SEA FISH INDUSTRY AUTHORITY
Industrial Development Unit

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THE INVESTIGATION OF THE POTENTIAL OF THE BAADER 34 AND 182 MACHINES FOR FILLETING SMALL GADOIDS

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SUMMARY

Large quantities of small haddock and whiting are landed in the U.K. There is no efficient filleting machinery currently available for these fish, and the cost of processing them by hand is disproportionately high. Consequently their market value is low, and often they are withdrawn from sale when landings are heavy.

The S.F.I.A. has been contracted by M.A.F.F. to carry out a commercial evaluation of the Baader 34 herring filleting machine, modified for blue whiting, for filleting these fish. The S.F.I.A. also undertook to investigate the new Baader 182, a filleting machine being developed for small gadoids from the now discontinued prototype Baader 121 blue whiting filleting machine. Blue whiting is a gadoid and thus is physically more similar to haddock and whiting than herring.

A preliminary assessment of the suitability of the modified Baader 34 was made during blue whiting processing trials of the TRS machine at Scalloway in April 1982. Whilst the machine filleted the smaller blue whiting well, it was clear that it was not as suitable for large blue whiting, whiting, and particularly haddock, because of their increasing dissimilarity in skeletal structure to herring. In particular the large included angle between the rib bones, and their heavy structure, in gadoids compared to herring, necessitates an additional pair of knives in gadoid filleting machines to cut around these bones. Because of the lack of space to fit these knives in the 34, and the major development programme, of uncertain outcome, that would be necessary, it was concluded that the Baader 34 is unsuitable.

The W.F.A. developed the prototype 121 in conjunction with Baader. The machine was developed to the point where it processed blue whiting well, but it required major modification in order to efficiently process the larger gutted gadoids, haddock in particular. Development of the 121 was discontinued because of lack of commercial interest in a blue whiting filleting machine, but Baader redirected the technology into the 182.

The trial of prototype 182's commenced early in 1983, and a machine was examined at Hirtshalls in February. It was immediately apparent that the 182 is a developed version of the 121, incorporating all the major lessons learnt during the earlier collaborative development. The 182 is designed specifically for processing small gadoids at a high throughput and with a high yield, and thus should meet the UK requirement. However it is, of necessity, a large, complex and expensive machine, although it should be a good investment for a large scale processor.

A 182 may be available for trial in the UK by the end of the year, and it is recommended that it is sited in Scotland and evaluated on a collaborative basis with Baader and a commercial processor.

The assistance of Torry Research Station in providing access to their modified Baader 34, and of Baader for providing access to their prototype 182, is gratefully acknowledged.

I N D E X

1. INTRODUCTION

Large quantities of small whiting and haddock are landed in the U.K., particularly in Scotland.

There is limited processing capacity and market for these fish, and thus their market value is low. Often they are withdrawn from sale when landings are heavy. This in turn leads to many fishermen taking little care over their gutting and stowage, a significant proportion are landed ungutted, and allegations that some are fishing merely for withdrawal compensation.

Processing these fish is a problem because of their small size. The minimum landing sizes for whiting and haddock are 25 and 27 cms overall length respectively. The costs of hand filleting are disproportionately high, a very large labour force would be necessary to cope with heavy landings, and suitable filleting machines are not yet available. The fish are marketed largely as block fillets, for which there is a limited demand. The high cost of processing by hand into laminated blocks, and thus into a wider range of products, limits their marketability.

Baader have for many years manufactured the 181 and 183 machines for single and block filleting these fish, and these machines have been purchased by UK processors, but very few remain in use because of their significantly inferior performance compared to hand filleters, particularly when processing soft fish. Baader have recently introduced the more advanced 184 machine for filleting somewhat larger fish of 30-70 cms overall length, but this is a large, sophisticated and expensive machine with a relatively low throughput to facilitate loading of 70cm fish, and which produces single fillets, and thus does not solve the immediate processing problem.

The SFIA has been commissioned by MAFF to investigate the development of machines suitable for filleting these small fish, and in particular to carry out a commercial evaluation of the Baader 34 herring filleting machine modified for blue whiting. In view of the physical similarity between blue

whiting, whiting and haddock, it was also decided to investigate Baader's current development of a new machine for small gadoids, the 182, which is based on the earlier prototype Baader 121 blue whiting filleting machine, the development of which was discontinued.

