. Bostock Papers, IMA Microfilm #1722 and #1723.

Favorable report on experimentation with Weber's electrocution system by S/S *Elektrisk Hvalskytning.*

329. Sundt, R. 1936b. Lars Andersen and the electrical killing of whales. [English] Translation. [From] 'Sandefjords Blad', 2/3.36, pp. 1–2 typescript. Old Dartmouth Historical Society, Whaling Museum Library, New Bedford, Mass. Bostock Papers, IMA Microfilm #1722 and #1723.

Complaint against Andersen who as a whaling gunner had a bad experience with electrical whaling gear and consequently became an outspoken critic of this method (see Andersen, 1936, entry 7).

330. Sundt, R. 1936c. The electrical shooting of whales. Reply to Lars Andersen from A/S Elektrisk Hvalskytning. [English] Translation. [From] Sandefjords Blad 10th March 1936 [with covering letter from A. C. Olsen, Sandefjord 11th March 1936]. [2 pp.] typescript. Old Dartmouth Historical Society, Whaling Museum Library, New Bedford, Mass. Bostock Papers, IMA Microfilm #1722 and #1723.

Reaction to published complaints by L. Andersen (1936, see entry 7) regarding difficulties with electrical whaling experienced on board catcher boat *H. J. Bull.*

331. Sundt, R. 1938. To The Delegates at the Whale-Conference in Oslo May 19th–24th 1938. A/S Elektrisk Hvalskytning, Oslo, May 19th 1938. [Copy seen at] Smithsonian Institution Archives, Washington, D.C., [File] RU 7165, IWC Conf. and IW Commn, 1930–1968. Box 5 Folder 1, pp. 1–8 typescript.

A/S Elektrisk Hvalskytning, a Norwegian company, has spent Kr. 600,000 since 1929 on experiments in electrical whaling. Studied 'several hundred whales in process of execution' to determine that voltage required has direct relationship to whale's size. Electric power per sq. ft about the same for all whales. Resistance of

whale skin between 80.000 and 200 ohms. Current goes from harpoon head through whale's body to its mouth, then through sea back to boat. Kills 'instantaneously'. 'If only paralised, the death immediately follows.'

A blue whale was killed with 10 volts, but more current normally used.

Current comes from 17k A.C. generator directly connected to steam engine and the ship's generator. Harpoon similar to conventional one, and 'ordinary gun' is used. Claims successful use of this electrical gear by A/S *Rosshavet* and on the 'Henkel floating factory 'Jan Wellem'.' About 2,100 whales have been killed by this method, with average for 3 electric boats on one cruise 210.66 whales vs. 203.5 for 6 shell harpoon boats. Advantages: increased humaneness, time savings, reduced gear expenditure, and less waste of products. To kill 104 whales, one boat needed 114 shots with electric harpoon. A 'patented electric spear' used to finish off whales as necessary. Average time from first shot to hauling alongside, 8–15 minutes, with electrocution. Expense only drawback, but Weber supposedly working on production of cheaper harpoon shaft. Norwegian government has spent Kr. 40,000 and 'recently guaranteed' another Kr. 30,000.

332. Tanner, A. M. 1892. An electrical harpoon for whales. *Scientific American*, Vol. 67, No. 6, p. 86.

Brief description of A. Sonnenberg's electrical method for killing whales, patented in 1852. A magneto- or dynamo-electric machine, consisting of a ring armed with induced coils turning before several permanent field magnets, with a current-collecting ring and brushes, was used together with an ordinary harpoon carrying the conductor embedded in the forerunner. The whale was to receive 720 shocks per minute, supposedly enough to stun or render it unconscious.

333. Thiercelin, L. 1866. Action des sels solubles de strychnine, associés au curare, sur les gros cétacés. *Comptes Rendus des Séances de l'Académie des Sciences*, Paris. Vol. 63, pp. 924–7.

334. Tønnessen, J. N. 1967–1970. *Den Moderne Hvalfangsts Historie. Opprinnelse Og Utvikling*. Sandefjord, Utgitt Av Norges Hvalfangstforbund. [Volumes 2, 3 and 4. For Volume 1 see Johnsen, A. O., 1959.]: Annet Bind 1967. Verdensfangsten 1883–1924. Del I, 1883–1914. p. I–XVI + 1–620; Tredje Bind 1969. Verdensfangsten 1883–1924. Del II, 1914–1924. Den Pelagiske Fangst 1924–1937. p. I–XII + 1–648; Fjerde Bind 1970. Den Pelagiske Fangst 1937–1969. p. I–XII + 1–698.

See Tønnessen 1982, entry 335.

335. Tønnessen, J. N. 1982. History of modern whaling; pelagic whaling 1937–1969. *Department of the Secretary of State of Canada, Canadian Translation of Fisheries and Aquatic Sciences No. 4825*, pp. [i–iv] + 1–24 typescript. (Translation of Tønnessen, J. N., 1970, Den Moderne Hvalfangsts Historie: Opprinnelse og Utvikling. Vol. 4, Den Pelagiske Fangst 1937–1969, pp. 524–541.

Summary of some attempts to develop alternatives to the grenade harpoon. Mention is made of unsuccessful, Norwegian-initiated experiments with curare conducted by two Swedish professors during the 1950s (p. 526).

Experiments with compressed air for killing whales were made by the Dutch during the 1920s (p. 527). Four shots were fired at blue whales in Prince Olav Harbour, 1924–25. Three whales were hit; two died and sank while the third escaped. Although the gas was released, the whales were not inflated. Further

experiments with harpoons charged with compressed carbonic acid during 1959–60 were also unsuccessful.

Carl Ulrich Wetlesen, a Norwegian engineer, received five patents on carbonic acid harpoons during 1943–51 (p. 528). Experiments were conducted at Kongsberg, Steinshamn, South Georgia, and in the Antarctic. Problems included the harpoon passing through the whale, failure of the acid container to open, and leaking of the acid through the wound. Wetlesen's tests off Iceland in 1957 resulted in a whale, which appeared dead immediately after shooting, having to be killed with a conventional grenade harpoon.

Two whales were shot with carbonic acid shells by the 'Balaena' in 1946–47 (p. 528). They were killed 'very fast', and 'the meat was of a much better quality than usual'. A poorly documented attempt to shoot whales with compressed air harpoons from helicopters apparently was made by Westland Aircraft Ltd. off Portugal.

There were proposals made in Norway for 'torpedoing' whales, using an electrically powered submarine deployed from a catcher boat (p. 529).

The history of experiments in electrical whaling is discussed (p. 529–30). During a 5–6 week expedition in Oslo Fjord in 1880 by the tugboat 'Alexandra', a fin whale was electrocuted. It 'allegedly died immediately of a 500-volt current'. Another experimental cruise was made off Bohuslän in 1880. An electric whaling gun invented by Professor K. Birkeland was used, unsuccessfully, at Durban between 1912 and 1917.

336. Tønnessen, J. N., and Johnsen, A. O. 1982. *The History Of Modern Whaling.* [Translated from the Norwegian by R. I. Christophersen.] C. Hurst & Company, London; Australian National University Press, Canberra. p. [i]–xx + [1] – 798. [The present edition is a much shortened version of a work originally published in Norwegian under the title *Den Moderne Hvalfangsts Historie: Opprinnelse og Utvikling*. Vol. 1 (by A. O. Johnsen), Oslo: H. Aschehoug & Co. (W. Nygaard), 1959; Vols. 2, 3, and 4 (by J. N. Tønnessen), Sandefjord, Norway: Norges Hvalfangstforbund, 1967, 1969 and 1970.]

An important work, with a useful bibliography (pp. 756–73). See Tønnessen (1982) for a summary of the section on development of alternatives to the grenade harpoon. The relevant chapter in this abridged, English-language work is number 37, found on pp. 687–729.

337. Tower, W. S. 1907. A history of the American whale fishery. *Publications of the University of Pennsylvania Series in Political Economy and Public Law*, No. 20, Philadelphia. pp. i–x + 1–145.

Chapter 7 titled 'Apparatus and Methods of Capture . . .' includes overview of developments (pp. 80–8). Consists of literature review (see Scammon, 1874, entry 310; Scoresby, 1820, entry 317; Starbuck, 1878, entry 325; Brown, 1887, entry 102).

338. Townsend, C. H. 1930. Twentieth century whaling. *Bull. New York Zool. Soc.* 33(1): 3–30.

Describes cannon fired harpoon with an explosive head, in which the bomb goes off as the line is tightened once it is inside the whale. To be totally effective and 'humane' the harpoon must enter the whale well forward, behind the hump near the fin, so that it struggles for just a few minutes. However, should the shot not kill the whale immediately, the animal struggles for hours, towing the boat for miles.

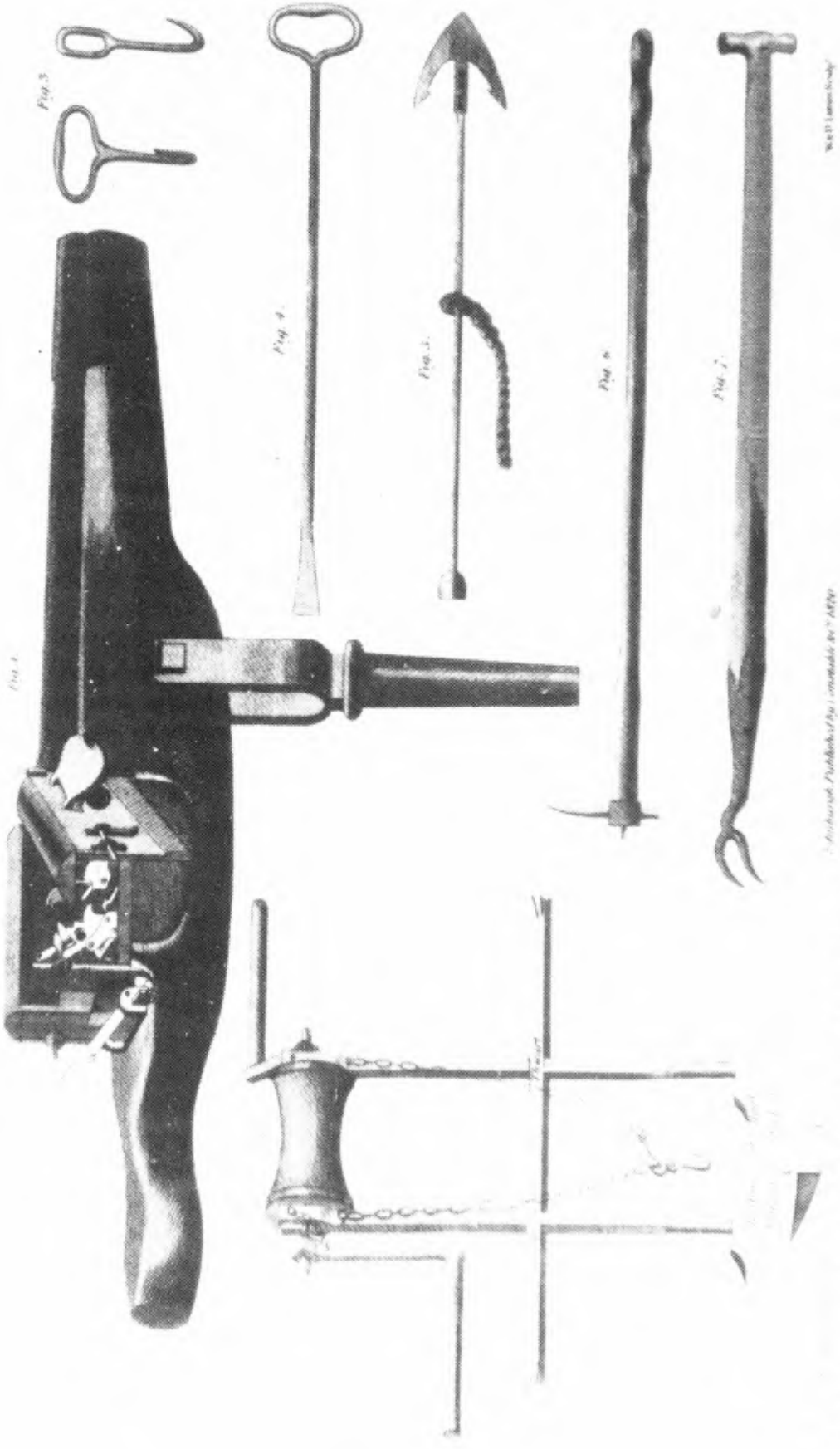

Fig. 24. 'Apparatus used in the Northern Whale-Fishery.'
Fig. 1. Harpoon-gun (scale 2 inches to a foot). Fig. 2. Boat's winch, used in whale-boats for heaving in the line when a great quantity has been withdrawn (scale 1 inch to a foot). Fig. 3. Hand-hooks. Fig. 4. Ice-drill. Fig. 5. Another form of gun-harpoon. Fig. 6. Seal-club. Fig. 7. King's fork, for moving pieces of blubber. 'To compensate in some degree, perhaps, for the laborious nature of the office of the person who uses it, he is honoured with the title of *King*.' From Scoresby (1820, vol. 2, plate XIX).

339. Trouton, R. de B. Ms. 1958. Information supplied by Mr. de B. Trouton of Messrs. Hector Whaling Ltd. Notes compiled in connection with the debate in the House of Lords on 'The Cruelty Involved in the Killing of Whales.' [Submitted to] The Working Party On Humane And Expeditious Methods Of Killing Whales, International Commission on Whaling, [London,] 4 March and 9 May, 1960. HM1: Document D, p. 1–3 typescript.

Claims 'nearly all' whales killed by the two British whaling companies die within 15 minutes of being struck. Up to 30 percent are killed 'instantaneously', and it rarely takes more than 30 min to kill and bring the whale alongside.

Passing reference to unsuccessful experiments with gas harpoons and curare poison. British experimentation with electrical whaling began in 1932. During 1949/50 a special lightweight gun was developed to harpoon and electrocute the whale, which was then shot with a conventional harpoon to permit towing. Over 50 whales were killed, and data on death-times were collected. In 1951 and 1952 trials were conducted at land stations in West Africa and Norway with a 'spigot gun' capable of firing a heavier electric harpoon and a forerunner thought strong enough for towing and winching. Further work with this equipment in the Antarctic during 1952/53 and 1953/54 was discouraging because broken ropes and faulty attachments made recovery of killed whales difficult.

It was decided in 1956 to fire the electric harpoon with the conventional gun, but problems were encountered in field trials in the Antarctic and the British sponsors gave up the endeavor, having invested £100,000 in electrical whaling since the war. Mention is made of tests with CO_2 harpoons to be carried out at Iceland in 1958.

340. Trouton, R. de B. Ms. 1960. Statement by Mr. R. de B. Trouton of Messrs. Hector Whaling Ltd. in Plenary Session of the Commission's Eleventh Meeting. [Submitted to] The Working Party On Humane And Expeditious Methods Of Killing Whales, International Commission on Whaling, [London,] 4 March and 9 May, 1960. HM1: Document E, p. [i] typescript.

Hector Whaling Ltd. spent more than £100,000 during 7–8 years experimenting with electric whaling. Short-circuiting occurred when the harpoon penetrated completely through the whale or when water entered the wound. A combination explosive/electric harpoon worked less well than the ordinary explosive harpoon alone. Some gunners refused to use electricity because they believed it was inhumane when electrocuted whales escaped.

Same company tried CO_2 harpoons 'at infrequent intervals' with poor results. Recommends against further experimentation with electric or CO_2 methods.

341. Vaucaire, M. 1941. *Histoire de la Pêche à la Baleine. Payot, Paris, p. 1–263 + 8 pls.*

Includes descriptions of whaling implements and methods, historical and modern (pp. 193–234), and a useful bibliography. [In French.]

342. Venables, B. 1968. Baleia! *The Whalers of the Azores.* The Bodley Head, London, Sydney, Toronto. pp. frontis + 1–206 + pls. 1–16.

An account of present-day whaling in the Azores. Detailed description, with specifications and illustrations, of 'Temple gig' or 'toggle-headed iron' — the harpoon developed in 1848 and still used by the Azores whalemen (pp. 99–103). Four harpoons are carried in whaleboat. Harpooner attempts to get fast with two harpoons, then invariably uses a steel-tipped iron lance to kill the whale (pp. 104–6). 'Certain firearms' were adopted for a period during the late 19th or early

20th century, but Azoreans returned to hand weapons except for the recent short-lived experiment with bomb-lances (p. 106).

The sperm whale's death in this fishery 'may come in moments . . .; more often it is longer, several minutes' (p. 125). However, this refers to the death-time after lancing. It is preceded by a Nantucket sleighride: 'The time comes when the power of the whale has drained enough for approach to be made for lancing; the period for that is widely variable, a few minutes occasionally, often an hour or more, and the shorter time is no suggestion that the interval to the kill will be comparably brief' (p. 123).

343. Villiers, A. J. 1925. *Whaling In The Frozen South. Being the Story of the 1923–24 Norwegian Whaling Expedition to the Antarctic.* Indianapolis, The Bobbs-Merrill Company, Publishers. pp. frontis + [i–iv] + [1] – 292 + 30 pls.

Illustrated first-hand account of modern Antarctic whaling by a newspaperman who shipped aboard the *Sir James Clark Ross* specifically to document the fleet's activities. The capture process is described (pp. 122–6). If a blue whale is not first struck in a vital spot, 'it will require two, and even three, great steel harpoons and bombs to finish it, despite the terrible destruction of its organs by the bursting of the soft-iron bombs.' 'If the head is struck, the harpoon does not enter at all, and if the shot has gone to near the tail the whale will tow the little steamer furiously about for hours.'

344. Waterman, T. T. 1967. *The whaling equipment of the Makah Indians.* University of Washington Press, Seattle and London, p. 1–[67]. [Originally published as Volume 1, Number 1, of the *University of Washington Publications in Anthropology*, 1920.]

Detailed account of primitive whaling equipment and methods used by this tribe in the Pacific Northwest of North America.

345. Weber, A. 1938. Die Jagd auf Wale. pp. 142–152 *In*: Peters, N. (Ed.), *Der neue deutsche Walfang. Ein praktisches Handbuch seiner geschichtlichen, rechtlichen, naturwissenschaftlichen und technischen Grundlagen.* Verlag 'Hansa' Deutsche Nautische Zeitschrift Carl Schroedter, Hamburg. pp. (i) – viii + 1–263.

346. Weber, A. 1939. Elektrische Waltötung. *Elektrotechnische Zeitschrift*, 60. Jahrg., Hft. 43, 26 Oktober 1939, pp. 1229–32.

Basic technical description of the physical basis of electric whaling, with illustrations and test data on characteristic shots into muscle at various positions. [In German.]

347. Whalemen's Shipping List and Merchants' Transcript. New Bedford, Mass. Vol. 1, No. 1 (17 March 1843) to Vol. 72, No. 52 (29 December 1914).

