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AUTOMATION OF SMALL AND MEDIUM-SCALE INDUSTRIES

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REPUBLIC OF KOREA

Technical report: Review of organizational and operational structure through automation, retrofitting to existing equipment and establishing manufacturing cells based on group technology. *

Prepared for the Government of the Republic of Korea
by the United Nations Industrial Development Organization,
acting as executing agency for the United Nations Development Programme

Based on the work of Stephen Chatt
Expert in Assembly Automation

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Engineering Industries Branch

United Nations Industrial Development Organization
Vienna

3a/22

* This document has not been edited.

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Date	Day	Work Class	Name of Company	Location	Contents
6.17	Fri	Arrive		Seoul	P.M.
18	Sat	Rest			
19	Sun	Rest			
20	Mon.	Meeting	UNDP, SMIPC	Seoul	Report to UNDP Discuss Problem areas, introduction
21	Tue	Visit	Kong Hwa Metal	Ansan	Thermostat, Oil Pressure Switch
22	Wed	Visit	Royal Metal	Bucheon	Nail Clippers
23	Thu	Visit	Korea Automatic	Bupyung	Automation Mfg.
24	Fri	Other	SMIPC	Seoul	Summarise Visit, Study, etc.
25	Sat	Other	SMIPC	Seoul	as above
26	Sun	Rest			
27	Mon	Visit	Han Kook Sin Yak	Daejeon	Packaging
28	Tue	Visit	Dea Yang Fish Hook	Busan	Fish Hooks
29	Wed	Visit	Shin Hung Precision	Pusan	Auto Parts Machining
29	Wed	Visit	Sung Jo Industrial	Pusan	Machining

Date	Day	Work Class	Name of Company	Location	Contents
30	Thu	Visit	Kong Wha Metal	Ulsan	Assembly areas. Oil Pressure Switches
7. 1	Fri	Travel			Back to Seoul
2	Sat	Other	SMIPC	Seoul	Summarise Visit Report, Discuss
3	Sun	Rest			
4	Mon	Consult	Kong Wha Metal	Ansan	Revisit for Discussions on problems and improvements.
5	Tue	Consult	Royal Metal	Bucheon	Revisit for Discussions on problems and improvements.
6	Wed	Other	SMIPC	Seoul	Discussions on consulting Visit and evaluate.
7	Thu	Other	SMIPC	Seoul	Standard Model study, Report.
8	Fri	Depart	SMIPC, UNDP	Seoul	Report to UNDP Departure.

B. INTRODUCTION

Briefing.

The mission began on wednesday 15 June 1988 at U.N.I.D.O in Wienna with an exceptionally well organised briefing session on that day. During which time I was briefly acquainted with the main objectives of the overall Support of the 6th Economic and Social Development Plan 1987/91, with particular reference to those objectives covering the expertise requirements to develop five LCA models based on the needs of 30 Companies, selected within the Korean Small and Medium sized Companies. To review organisational and operational structure through automation, retrofitting to existing equipments and establishing manufacturing cells based on group technology.

Further explanation was given in connection to the above objectives that there are five project areas within which there are allocations for experts or expertise for its achievements and these were listed as follows;

1, Lathe loading and unloading.
2, Special Purpose Machinery.
3, Assembly area.
4, Press loading and unloading systems.
5, Grinding.

From the above project expertise areas I had a particular assignment task for item 3, (Assembly area).

It was understood that the field of Assembly Automation is an extremely wide activity and it is a global term, covering a very complex combination of skills and expertise requirements within several aspects of industry. For this very reason it was

acknowledged there could not be a special project specification for a preconceived development of a specific objective or to perform a specific task.

Therefore, it was acknowledged that the primary objective was to ascertain on mission and evaluate those needs which would best enhance the success of the overall plan and act accordingly as to the requirements compatible for the SMIPC.

Mission.

The working session began on Monday 20 June 1988 and ended on Friday 8 July 1988 covering a period of 15.5 working days with 10 visits to Companies, spanning a wide range of manufacturing interests, introducing me in quick succession to the equally wide ranging basic problems which was a good example to form an opinion as to future requirements for the furtherance of the set objectives.

During this period I had worked in close association with SMIPC personnel, particularly with Mr. Hong Keung-Sik who was my partner and guide throughout the whole time during my stay. With his impressive knowledge, both technical and of the industry, we were able to agree on the precise basic needs of the overall project and with his assistance and understanding the future proposals were formulated.

Debriefing

After returning from the Republic of Korea, at my debriefing session with Mr. Hans J. Fritz I gave a verbal summary of all the relevant events of my activity and involvement. I have given an account of the present scene which reflects not only the assembly areas expertise requirements, the intended purpose of my mission,

but also the overall status of the engineers interpretation at SMIPC of LCA (Low Cost Automation). I also expressed my view that these were very much in line with my past activity and it does involve the whole range of expertise other than assembly. For this reason, with my extensive knowledge in this field I was able to give Mr. Hans J. Fritz a brief verbal assessment from the 10 visits I made, and what kind of services the Korean small and medium sized industry expects from SMIPC. Relating these to that of my in depth analysis of the frequent discussions with Mr. Hong Keung-Sik the resulting proposals would enhance the better utilisation of available and future expertise needs of the SMIPC.

C. RECOMMENDATIONS

Introduction.

It must be said beforehand that the majority of the Korean engineers I have met during the numerous company visits were skilled, self-reliant and were responsive to the multitude of suggestions which emerged during the discussions. These facts are more so true to those engineers within SMIPC for whom I have developed great respect and admiration in their endeavour for technical knowledge and enthusiasm with which they are developing solutions to those problems which are presented to them by the industry. I am therefore, reluctant to criticise, but in a constructive way I have to point to those short comings, of which SMIPC engineers are in agreement, which would need to be addressed. This is the apparent lack of confidence, which would only be obtained with experience particularly in the field of automation. I am referring to the experience of those practical elements of automation, that we developed a long-time ago and they are now proven to be the standard principles for the basis of proposals for a specific application. These LCA elements or modules in many applications of today are the foundations of the sophisticated automation techniques like Flexible Manufacturing Systems, Computer Integrated Maufacturing and alike.