Blue whiting is a gadoid, although of smaller and slimmer proportions than whiting and haddock, whereas herring, being a totally different species, has significantly different proportions and skeletal structure to whiting and haddock.

2. OBJECTIVES

2.1 To carry out a commercial evaluation of the Baader 34 herring filleting machine, modified for blue whiting, for filleting small whiting and haddock.

2.2 To investigate Baader's current development of the 182, a machine for small gadoids derived from the earlier prototype 121 blue whiting filleting machine.

3. BACKGROUND TO THE DEVELOPMENT OF BLUE WHITING FILLETING MACHINERY AND THE CURRENT INVESTIGATIONS

The W.F.A. blue whiting R&D programme was halted in 1980 owing to lack of U.K. commercial interest. Part of the programme had been the development, in conjunction with Baader, of the prototype 121 filleting machine. By then, the WFA's prototype machine performed well on blue whiting, which, because of their small size and very high catch rates, were landed ungutted. The WFA briefly continued to develop the machine to fillet small whiting and haddock, but that was halted when it became clear that it was necessary to make major alterations to the machine in order to fillet gutted fish, and that further major alterations were desirable in order to maximise the fillet yield from these species. Baader continued with that line of development, but soon decided that the degree of alteration required in total to process these species, and small hake, was such that it would be best to discontinue the 121 and redirect the technology into a new machine, the 182. It was not considered worthwhile to market a specialised machine for blue whiting.

The Faeroese fishing industry is now commercially exploiting blue whiting for human consumption, and indeed is exporting blue whiting products to the U.K. The fish is available in Faeroese waters for much of the year, part of the stock remaining in the waters to the North of Faeroe during the summer, and their fish is in very good condition compared to the spent fish caught on the spawning grounds North West of the U.K. during spring. The Faeroese are processing the fish on factory vessels using Baader 34 herring filleting machines modified by Matcon of Denmark.

TRS has a continuing blue whiting R&D programme, and has purchased a refurbished Baader 34 and modified it in similar fashion. The machine was installed in the Ice Atlantic factory at Scalloway on the Shetland Isles during the spring of 1982, for trials on fresh blue whiting to be supplied by the R.V., G.A. REAY. These trials have been reported in TRS Report "Blue Whiting Processing Trials, Scalloway 1982".

The Author visited Scalloway during those trials to make an initial assessment of the machine prior to setting up any commercial trials.

The prototype Baader 182 commenced its initial commercial trials at Hirtshalls in Denmark early in 1983, and the Author briefly visited those trials, and later held discussions with Baader at Lubeck in Germany.

4. THE BAADER 34

4.1 Visit to Scalloway

The Author visited Scalloway on Tuesday and Wednesday, 20th and 21st April 1982, and returned via TRS.

The TRS officer in charge at Scalloway was Ian McDonald, who has also sailed on a Faeroese blue whiting factory vessel and was responsible for the modification of the TRS Baader 34. TRS had installed the 34 together with a Baader 51 skinning machine and a Baader 694 bone separator, and interlinking conveyors. The objective of the TRS trials was to produce quantities of blue whiting products (fillets, laminated blocks and mince) using the facilities of the Ice Atlantic factory. However, during the Author's visit the G.A. REAY had broken down and returned to Aberdeen, and so the time was spent processing sample batches of frozen at sea (on the G.A. REAY) blue whiting, fresh whiting, and a few haddock. This was probably more valuable for the immediate S.F.I.A. requirements than had TRS been in blue whiting production.

Later at TRS, the suitability of the 34 for processing small gadoids was discussed with the Director, Jack Connell.

4.2 Description of the Baader 34

The 34 has a standard herring filleter configuration, i.e. a heading unit set at right angles to a filleting unit and with a transfer unit inbetween. Two operators feed herring at up to 250 fish/minute (if they can) into pockets on a conveyor passing through the heading unit. The heading unit automatically positions each fish in its pocket according to its size so that the heading cut is made in the correct place, and the head is cut

off by a single cut. The automatic positioning mechanism of the TRS 34 appeared rather crude compared to units fitted to other types of machine, and on the latest machines it has been superseded by an improved unit. The fish pass around the end of the heading conveyor, having their tails cut off in so doing, and drop through guides below onto a complex moulded belt which aligns the fish and transfers them into the filleting unit. The layout of the filleting unit is conventional, as shown in figure 1. The fish are gripped between a pair of belts and transported through a pair of belly trimming knives, a belly cleaning wheel, a pair of ventral knives, and then a pair of block filleting knives. An additional pair of splitting knives can be fitted after the block filleting knives to split the block fillets into singles if required. The unusual and significant feature of the filleting unit is that the faces of the transport belts are covered with fine wire needles to positively grip the fish.