A trade periodical containing short articles and notes on contemporary whaling practices and other matters of interest to whalemen. References to new whaling techniques are made frequently. The shipping list is also a unique source of advertisements, often making exaggerated claims on behalf of various whaling paraphernalia.

348. [Wheatley, J. and others.] 1789. [Certificates of capture of whales by use of the gun-harpoon.] *Transactions of the Society Instituted at London, for the encouragement of Arts, Manufactures, and Commerce; with the Premiums offered in the Year 1789*. Vol. 7, pp. 175–86.

Statements by British whaling captains certifying that various individuals harpooned whales (all or most of them bowheads) with gun-harpoons in 1785–88. These certificates were needed before premiums could be awarded to the harpooners by the society. Periods of up to 8 hours from first strike (in this case, through the tail!) to the whale's death are noted.

349. Williamson, G. R. 1974. The riddle of the rorquals. *Sea Frontiers*, Vol. 20, No. 3, pp. 152–7.

Describes effort made off Japan to photograph living rorquals underwater. Non-explosive harpoons were used to tether minke and sei whales to the catcher boat, allowing a diver to swim near the animals. Behavior of whales after being harpooned is described, and differences in this regard between rorquals and sperm whales are noted.

350. Winter, F. H. and Schmitt, F. P. 1975. America's first scientific whaler. Captain Thomas Welcome Roys. *Oceans*, Vol. 8, No. 3, pp. 34–9.

A popular account of Roys' life, including a photograph of his rocket harpoon in the Smithsonian Institution's collection. For a more comprehensive treatment of the subject, see Schmitt *et al.* (1980, entry 314).

351. Winter, F. H. and Sharpe, M. R. 1971. The California whaling rocket and the men behind it. *California Historical Quarterly*, Vol. 50, No. 4, pp. 349–62.

A well illustrated account of the development of the harpoon gun that became known as the California whaling rocket. This development began with experiments by Captain Thomas Welcome Roys in the 1850s. Roys worked on his invention, sometimes in collaboration with Gustavus Adolphus Lilliendahl, during the 1860s and until his death in 1877. The Roys & Lilliendahl whaling rocket continued to be improved and tested on rorquals along the California coast, and it was used on a major scale in the Arctic whale fishery during the late 1870s. A specimen of the California whaling rocket in the collections of the National Air and Space Museum, Smithsonian Institution, is illustrated. The rocket and shell assembly weighed 28 lbs; the bomb itself, 10 lbs. An improved version developed by John Fletcher and Robert Suits weighed 32 lbs, 'even a cabin boy could operate it', and supposedly this apparatus could fasten the harpoon to a whale at 300 ft, 'a considerably greater distance than could be reached even by gun lances'.

352. Wise, T. 1970. *To catch a whale*. London, Geoffrey Bles Publishers. pp. 1–190 + 20 pls.

Personal account of a whale hunt on the British factory ship *Balaena* to the Antarctic in 1957–1960. Description of techniques used on this cruise (pp. 89–95), including exploding grenade with 3-sec fuse. 'Killer bar' — 'a harpoon with a grenade but having only two short fins instead of barbs, a lightweight hollow shaft and no line attached' — used when first harpoon failed to kill. Third and fourth harpoons needed 'in rare instances'. Review of whale killing techniques used before and after development of Svend Foyn gun (pp. 95–7).

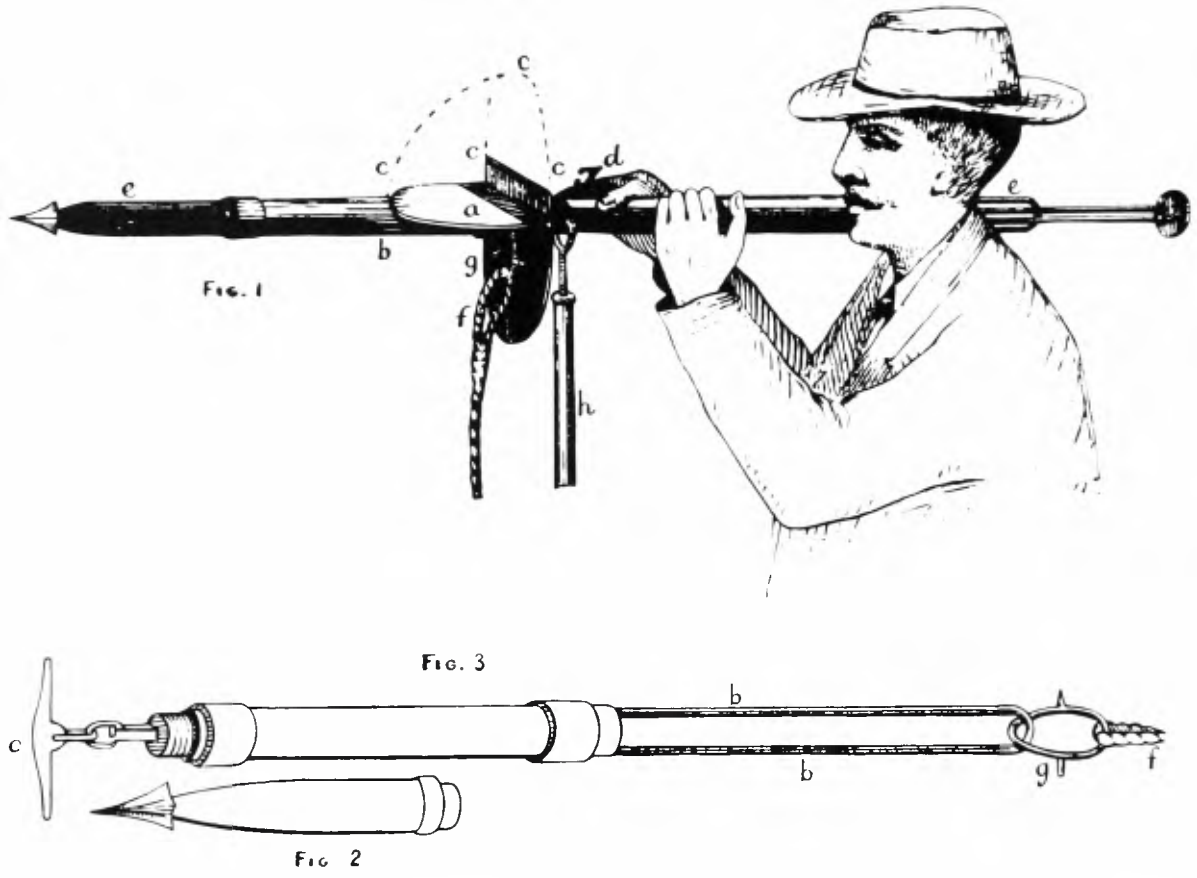

Fig. 25. Whaling rocket. The projectile consists of a cast-iron shell (Fig. 2), and a rocket with a loop extension (Fig. 3). The shell, 15 inches long, has been detached to show the toggle, which is fastened by two links to the projecting end of the rocket. The bomb is filled with 'peculiar composition said to be known only to the inventors'. The rocket is made of brass and the loop extension (*bb*) of wrought-iron; the total length is 66 inches, and the length of the toggle (*a*) about 10 inches. When the bomb with its rocket attachment (Fig. 3) is loaded in the gun (Fig. 1) which is partially supported by a standard (*h*), the link (*g*), with the tow-line (*f*) attached, hangs from the muzzle. The two rods projecting in the rear fastened to the iron plate, form the hinder part of the gun. The adjustable flange (*a*) occupies a position parallel to the gun when the gunner takes aim. The fire is communicated to the combustible material in the rocket-chamber by means of a pistol (*d*) and the issue of gas from the rear of the rocket propels the apparatus. During its flight the shackle (*g*) and the tow-line (*f*) take the position shown in Fig. 3. When the bomb explodes in the whale the toggle (*a*) and chain are released and fasten in the blubber or flesh, preventing the withdrawal of the apparatus. Simultaneously with the discharge of the gun, the flange (*a*) is thrown up in a vertical position following the path, as represented by the dotted lines (*cc*), to protect the eyes of the gunner. From Goode (1887, plate 199).

353. Wyatt, C. 1956. Hunting the white whale. *Country Life* — September 6, 1956, pp. 460–2.

Describes Inuit white whale hunt in Mackenzie delta. Whales shot by rifle, from schooners, then harpooned for retrieval. Although hunt occurred in shallow water, one of three whales killed was lost.

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'During the first post-war years, the local people of Chukotka used rifles for taking gray whales and attempts were later made to use other methods. These methods were not found to be suitable as considerable numbers of whales were lost and in some years up to 30% of shot whales drowned or escaped wounded.' Since 1969 'a specially rented whaling ship' has been used to catch gray whales on the local people's behalf (p. 242).

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363. Anonymous. 1951a. Dai 5ji Namhyoyo–Hogei ni okeru Denki–mori Zitsuyo Zikken Hokoku-sho. [Report on experimental whaling with electric harpoon in the Antarctic season 1950–51.] Hogei–Sempaku–Sobi–Kaizen–Iinkai. [Committee for Improvement of Whaling Vessels and Equipments.] Mimeographed, 16pp. [in Japanese]. [From H. Omura *in litt.*]

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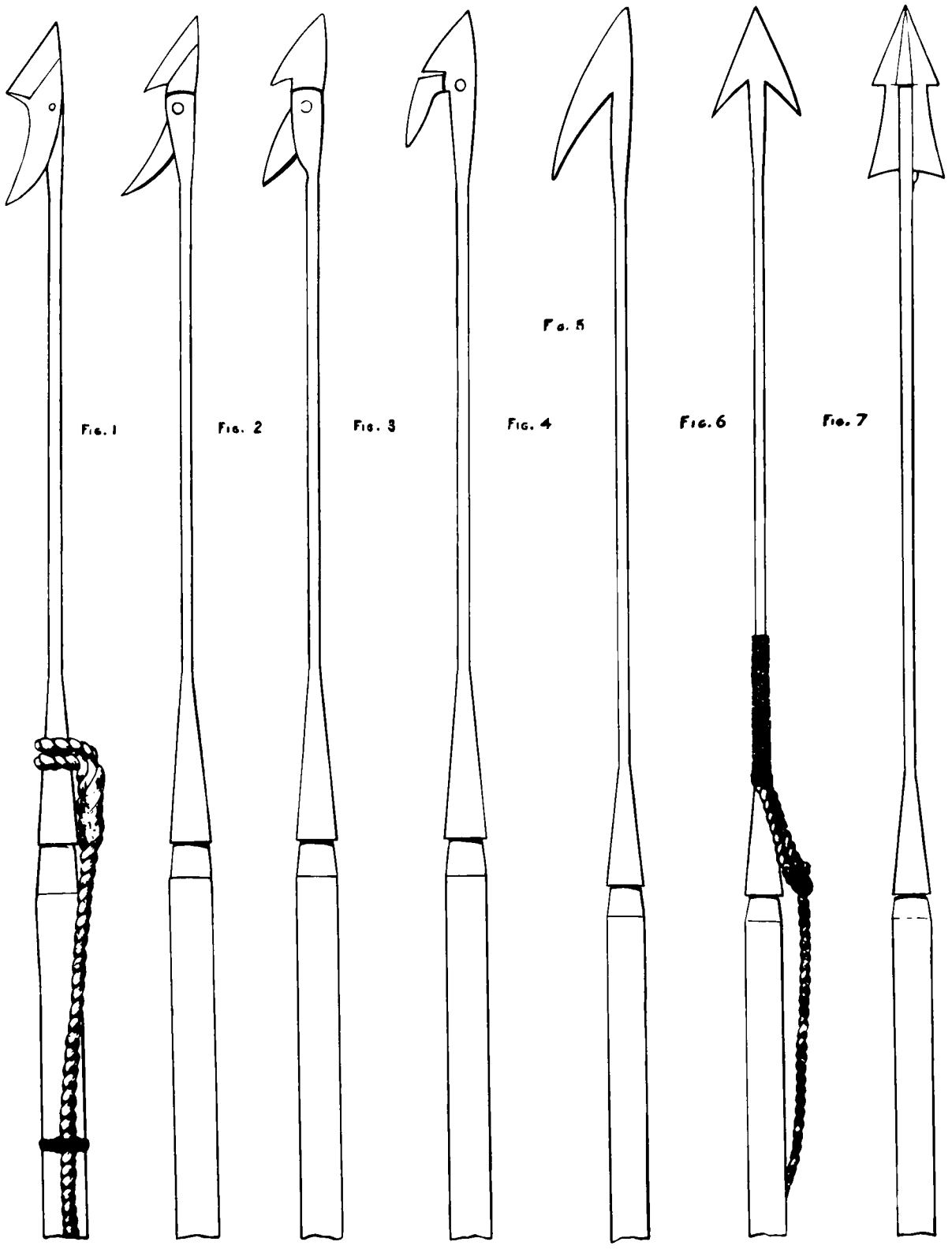

Fig. 26. An assortment of nineteenth century harpoons.
Fig. 1. Improved harpoon of toggle-iron in use during the 1880s. Fig. 2–3. First forms of toggle-iron made by Lewis Temple. Fig. 4. 'One-flued' harpoon with hinged toggle. Fig. 5. 'One-flued' harpoon. Fig. 6. 'Two-flued' harpoon. Fig. 7. Provincetown toggle-iron; no longer in use by early 1880s. From Goode (1887, plate 194).

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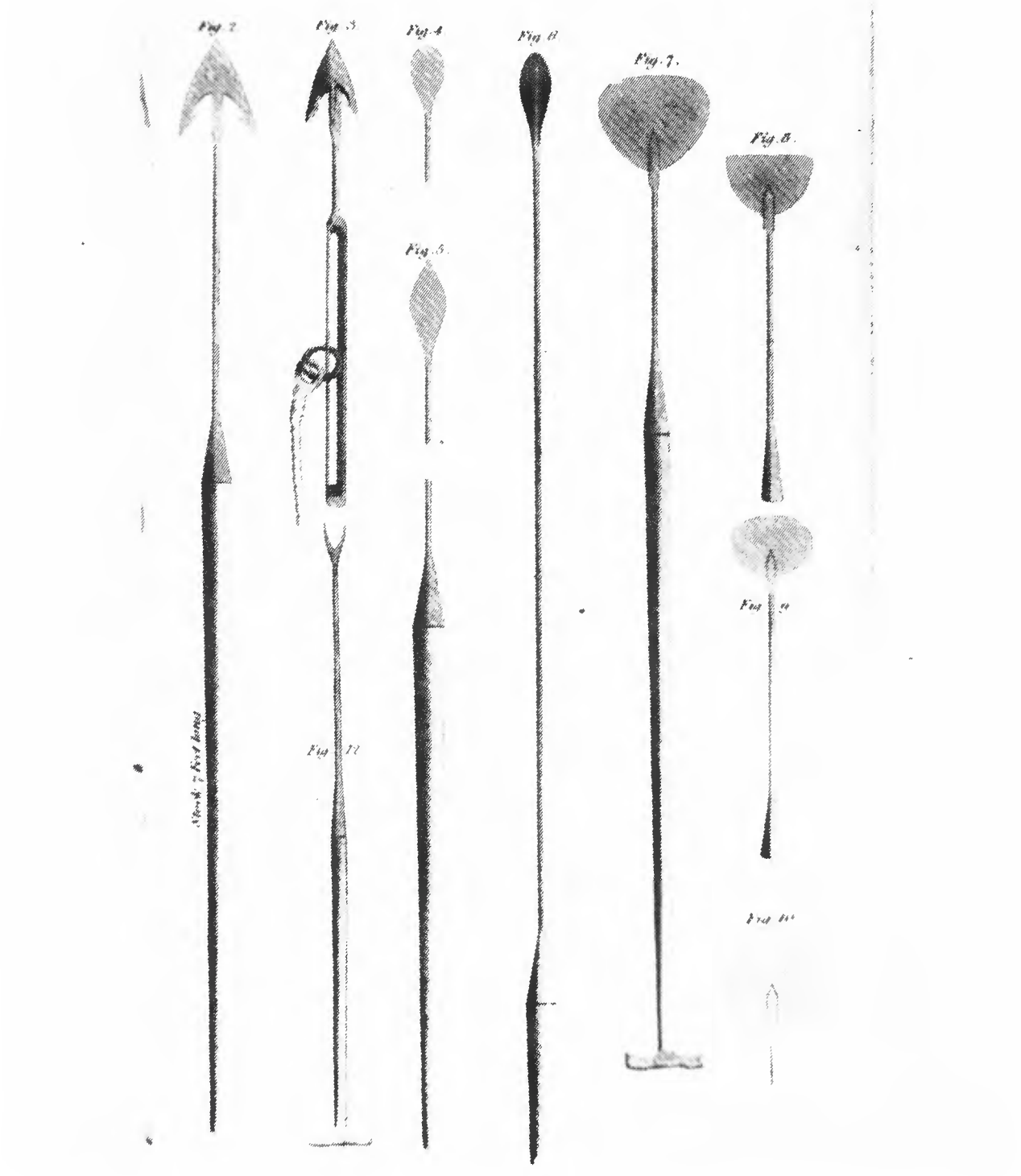

Fig. 27. 'Instruments used in the whale Fishery.' Fig. 2. Harpoon. Fig. 3. Gun-harpoon. Figs 3–6. Lances. Figs 7–10. Blubber-spades. From Scoresby (1820, vol. 2, plate XVIII). [Note that Figs 1 and 11–12 could not be copied.]

APPENDIX I

Aspects of Pre-World War II German Electrical Whaling

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As a result of the current International Whaling Commission (IWC) initiative on humane practices in whaling, the above bibliography represents an attempt to summarize the literature on killing technology and to help make current research efforts efficient and ensure that they are firmly based on the work that has gone before. Partly as a result of this I became interested in whether early efforts to develop electrical whaling devices might hold lessons for those attempting to develop new 'humane' whaling technology. My particular interest in electrical whaling was reinforced by a chance inquiry from a private collector of whaling implements about the identity of a putative harpoon.

Robert Hellman learned of a collection of large metal tubes or rods piled under the porch of a private residence in New York state. These were being offered for sale as harpoons from a whaling vessel. On examination, Hellman found the artifacts to be of a type unknown to him. He solicited my aid in identifying the objects and even expressed doubts that they were harpoons. They were alleged to have been removed from a whaling vessel undergoing refit in the Brooklyn Navy Yard during or after World War II, where they were salvaged and retained by a welder who took them home intending to use them for fence posts. The shank of the 'harpoon' was not split for a sliding ring like most modern harpoons. Rather, it was a closed tube with a cap at the proximal end containing two threaded plugs or bolts. The head was pyramidal in form. The separate tip swiveled in one direction in an enclosing clevis in the base of the head which in turn was solidly fastened to the shank. There appeared to be no articulation between the head with flukes, and the shank. There was a 2 × 2⅜″ hole, apparently for line located in the shank or neck between the flukes. On one side, near this hole, there was a large set screw. A non-metallic sleeve encased some of the deteriorated harpoon shanks. There were no maker's marks present, but some of the harpoons bore chisel-marked Roman numerals, including 'XVI' on one and 'XXII' on another. Overall, the 'harpoons' were approximately 160 lbs in weight and 70″ in length, and the shank or shaft was 3½″ in diameter.