Small and Medium Industry, especially the engineers within the SMIPC have the greater need for these and would require access to those elements of automation which are the foundations of Low Cost Automation. They would benefit from a programme where these elements and their wide choice of applications are demonstrated in actual operating conditions.

Reasons

The field of automation is a very complex one and within this term are the references of 'Assembly automation', 'LCA', 'Mechanisation' and alike. These are used as global references with different meanings in many minds in as many industries without specific reference as to where one ends and the other begins.

Interpretation of these terms as applied to a particular problem can have several forms of approach, and if one engineer chose so due to the lack of practical applications experience, these can be referenced to any one of the categories of automation whilst the actual economic solution would lay within a different approach. During my short stay in Korea I found this to be even more appropriate.

Automation, whichever form or interpretations it is referenced to can only be successful if the original intent is understood by all concerned e.g.., the originating company, SMIPC and the consulting expert. Therefore, a particular project or problem and the ultimate goal must be put in perspective by the means of a conceptual project brief. Only when this has been completed and the course or possible courses are identified can the consulting expert be of substantial value. Where these rules were followed and the projects were conceived and outlined with good enough specifications before hand, then the expert was able to set out to fulfil his task, objectively to requirements. Within the field of LCA intended to be applied to assembly areas, considering the wide applications across various sectors of industry, the task becomes more difficult than a special purpose application. If there are no project objectives, this task will be almost impossible to execute within that mission.

Therefore, I have outlined a programme to organise and bring to a successful conclusion the LCA development projects. The proposed

programme takes cognizance of all the principal factors, described within this heading. I: is proposed with the acquired knowledge, derived from my mission designated to deal with assembly area automation, and of the knowledge gained to understand those needs with which the SMIPC engineers are seeking to achieve the aims of the development programme.

Programme.

1., This would be the first phase where perhaps two engineers from the SMIPC would visit the U.K. and I would organise for them an itinerary of visits to companies which are involved in the design and manufacture of fundamental elements for the implementation of LCA. Further visits could be organised to companies manufacturing complete solutions for assembly tasks, including automation and special purpose machinery, and seeing these being built so the approach to the techniques involved could be observed.

2., Following the manufacture and design sector visitations to companies which are the leaders in the use of this equipment, not only from the companies previously visited but from other manufacturers, and also using their own design and development to special purpose applications.

3., The U.K. visit would then be concluded in the participation of a consultative seminar at the British Institute of Automation or at the Production Engineering Research Association on those techniques which are related to the subject.

4., After the conducted programme I would collect and collate a

library of LCA elements and basic automation techniques. These would include references and outline drawings on the fundamental modules from which specific application concepts can be developed. This would be a useful asset not only for the SMIPC engineers but it would allow more time for experts on mission to concentrate on problem solving and unloading of ideas either in the SMIPC or at companies selected by them, rather than spend the time on the drawing board and re-creating that which already exists.

5., Whilst item 4., is being done, the returning engineers would assess the observed techniques and approach. These could also be communicated to their fellow colleagues with a view to finding and selecting projects for case studies.

6., To ensure the development programme objectives are achieved and further the interest of continuity, the SMIPC engineering staff should have an accelerated practical training within the specialised areas of LCA. The field of loading/unloading and positioning mechanism for example are specialised technologies on which the whole concept of LCA is dependent and can make the difference between success and failure. Therefore, perhaps two engineers from the SMIPC should participate in a training programme in these fields. The training should be within a working environment, sharing new technology concepts within leading industries and the implementation of technological change. There are several British companies I am in connection with, which would be a suitable ground for on the job in house training purposes. These include companies with substantial reputations like John Brown Automation, GKN and Vavis Engineering to name a few.

7., In conclusion of the programme of recommendations is the imperative case study program. Projects which have been approved by SMIPC and when these are available and have been

put into a conceptual perspective, I would participate in the execution of the concepts, designs and constructions with the SMIPC engineers. This would cover assembly areas and will indeed overlap with other fields of expertise, referred to in the introduction, these could then be called upon as required when the project concepts and most importantly, their acceptance with the industrial enterprise who would be the end user/manufacturer.

D. ACTIVITY

An account of the companies visited, the problems presented/discussed, and the advisory recommendations.

1. Company; KONG HWA METAL INDUSTRIAL Co Ltd.

1.1 Points of Discussions.

1.1.1 Oil Pressure Switch assembly: Methods of assembly with conventional bench method, no mechanical aid which would be classed as automation is used. The method of picking components are not from dispensers and the placing aside the assemblies are batched for manual transport to the next assembly point. A form of automation was discussed but there were signs that models may change and the degree of automation therefore should take cognizance of this. However, the present method could not be observed in depth at the Seoul plant since the full assembly lines are at the company's Ulsan plant. Visiting this plant gave more insight to the operations but the methods employed were as conventional as at the Seoul plant.

1.1.2 Thermostat Assembly: The methods of assembly are the same as for the Pressure Switch. This assembly is more laborious and again they were not sure how long the present type, for which automation or mechanisation could be considered, will be in production.

1.2 Advisory recommendations.

Initially the understanding was that the company would require an automatic assembly unit for each of the two assemblies which are for the motorcar industry, . Although at the Seoul plant they have an automatic assembly unit for the Thermostat's sealed switch, during my visits this was not running.