In overall arrangement the Baader 34 is a neat and compact package.

The modifications made to the machine to process blue whiting are few and simple, but no-doubt crucial to its operation. The profile of the automatic heading adjustment is altered, the guides feeding the fish onto and off the transfer belt are altered, and the fixed guides around the block filleting and fillet splitting knives are altered.

The improved positioning unit was seen during the later visit to Baader at Lubeck. The new unit is associated with new pockets on the heading belt and consists of a carousel, similar to that fitted to other recent Baader machines, which rotates as the belt passes and pushes the fish into their correct positions.

4.3 Observations of the Performance of the Baader 34 at Scalloway

The 34 processed the small and average sized blue whiting well, but fish above 33cms overall length not so well. The maximum size capability claimed by the Faeroese is 35cm.

The heading unit did not self adjust very effectively, in fact to cover a typical blue whiting size range it would probably be cost effective to grade the fish and use two machines set up differently. Also the heads of large fish tended to jam in the unit after being cut off. The heading units on other machines, such as the Baader 121, handle blue whiting much more effectively. Hopefully the new unit for the 34 will perform as well. The problem of large heads jamming could presumably be overcome by relatively minor alterations to provide more clearance around their outlet path.

The transfer unit worked well on the fish processed during the visit, but the blue whiting frozen at sea on the G.A. REAY always appears to the Author to be of excellent quality compared to that frozen on commercial vessels, presumably because the G.A. REAY usually catches only a few baskets of fish at a time and they are carefully handled. Whether the unit would realign the relatively high proportion of twisted and damaged fish in commercial landings is uncertain at this stage. Apparently the transfer unit does not work well on gutted fish,and thus they tend to be miscut in the filleting unit, but only a few gutted haddock were processed during the visit. The W.F.A. and Baader experience of similar problems with the Baader 121 also suggests that it is unlikely that this type of transfer unit is suitable for development to handle gutted fish.

The filleting unit worked well on blue whiting up to 33cms overall length, but above that length the ends of the ribs and

sections of backbone near the tail were left in the fillets. The pin bones were of course left in the fillets, as to remove them in this machine would involve cutting off a very large proportion of the fillet. As usual when splitting the fillets into singles a proportion of the fillets had dorsal fin bone attached, but the sprung guides above the block filleting and splitting knives which are crucial for the alignment of the fish are very crude compared to those developed by the W.F.A. for the Baader 121, and no doubt the performance of the 34 could be improved in this respect. The most remarkable feature of the performance of the filleting unit was the grip provided by the needles on the transport belts, and as a result the absence of the jamming which has been the bane of other machines when filleting blue whiting.

The yields from the machine when processing blue whiting inevitably vary considerably with the condition of the fish, and after only one visit the figures must be noted with extreme caution, but in general the yields appear to be similar to those of the Baader 121, i.e. approximately 25-30% is available after skinning for laminated block production.

The machine processed very small ungutted whiting well, but any whiting significantly above the legal minimum size again had the ends of the ribs and sections of backbone left in the fillets. The machine totally miscut the few haddock available, the filleting unit leaving a very large part of the skeleton attached to the fillets despite the fish having been transferred with a reasonable alignment. The heads of these fish also jammed.

4.4 Discussion of the Performance and Potential of the Baader 34

The reason for the poor performance of the machine on whiting, haddock and large blue whiting is clearly that the knife configuration

of the filleting unit is designed for herring type skeletal structure and not gadoid type structure. As shown in figure 2, herring have thin and flexible bones and a small included angle between the ribs, whereas gadoids have thicker bones with a much greater included angle between the ribs (120^{o}), and in particular have well developed rigid extensions of the vertebra leading out to the ribs. The block fillet knives are designed to cut around the ribs and backbone of a herring, and will cut around the bones of small blue whiting because their bones are relatively thin and flexible compared to other gadoids and will conform to the machine. The bones of the larger blue whiting will not conform and thus the block fillet knives cut the ribs, and the larger vertebra near the tail tend to jam between the knives and are thrown out by their rotation. Whiting have a heavier bone structure than blue whiting, and haddock a much heavier structure with very well developed vertebral extensions. Hake has even more developed vertebral extensions.