If these were harpoons intended to fit standard, commercial whaling cannons, they were unlike the modern harpoons illustrated in most sources on the whaling industry and its history. The weight, length and diameter all approximated corresponding dimensions for the standard 90 mm harpoon. However, the side-moving tip of the head, the lack of a universal-joint type articulation between the head and the shank or shaft, and the absence of a 'split-shank' or bipartite shank split to receive a ring on which to fasten the foregoer, indicated a radically different technology.

I considered that they might be 'killer harpoons' like those fabricated by many whaling companies from pipe and scrap metal. These low-cost unattached projectiles were used for a final head shot once a whale was harpooned and fastened-to with a regular harpoon. But if the Hellman find was someone's version of a killer harpoon, why the elaborately swiveled head tip, the screws in the neck and at the base, and the non-metallic composition material covering the outside of the shank?

It seemed logical that if it was a harpoon, it might be an electrical harpoon. This would account for the bolt on one side near the hole between the flukes in the shank, for attachment of a conductor cable, and the presence of the composition material as insulation on the shank. However, perusal of the published literature on electrical whaling did not yield any good illustrations or descriptions that accorded with this harpoon. In fact, the British electric harpoon, developed after the Second World War, had a 'detachable-leg' shaft that came off. This is quite different from the Hellman find. However, the British harpoon (e.g. Marsden, 1952c; McGaffin, 1953) had a swiveled tip on the head and a large hole or excavation between the flukes behind which the line was attached. There were some resemblances, sufficient to show that this was a harpoon, in all likelihood an electrical harpoon.

In searching the literature for detailed, technical illustrations of 90 mm harpoons, I was struck by the paucity of books or articles on the subject of cannons and their harpoons. The literature is widely scattered (see the Bibliography section of this volume) and most sources are very general in their treatment of the structure and specifications of harpoons and cannons. The first modern monograph on harpoons and other whale craft (Lytle, 1984) includes shoulder guns but does not cover 19th-century European and 20th-century deck-mounted cannons and harpoons. It remains for the definitive international overview of harpoon cannon history and technology to be written. Illustrated catalogues of particular collections or makes would be welcome.

I turned to leafing through the patent illustrations in the Bostock Papers (Bostock, 1930s–1950s). There I found an illustration showing the swivel tip of the head, the set screw and other features that clearly identified the Hellman find as a cache of Albert Weber electric whaling harpoons. Subsequently, Klaus Barthelmess called my attention to the one small, published photograph now known to me of a Weber electric harpoon, in Peters' *Der Neue Deutsche Walfang* (1938). So the artifacts were harpoons, they had been used at least before the Second World War, and they had a history. These may be the only surviving examples of this important experimental whaling technology in North America and possibly Europe.

The story of 1930s commercial whaling is a story of Norwegian dominance in whaling. The nature and scope of modern whaling had been set by the turn of the century. Modern whaling involved deck-mounted cannons shooting harpoons with exploding grenade heads, direct fastening to the whale using elastic foregoers, spring winches and compensators, and engine-driven catcher vessels. Much of the experimentation and many of the patents relevant to the development of modern whaling were Norwegian (Johnsen, 1947). The Norwegians continued to refine old technology and invent new devices and procedures for the ever-more efficient killing, retrieval and processing of large whales. Johnsen (1947, p. 37) identified the years *ca* 1924–1936 as the period of transition to predominantly pelagic whaling which was accompanied by a marked industrialization of the industry. A fair proportion of the patents taken out during the period related to electrical shooting

appliances but of the 26 such Norwegian patents taken out to 1940, only one was granted to a foreigner (Johnsen, 1947, p. 111). Although it is not reflected in the list of patents, there was substantial German involvement in this Norwegian experimentation, and German individuals and companies were sometimes involved in the Norwegian patents. One such individual was Albert Weber associated with A/S Electrisk Hvalskytning as will be mentioned below. (I follow other authors (e.g. Anon., 1937 Ms) in referring to this work as 'German' although it is clear that it is so intertwined with Norwegian companies, whaling and patents that it is more properly termed 'Norwegian'.)

Germany has a long history of whaling. Hamburg, Schleswig-Holstein and Frisian whalers were prominent in the early Spitsbergen whale fishery, and Bremen, Hamburg, Schleswig-Holstein and vessels from many other German ports played a role in the mid-19th century South Sea Fishery for sperm and right whales. In the late 19th and early 20th centuries, there was German involvement in other whaling operations. Germans were involved in the early discussions of the efficacy of electricity for killing whales (Anon, 1852, 1853).

At the beginning of the 1930s Germany embarked on an ambitious and comprehensive state-subsidized whaling industry as one part of its national fat plan to supply the populace with edible fatty substances. The German consumption of whale oil was the highest of the six nations utilizing it during the period 1930–1937 (Brandt, 1948, p. 1). Advances in hardening or hydrogenation in which whale oil is converted from unsaturated to saturated fats and other refining techniques helped transform whale oil from an inferior industrial product to one of the most desirable (in the form of the edible oleomargarine). Germany and Britain absorbed about 60% of the available whale oil during this time, and from 1937 they competed to stockpile more for the war emergency (Brandt, 1948, p. 3). By 1940–41, Britain had a stockpile of *ca* 470,000 metric tons of whale oil compared to *ca* 150,000 metric tons in the German war food administration (Brandt, 1948, pp. 11–12).

As a result of the 'war on margarine' and the forced reinvestment of foreign (e.g. the giant Unilever Group with interests in soap and margarine) earnings in Germany, the four German whaling expeditions operating in the 1937/38 Antarctic whaling season were fully or partially owned by Unilever. Goering recognised the importance of whaling to Germany noting that foreign capital and the ubiquitous Norwegian whalers 'offer the possibility of supporting the supply of fats to our people, and thereby contributing to the attainment of the great goal of freedom in raw materials and food' (Tønnessen and Johnsen, 1982, pp. 394–8).

In the mid-1930s, Germany began building a pelagic whaling fleet, and within three seasons, during the last peace-time season of 1938/39, fielded five owned and two chartered factory ships. The 1938/39 season saw diminished catches for whaling ships of all nations (Brandt, 1940, pp. 79–80), and the 1937/38 season remained the most successful for Germany with her vessels securing 11.4% of all Antarctic catches. War broke out in September 1939. Germany ceased whaling operations but Great Britain, Norway, Japan and the United States had a total of 28 factory ships working in the Antarctic during the 1939/40 season (*Norsk Hvalfangsttid.* 1942 (7), p. 120; Brandt, 1948, p. 5, [27 on p. 195]).

Germany did not whale for the rest of the war. Other nations did but with lower results and severe loss of vessels. There was a total loss of 27 or 28 floating factory ships, with only nine or ten seaworthy factory ships left by the autumn of 1945 (*Int. Whal. Statistics* 17, pp. 6–8; Brandt, 1948, p. 8).

The beginning of hostilities also clearly influenced the flow of information of

both a scientific and technical nature. However, notwithstanding this problem it is clear that Weber's electrical whaling work was well in hand by 1938 and that not only general papers had been published on the results to date (e.g. Weber, 1938, 1939; Anon, 1941 abstract of Weber, 1939) but that patents had been filed for most of the technology that was proving to be workable and even efficient. This is in spite of the statement, 'Durch den Kreig sind leider sämtliche Unterlagen Webers vernichtet worden'[1] (Schubert, 1955, p. 99). Most post-World War II sources in the English language acknowledge that there was important experimentation by Norwegians on electrical whaling and that German work was also important. 'Some experimental work in electric whaling was done in Norway in the twenties, and much progress was made there during the war under a Nazi engineer named Weber, who committed suicide after the German defeat' (Anon, 1952b), when he 'destroyed all his papers on committing suicide' (Anon, 1952c: 143). The work of Weber was supposed to have been recorded in broad outline, but the 'fundamental and essential details, which it is presumed he kept personally, were lost at the time when he committed suicide in 1945' (Marsden, 1952c: 127).

During the war apparently the interest in this technology continued although the war disrupted Weber's work (Schubert, 1955, p. 99). In Japan some experiments were carried out in 1941–42 (Øen, 1983). The Japanese interest was clear (e.g. Omura, Matsuura and Miyazaki, 1942, p. 154–55). (I am uncertain whether or not the electric harpoon pictured by Hirata, 1951, fig. 4, owes its ancestry to the Weber patents.)

Experimentation with electrical whaling techniques continued after the war both by Norwegian companies and British interests. Their goals were somewhat different—the Norwegians were primarily interested in developing more efficient catching methods, while the British wanted to make the killing methods more humane (Tønnessen and Johnsen, 1982, p. 704). In Norway, Electrohval and the Kongsberg Gun Factory worked to electrify the harpoon shot from a standard Kongsberg cannon, and finally developed a detachable shaft or 'leg' on the harpoon to lessen electrical current leakage in those instances when the shaft protruded from the entry wound (Clarke, 1952). (Electrohval (Bj. Gundersen and Co.) was the reorganized A/S Elektrisk Hvalskytning, the transition occuring about 1948.)

The British interest in developing an electric whaling technology was initiated by Commander N. Simon in a 1947 letter to *The Times* (Anon, 1952b). The energy of Dr H. H. Lillie helped get the initiative off the ground. Lillie emphasized the suffering caused to whales by the explosive harpoon, after first hand observations as a surgeon on the Antarctic whaling expedition of the *Southern Harvester* in the 1946/47 season (Lillie, 1949a, b; Lillie and Hume, 1949). With Major C. W. Hume of UFAW, they interested United Whalers Ltd. in electric whaling. 'A successful search was made for Weber's papers, and a catcher was equipped for electric whaling in time for the 1948–49 Antarctic season' (Clarke, 1952). B. R. Bostock of United Whalers Limited gathered the materials, which included substantial material on Weber's work.

The British initiative tackled the difficult problem of placing an electrical conductor in the foregoer. The earlier problems of damage to the electric cable inside the forerunner due to differential stretching of the two under tension, the

[1] 'All of Weber's documentation were unfortunately destroyed through the war'.

added weight of the conductor, and other problems were addressed (Clarke, 1952). United Whalers Ltd. and associated firms then developed a new 'spigot' cannon that fired a newly designed and lightweight harpoon. However, this 'special cannon proved so inefficient that they reverted to the ordinary kind' and the problems with the forerunners were never really resolved (Tønnessen and Johnsen, 1982, p. 704). The British effort was finally dropped in the late 1950s-early 1960s (see also Marsden, 1952a, b, c; Anon, 1952b, c; Anon, 1953; McGaffin, 1953). IWC reviews of this initiative recommended cooperation between the British and Norwegian efforts in electrical whaling where 'the special advantage of British equipment and the superior Norwegian forerunners and harpoons should be combined' (Tønnessen and Johnsen, 1982, p. 704). The IWC's final judgment was that there was no basis for starting new experiments, especially since the method 'cannot be said today to offer definite advantages over the shell harpoon method' (*Ibid*, 1982, p. 704).

Subsequently, the IWC has again addressed the issue of humane killing of whales, and in the course of these inquiries and investigations the supposed efficiency and humaneness of electrical whaling has again been examined. (Current interest and work is summarized by Donovan in Appendix II of this volume, and current published references are cited above in the Bibliography section.) It is quite clear that some of the early claims for the utility of electrical whaling coincide in part with requirements for humane killing methods such as rapid immobilization of the whale, shortened time to death and possibily rapid loss of consciousness. Thus a brief summary of the supposedly successful German efforts before the Second World War seems appropriate.

In 1929 Albert Weber, a German engineer, became interested in electrical whaling, and the company A/S Elektrisk Avlivning av Hval (later changed to A/S Elektrisk Hvalskytning) was formed in Oslo (Clarke, 1952). This company took out 21 Norwegian patents on electrical whaling (Johnsen, 1947, p. 75). Weber was entrusted with the scientific and technical work of the company. Four fin whales were electrocuted with preliminary equipment in experiments to study physical and biological parameters in 1929 (Weber, 1937; Øen, 1983). Then followed years of fabricating and experimenting with forerunners, cables, harpoons and other apparatus and equipment. Trials were undertaken during two expeditions to the Arctic Ocean and four to the Antarctic (Weber, 1938).

> The technical development is now completed and rich scientific material is available on the distribution of the current in the whale, about consumption of voltage for the killing, conduction in the whale, etc. with the help of which information it was possible to solve all practical questions (Weber, 1938, p. 151).

I did not have all of Weber's published papers at hand in preparing this account—for example, a 1937 paper in *Hvalfangstliv* cited by Schubert (1955, p. 198) and Øen (1983) or the original Weber article cited in *Science Abstracts* the text of which appeared as Anon, 1941. Weber was also assisted by Siemens-Schuckertwerke Aktiengesellschaft in this work (Winterhof, 1974, p. 159) and although some of their patents relate to the problems encountered by him (e.g. Anon, 1935a, b) I have limited this discussion to the work of Weber and his company. I have adopted the useful listing of Norwegian patents given by Johnsen (1947) who gives titles translated into English as a guide to the work of Weber and A/S Elektrisk Hvalskytning (Table 1, pp. 130–1). Weber worked in Norway and the company was based there, thus it would be expected that the Norwegian patent

system would be their first recourse to protect their results. Also I probably missed much in my search of English and German patent records (Table 1).

After the war, B. H. Bostock of United Whalers undertook to locate information on the technology developed by A/S Elektrisk Hvalskytning and Albert Weber. He came into contact with Bjarne Gundersen, a representative of the same company. Gundersen supplied Bostock and United Whalers with correspondence, English translations of German language reports by and relating to Weber and his work, and other unpublished material (e.g. Bostock Papers, 1939s–1950s, file on 'Electrical Killing of Whales. Elktrohval and Hvalskytning') that has proved useful to the following account.

The work can be generally grouped as separate but parallel development of: the aboard-ship electrical plant with appropriate switches especially on the cannon; a flexible and strain-resistant electrical conductor embedded in the forerunner and first whale line; a suitable harpoon that functioned both as a mechanical fastening device and an electrode, the penetration and orientation of which could be controlled; and auxiliary devices such as cable testers and electrical killing lances.

The main features of the aboard-ship electrical installation for the killing of whales were patented by A/S Elektrisk Hvalskytning on 8 July 1931 (57560). It was clearly recognized at the outset that

> the strictest requirements must be made with regard to the safety of the operating crew, as it is in this case worked under such difficult conditions of insulation, as are scarcely met with in any other branch of electro technics.

The patent illustration (Plate A) shows installation with the working and signalling conductors (Fig. 1), the change-over switch in two different positions (Figs 2 and 3), and the mounting of these components on a catcher boat (Fig. 4). Part A of the installation comprises a current limiter (1), change-over switches (2, 4), an ammeter (3), a current transformer (4^1) and signal lamps (5, 5^1, 6). Part B is a signal lamp on the foremast. Part C, near the gun, is a relay (8), and signal lamps (9, 10). Part D is in the fore-hold of the catcher vessel, and includes a connection for each whaling cable. 'From a generator over a transformer 11 the installation is supplied with a suitable alternating current'. In this installation the killing current is led to the gun where a switch acting on the recoil of the gun closes the circuit. On shooting, the harpoon is brought under voltage by the time it has travelled about ten meters from the cannon.

> When the harpoon strikes the whale, the killing current will go from the upper terminal of the transformer 11, though the current limiter 1, across the switch contacts 2 *a–b*, the contacts *e*, the bimetallic arm h^1, the switch contacts 2 *d–e*, the ammeter 3, the current transformer 4^1, the switch 4, through the fired cable and harpoon into the whale, through the body of the latter, the mouth cavity and back through the sea (Fig. 1).

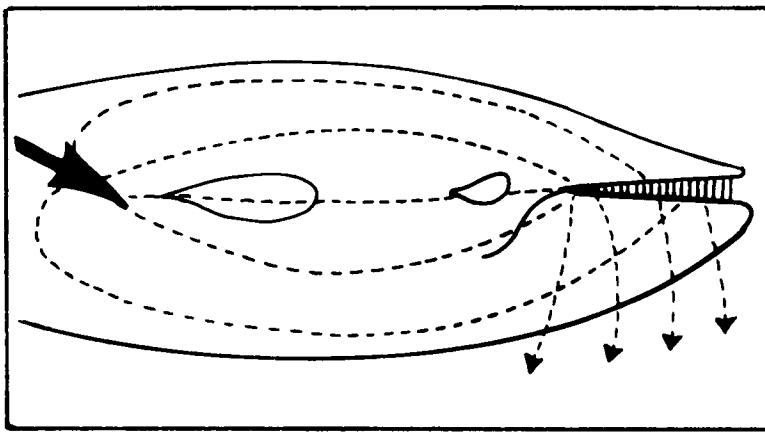

Fig. 1. Conduction of electrical current from harpoon electrode through blubber-insulated whale to buccal mucous membrane, then via seawater to hull of catcher vessel. (Redrawn from Schubert, 1949 after Weber, 1939a.)

The blubber of the whale was an insulator, so the current was conducted out of the whale, back to sea water via the lining of the mouth.

After a suitable interval, the killing current is broken due to the heating of the bimetallic arm h^1 of the heating coil h. However, if the shot misses the whale then lamp 10 goes out indicating that a short circuit through sea water activated the current limiter. The installation can also be used to employ the killing circuit directly from the bridge, by-passing the gun.

In subsequent patents, this latter feature was emphasized, such that

> the harpoon is placed under voltage and also in which as a result of the firing of the shot or by being manually operated, an auxiliary switch, the closing of which places the harpoon under voltage (57561, 26 April 1933 and see 51871, 27 May 1929).

This system of bypassing the gun entirely with the very large diameter killing cable going directly to the bridge or other suitable place was clearly designed in response to considerations of gunner safety. The killing current was 220 volt alternating current of 50 Hz from one pole current supply (Schubert, 1949). However, Weber (1937; Øen, 1983) found that resistance was so low that on average a potential of 20 volts passing through the body was lethal.

Switching arrangements on the cannon thus were a major issue, both from the technical viewpoint and in the view of the gunners who were asked to shoot a high voltage electrical harpoon from the exposed, salt-water drenched gun platform of a catcher boat. Patent 53887 (8 November 1932; Plate B) described closing the circuit by action of the trigger of the cannon and 53888 (8 November 1932) by using the action of the recoil, and 54840 (9 November 1932) proposed as an additional safety feature to short circuit the head of the harpoon to the cannon by means of a conducting wire (7 in Plate C) bringing the harpoon to the same potential as the gun.