Although, the company's products in principal are suitable for automation and these indeed are manufactured by the majority of small/medium companies in Europe mostly on a special purpose machine. Automation however does require that the methods and the design are in harmony with the objective. Therefore, I have suggested the first objective should be to establish all round method improvements throughout the whole technology of manufacture before automation can be effective. An example to this is my proposal (Annex, Figs.12. and 13.) illustrate how substantial benefits can be achieved. Initial approach in this direction would strongly be advised, particilarly for assembly areass. This company would require further attention and study but in the first observations the following suggestions could be made;

1.2.1 Press operations efficiency could be substantially improved with a mechanisation programme for loading and stacking of components on and off presses. It has been agreed that I will furnish SMIPC with further information and details from my collection of previous activities in a suitable form which could form the basis of a LCA module development for wider applications throughout the small and medium companies.

2. Company; ROYAL METAL IND. Co. Ltd.

2.1 Points of Discussions.

The product, although these are in several styles and sizes, are manufactured with the same production methods from the pressing process, through heat treatment and to final assembly. The plating plant is automatic but loading/unloading and placing onto jig-frames is by the conventional method. Plating is followed by applying the decorative finish and packing. The assembly of the products are at present subcontracted but the method deployed were demonstrated. Discussions therefore, were largely concentrated on the present problem area which is the Grinding section. The method deployed requires skilled operators for manually grinding the cutting edges (annex, Fig.1 & Fig.2). Dependence on the operator's skill also causes problems with the resulting quality.

2.2 Advisory recommendations.

2.2.1 Grinding of the cutting edges with the present method is performed after assembly as the technique requires the operator to gently squeeze on the lever to maintain a perfect edge. My recommendation, which is important from the automation point of view is to grind first and assemble afterwards. This was agreed with a view to facilitate the design of a special purpose but flexible automatic machine to accommodate all present and future models of similar styles. Further suggestions and a design concept was presented for a LCA unit where at a later stage additional processes could be added to additional stations (annex, Fig.3 & Fig.4). To achieve this a further study of the processes would need to be undertaken in conjunction with setting a company objective.

3. Company KOREA AUTOMATIC MACHINERY IND. CO. LTD.

3.1 Points of Discussions.

At the time of the visit they had completed development and were in the final stages of assembling an eight station index type machine centre for the machining of the first phase of a small and delicate component.

In concept, the approach with which they deployed design and construction indicated good engineering skills and I have every confidence that when they commence trials they will solve the incurring troubles and the machine will perform to satisfaction.

As the machine was almost complete, there was little room left to advise on improvements which could easily and without substantial costs be implemented, however, advice for future consideration on the company's approach to automation machines concept in general was discussed.

3.2 Advisory recommendations.

As an upcoming young company, they are tackling the automation concept in the right way. However, if their aim remains to establish themselves in the field of supplies of automatic solutions including indexing type of machine centres, the present approach to design and manufacturing the individual units of work stations without consideration to standardisation is not a practical practice. I have recommended that they address themselves, like many other successful companies in this field, to standardisation of LCA models along the following lines.

3.2.1 Development of a Basic Machine Module with the purpose of being future KAMIC (Korea Automatic) system for about 90%-95% of the automatic solutions they undertake for machining solutions.

3.2.2 Develop a standard building block of KAMIC work station modules for horizontal and vertical feed activities which could then be used for all applications as required, either singular or in combination to provide 2 axis movement.

3.2.3 Develop a standard KAMIC work piece holder which could be the base for most types of cylindrical workpieces and easily adapted to other types of workpieces. With this method only the immediate holding fixture to suit the part in question needs to be designed with a linkage to the existing holder unit.

3.2.4 Since I have been involved in development of a similar field in the past and have introduced special purpose machinery concepts for successful applications through the whole technology of machining application layouts with basic assembly operations added. This knowledge and experience, if required, is available and there is an opportunity for this company to develop and be a supplier of LCA concepts to the manufacturing small and medium industries.

4. Company; HAN KOOK SIN YAK PHARM.Co LTD, DAEJEON.

4.1 Points of Discussions.

The discussions were centred around the present method of packaging. The products, presently packaged are approximately 10mm diameter ball shaped objects. Two methods are employed for two different requirements, both require some degree of dexterity by the operators

4.1.1 The first method involves an aluminium foil of approximately 4mm square onto which the 'ball' is placed by the operator and then folded in a specific way to end up wrapped with a square edged look. This is then sealed with a narrow self adhesive label, again this is applied in a predetermined way to prevent unwrapping until it is used.

4.1.2 The same or similar looking ball shaped product with the second method is wrapped in gold foil, then this again is covered in rice paper after which it is placed into a plastic half sphere and then closed with the other half. This operation, we all agreed, is a difficult one due the foil's extreme thinness.

4.2 Advisory recommendations.

Any recommendations to design an LCA based solution to the company's present method of packaging these objects would be very difficult to execute with low cost. The volumes of 200,000 and 100,000 pieces per month, are by comparison with this type of automated operations, extremely low. Automatic machinery of this type is capable of producing the company's monthly requirements within three hours, therefore this is a high cost equipment which would not be easy to justify.

5. Company: Dae Yang Fish Hook Ind. Co. Ltd.

5.1 Points of Discussions.

From the discussions during the visit it became apparent that the company has achieved a degree of low cost automation where the operation was of a less complex nature. The automation techniques deployed are the extensive use of cam operated linkage systems. The areas which were shown to me and would require improvements are those which at this time are very labour intensive. Discussions on these areas are summarised in the following.

5.1.1 Treble hooks are constructed from one double hook and one single hook with an eye. These are then assembled in an area with 12 work benches where three or four operatives are assigned per bench. Within this environment one operator does the welding whilst the others main task is to feed this person with a single loaded fixture, therefore the process can be continuous. Thinner gauged wire hooks take less time for heating up to the right temperature and require one more feeder. The company made an attempt to introduce mechanisation for this operation for one of the product ranges but this did not work satisfactorily.