To overcome this problem, gadoid filleting machines have an additional pair of flank knives set at a large included angle (120^{o}) which cut around the ribs before the block filleting cut, and the ventral knives are set further apart and cut deeper at the tail, or additional knives are fitted to cut alongside the backbone.

There is very little space available within the filleting unit of the 34 for fitting a pair of rib knives and their necessary drive, actuation mechanism and guides. To attempt to do so would be a major engineering project followed by a typical fish processing machinery development programme of uncertain outcome. Simply increasing the included angle between the existing block fillet knives could be considered, but only a small increase of very limited effect could be achieved without major re-engineering, and a larger increase would inevitably lead to a substantial drop in fillet yield.

4.5 Other Machinery coupled to the Baader 34 at Scalloway

The Baader 51 had been fitted with optional soft rollers to press the fillets onto the skinning drum, but not with the optional fine tooth drum and skinning knife for small fish. The machine skinned blue whiting adequately for laminated block manufacture, but in the absence of the optional drum and knife, some fillet damage resulted.

The Baader 694 bone separator was not seen in operation, but TRS had constructed a simple conveyor connection between the 34 and the 694 to feed the fillets onto the perforated separator drum with their fleshy side against the drum to ensure a clean mince, in similar fashion to the integrated unit of the prototype 121.

5. THE BAADER 182

5.1 Visit to Hirtshalls and Lubeck

The Author inspected the prototype 182 in the premises of a commercial processor at Hirtshalls on Tuesday afternoon, 22nd February 1983. Fortuitously it had been possible to visit Denmark for the combined purposes of studying Danish fish handling and distribution practices, and investigating the 182. Considerable difficulty was experienced in gaining access to the premises, despite the goodwill of Baader, and the machine was not seen in operation. However, discussions were held with the development engineers, known to the Author from the collaborative work on the 121.

The machine had been installed only a few weeks previously, and to date only gutted whiting had been available for processing, but commercial quantities had been processed with encouraging results. A second prototype had been shipped to America for trial on hake, this being a significant potential market for Baader.

During the return journey to the U.K., the Author visited the Baader factory at Lubeck on Friday morning, 25th February, 1983, and discussed the progress of the 182 with Jurgen Drews, Baader's head of development.

5.2 Description of the Baader 182 and it's Development

First sight of the 182 revealed that it is in essence a refined and modified 121, incorporating all the major lessons learnt during the collaborative development of the 121.

The design specification of the 182 is to fillet gutted or ungutted small gadoids of overall length 25-45cms into block or single fillets at a rate of 120 fish per minute, and to clean the belly flaps and provide the option of cutting off the cleaned flaps including pin bones for bone separation and recovery of the cleaned flesh. The integral skinning units and bone separator of the 121 have been dropped in favour of a simpler basic machine with the facility of auto feeding into a 51 skinning machine and 694 bone separator.

To achieve a high throughput the 121/182 has a herring filleter configuration similar to the 34, i.e. a heading unit set at right angles to a filleting unit with a transfer unit inbetween.

In the 121, a sprung mechanism positioned the fish in the pockets of the heading unit prior to removal of the head. The pockets then tipped allowing the fish to fall between a pair of converging transfer belts which aligned and conveyed the fish into the filleting unit. The layout of the filleting unit is shown in figure 3. The fish were gripped between a pair of spiked chains and transported through a pair of ventral knives, a pair of belly flap trimming knives, a pair of flank knives, a pair of block fillet knives, and an optional pair of splitting knives. The knives were surrounded by a complex series of sprung guides.