One of the most vexing technical problems faced by this and other engineers attempting to develop a simple, dependable and safe electrical whaling technology was how to conduct the current through or along the fore-goer or forerunner from the vessel to the head of the harpoon embedded in the struck whale. The material whalers selected for this line attached for the first few tens of meters behind the harpoon was elastic and had to withstand immersion in sea water due to the conditions imposed on it. However, conducting cable, usually copper, needed to be well insulated and often broke under the force imposed on it by the interplay of a multi-ton vessel and whale.

A/S Elektrisk Hvalskytning was involved directly in this work to a limited extent. One patent (58657, 22 July 1933) covered a mechanism for a releasable connection for the proximal end of the conductor in the line room. Another covered a device to detect a circuit break in insulated cable (58694, 30 November 1935). Four others related to improvements on the construction of the forerunner and line especially the insulation around the conductor and methods of marrying the line to the conductor (e.g. 53345, 25 May 1929; 53460, 31 May 1932; 56350, 2 July 1929; 60399, 30 November 1935). None of these really solved the technical and field problems encountered in day to day whaling.

In giving an overview of this technology, Weber (n.d., Ms.) indicated that all these changes mainly bearing on insulation should be directed towards weight reduction of the foregoer and line, to increase stability and range of the harpoon's trajectory. The German experience was that a forerunner only lasted about a week, due to its diminishing length resulting from cutting it off at the surface of the whale's carcass and deterioration of the rope material. Such breaks in the

conductor as occurred were generally within 8 m of the harpoon. (The forerunner was followed by five lines each 200 m in length but only the forerunner and the first of the five three-strand lines were provided with the three embedded electrical conductors.) Between 15 and 20 whales were killed using a single forerunner, and a newer specification gave 25 kills. This was alleged to have been about one-half the consumption of forerunners in shell catching (Weber, n.d., Ms.).

The basic outlines of the harpoon were established early. The first Norwegian patent (50485, 28 February 1929) was closely followed by two more (53344, 8 April 1929; 53532, 25 May 1929) and soon the basic design was somewhat stabilized (55057, 5 September 1931). It was comprised of a hollow tube around which was insulating material, held in place by a disc closing the base of the tube and screwed to the insulation. The metal disc and the insulating socket (5 and 3, respectively, in Plate D) are force-fitted on the tube with a coating of varnish. Note the standard (for that time) pointed and ridged tip of the head, and normal flukes or barbs. There is no toggle or universal joint in the neck of the head.

Weber soon found that this projectile often penetrated completely through a whale, with resulting short circuiting of the electrical current. The next three Norwegian patents on the physical structure of the harpoon then dealt with braking devices (54796, 11 June 1932; 54797, 11 June 1932; 55243, 4 February 1933). These were meant to stop and/or deflect the harpoon soon after entry so that the entire harpoon remained within the whale's body.

Weber tackled this problem with two different basic designs. In one, the entire harpoon from base of shaft to tip of head was one rigid structure, with the brake comprised of a piece of round stock shaped like a Z but with the bends at right angles (54796; 11 June 1932; Plate E). This 'braking member' rotated in a cross-wise hole through the base of the head, and only when a cam or disc was rotated on entry into the whale's body was it freed to be rotated to a position crosswise to the direction of motion of the harpoon.

In the other design, the distal one third of the head is separated off as a hingeable tip, rotating in a clevis on a transverse pin (54797, 11 June 1932; Plate F). The tip is locked in place by a bolt which is released by the movement of a lever upon the bursting of the lashings on the flukes when the harpoon enters the whale's body.

There were no further patents on the harpoon in Norway until 16 July 1938 (62699) when further refinements and alternatives to the problem of insulating the shaft from the head were described. The same patent was filed 5 August 1938 in Germany but a casual search did not turn up a comparable patent in England as was the case for almost all the preceding patents, Table 1.

Weber believed that insulating the shaft completely was the best way to avoid the problem of short-circuits when the shot protruded. This had been accomplished with an insulation of linen and liquid insulating material ('Linex') that was neither hygroscopic nor inflammable, and which was pressed onto the harpoon shaft. Unfortunately this insulation was expensive, and accounted for about 40% of the cost of an entire harpoon (Weber, n.d. *ca* 1939?). The solution was to completely separate the shaft from the head with a non-conducting segment, rather than the earlier structurally simpler solution of covering the entire shaft with insulation.

Apparently there were problems not only with the end of the harpoon protruding from the whale's body, but also depending on the final position of the harpoon and its exposure to blood, with current leakage flowing from the head to the shaft along the flow of blood (and cf. Øen, 1983, p. 320). This problem and the

goal of finding a cheaper and simpler method of insulating the head of the shaft led Weber to develop alternatives after observations on about 300 whales killed by electricity.

Thus a mechanically resistant cover made from electrical insulating material was inserted between the head and the shaft. Its length was to be sufficient to give enough current resistance to overcome the short circuit of the head and shaft by blood flow. Alternatives included a solid, insulating shaftpiece separating fore and aft ends of the shaft. The shaft was to be covered or renewed with lacquer before each shot.

Weber explained (Norway 62699, 16 July 1938; German Reich 706343, 5 August 1938) that once the harpoon is stuck into the whale (Plate G) the current I divides into two currents on impact. Current I_1 runs through the body to the mouth of the whale thence through the water to the catcher boat. Side closing current I_2 goes through the body to the proximal portion of the uninsulated shaft in the whale, thence to the part of the uninsulated shaft outside the body and from there via water to the boat (e.g. circuit design in Fig. 2 of Plate G).

The ratio of the resistances of both circuits is 1:5, with the side closing circuit (I_2) intensity about 20% of the killing circuit (I_1) intensity. In one example given, the total current intensity is 56 amps, at 200 volts. The transitional resistance from the harpoon head to inside the whale is 3.49 ohms, by far the largest single part of the total resistance of the 5.10 ohms in the killing circuit and 0.84 ohms in the parallel circuit.

Once harpooned and apparently electrocuted, the whale might not be dead. Necessity prompted the invention of the hand killing-spear (60984, 8 August 1936). This was used if the gunner doubted that the whale was dead, or if the electric harpoon head did not penetrate deep enough and short-circuited to the water. It used a current of between 38 and 42 amps (Weber, n.d., Ms.). It was stuck in the back near the vertebral column so as to influence the spinal cord, and was alleged to kill even the largest of blue whales 'momentarily' (Weber) or in a few seconds (Reichert, 1949). (Possibly the same Captain Reichert is mentioned by Weber, n.d., Ms, as having performed or commented on firing tests of the electric harpoon at Wernigerode for the Erste Deutsche Walfanggesellschaft.) For those whales wounded by grenade harpoons and pulled alongside for administration of the coup de grace by the electrical spear, Reichert (1949) found interrupted rather than uninterrupted impulses of alternating current killed faster.

From the foregoing overview of the nature and timing of patents filed by Weber and the company, it is clear that by about 1935 (Schubert, 1949) or soon thereafter Weber believed that enough of the technical problems had been solved to begin using the system on a commercial scale. Practical considerations such as a machine to re-straighten bent harpoon shafts and re-insulate them (Bostock, 1930s–1950s) are not summarized here but indicate the technology was far along and pragmatic considerations of field maintenance were being addressed.

Results at sea were striking. The harpooned whales were instantly paralysed and rolled over on their sides with flippers and flukes above water. Within 10 seconds to two minutes, death was characterized by lowered flippers and open mouths (Schubert, 1949). The whale floated due to muscle paralysis preventing the already inhaled air from being exhaled. 'In cases with unlucky shots the whale is usually paralysed and not able to get away' (Anon, n.d., *ca* 1948) and fin whales were so susceptible that current impulses of ½–1/20 were sufficient to stun them (Weber, 1939b). Unconsciousness was thought to be characterized by a whale lying on its

side with eyes closed, no blowing. Hits above the spine were associated with the greatest muscle contractions including flexion of the trunk, but these were reduced when the voltage was increased from 160 V on older electrical plants to 220 V in newer installations (Weber, 1939b).

The first full field trials were carried out on the recommendation of the Norwegian Association of Whaling Companies (Granöe *et al.*, 1934 Ms) as part of the commercial operation of the fleet, in the season 1934/35 when a Norwegian catcher shot 212 whales killing and landing 198 (Tønnessen and Johnsen, 1982, p. 703; 200 killed but 2 sank, Schjold, 1936). These and other results were the subject of a letter from mate E. Gustavsen to Bjarne Gundersen of A/S Elektrisk Hvalskytning in Sandefjord, 10 June 1939 (Bostock 1930s–1950s):

Star XIV . . . . M.S.K. 850, H. K. Gunner Kristensen, Nesbryggen.
Season 1934–1935
Blue-whales 51, finback 87, humpbacks 60 = 198 whales, about 80% floating in the runner, used 18 Mandal forerunners, 12 breaks, 31 shot twice.

Star XIV . . . .Season 1935–1936. Gunnar Jörgensen, Onsöy, his first year as gunner.
Blue-whales 123, finbacks 61 = 184 whales, 90% floating, 31 shot twice, 14 breaks, used 17 Mandal forerunners.

Star XIV . . . .[Season] 1936–1937. Jörgensen, Onsöy.
Blue-whales 101, finbacks 117, humpbacks 2 = 220 whales, 28 shot twice, used 16 Mandal forerunners, about 90% floating whales, 15 breaks.

Star XIV . . . .Season 1937–1938. Jörgensen, Onsöy.
Blue-whales 77, finbacks 171, humpbacks 3 = 251 whales, 33 shot twice, used 16 Mandal forerunners, 90% floating, 14 breaks.

Tref III . . . .Season 1938–1939. Gunner Jacobsen, Nottaro.
167 whales electric killed. Jacobsen had a total of 228 whales, but used shell until I came on board. I checked 81 whales. Of 81 whales, 2 breaks, 6 shot twice, 77 whales floating.

Gustavsen also noted that it took only 5–10 minutes from shooting the whale to flagging it.

The results of the weekly take in the second season, with three catchers fully fitted out with the electrical system and the remainder using the exploding grenade harpoon ('granat'), were given by Weber (Bostock Papers 1930s–1950s):

'Sir James Clark Ross'
Catchings of the season 1936/37.

	Number of Whales				Calculated Whales			
	Star XIV	Star XVI	Star XXI	Average of granat boats	Star XIV	Star XVI	Star XXI	Average of granat boats
20/12-36	27	17	33	32.5	23	14.3	28.8	29.3
28/12-36	38	27	47	47	33.3	21.4	41.5	41.9
3/1 -37	55	38	65	63	48.7	30	56.5	55.5
10/1 -37	87	54	91	87	73.2	42.7	77.6	75.7
18/1 -37	116	69	116	109	92.4	52.5	93.4	91.8
24/1 -37	132x)	87	135	128	103.5	65	107	106.5

x) Dynamo damaged

During the 1937/38 Antarctic season, three of the catcher boats from the factory ship *Sir James Clark Ross* were fitted out with electrical whaling technology. These were the *Star XIV, Star XVI* and *Star XXI*. On the return to Norway, the gunner

Otto Olsen was interviewed with regard to the success of the electrical whaling system:

> I have to admit however, he says, that it did not work so well the first year [1936/37]. I just got 40 whales and had less whales than the Buoy boat. There was always something wrong. This year, however, I have managed to get 229 whales with 335 shots. That is 1,4 shot per whale. Last year the figure was 1,5. With shell harpoons the average is 2 shots per whale, and there have even been occasions when 7 shots have proved necessary to kill one single whale.
>
> . . . . . .
>
> . . . . Almost every shot kills instantly. Contrary to the shell harpoon, it does not make much difference where the whale is hit, because the electricity works practically the same wherever the harpoon hits. Many times the whale dies almost too quickly for us so we have to make a sharp turn to avoid getting into the line. But with the present whalers, which are able to make such sharp turns, there is not much of a chance that this will happen. We have also often the line on the winch, so that this goes in almost immediately the shot has gone off. (Anon, 1938.)

Other and similar testimonials appear in the papers of the A/S Elektrisk Hvalskytning (Bostock, 1930s–1950s).

The statistics of this last full season were used by Weber and others in reports from A/S Elektrisk Hvalskytning in attempts to show that the electrical method was not only more efficient in capture time but in total whales caught per boat in comparison with grenade whaling (Bostock 1930s–1950s; Anon., n.d. ca. 1948; etc.):

'Sir James Clark Ross'
Catchings of the season 1937/38

Catcher:	Gunner:	Calculated Whales	Number of Whales
X) Star XIV	Ludvig Jörgensen	182,26	248 x
X) Star XVI	William Andresen	110,19	152 x
Star XVIII	Jens Christoffersen	56,80	90
Star XIX	Ludvig Pattersen	147,49	191
Star XX	Lars Fredriksen	143,21	199
X) Star XXI	Otto Olsen	177,63	232 x
Star XXII	Anton Engeli	173,23	239
Star XXIII	Ingemar Martinsen	186,10	250
Star XXIV	Mikkal Mikkelsen	180,39	252
X) Electric		1357,30	1853
Average:			
of 3 electric boats		156,69	210,66
of 6 shell-boats		147,87	203,5

The two boats STAR XVI (electric) and STAR XVIII (shell) have first-year's gunners. If one excludes these two boats, one gets the following:

Average:		
of 2 electric boats	179,94	240
of 5 shell-boats	166,08	226,2

This last comparison only gives a fairly correct view as the shell-boats have exclusively gunners with twelve to twenty years experience. On the other hand on the electric boats only gunner Olsen on STAR XXI has several years of experience, while gunner Jörgensen on STAR XVI only had his third season as gunner.

It also ought to be taken into consideration that STAR XIV was the oldest and smallest of the catchers, and with the oldest electric equipment.

These crude statistics clearly indicate that the electrical method used on some *Star* boats[1] was the equal of the grenade harpoon used on other *Star* boats, although the meat product retained more blood. Thus, up until March 1938 about 1,900 to 2,000 whales had been killed electrically with this system (Weber, 1938). (Norwegian whalers had killed a total of 2,658 whales electrically before the war—apparently including those mentioned by Weber—Tønnessen and Johnsen, 1982, p. 703.) Weber's electrical whaling technology was cited for only 7.5% loss of whales due to breakage of the forerunner versus a 33% loss with shell-killing in the German factory fleet operating in 1938/39 (Weber, 1942 Ms). German expeditions did not whale in the Antarctic season of 1939/40 (*Norsk Hvalfangsttid.* 31(7): 120).

The views of the whalers were reinforced in another published account by a whaler experienced with Weber's system, Capt. W. Reichert (1949). Reichert gives efficiency statistics showing electrical superiority over grenade whaling, including his estimate of the average time from the hit until the boat moves on—e.g. time spent hauling the whale in, pumping with air to insure flotation, and securing alongside the vessel—of 10 min versus the 45 min in grenade whaling. 'Even in stomach shots while current loss occurs through the mucous skin of the mouth the whale dies within 2–3 min.' Best results occurred with 200 volt alternating current at an intensity of 50–60 amps. Hits in the abdominal cavity might take 120 amps (Fig. 2). The resulting whale meat was always dark due to

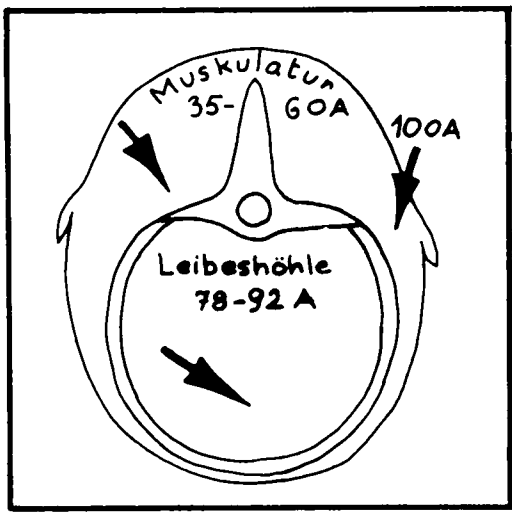

Fig. 2. Diagrammatic cross-section through a mysticete showing lethal amperage necessary for shots placed in the musculature (35–60 amps), abdominal cavity (78–92 amps) and a protruding harpoon electrode (100 amps). (Redrawn from Schubert, 1949 after Weber, 1939a.)

[1] As an aside here I note that the chiseled roman numerals XVI and XXII on some harpoons in the Hellman cache correspond to the numbers of the *Star* catcher boats. However, there is no indication in these statistics that *Star XXII* was fitted out for electrical whaling and this may be an error. The fate of the *Star* boats is not clear from the published literature available to me at this writing. *Star XIV, XVI* and *XVIII* through *XXIV* were listed as attached to the floating factory *Sir James Clark Ross* in *ca* 1939 (*Norsk Hvalfangsttid.* 29 (3):90). In the 1939–40 season, the Norwegian whaling fleet did not return home and apparently *Star XVI* did not accompany the fleet that year (*Norsk Hvalfangsttid.* 29(10): 249–53). *Star XXIII* was refitted in the Norwegian shipyard of A/S Bergens mek. Verk steder (*Norsk Hvalfangsttid.* 34(11): 179) and accompanied the floating factory *Pelagos* in the 1945–46 season (*Norsk Hvalfangsttid.* 34(10): 153). The floating factory *Thorshammer* had been obliged to use a variety of catchers in the 1945–46 season, including *Star XVI. Star XVI* had been repaired and reconverted in Halifax (*Norsk Hvalfangsttid.* 34(11): 181. The *Thorshammer* had visited Halifax 6 October 1945 and New York from the 6th to 10th of October for provisions and outfitting (*Norsk Hvalfangsttid.* 34(9): 133; and see 34(11): 175). I conject that it was at this time that the Weber electric harpoons were removed from *Star XVI*, including some perhaps mislabeled or meant for other *Star* boats before WW II. *Star XVI* and *XXIII* accompanied the *Sir James Clark Ross* subsequently (e.g. *Norsk Hvalfangsttid.* 35(10): 249, 260, 262; (11): 298; (12): 314, 334).

blood coagulation although an 'electro stimulation effect' could also result in more tender meat (Øen, 1983, p. 322). This problem may be a serious one in fisheries where the meat is the main product. Ballistic problems with the harpoon, short range, and preparation time for repeat shots were also serious problems (Øen, 1983).

The technology seems to have been successful, although whether the current passes through the brain to stun the whale in an acceptably humane manner is not certain. If the current passes through the brain it paralyses the respiratory center, and if through the heart it causes heart flutter and subsequent cardiac arrest. Lower potentials can paralyse the respiratory muscles (Øen, 1983; and see Weber, 1939a, b). The equipment moved fairly rapidly from the patent and prototype stage to field trials, then to full-scale commercial operations in which it was shown to be the equal of the competing system. Aside from the Second World War which appears to have been the major impediment to its deployment and commercial success, the question arises why did the company not develop the system further?

> The company itself declared that this was for financial reasons. The equipment for the electric method cost Kr. 40,442 per catcher and the shell method Kr. 16,219. Furthermore the electric method was more expensive to maintain (Tønnessen and Johnsen, 1982, p. 703).