5.1.2 A process which is deployed for another type of fish hook could be the subject of improvement. The process involves cleaning after heat treatment by tumbling in a barrel. This operation has the effect of not only cleaning but entangling the hooks in a mass which requires separation with considerable effort and time.

5.1.3 Swivel rings which are an accessory to the hooks are produced in several diametrical sizes. Those which have

three equally spaced holes on their side of 0.8 mm diameter and the ring's themselves are between 5mm and 8mm in diameter with a 5mm wall thickness can be the subject of automation. The holes are punched with a hand operated bench press whilst the operator holds and positions them individually while with the other hand operates the press.

5.2 Advisory recommendations.

5.2.1 Treble fish hook assembly requires one person constantly for the welding per bench and it can be classed as skilled work whilst the feeders need dexterity but the task is not necessarily skilled. The most advantageous benefits could be derived if the feeding or the loading/unloading is automated whilst, initially the welding remains as it is. This suggested approach is different from their previous one where they automated the welding and retained the feeders on the circular machine. The concept of the suggested automatic machine with the recommended method is illustrated. (annex, Fig. 14). The development of this machine would use standard LCA module technology but would impose a requirement for the maintenance of tôlerances during previous processes where the present methods do not provide the necessary consistency suitable for automation. These by all means do not represent an obstacle to achieve automation. Therefore, the whole process needs a deeper investigation than present time has allowed before detailed design can be proceeded with.

5.2.2 Cleaning the hooks by the barrel method is an effective process but the resulting entanglement is undesirable. There are chemical processes available but I was informed the company had tried them before. The alternative would be to use the vibratory technique of cleaning which is a

recently improved technology.

5.2.3 Punching of the holes on the circumference for the small swivel rings can be automated which would be on a special purpose machine of rather more complexity than if the method is changed and these holes would be drilled and deburred. The automatic machine for this purpose would be constructed from available and proven LCA modules with substantially less effort and cost than using the punching method.

6. Company: Shin Hung Precision Machinery.

6.1 Points of Discussions.

The company's main activity is predominantly cylindrical grinding and the loading of the workpieces are mostly automated whilst the automatic unloading is not yet as widely used. The longer shafts are straightened on a hydraulic press and at present are entirely operator dependent. Around this area they were interested in possible improvement.

6.2 Advisory recommendations.

The solution for the straightening operations are presently too expensive in the form of purchasing a numerically controlled modern machine. There is however, a possible way with less expense to retrofit computer control servo systems, which are available for this purpose. I have promised to enquire and supply them via SMIPC with the relevant information.

7. Company: Sung Jo Industrial Co.

7.1 Points of Discussions.

The machinery within this company were the most modern, automatic loading was applied successfully for the majority of cases. The production consists mostly in turning operations. The problems we discussed were method engineering related and the resulting non consistent quality. It would be possible to examine more thoroughly the causes but the available time prevented this. I therefore, gave advice upon the effect of the resulting problems with the three workpieces they were concerned with and pointed in the direction which should be investigated and suggested the modification of the relevant tools which I believe are the probable source of the problem.

8. Company: KONG HWA METAL INDUSTRIAL Co. Ltd.; ULSAN Plant.

8.1 Points of Discussions.

This is the second plant of the company visited at Seoul but the manufacturing unit only assembles oil pressure switches with the same method. Here we had a better opportunity to examine not only the methods but could also observe the tooling used. The discussions were short, this was done with the management at the Seoul plant, therefore, most of the time was spent in the assembly shop.

8.2 Advisory recommendations.

The recommendations, with reference to the oil pressure switch assembly are summarised on page 14, referring to the visit at the Seoul plant and the concept of a proposal made is Illustrated (Annex, Figs.12 and 13). This highlights the importance of those views, expressed (page 9) that assembly area automation is different to process automation and requires an outlook for a wider approach. Using the technique of Value Analysis for the Switch Cover Assembly in the proposal suggest three components and one press operation can be eliminated. These changes would have a dramatic effect upon LCA implementation.

E. ANNEXE

1. List of Companies visited and personnel involved in the discussions.

1.1, Company; KONG HWA METAL INDUSTRIAL Co Ltd., Ansan,(Seoul)

Mr Jung Koo Hak., Director
Mr Lee Chong-Won., Technical Dept;
Mr Lee Joun Hoon., President.
Mr Lee Hyung Guyn., Eng. & Design Dept. Manager.

The company are manufacturers of car thermostat and oil pressure switches for the motor car industry. These are the main production items but they also produce, in smaller quantities a few other items of similar nature.

1.2. Company; ROYAL METAL IND. Co. Ltd., Bucheon, (Seoul)

Mr Kim Jun C., Vice President
Mr Kim Kap Soo., Production Manager
Mr Jun K. T., Section Chief.

The company's plant at Buchun produces nail clippers of different size and construction:

1.3. Company KOREA AUTOMATIC MACHINEPY IND. CO. LTD., Seoul

Mr Lee Youn Ho n President.
Mr Lee Hyung Guyn Chief Design Mgr.

A small industrial enterprise with about 12-15 employees in business to supply special purpose automation solutions. At the time of the visit they had completed development and were in the final stages of assembling an eight station index type machine centre for the machining of the first phase of a small and delicate component.

1.4. Company; HAN KOOK SIN YAK PHARM. Co. LTD, DAEJEON.

Mr Lee Young Ho, Managing Director

The company are mainly manufacturers of herbal drugs and pharmaceutical products.