In practice the two operators of the 121 had difficulty feeding blue whiting at the machines full capacity. The heading unit worked well on ungutted fish, but gutted and naped fish were cut asymetrically. The transfer unit aligned ungutted fish fairly well, but failed hopelessly on ungutted fish. This type of unit is adequate for deep bodied herring type fish which can be aligned by side pressure, but the protruding ribs of gutted gadoids tend to force the fish out of alignment when subjected to side pressure. After considerable development the filleting

unit of the W.F.A.'s 121 worked well on blue whiting, even on frozen at sea spent blue whiting, although jamming remained a problem with these fish if the operators did not reject the badly damaged fish. Particular areas of development by the W.F.A. were a new system of guides around the block fillet and splitting knives which re-aligned the fish by gripping their dorsal fins, and the interlinkage of the guides around the flank knives to adapt to the size of fish. Further work developed the guides for filleting whiting, but increasing difficulty was experienced in making the machine adapt to yet deeper bodied and thicker boned fish such as haddock, as well as thin blue whiting, and the work was halted. It had also become apparent that the belly trimming knives needed to be moved beyond the flank knives in order to recover the flesh from the belly flaps of these deeper bodied fish, and possibly remove the pin bones.

Baader modified their prototype 121 to incorporate a new transfer unit for gutted fish, in which the fish fell onto a shaped conveyor which supported the ribs, and which passed below a series of powered wheels sprung onto the fish to align them, and repositioned the belly trimming knives. However, further difficulties were then experienced in adapting the machine to the smaller fish, which remained misaligned without the W.F.A.'s guides. Baader then returned to the drawing board.

The 182 now incorporates electronic fish measurement and control to adapt to the range of fish shapes and sizes. The feeding section of the heading unit has been lengthened, and the sprung mechanism positioning the fish prior to heading has been replaced by an electronic measurement of the width of the head and a stepper motor mechanism to position the fish. The measurement data is passed into memory and used in the filleting unit. The transfer unit is a refined version of that developed by Baader for their 121. The layout of the filleting unit is shown in figure 4. The belly trimming knives have been moved to beyond the block fillet knives and are now electronically controlled so that they can remove a shaped section of belly flap complete with pin bones. The guides in front of the flank knives are also electronically controlled.

Developed versions of the W.F.A.'s dorsal guides are fitted around the block filleting and splitting knives. An additional pair of knives has been fitted in front of the block fillet knives to cut the thick vertebral extensions of hake so that they do not jam in the block fillet knives.

In overall arrangement the Baader 182 is inevitably large and complicated, and no doubt its capital cost will be high compared to the Baader 34. The Author estimates that the cost of the 182 will be at least £50,000. However, the capital cost of a fish filleting machine is low compared to the value of fish that it can process per annum, and thus a machine is a good investment to a large scale processor provided it performs well.

5.3 The Development Programme for the Baader 182

The already long history of the 121/182 demonstrates the uncertainty of prediction of when the 182 will be in production. However, Jurgen Drews estimated that if all goes well in Denmark and America, a machine could be available for evaluation in the U.K. by the end of the year. Siting a machine in Scotland would have the advantage of regular supplies of small fish, gutted and ungutted (it is illegal to land ungutted fish in Denmark). The full cost of such an evaluation would be considerable, and it is suggested that it would have to be a collaborative effort with Baader and a commercial processor. The net cost would then depend on the details of the arrangement.

6. CONCLUSIONS AND RECOMMENDATIONS

6.1 The Baader 34

6.1.1 The Baader 34 in its current form is unsuitable for filleting small whiting and haddock, and its defficiencies are such that in the view of the Author further work to commercially evaluate the machine would not be worthwhile.

6.1.2 The modified Baader 34 is clearly a practical machine for processing blue whiting which is in good condition and of average size. The machine is neat, compact, has a high throughput and yield and is not prone to jamming. When coupled to a Baader 51 skinning machine and Baader 694 bone separator, block fillets, single fillets skin on or off, or high grade mince can be produced.

6.1.3 There is scope for further improvement of the 34 for processing blue whiting, particularly relating to the heading unit (a new unit is now available) and the alignment of the dorsal fins in the filleting unit, and the experience of development of the Baader 121 could well be relevant.

6.1.4 Whether the 34 would be practical for processing the commercial quality of frozen at sea spent blue whiting caught North West of the U.K. remains uncertain. In the Author's view the poor quality of the fish makes it unlikely.

6.1.5 The filleting knife configuration of the 34 is designed for processing herring type fishes which have relatively thin bones and a small included angle between the ribs, whereas gadoids have thicker bones and a much larger included angle between the ribs.