A/S Elektrisk Hvalskytning made a representation to the 1946 Whaling Conference in Washington (Anon, 1946 Ms). That this technology was regarded favourably is clear from the fact that the subsequent British initiatives, e.g. with General Electric (Marsden, 1952a, b), were initially and primarily based upon the technology of A/S Elektrisk Hvalskytning (Bjarne Gundersen *in litt.* to Messrs Bugge and Krogh-Hansen, 26 October 1948, Bostock Papers) and of the cooperating company Siemens-Schuckertwerke A.G. (Anon, 1947 Ms, 1949 Ms).

The unpublished material on the electrocution of whales, the competition and cooperation between national groups, commercial firms and individuals to devise a workable and acceptable method, and the role electric whaling played in the pre- and post World War II eras remains virtually untouched. It merits study and interpretation.

ACKNOWLEDGEMENTS

I thank Mrs Gisela von Hoyningen Huene for aid and encouragement in the translation of German papers and patents, Elizabeth Cooke for finding patents in the Holborn Reading Rooms of the British Library, Nick Carter of the International Society for the Protection of Animals, Douglass Fonda and A. W. Craig of the International Marine Archives for a copy of and access to the Bostock Papers (the microfilms of which are now under the care of Virginia Adams of the Old Dartmouth Historical Society), A. Evely for technical aid, Tom Garrett for references, Klaus Barthelmess for calling the Peters photograph to my attention, and Bob Hellman whose request for an evaluation of the cache of harpoons led to this inquiry. Finally thanks to Greg Donovan for patience above and beyond the call of duty.

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Table 1. Listing of some patents on electrical whaling issued to A/S Elektrisk Hvalstytning and/or A. Weber. The first two Norwegian patents were to Elektrisk Avlivning av Hval, which we assume to be an earlier name for this company.

NORWAY		ENGLAND		GERMANY	
Patent no. Date	Title	Patent no. Date	Title	Patent no. Date	Title
50485 28 Feb 1929	Harpun til brek ved elektrisk avlivning av hval og andre sjodyr.				
51371 27 May 1929	Stomslutningsanordning ved elektrisk avlivning av hval og andre sjoder.				
53344 3 Apr 1929	Harpun til avlivning av hval og andre havdyr ved elektrisk strom.				
53345 25 May 1929	Line til bruk ved elektrisk avlivning av hval og andre sjodyr.				
53460 31 May 1932	Utforelsesform for stalvire for hvalskytning.				
53532 25 May 1929	Harpun til avlivning av hval og andre havdyr.				
53887 8 Nov 1932	Innkoblingsanordning for strommen ved elektriks avlivning av hval.	407,647 8 Nov 1933	Switching arrangement for the current in the killing of whales by electricity.	609823 8 Nov 1933	Vorrichtung zum einschalten von elektrischem strom auf harpunen zum elektrischen töten von walen.
53888 8 Nov 1932	Stromslutningsanordning ved elektrisk avlivning av hval.	409,606 8 Nov 1933	Circuit closing arrangement for the killing of whales by electricity.		
54796 11 Jun 1932	Bremseanordning for harpuner.	408,831 10 Jun 1933	Braking or stopping device for harpoons.	627767 9 Jun 1933	Bremseinrichtung für harpunen.
54797 11 Jun 1932	Bremseanordning for harpuner.	407,846 10 Jun 1933	Braking or stopping device for harpoons.	628411 9 Jun 1933	Harpune.

Table 1 (*cont.*)

54840 9 Nov 1932	Anordning til a forebygge ulykker ved stromstot ved betjening av harpunkanoner for elektrisk avlivning av hval.	407,648 9 Nov 1933	Safety arrangement for use in the killing of whales by electricity.	607180 9 Nov 1933	Einrichtung zur Verhütung von unfallen durch elektrischen schlag bei der bedienung von harpunenkanoner.
55057 5 Sep 1931	Harpun til elektrisk avlivning av hval.	379,267 25 Jun 1932	Harpoon for the electric killing of whales.		
55243 4 Feb 1933	Anordning ved bremser for harpuner.				
56350 2 Jul 1929	Line til bruk ved elektrisk avlivning av hval.				
57560 8 Jul 1931	Anlegg for elektrisk avlivning av hval.	380,422 25 Jun 1932	Installation for the electric killing of whales.		
57561 26 Apr 1933	Koblingsanlegg for elektrisk avlivning av hval.	417,037 26 Apr 1934	Installation for the electric killing of whales.	631702 27 Apr 1934	Schaltanlage zum elektrischen töten von walen.
58657 22 Jul 1933	Anordning for losbar forbindelse av den elektriske leder i en hvalline med kraftkilden.	427,166 15 Jan 1935	Improvements in or relating to the releasable connection of the electrical conductor of a whale line with a source of current.		
58694 30 Nov 1935	Anordning for bestemmelse av beliggenheten av et ledningsbrudd i en isolert ledning.				
60399 30 Nov 1935	Anordning ved forlopere med innlagt elektrisk leder for elektrisk hvalskytning.	467,009 30 Nov 1936	Improved forerunner with inlaid electric conductor for electric killing of whales.	673564 1 Dec 1936	Harpunenseil mit eingelegtem elektrischem kabel.
60984 8 Aug 1936	Fremgangsmate og innretning til bruk ved elektrisk avlivning av hval.				
62699 16 Jul 1938	Harpun for elektrisk avlivning av hval.			706343 5 Aug 1938	Harpune zum töten von walen mittels elektrischen stromes.

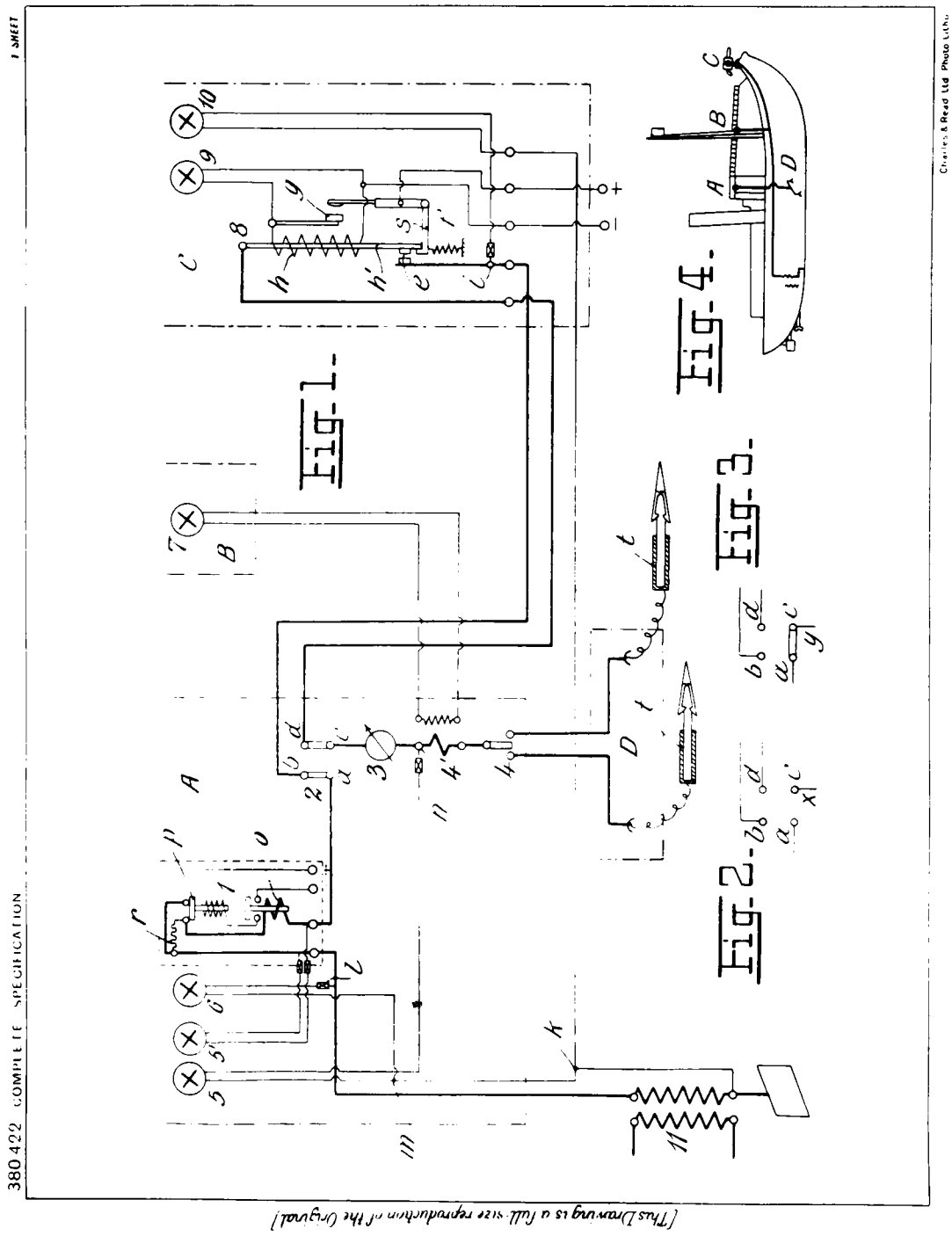

Plate A. An early version of the aboard-ship electrical installation developed by Albert Weber and A/S Elektrisk Hvalskytning (UK Patent 380422, cf. Table 1). Part A included the current limiter, transformer and switches, and Part D was in the fore-hold of the catcher (see text for details). Subsequent improvements and modifications resulted in a workable sea-going plant by *ca.* 1936. Some of the experimentation after WW II apparently owes much to this technology (e.g. Anon, 1947 Ms).

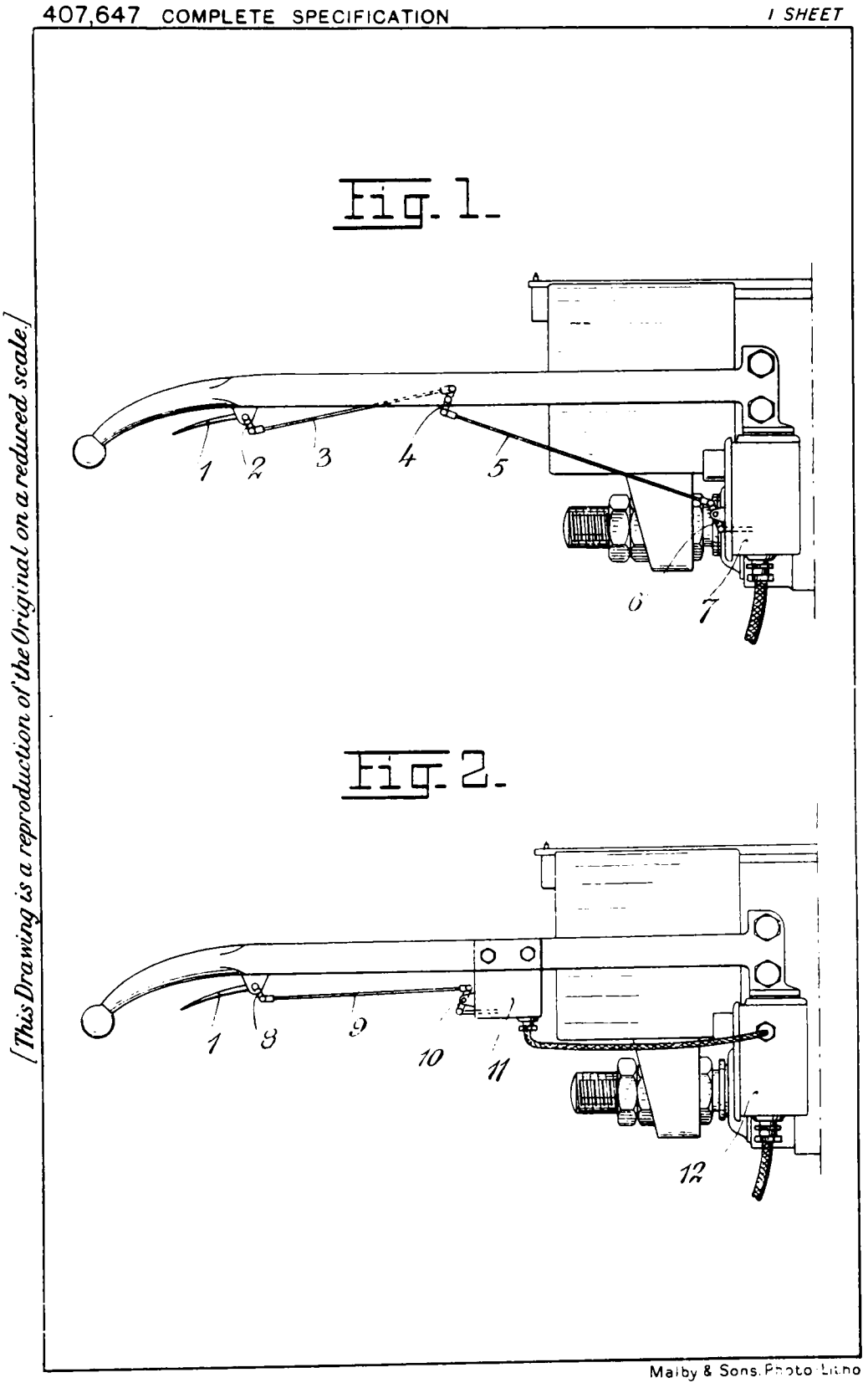

Plate B. Two versions of a switching arrangement at the trigger of the standard Kongsberg 90 mm harpoon cannon to protect the gunner from accidental shock (UK Patent 407647, cf. Table 1). In Fig. 1, a system of levers (2–6) transmits the action of the trigger to a relay box (7) which switches on the current to the harpoon. In Fig. 2, a second relay box (11) is inserted between the trigger (1) and the relay box (12). Other patents used the recoil of the cannon to effect the switching on of the current. Photographs by R. Hellman.

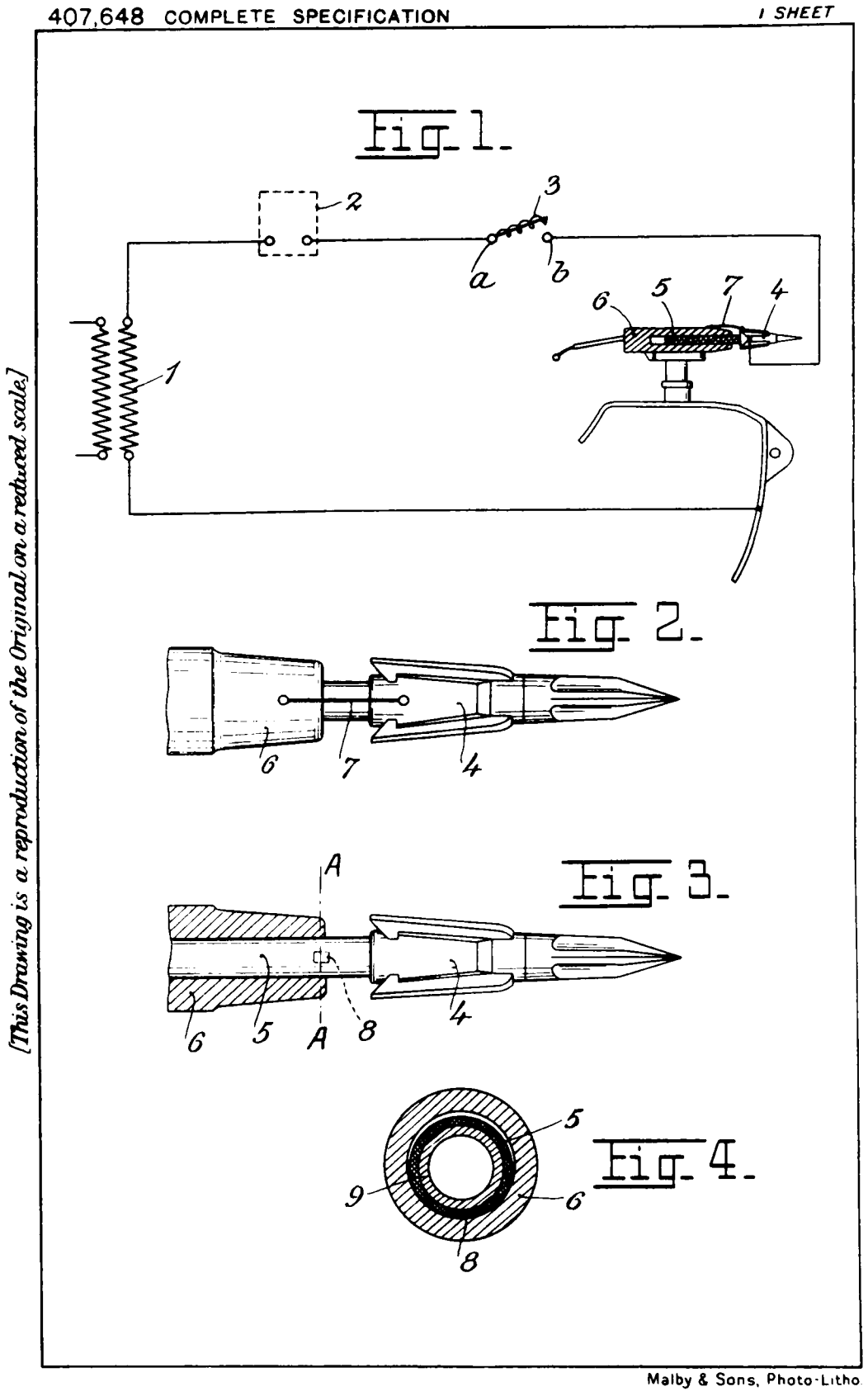

Plate C. Another method of insuring gunner safety (UK Patent 407648, cf. Table 1). In Fig. 1, the harpoon is loaded in a cannon connected to an electrical current but the switch is open. If the switch should be accidentaly closed before firing the harpoon, a short-circuit prevents injury to the gunner. The harpoon is short-circuited to the cannon by means of a wire (Fig. 2) or a metal plate or ring (Figs 3–4, detail 8) attached to the shaft and replacing a small part of the insulation which contacts the bore of the cannon.