1.5. Company: Dea Yang Fish Hook Ind. Co. Ltd., Busan, (Pusan)

Mr. Choi H. Y. Assistant Manager
Mr. Jung M. S. Production Section Chief

The company are the producers of a large variety of fish hooks and other accessories for the same application.

1.6. Company: Shin Hung Precision Machinery., Pusan.

Mr. Choi Sung Jae, Sales Department Manager.

Small manufacturing unit subccntractors to the motorcar industry.

1.7. Company: Sung Jo Industrial Company., Pusan.

Mr. Lee J.M. President
Mr. Kim Young Dong. Manager.

Small well equipped manufacturing unit suppliers of component parts for the motorcar industry

1.8. Company: KONG HWA METAL INDUSTRIAL Co Ltd., Ulsan,(Pusan)

Mr Jung Koo. Ryong., President.
Mr Lim B. H. Section Chief.

The plant is an assembly unit of the company visited in Seoul.

2. An LCA Model Concept for Special Purpose applications.

The concept is a proposal for the Royal Metal Ind. Co. for automation of grinding the cutting edges on the nail clippers.

It is an adaptable construction for a variety of uses throughout small and medium size industry where the emphasis is not on the assembly process. The Linear Link Conveyor can be designed in a modular principal and could be made in a wide variety of lengths. The advantage of linear construction is the space saving feature and it easily interfaces with existing machinery.

The illustrations show a linear link conveyor design proposal for Royal Metal Ind. Co. Ltd., (Fig. 3 & Fig. 4) where the grinding operations would take place automatically. It is proposed that not only the cutting edge is ground but the existing side grind operation can also be considered. Additional operations can be added gradually to achieve a fully automatic line.

Also illustrated (Fig.5) is the fixture concept, taking into consideration the requirements as it was pointed out during my visits.

NAIL CLIPPER

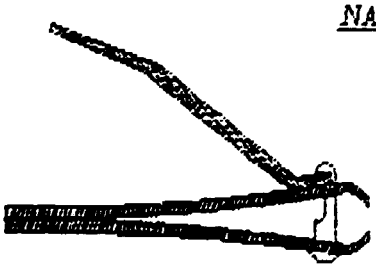


Fig: 1.

Semi assembled with handle.

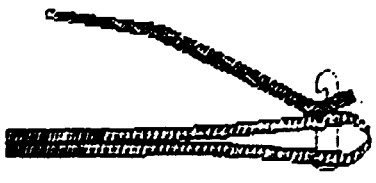


Fig: 2.

Handle action closes cutting edge.