6.1.6 The 34 fillets average sized blue whiting well because blue whiting bones are relatively thin and flexible and will conform to the herring pattern, but the bones of large blue whiting, of ordinary whiting, and particularly of haddock are thicker and the differences to the herring pattern much more pronounced, and thus the machine does not fillet these fish well.

6.1.7 In machines designed for filleting gadoids, additional knives are fitted to cut around the ribs. There is little space available within the 34 for fitting such knives and their associated mechanism, and it would be a major R&D project of uncertain outcome to attempt to do so.

6.1.8 The 34 is designed for processing ungutted fish, and based on experience with the Baader 121 it is most unlikely that gutted fish would remain in alignment when transferred from heading to filleting units, and thus gutted fish would tend to be miscut.

6.2 The Baader 182

6.2.1 The development of the Baader 182 is currently at the stage of prototype trial, and thus the final performance of the machine is uncertain, however its design specification meets the U.K. requirement for filleting small gadoids.

6.2.2 The Baader 182 is in essence a developed version of the earlier prototype Baader 121 blue whiting filleting machine, incorporating all the major lessons learnt during the collaborative development of that machine by Baader and the W.F.A., and thus that earlier work has not been wasted and may in the future prove to be of great value to the U.K. fish industry.

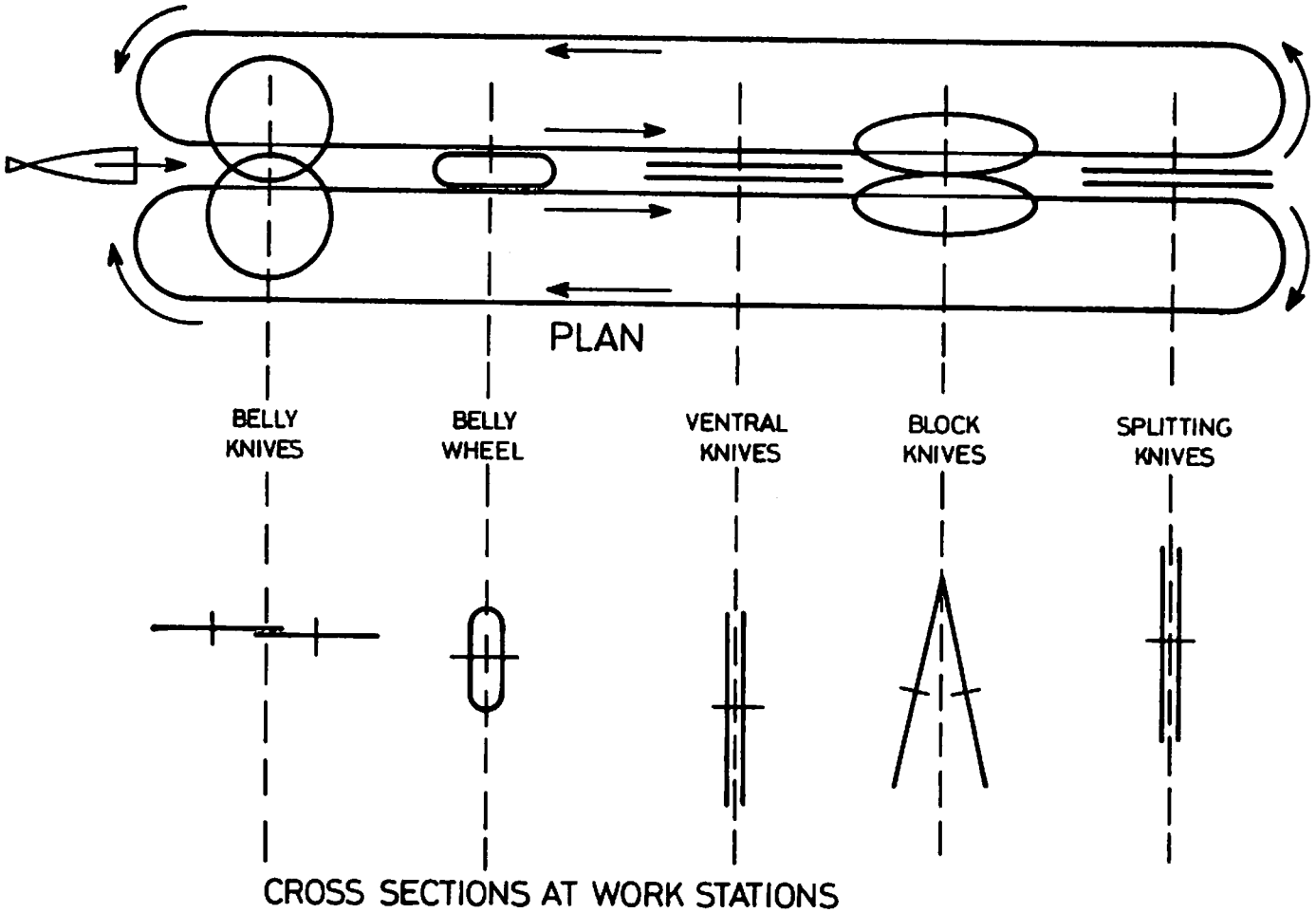
6.2.3 In order to achieve a high throughput, the overall configuration of the 182 is similar to a herring filleting machine, incorporating a feeding and heading unit set at right angles to a filleting unit,and with a transfer unit inbetween. But the knife layout of the filleting unit is specifically designed for the bone structure of gadoids and should therefore have a high yield, the transfer unit is specifically designed to align gadoids, gutted and ungutted, and the whole incoporates electronic control to increase its adaptability.