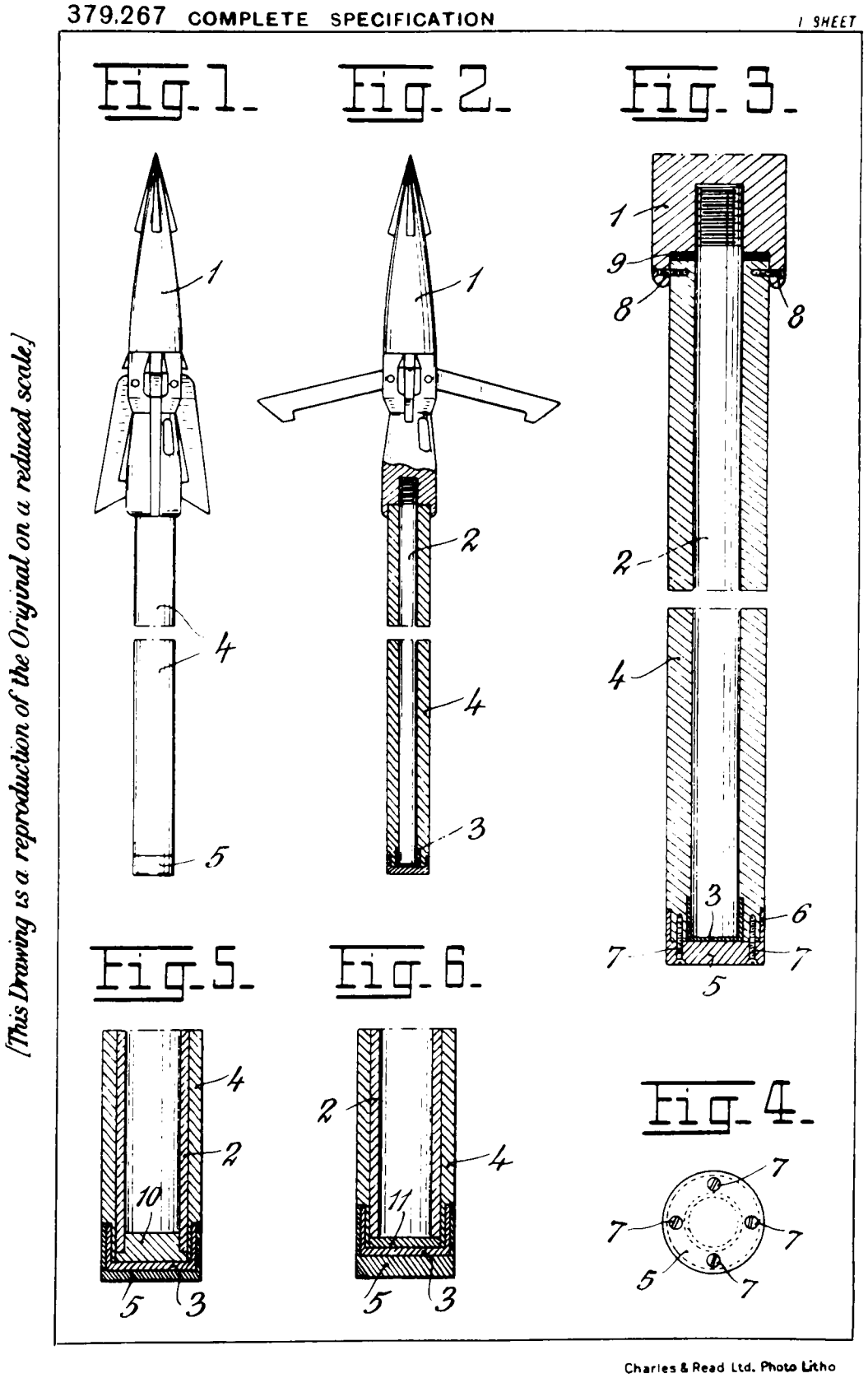

Plate D. The basic patent (UK Patent 379267, cf. Table 1) for the Weber electric harpoon. The shaft is insulated with a cylinder of insulation material (4) and with a socket of insulating material such as bakelite (3) capped with a metal disk (5) held in place by screws (7). At this time the insulation on the shaft could be wood, linoleum, celluloid or other material, but later 'Linex' was used (see text).

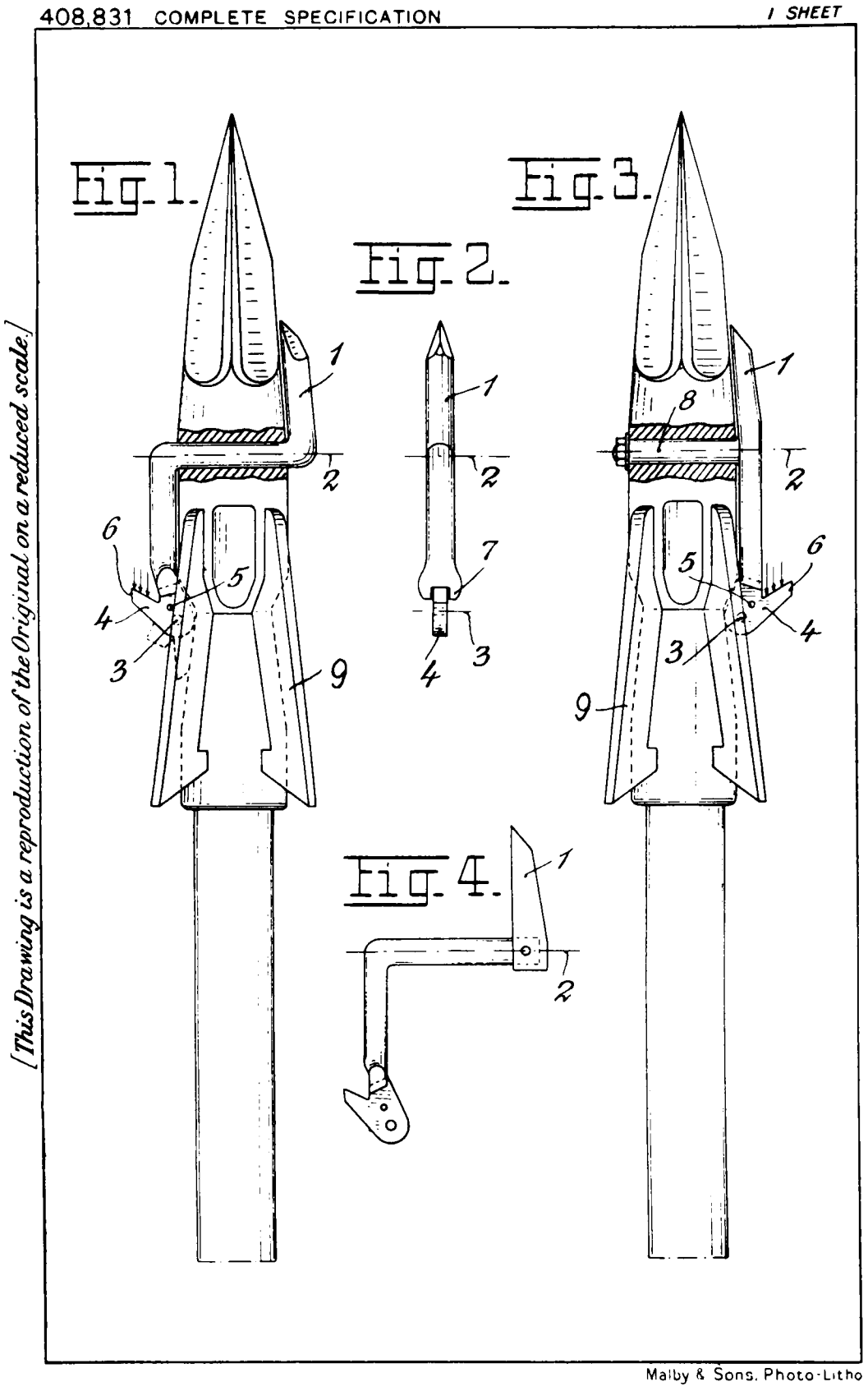

Plate E. One version of the brake, a stopping device to prevent the harpoon from penetrating completely through the whale (UK Patent 408831, cf. Table 1). The braking member (1) rotates in a transverse hole through the head around axis (2). It is released to swing around crosswise to the direction of harpoon travel by the action of a projection (6) on a disk (4) striking the body of the whale and rotating the disk, releasing the braking member.

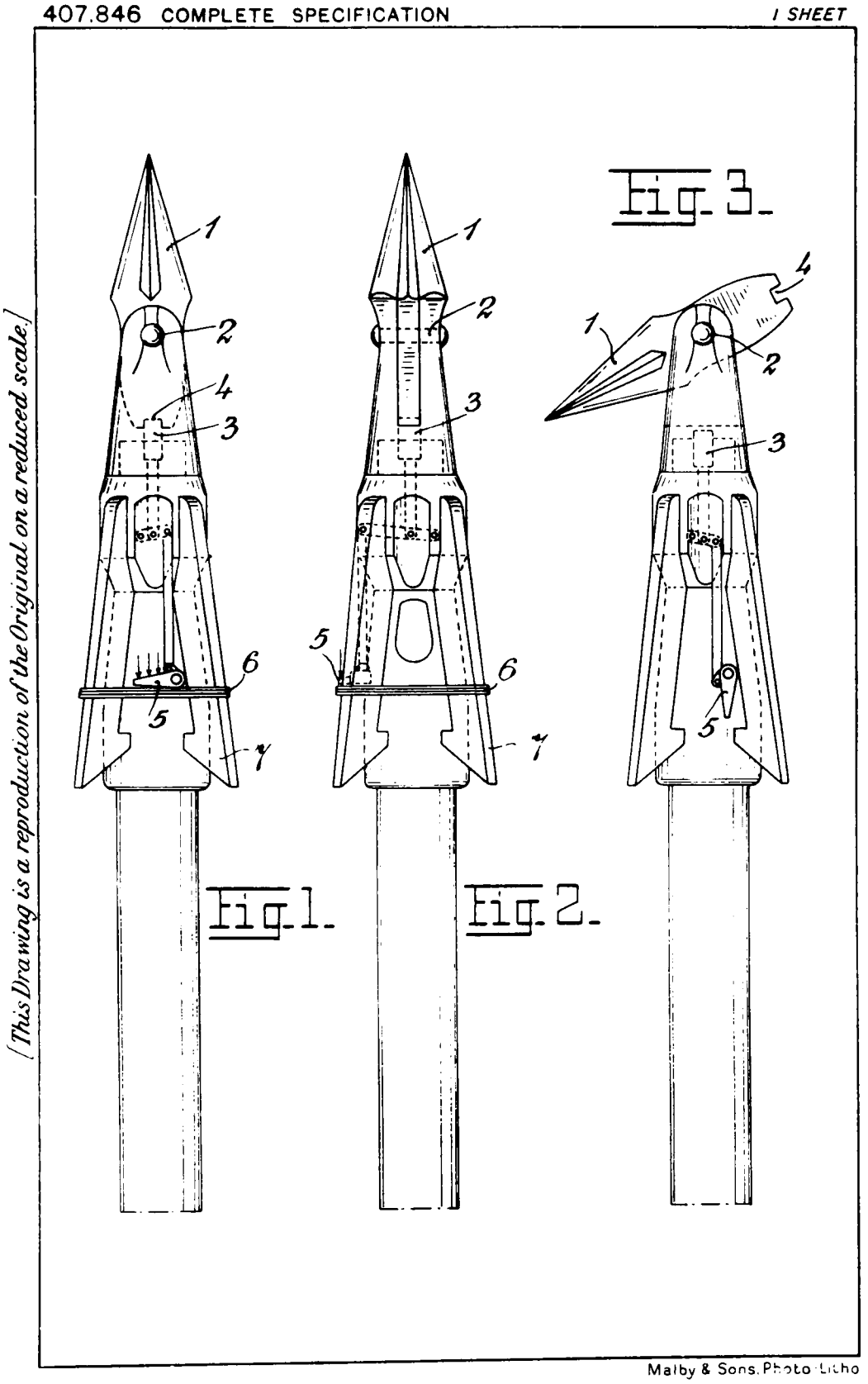

Plate F. Another and apparently the more successful version of the brake (UK Patent 407846, cf. Table 1). The tip of the head was hinged on a pin in a transverse clevis. It was unlocked by the action of lashings (6) being burst on impact with the whale, releasing lever (5) and thus the locking bolt (3).

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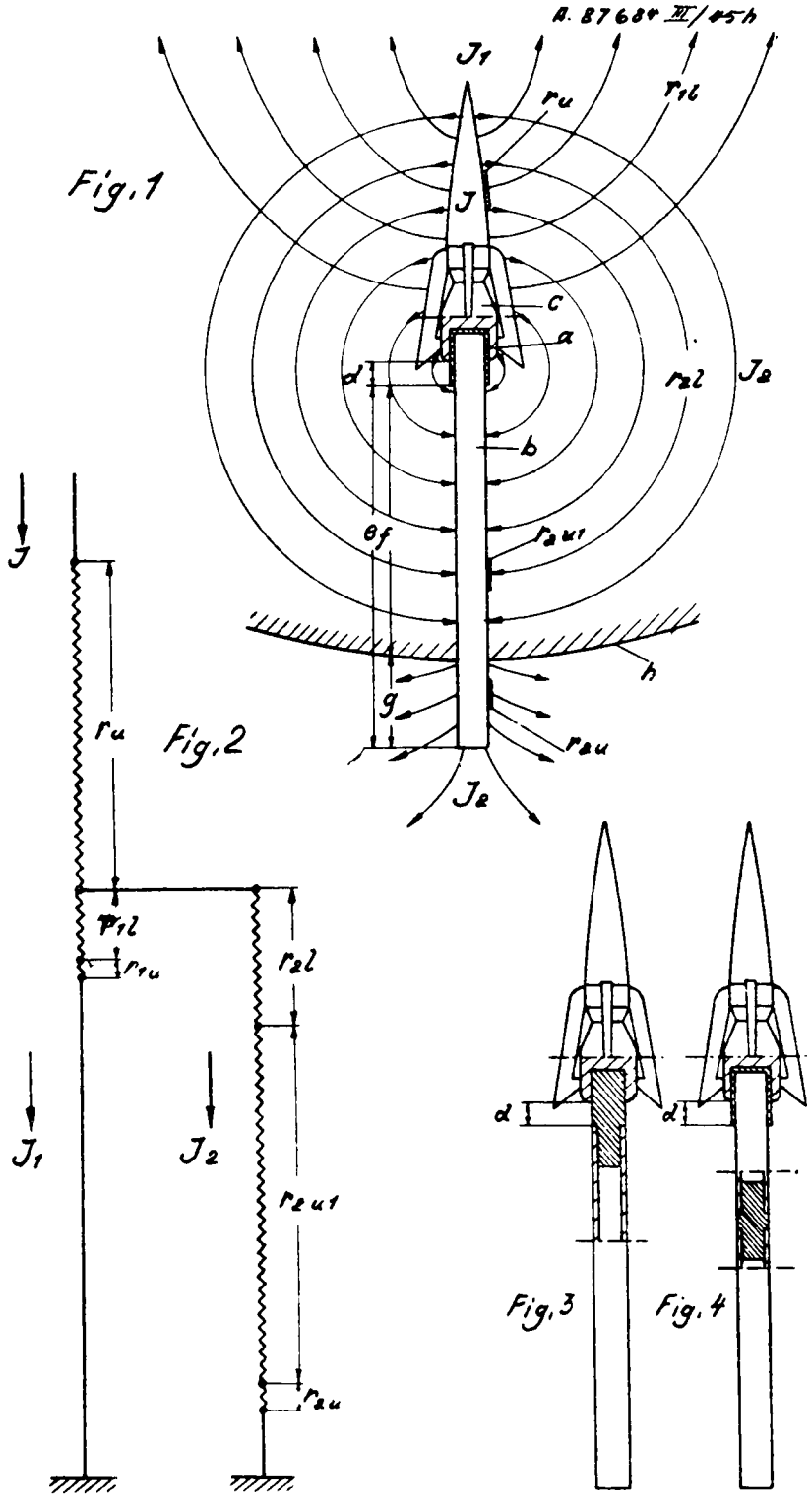

Plate G. Two electrical currents resulted once the harpoon was implanted in the whale. In the example illustrated (German Patent 706343, cf. Table 1), the current I divides into the killing current I_1 which runs through the body to the mouth and through seawater to the vessel; and side-closing current I_2 which goes to the proximal portion of the uninsulated shaft, then to the part of the shaft protruding and via seawater to the boat (circuit design in Fig. 2, see text). Note the two variations of the plug or insert in the partially insulated shaft illustrated in Figs 3–4.

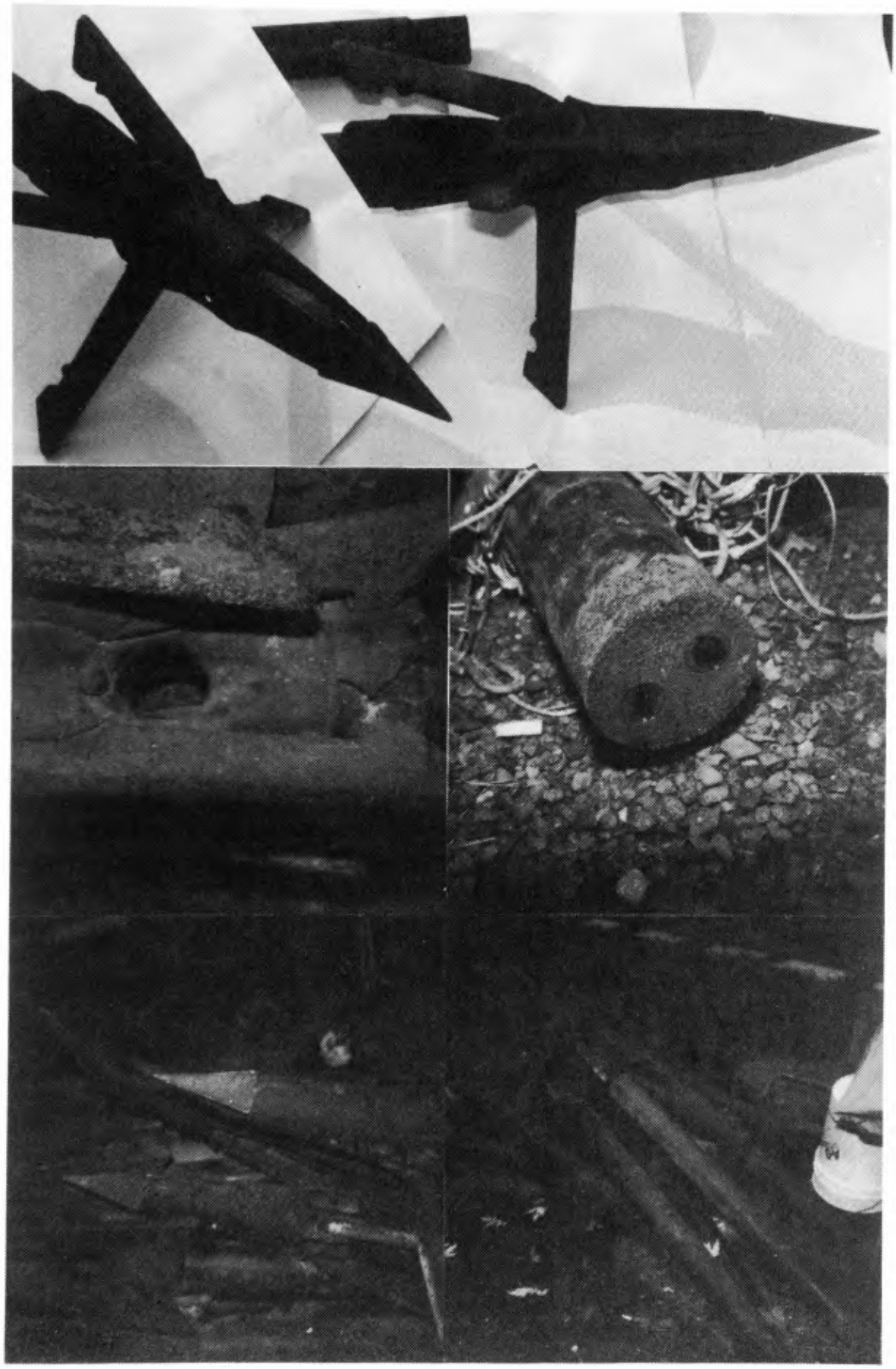

Plate H. Photographs of the Hellman cache of Weber electric harpoons. Presumably this represents a late version of the harpoon. Note the two screws, instead of four, in the disk on the end of the shaft, and the extra bump or process on the inside tip of the flukes. The tip of the head appears to have flat surfaces and sharp edges as opposed to the 'fins' on some earlier versions. (The fossa and set screw for connection of the cable may be one of the Siemens patents not discussed in this paper.)