Method required during grinding

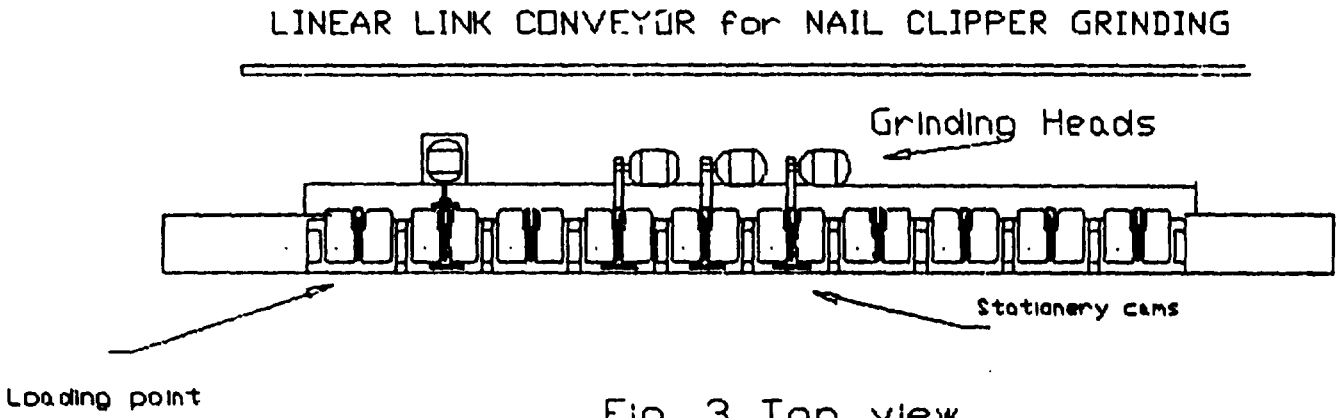


Fig. 3 Top view

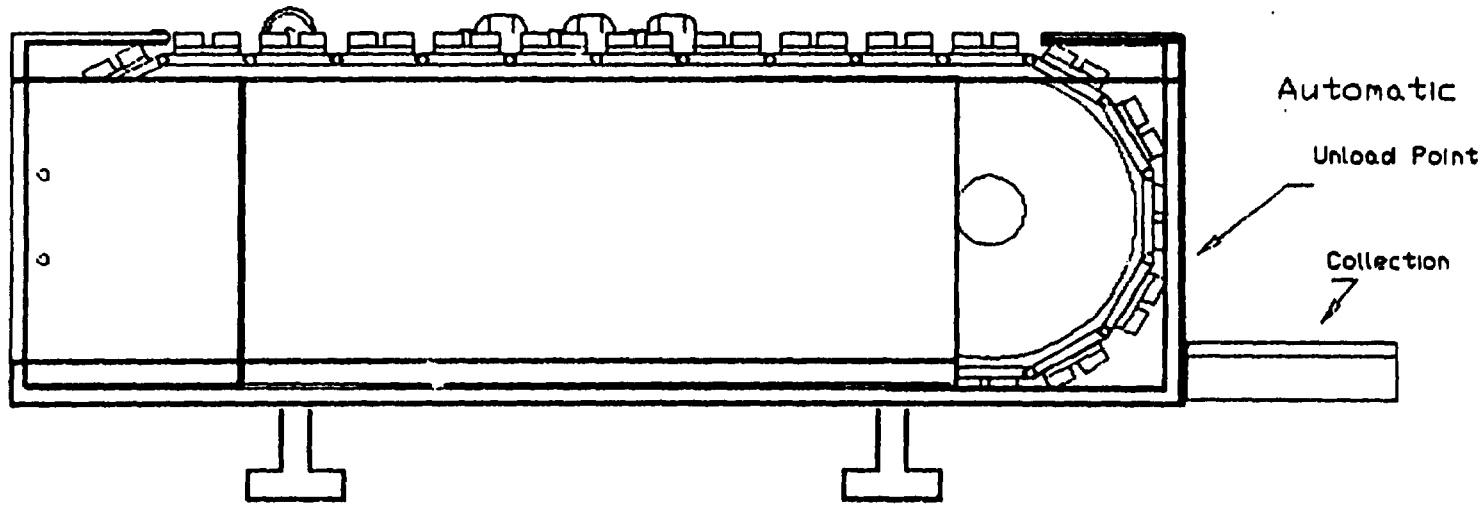


Fig. 4 Side view

CONVEYOR LINK and GRINDING TOOL ASSEMBLY

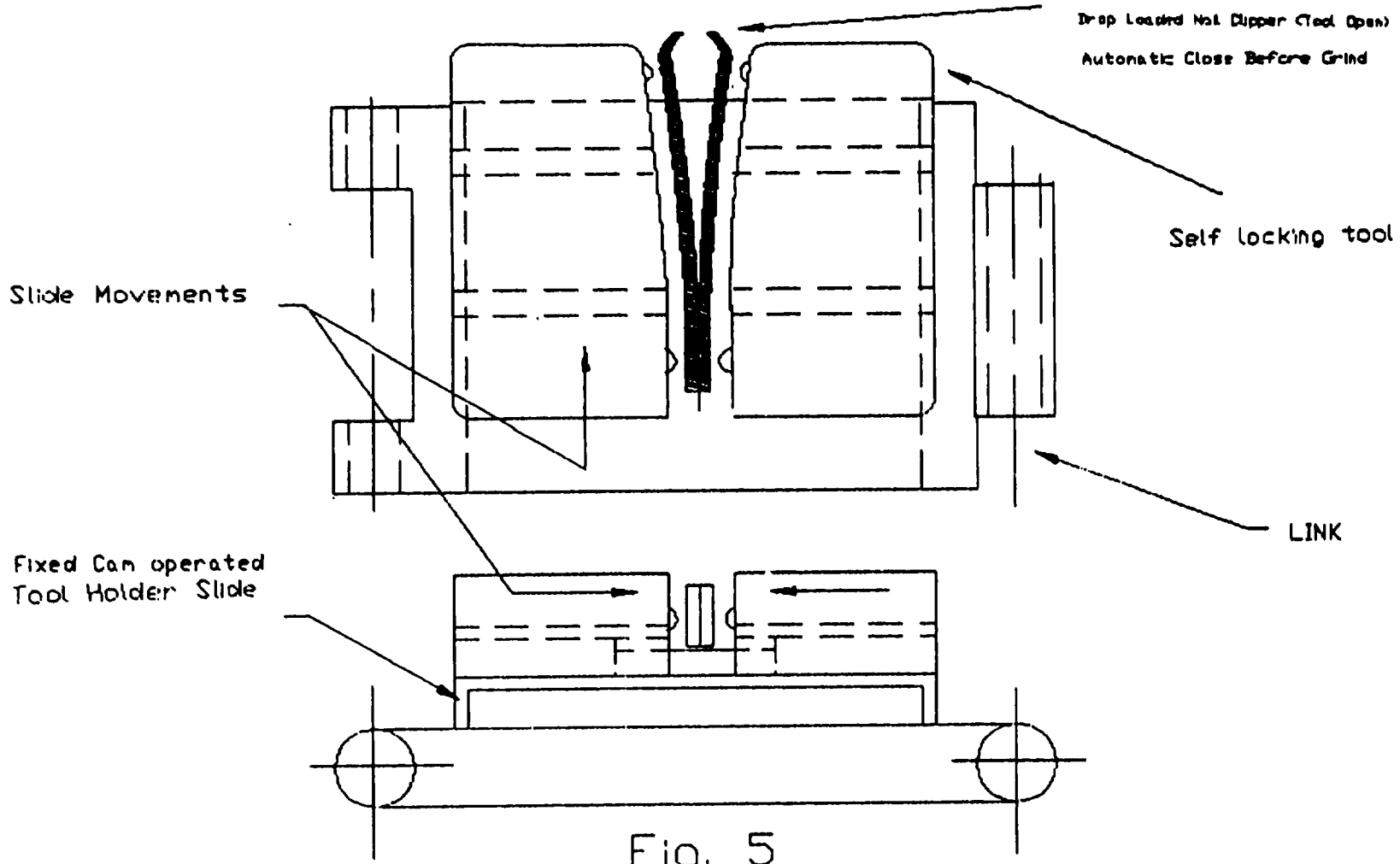


Fig. 5

3. An LCA Module Concept for Assembly Areas.

This application concept could be suitable to assembly areas throughout the Small and Medium Size Industry as well as to those companies reffered to in this report.

I have implemented this system, in several configurations and applications in the past and it can be used for semiautomatic or fully automatic assembly of medium batch size or for mass productions. The assemblies are on jigs, transported on platens (Fig. 6)and there can be more than one one type of assembly on the jig or platen.

The platens are transported on linear tracks and are attached to a small conveyor belt. The system is designed to move the platens in a straight direction along the module and at the end of a module segment are turned 60 degrees to pass from one module to the next. On each module there can be one entirely manual operation or automatic operations of Automatic feeding and placing of components, spin riveting, pressing, screwing, greasing, testing, etc. but there are almost no limitations. Dependent on the required operations several transport modules can be linked together, (Fig. 7-11) in almost limitless combinations but the basic hexagonal concept with perhaps buffer zones is the most suitable to start off with.