6.2.4 The 182 is inevitably a large and complicated machine that will have a high capital cost, however the machine should be a good investment to a large scale processor provided it performs well.

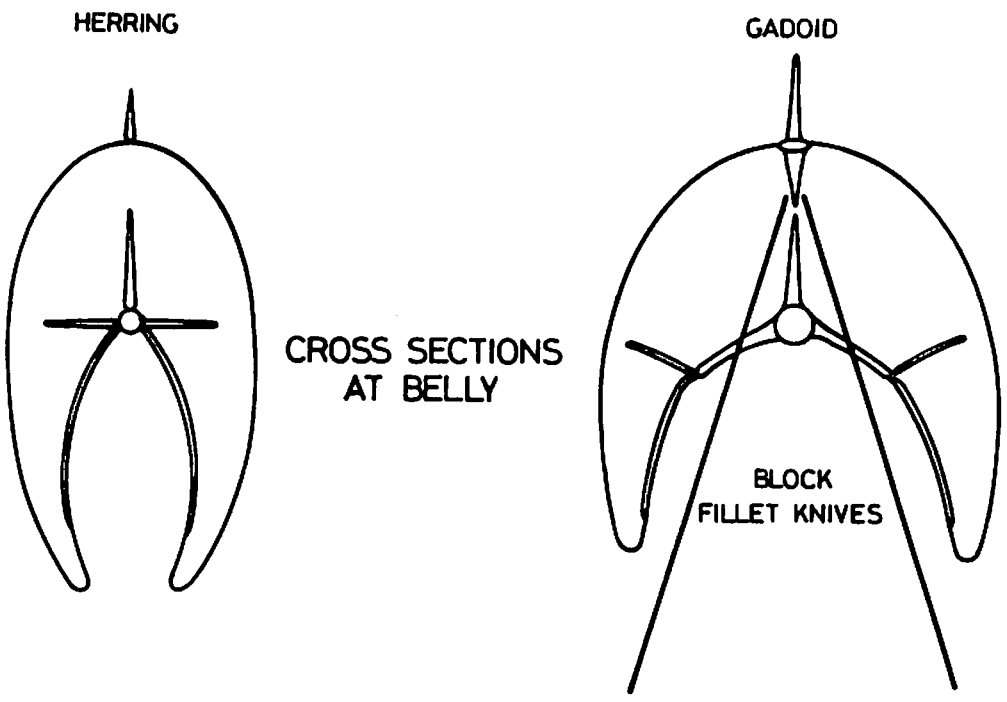
6.2.5 The future availability of the 182 for evaluation in the U.K. is uncertain, and previous experience councils caution. However, a machine could be available by the end of the year.

6.2.6 It is recommended that when available a 182 is evaluated in Scotland in the premises of a commercial processor, and that this should be a collaborative effort between the S.F.I.A., Baader and the processor.