Plate I. Photographs of a Weber harpoon in Robert Hellman collection. Top four side views each from aspect 90 degrees from adjacent view(s). Bottom two details of head showing brake and flukes or claws in position before shooting, and with brake rotated and claws extended as after a hit. Photographs by Luigi Pellettieri.

APPENDIX 2

The International Whaling Commission and The Humane Killing of Whales, 1982–1986

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INTRODUCTION

The purpose of this paper is to bring up to date, in a chronological manner, the history of the International Whaling Commission's involvement in the subject of humane killing techniques begun by Mitchell, Reeves and Evely in their introduction to the bibliography section of this volume. As many of the references are unpublished and are too recent to have been included in the Bibliography section, I have summarised them in some detail in this paper. At the start of the 1982 series of IWC meetings the situation was as follows.

(1) The ban on the use of killing whales in commercial fisheries using the cold grenade (i.e. non-explosive grenade) harpoon (IWC, 1981) had been extended to include minke whales from the beginning of the 1982/83 pelagic and 1983 coastal seasons

The extension of this prohibition to minke whales (IWC, 1982) was more significant than the original prohibition which had excluded them. This becomes apparent when the number of countries lodging formal objections[1] to the respective bans is considered. Only the Republic of Korea had objected to the original ban since all other whaling operations for species other than minke whales already used explosive grenade harpoons. However, the extension to include minke whales caused formal objections to be lodged by Brazil, Iceland, Japan, Norway and the USSR, i.e. all commercial operations which took minke whales apart from, paradoxically, the Republic of Korea, which had also withdrawn its objection to the earlier ban (although it continued to use non-explosive harpoons).

The objecting countries explained their position in terms of practicality not principle. While they supported the view that alternatives and improvements to the non-explosive harpoon were needed, they believed this to be impractical within the given time frame. Minke whales are relatively small whales and it was technically difficult to develop a fuse which would explode within the whale and an explosive which would rapidly kill the whale but not destroy too much of the meat, particularly when crew safety on both the large and small vessels used in these

[1] Under the International Convention for the Regulation of Whaling, 1946, any member nation of the IWC has the right to lodge an objection to any regulatory decision taken by the Commission, within a prescribed period (initially 90 days); the regulation is then not binding upon that nation unless or until it withdraws that objection.

fisheries was taken into account. They indicated that considerable effort was being expended to improve the current methods.

(2) The Workshop on Humane Killing Techniques for Whales held in 1980 (IWC, 1980, well summarised as entry 210 in the 'Bibliography' section of this volume) represented a major IWC initiative on humane killing

The Commission had noted the contents and recommendations of its report, particularly with respect to improvements of non-explosive grenade techniques, field research into behavioural indicators of unconsciousness and death and the physiological mechanisms of various killing techniques.

Before proceeding it will probably be helpful if I give a simplified explanation of the way in which the Commission works. Each year a series of meetings are held. The first of these is the meeting of the Scientific Committee. Its report and recommendations are submitted to the Technical Committee. After the Scientific Committee meeting has been completed and before the Technical Committee commences, a series of other working groups or sub-committees on a variety of topics may meet. Two of particular relevance to this paper are the Working Group on Humane Killing and the sub-committee on aboriginal subsistence whaling.[1] These both report to the Technical Committee. The decision-making body of the IWC is the Commission, meeting in Plenary session, which comprises one Commissioner from each member nation (who has a vote) accompanied by his/her group of advisers. In practice the composition of the Technical Committee is identical to that of the Plenary. The major difference is that recommendations to the Plenary by Technical Committee require only a simple majority of votes cast—regulatory decisions in the Plenary require a 3/4 majority of votes cast (although Resolutions require a simple majority). In effect therefore the Technical Committee is a 'test' of opinion to give an idea of whether negotiations are needed before discussing matters further in Plenary.

1982 IWC MEETINGS

Scientific Committee

The item 'Humane Killing' had been on the Scientific Committee's agenda since 1976 when the matter resurfaced within the Commission, having been little discussed since the late 1950s. In 1982, Norway (Øen, 1982; 1983a), Japan (Kano and Hasui, 1982) and the USSR (Golovlev, 1982) submitted progress reports on their research to the Scientific Committee. Norwegian studies had comprised a review of literature on suggested techniques leading to field work on the most promising.

Øen (1983a) reviewed electrical whaling literature and concluded that while certain theoretical arguments existed to suggest it may be a suitable approach to follow in developing a more humane method for killing whales, technical considerations suggested that it was not worthy of pursuing further. In addition the 1980 Workshop (IWC, 1980) had raised questions as to the 'humaneness' of electrocution.

Øen (1982) reported on Norwegian studies during the first half of 1981. Literature reviews suggested that development of explosive harpoons and use of

[1] This sub-committee has been variously known as aboriginal/subsistence and aboriginal subsistence. In the text I use the latter for consistency.

high velocity projectiles warranted further study whereas electrical methods (see above) and the use of drugs did not appear promising. Preliminary field results showed that position of hit (whether for explosive or non-explosive grenade harpoons) was the most important factor in time-to-death. Work on high velocity projectiles, a CO_2 harpoon and ballistic trials on a modified harpoon head would be undertaken in 1982.

Kano and Hasui (1982) reported on Japanese experiments with grenade harpoons which used the explosive 'penthrite' rather than the more conventional 'black powder'; the former is over six times more powerful. Safety problems appeared in association with the development of a triggering mechanism which would ensure detonation inside the whale. Only about half of the 298 firings successfully detonated within a whale, the rest either exploding before impact (3%), after passing through the whale (27%) or not detonating at all (17%). For those animals for which detonation took place inside the whale, the mean time to death was 2 min 5 s (40% died instantly) whereas for the rest the mean time was about twice that (4 min 4 s; 10% died instantly). Future work would try to improve all safety aspects and try to increase the success rate of detonations within the whale.

Golovlev (1982) discussed Soviet experiments during the 1981/82 season using a 90 mm cannon (the Japanese fishery uses a 75 mm cannon and the Norwegian fishery a 60 mm cannon). He found that in almost all cases (only once did the first harpoon detonate inside a whale) the harpoon passed through the whale. Not surprisingly perhaps, in view of this, a comparison of death times for whales killed using an explosive grenade and those with a non-explosive grenade (both using an electric lance to deliver the coup de grâce) was not significantly different (about 5 minutes). As he had in an earlier study (Golovlev, 1955), and as had Øen (1982) and Kano and Hasui (1982), the author drew attention to the importance of a correctly placed shot. He concluded that he believed improvements in the development of electric lances to be the most profitable way to improve death times.

The Japanese and Norweign papers in particular provided considerable technical detail on harpoon/grenade design etc. The Scientific Committee agreed that it did not have the required expertise to discuss these documents adequately and recommended that the Commission set up a working group of experts to examine this and any other such work (IWC, 1983a). Much to its relief, I suspect, 'Humane Killing' was no more to appear on the Scientific Committee's Agenda.

Technical Committee/Commission (IWC, 1983b)

The Commission noted the Scientific Committee's recommendation concerning the establishment of a working group of experts which it was agreed would meet prior to the 1983 Annual Meeting.

It also passed by consensus (with reservations by those countries who had lodged objections to the ban on the use of non-explosive harpoons) a Resolution (IWC, 1983b, p. 38) which called on those nations who had objected to the ban on the use of non-explosive harpoons to comply with the ban. The irony of a Resolution which was agreed by everybody except the people it was aimed at was not lost upon the Japanese delegation. However, a proposal made by the United Kingdom in Technical Committee for a Resolution effectively asking countries to withdraw

their objections as soon as possible was considered equally inconsistent by those nations who had voted for the original regulation implementing the ban.

1983 MEETINGS

Report of the Working Group on Humane Killing (IWC, 1983)

Three new papers, outlining further progress in the research carried out by Norway, Japan and the USSR, were presented to the Working Group.

Øen (1983b, c) reported on progress in the Norwegian programme. Death time data were collected for 1981 and 1982. Instantaneous death was recorded for about 22% of animals and the median death time was about 10 minutes. In almost 90% of cases the harpoon passed directly through the whales. Problems in determining precisely the moment of death had already been noted (IWC, 1980) and Øen stressed that the criteria he adopted (cessation of movement, relaxation of flippers and mandible, all only visible after the whale has been brought close to the vessel) probably would overestimate actual death times but would enable the data to be used for comparative purposes.

Studies on high velocity projectiles (20 mm projectiles fired at 1,050 ms^{-1} using a naval gun) were continued but experiments revealed that while a certain design of bullet (some fragmented on impact with bone) accurately placed in or near the central nervous system can result in instantaneous death, such accuracy is difficult to achieve under whaling conditions. In practice a whale must be harpooned before shooting in order to prevent it sinking and improvements to harpoon/cannon technology in combination with a coup de grâce given by a rifle seemed a more productive approach than high velocity projectiles.

In addition to this work Norway had carried out field experiments based on the Japanese work with penthrite. Although initial attempts to modify Japanese systems based on 75 mm harpoon guns to the 60 mm Norwegian system met practical problems, they indicated that with further design work, a penthrite grenade would be an efficient and humane way of killing minke whales. Such refinements were planned for 1983/84.

Results of the Japanese programme were given in Anon. (1983). Between 1980/81 and 1982/83 Japan had spent US$372,000 on developing suitable explosive grenade harpoons. In the 1982/83 season in the Antarctic, only explosive harpoons had been used (1,180 penthrite; 2,753 black powder). Average death times for the three methods used (non-explosive harpoons 4 min 2 s; black powder harpoons 3 min 10 s; penthrite harpoons 2 min 38 s) revealed the achievements of the programme. Work was continuing to adapt the 'Antarctic' technology to the smaller vessels in the coastal fishery and it was expected that only penthrite harpoons would be used by the 1983/84 Antarctic and the 1984 coastal season.

Golovlev (1983) discussed Soviet experiments in 1982/83. In an attempt to improve the proportion of whales for which the grenade exploded inside the body, the black powder charge was reduced from 210 g to 180 g or 150 g but the results were poor, and mean death times were not significantly different between explosive and non-explosive harpoons (about 4 min). The author noted that up to 14% of the body weight of meat was rendered unsuitable for human consumption when explosive harpoons were used.

The Working Group discussed the three papers and in particular praised the progress made by Japan. It noted that the use of 90 mm cannons and black powder

probably led to the high meat loss in the Soviet experiments. Depending on amounts of penthrite used, Japanese experiments showed meat damage of only 1.6–2.2%.

There was some discussion on the importance of accurate shooting irrespective of the harpoon technology involved and although it was apparent that hits in the head region were most effective, it was recognised that such shots were not always practical under whaling conditions.

The Working Group made several recommendations to the Technical Committee of the Commission and hence the Commission and these are discussed below.

Technical Committee/Commission

The Commission noted the Report of the Working Group and endorsed its recommendations as follows (IWC, 1984a, p. 26):

(1) That electrical harpooning, the use of drugs and of high-pressure gases are not at present suitable methods for killing minke whales and the Commission recommends that they continue not to be used at this time.

(2) The whaling operations using electrical lances to kill harpooned whales should provide the Commission with information on the time elapsing between application of the electric current and death, together with information on the pathways of the current through the animal's body.

(3) The Commission invites Contracting Governments to submit the relevant information from their legislation which they think may be helpful as a guide to the Working Group in setting goals for the humane killing of whales.

(4) The Commission draws attention to the fact that it is desirable that appropriate experts be brought by Contracting Governments to such Working Group meetings and that provision be made for invited experts also to attend.

(5) The Commission draws attention to the advantages of penthrite grenades in reducing the time to death and loss of meat, and suggests that the USSR whaling operations consider their use.

(6) The Commission noted that there are possibilities for improvements in both the training of gunners as well as research on new improved sighting mechanisms and encourages their development.

The Commission also agreed that the Working Group should meet prior to the next Annual Meeting. Its terms of reference were extended to include: humane killing in aboriginal subsistence whaling (as recommended by the Scientific Committee in 1981—IWC, 1982b); and a review of a study to be carried out in summer 1983 on the humane killing of large whales in Iceland (supported by the Scientific Committee in 1981—IWC, 1982b).

1984 MEETINGS

Report of the Working Group on Humane Killing (IWC, 1984b)

Alternatives to non-explosive harpoons in minke whaling

Øen (1983c, 1984a) reported on considerable progress in the development of a suitable penthrite grenade for the Norwegian fishery. Two grenade types had been developed and Øen (1984a) discussed and illustrated the modifications to the head and the grenade (and in particular the detonating mechanism). Preliminary results from the 1984 season were very promising—of 29 animals observed over 80% (24) were recorded dead or unconscious instantly. Malfunctions only occurred in Type I

grenades and it was likely that only Type II grenades would be used in the coming season. In addition to these technological advances a programme of training for gunners had been instituted.

Japanese experiments during the 1983/84 Antarctic and 1983 coastal seasons were described in Anon. (1984). Improvements were made to prevent premature detonation (the most serious danger to personnel). Three different penthrite grenade designs/specifications were used (described and illustrated in the paper). The main problem encountered was the continuing high percentage of grenades failing to detonate (almost 20% in 1983/84) and future work would concentrate on detonating mechanisms. Only explosive grenades were used in the 1983/84 Antarctic fishery and experiments in the coastal fishery in 1983 made it likely that only explosive harpoons would be used in that fishery in 1984. The paper also provided data on the use of electric lances in the fishery in response to the Commission's request last year. Two lances are applied (100V, 5–6A, 15–20 s bursts) to the body of those whales not killed instantly by the harpoon. The position of placement of the lances varies with practical circumstances but in most cases whales are killed within one minute of current application, even if the lances are not placed in the ideal location (one just behind the head, the other near the heart).

Golovlev (1984) reported on Soviet experiments in 1983/84. No progress appeared to have been made with the detonation problem—all 69 harpoons passed through the whale before exploding. However, improvements in electrical killing (two lances are used, one on the body of the animal, one in water) had resulted in a decrease in average killing times from 5.4 min (in 1980/81) to 3.5 min (in 1983/84).

For the first time a report on Brazilian experiments was submitted (Saito and Sato, 1984). In November 1983, nine grenades were modified to incorporate an 'immediate detonation friction-fuse' designed by a gunner at the Brazilian whaling station (and illustrated in the report). Five of the nine detonated correctly, three prematurely and one not at all.

In discussion of these papers the Working Group commended the progress of the Norwegian and Japanese studies and drew the attention of their work to Brazil the USSR. In particular the group was interested in more details on the technical problems the USSR reported verbally concerning the use of penthrite.

Results of experimental work in Iceland

The 1980 Workshop on Humane Killing Techniques (IWC, 1980) and the IWC Scientific Committee (IWC, 1982b) had recommended that behavioural observations on whales being killed be carried out in conjunction with subsequent post-mortem analyses. A study of this nature, part-sponsored by the IWC, was carried out in Iceland in July 1983 (Lambertsen and Moore, 1984). Observations and post-mortem examinations of 19 fin whales were made during normal whaling operations. The fishery uses a 90 mm cannon firing a 70 kg harpoon with a 10 kg fragmentary grenade containing 0.65 g black powder. If a secondary 'killer' harpoon is needed a 40 kg harpoon with the same grenade is fired into the head at close range.

Lambertsen and Moore (1984) provided information on each whale caught and used a combination of behavioural and post-mortem data to estimate 'time to terminal consciousness'. A comparison of this with the purely behavioural 'time of terminal movement' revealed that the latter tended to overestimate the former (medians 2 min vs 3 min; means 3 min 42 s vs 5 min). However, they concluded that

the only consistent behavioural feature which could be recorded for comparative purposes was that of cessation of movement.

In discussion of the report in the Working Group it was agreed that the study had considerably improved understanding of the killing process. Although a biased estimator, the group recommended that as a practical field measurement, cessation of movement be recorded as the criterion for death, and that this should be determined by direct observation of the whale at the surface (Lambertsen and Moore had observed that behaviour of the harpoon line provided some indication as to cessation of movements but there are interpretational problems associated with this).

Arising out of discussions on this paper and those on minke whaling the Working Group also recommended that, as a result of the skewed frequency distributions of time to death, future reports should contain the following summary statistics:

(1) median time to death;
(2) time by which 90% of the animals die;
(3) maximum recorded time to death.

Other business

No responses to the requests for information on humane killing in aboriginal subsistence whaling had been received. The Working Group outlined the type of information it would like to receive the next year including: time from strike to landing; time to death; weapons used; description of nature and extent of injuries, etc.

Two nations had responded to the request made by the Commission the previous year with respect to national legislation (Iceland and Japan). Although this provoked little discussion the Working Group agreed that it was 'useful' to get information from as many Governments as possible.

Technical Committee/Commission (IWC, 1985a)

There was relatively little discussion of the Working Group report in either the Technical Committee or the Commission. The Commission agreed to ask for information on aboriginal subsistence fisheries and national legislation and endorsed the recommendation concerning the presentation of summary statistics.

1985 MEETINGS

Sub-committee on aboriginal subsistence whaling

The Working Group on Humane Killing did not meet in 1985 but the question of humane killing in aboriginal subsistence fisheries was discussed by the above sub-committee of the Technical Committee (IWC, 1985b).

The USA (Anon., 1985) provided a description of the techniques used in the bowhead whale fishery and reported on a programme to improve the weapons used being undertaken by the Alaska Eskimo Whaling Commission. These weapons are essentially those of 19th century whalers. Initially the harpooner throws a hand-held harpoon ('darting gun') into the whale. This attaches a line and float to the whale and also includes an explosive projectile. After this the 'gunner' shoots additional explosive projectiles (different from those of the darting gun) into the whale.

The improvements described included the substitution of black powder for smokeless powder to increase 'lethality' and the improvement of the fusing mechanism to reduce failure rates. It was stated that further work would be undertaken.