Some assemblies will require a number of independent stations, manual and automatic, and all can be linked together. Each platen can be coded thus the sequence of assembly can be followed automatically if Programmable Sequence Controller is added. The flexibility allows sections to be inserted between any transport modules thus the number of stations and the system's configuration is virtually unlimited.

A system, like the concept I propose here, is an indication of how LCA can be applied to assembly technology.

LCA ASSEMBLY SYSTEM CONCEPT

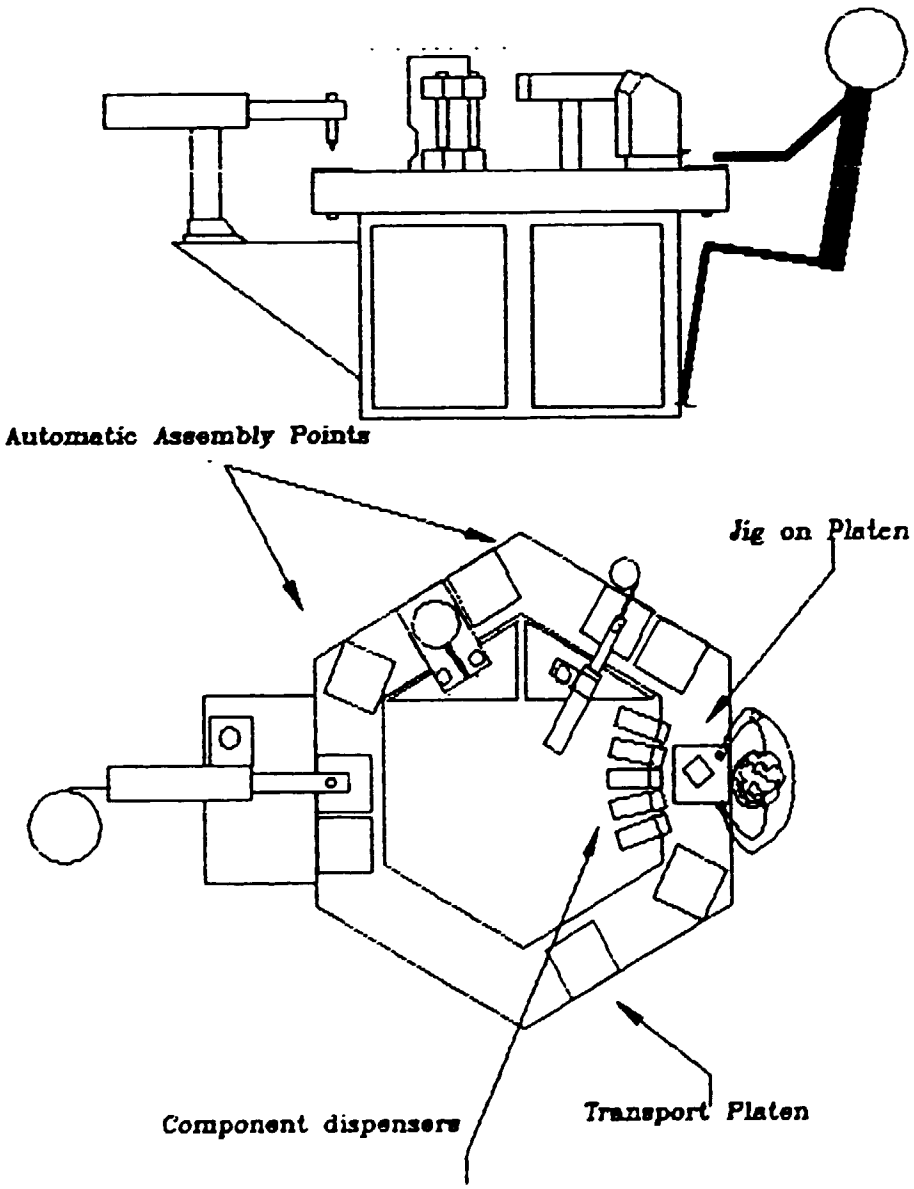
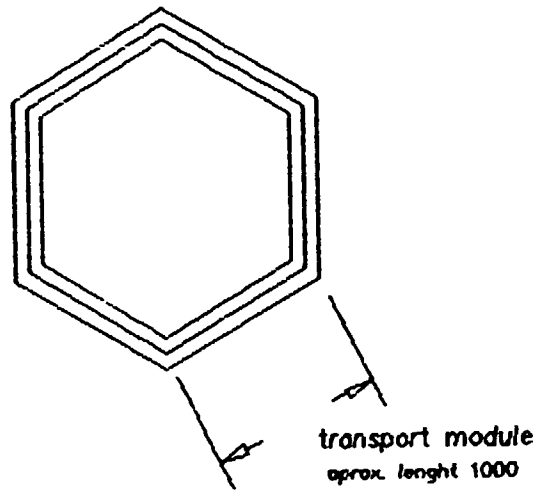