LAYOUT OF BAADER 34 FILLETING UNIT Fig. 1

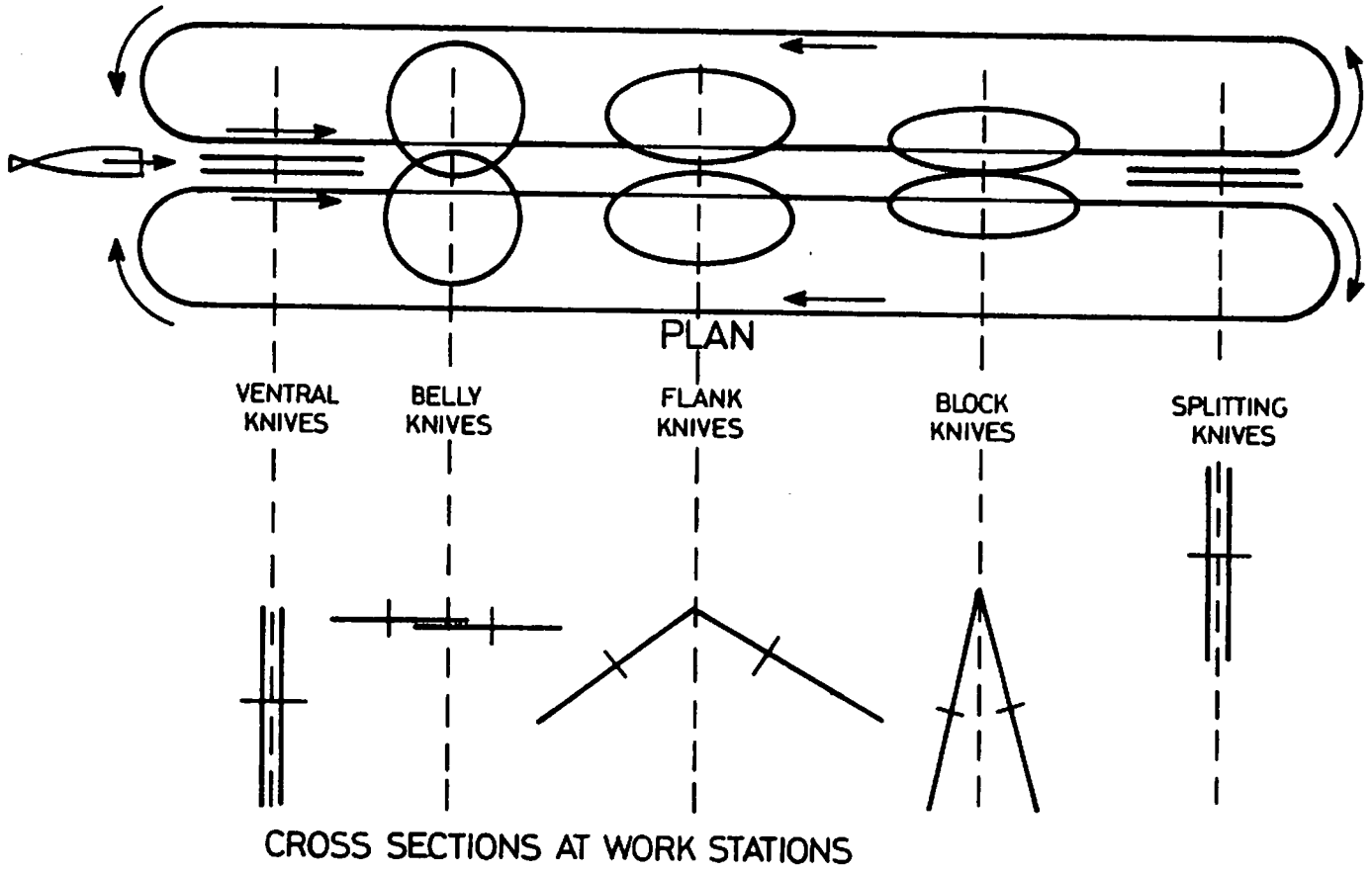


DIFFERENCES BETWEEN HERRING AND GADOIDS Fig.2



LAYOUT OF BAADER 121 FILLETING UNIT

Fig. 3



LAYOUT OF BAADER 182 FILLETING UNIT

Fig. 4