Helms, Hartz and Kapel (1984) reported that in Greenland, fin, humpback and some minke whales are taken by small fishing boats using 50 mm cannons and non-explosive harpoons; other minke whales are taken collectively using hand-harpoons, bladder floats and high powered rifles for killing the animals.

The Soviet fishery has chartered a catcher boat since 1969 (Ivashin and Mineev, 1981) which is equipped with a 90 mm cannon and explosive harpoons.

No information on death times was provided for any of the operations.

The sub-committee recommended that the Humane Killing Working Group examine and report on killing methods in aboriginal subsistence fisheries in conjunction with affected aboriginal people for the 1986 meeting.

Technical Committee/Commission (IWC, 1986)

In addition to accepting the report and recommendations of its aboriginal subsistence sub-committee, the Technical Committee examined three other items concerning humane killing: national legislation; Norwegian minke whaling; and the Faroese pilot whale fishery.

A further five countries submitted national legislation in accordance with previous years' requests but this provoked little discussion other than the general comment that all the legislation effectively 'called for animals to be killed as quickly and painlessly as possible, causing the minimum of suffering'. This year there was no request to try to obtain details of legislation from the remaining member nations.

Øen (1985) again reported on progress in the development of an explosive grenade harpoon for the Norwegian minke whale fishery. The 1984 experiment revealed Type II grenades to be less prone to detonation failure than Type I grenades (this was in accord with the preliminary results given by Øen, 1984a). Including data for malfunctioning harpoons, 68% of the animals were dead or unconscious within 1 min, 90% within 15 min and the median time to death was under 20 s (note these are likely overestimates—see discussion above). Improvements in shooting accuracy (including sighting equipment) and catching routine, as well as exclusive use of Type II grenades would be introduced in 1985.

In view of the success of its programme Norway announced the withdrawal of its objection to the ban on the use of non-explosive harpoons.

In Technical Committee the UK spoke of its concern over the Faroese pilot whale fishery (which had been given publicity in the British press during the time of the meeting) including the method of killing and suggested that the latter might be examined by the Humane Killing Working Group.

There had been (and still is) a continuing unresolved dispute within the IWC as to whether the Commission has the legal authority to regulate or even discuss 'small cetaceans' of which the pilot whale is one (despite the lack of any 'official' definition of small cetacean it is generally taken to include all cetacean species except rorquals, humpback, gray, right and sperm whales). In addition to this the USSR has consistently stated its view that consideration of humane killing is outside the terms of reference of the Commission. It is therefore perhaps a little surprising that Denmark, while reiterating its belief that the IWC was not

regulate small cetacean fisheries, agreed that the matter be examined by the Humane Killing Working Group; a view which was shared by the full Commission.

During a discussion of 'Any Other Business' a Resolution was introduced by St Lucia, which, after considerable discussion, was modified and adopted by consensus (with the reservation of the USSR for the reason given above). This effectively urged the prompt adoption of more efficient and humane methods of killing whales in certain (unspecified) aboriginal subsistence fisheries.

1986 MEETINGS

Report of the Working Group on Humane Killing (IWC, 1986b)

The Working Group discussed fisheries from three areas: Alaska; Greenland; and the Faroe Islands, and I deal with each in turn here.

Alaskan bowhead whale fishery

The USA (Anon., 1986) expanded its submission of the previous year although information on improvements made by changing the powder and design of fuse was essentially that given in Anon. (1985). Additional information on the use of acoustic and radio equipped floats in order to help locate struck but lost whales was given (although it is not clear to me that this is relevant to the 'humaneness' of killing techniques—it seems more relevant but to the question of waste).

During discussion, the USA reported that misfirings have meant that the use of the new fuse has been abandoned pending further work, although the new powder was working well. The paper had given no information on times to death or on a quantitative field study of any real effect of the use of black powder over the previous powder. Norway was particularly concerned that there were no experimental field data and believed that with relatively minor modifications the explosive projectiles could use penthrite, which was 10–20 times more effective than black powder. A more sophisticated fusing mechanism would of course be needed for safety reasons.

A suggestion was also made about the possibility of using neurotoxins in the hunt. Although the USA had reservations about the appropriateness of suggesting changes in the nature of an aboriginal fishery, and the Working Group had previously expressed the view that drugs were not a suitable option (e.g. IWC, 1983c), it was agreed that a further investigation into neurotoxins might be useful. Further information on time to death for this and other fisheries was also requested.

Greenlandic fishery for minke, fin and humpback whales

The information provided by Denmark was the same as in the previous year (i.e. from Helms, Hertz and Kapel, 1984). In the ensuing discussion Denmark explained that it had little additional information relevant to the Group with respect to death times, etc and reported that no programmes were underway with respect to improving technology or training. Consideration was being given to the possibility of using explosive grenades from Norway.

The Working Group expressed concern at the lack of progress made by Denmark in developing more humane methods and requested a report next year concerning weaponry, methodology, time to death, monitoring methods etc.

Faroese pilot whale fishery

Two papers were presented on this fishery. Hoydal (1986) detailed recent (1984, 1985 and 1986) Faroese legislation changes in the hunting regulations. The present regulations cover many aspects of the hunt including: closure of whale districts when enough meat and blubber had been acquired in a season; limitation of the use of spears and harpoons to only those boats containing the sheriff and foremen; closure of bays not considered suitable for hunting; regulation of killing method (e.g. use of hook, severing of jugular vein) and local control during the hunt by foremen and sheriff; prosecutions under the animal protection act.

The other report was from a British veterinarian who visited the Faroes but did not witness a hunt (Jordan, 1986). His report is based on interviews with people in the fishery, video recordings and a literature survey. It examines and comments on the current legislation and concludes that in his opinion none of the methods are 'humane' (i.e. resulting in instant death without stress) but singles out use of the gaff, lance and harpoon as causing most pain and noted that problems are more likely to occur where large pods are driven in.

In the ensuing discussion several points were raised concerning techniques used and the humaneness of the hunt but little quantitative information was available to support or refute many of the comments made. In conclusion the Chairman noted the concern expressed within the Group over the fishery and in particular the use of the gaff and spear.

Other business

After a gap of one year the question of submission of national laws on the killing of animals was again raised and it was agreed to re-institute the request that Governments submit such laws, although how this information, if received, might be used was not specified.

Report of the sub-committee on aboriginal subsistence whaling (IWC, 1986c)

It had been agreed that the relevant section of the Humane Killing Working Group's report should be examined by the sub-committee on aboriginal subsistence whaling before presentation of the former to the Commission. The aim of this was presumably to allow any purely objective view of the relative 'humaneness' of such fisheries or recommendations concerning improved techniques to be considered in the light of practicality for any given operation. This was reflected in the report of this sub-committee where although all countries agreed that an effort should be made to achieve 'humaneness' in all operations, the USA and Denmark added the proviso that standards and technology appropriate to commercial whaling should not and could not automatically be applied to aboriginal subsistence whaling.

Other than this the sub-committee had no further comments on the report of the Humane Killing Working Group.

Technical Committee/Commission (IWC, 1987)

The Technical Committee discussed the above two reports and agreed, as did the Commission, to the recommendations with respect to additional information from the USA and Denmark concerning the Alaskan and Greenlandic fisheries, and to the instruction to the IWC Secretariat for a 'survey of material of possible relevance to the use of neurotoxins for the killing of whales'.

There was considerable further discussion over the pilot whale fishery, centering on a proposal by the Netherlands that the IWC should recommend to Denmark that the use of the gaff be eliminated as soon as possible. There was some support for the proposal and some objections based on the views that the pilot whale and/or the issue of humane killing are outside the competence of the IWC. Eventually, with reservations from certain countries but with the agreement of Denmark, the Commission adopted a proposal (not considered a resolution) to ask the Danish Government to convey to the Faroese Government the IWC's concern over the methods used in the pilot whale hunt. Although the Commission recognised that the Faroese Government had already taken some measures in this regard, it particularly encouraged them to minimise the use of the gaff, spear and killing from boats, and to limit the fishery to those bays where the whales may be killed in a more humane manner. Denmark agreed to report on progress made during the coming year.

CONCLUSION

Considerable progress has been made in recent years with respect to improving death times, particularly for commercial minke whaling operations. Norway and Japan deserve much credit for having invested a good deal of time and money in developing a safe and efficient explosive grenade harpoon. Arguments over the wisdom of the introduction of the ban in the early 1980s on non-explosive grenade harpoons for minke whaling are equivocal. On the one hand it could be argued that, even with their considerable research effort, the fact that it was not until 1984 that all Japanese and Norwegian operations were able to use explosive grenade harpoons shows that the ban was unreasonably premature. On the other hand, it could be argued that the ban was needed to catalyse the research effort. In any event a major advance in killing techniques was the result.

Progress has been much slower with regard to aboriginal subsistence fisheries. No operation had to date reported the quantitative data required to allow a reasoned appraisal of the situation. Even given the additional cultural and practical constraints imposed by the nature of these fisheries, such data are required if progress is to be made rather than rhetoric exchanged.

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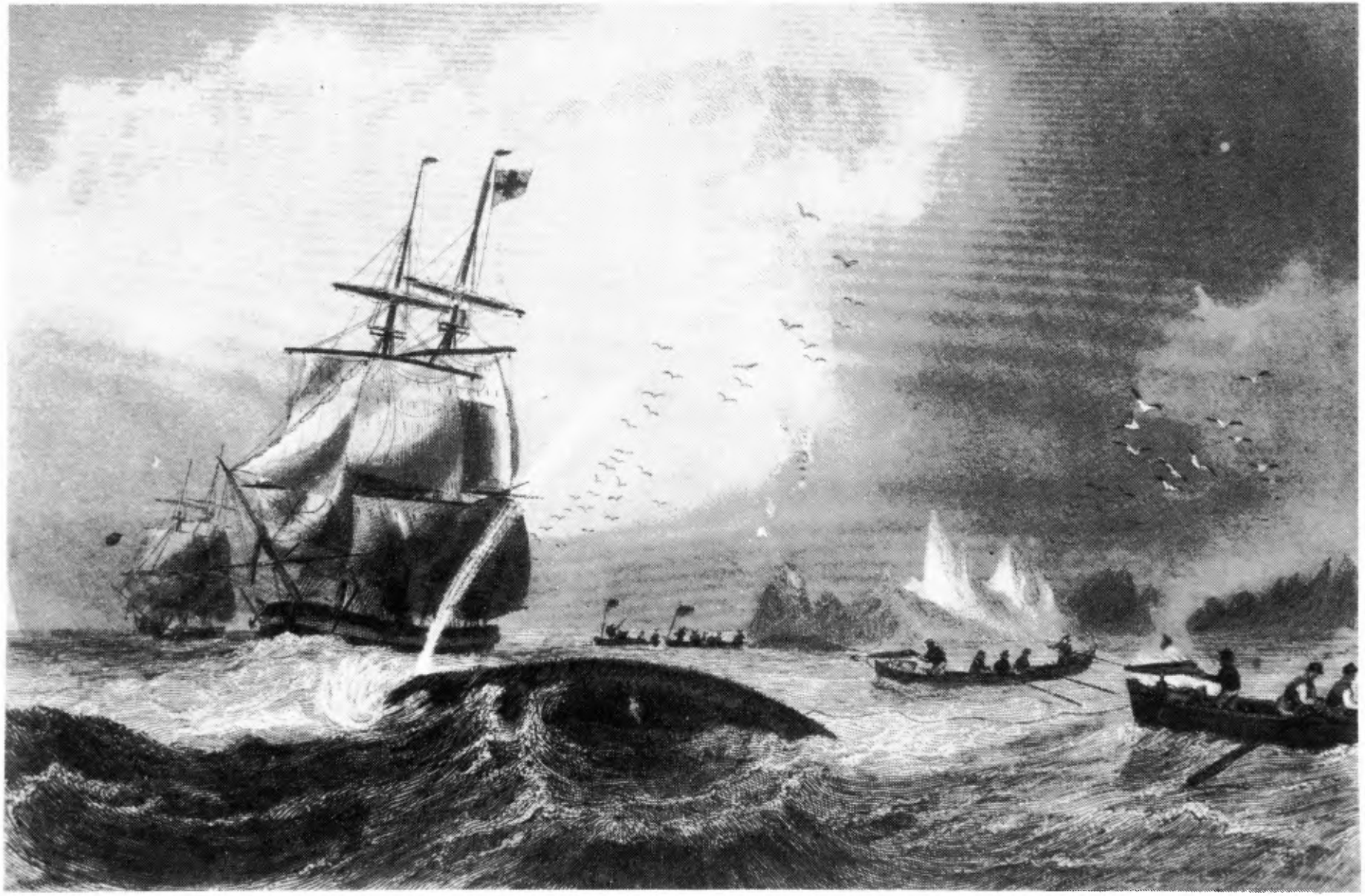


'Whale shooting', a coloured engraving (ca 1840) drawn by J. W. Carmichael and engraved by T. F. Nicholson. This type of bow swivel-mounted harpoon gun was invented as early as 1731 in England but was rarely used due to the resistance of whalemen to innovation. This particular scene would have been unusual as one of the problems with the gun was the difficulty of taking aim in rough seas.

Author Index

Roman numbers refer to Bibliographic entries, italicised numbers to page numbers

'Picturesque New England Industries—whaling off Cape Cod. 1. Shooting whales by means of a Bomb-Gun.' From *Frank Leslie's Illustrated Newspaper* 30 July 1887. Photo courtesy of the Peabody Museum.

'Provincetown . . . was one of the earliest whaling stations of New England. That picturesque industry still survives there, though it is not the extensive and serious business that it was half a century ago. The chase and capture of a sixty-foot finback, however, is as exciting to-day as it was then, and a good deal more scientific. From the shore, or from the masthead of his schooner cruising along the "Georgia Banks", the whaler sights his prey, disporting amid the deep-sea swells. It is not necessary, as in the old days, to approach in a dory and throw the harpoon by hand. The whaler is armed with a heavy gun, which fires a projectile consisting of a long, iron-pointed shaft carrying a bomb. The bomb explodes fourteen seconds after leaving the gun, and if well directed, puts an end to the whale. The body sinks; but it will rise to the surface again in the course of thirty-six hours, unless the water be more than forty fathoms deep. For this reason the whalers always endeavor to do the killing in shallow water. If a wounded or dead whale drifts away, and is found by other persons than the man who first shot it, it still belongs to the latter, who is identified by the iron point bearing his name or mark, and remaining imbedded in the carcass.'

Subject Index

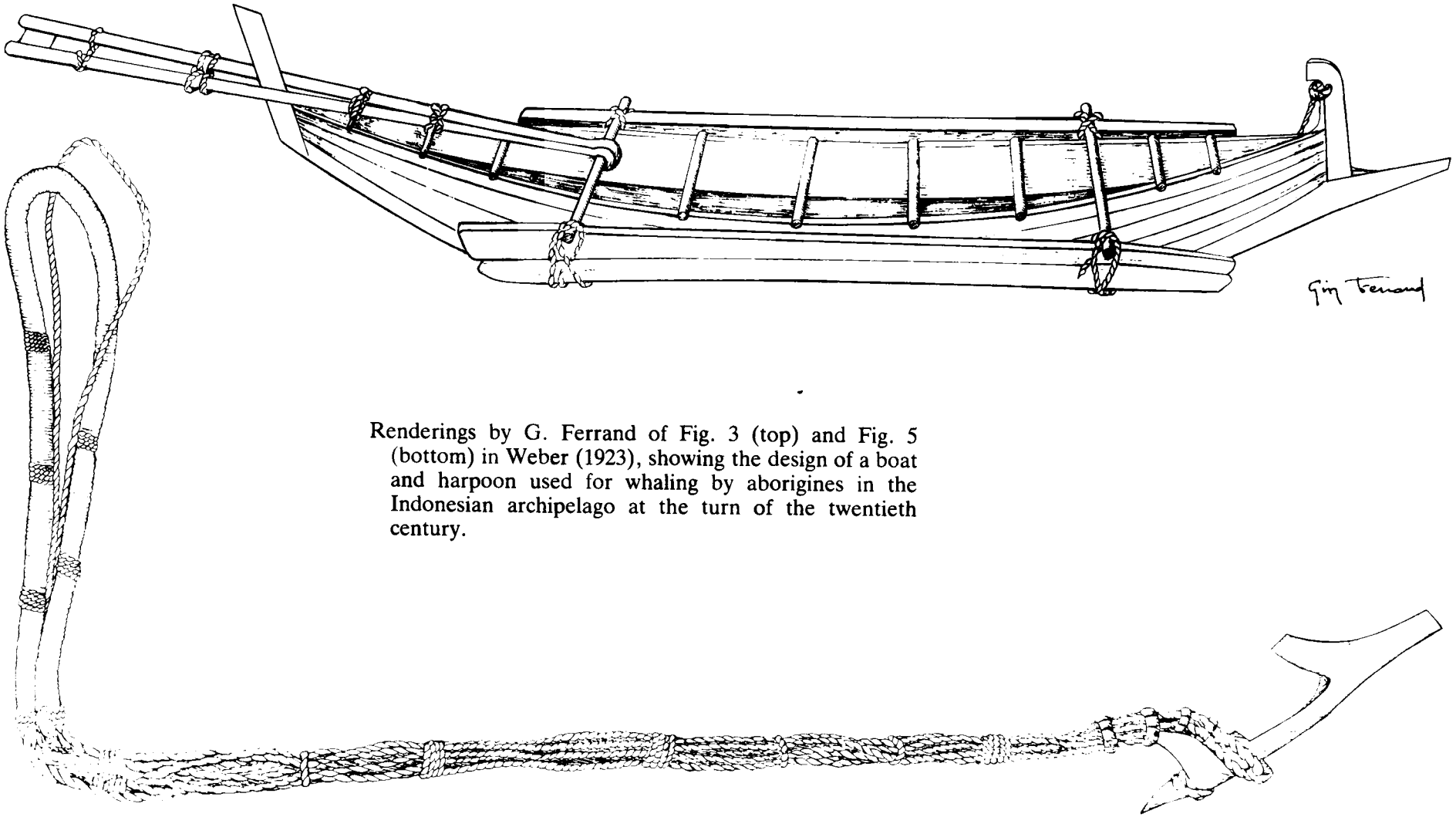
Many of the references cover general aspects of whaling techniques. The first part of the index lists these into three categories. 'Old' whaling generally refers to commercial whaling carried out before 1900 which did not utilise explosive grenade technology. 'Modern' whaling refers to all pre-1900 commercial whaling which utilised explosive grenade technology and all 20th century commercial whaling.

The second part of the index covers broad subject categories (where used 'old' and 'modern' whaling are defined as above).

Roman numbers refer to bibliographic entries, italicised numbers to page numbers.

A. General references

B. Broad subject categories



Renderings by G. Ferrand of Fig. 3 (top) and Fig. 5 (bottom) in Weber (1923), showing the design of a boat and harpoon used for whaling by aborigines in the Indonesian archipelago at the turn of the twentieth century.