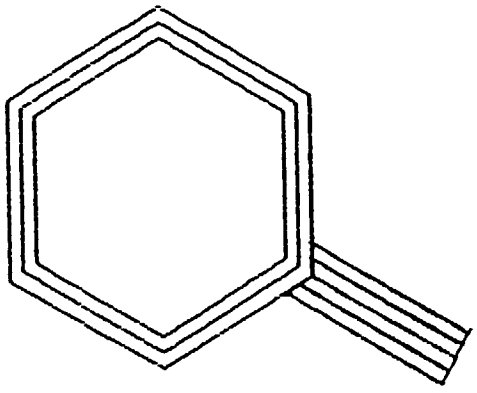
Fig. 6

LCA Assembly system flexibility.
Examples of Modularity



BASIC UNIT

Fig. 7



BASIC UNIT

with buffer module

Fig. 8

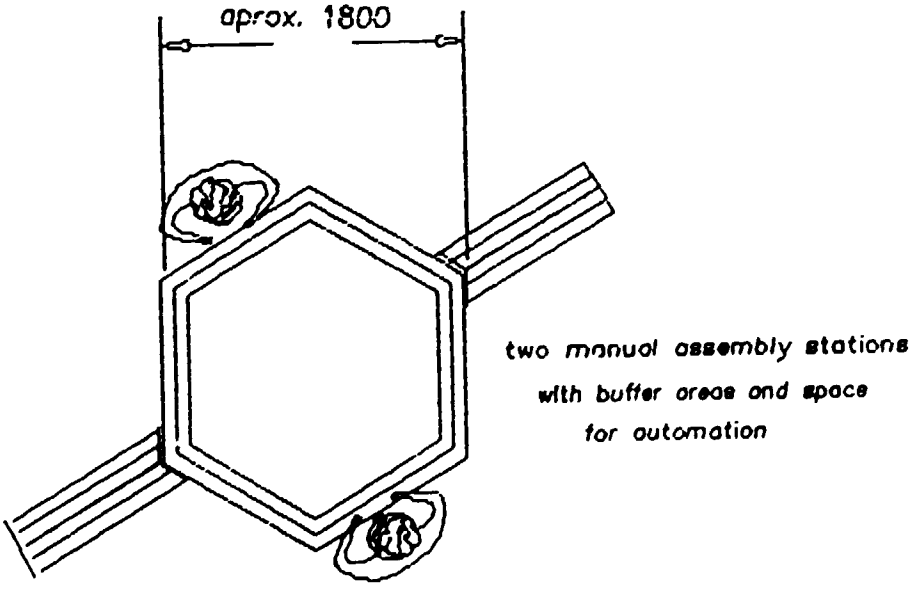
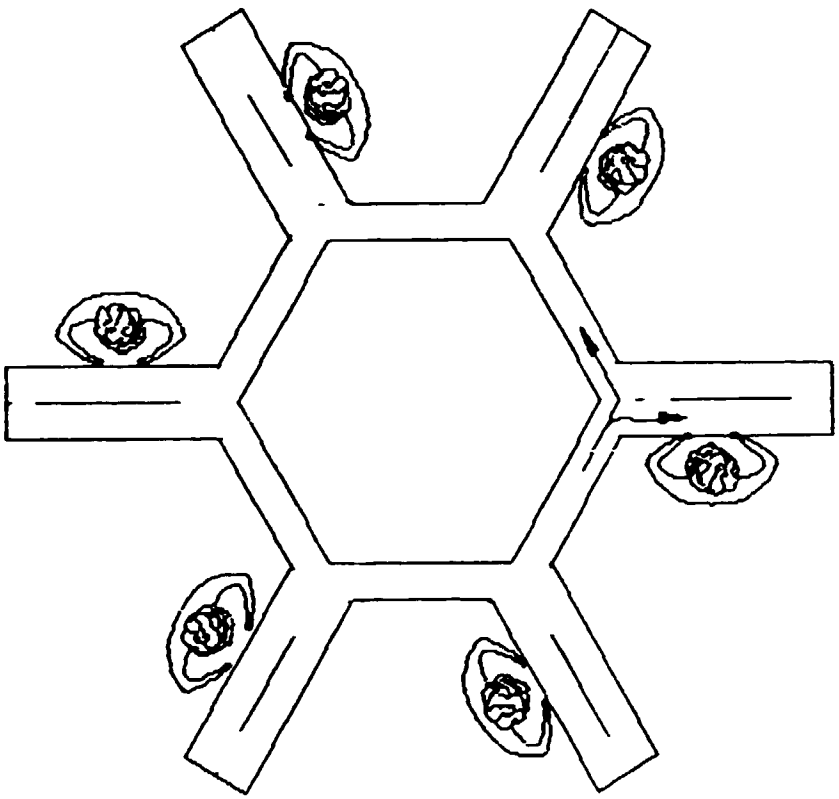


Fig. 9

LCA Assembly system flexibility.

Further Examples of Modularity



Six station Manual LCA Unit of approx. 1700 radius

More than one Assembled Components on one units

Fig. 10

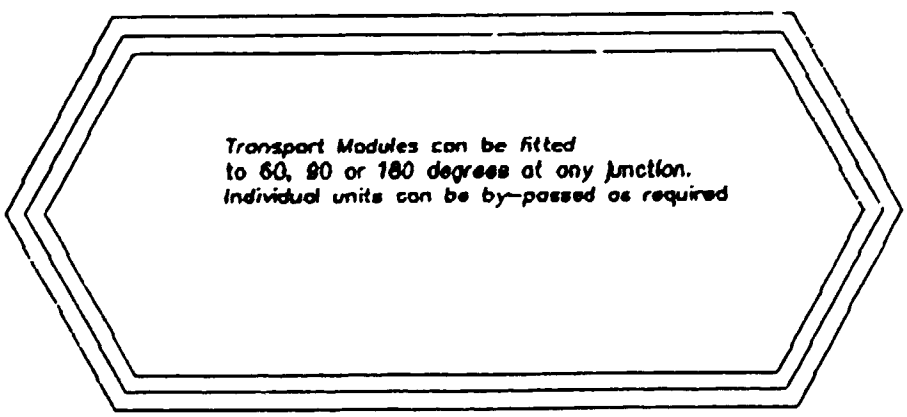


Fig. 11

Oil Switch Cover

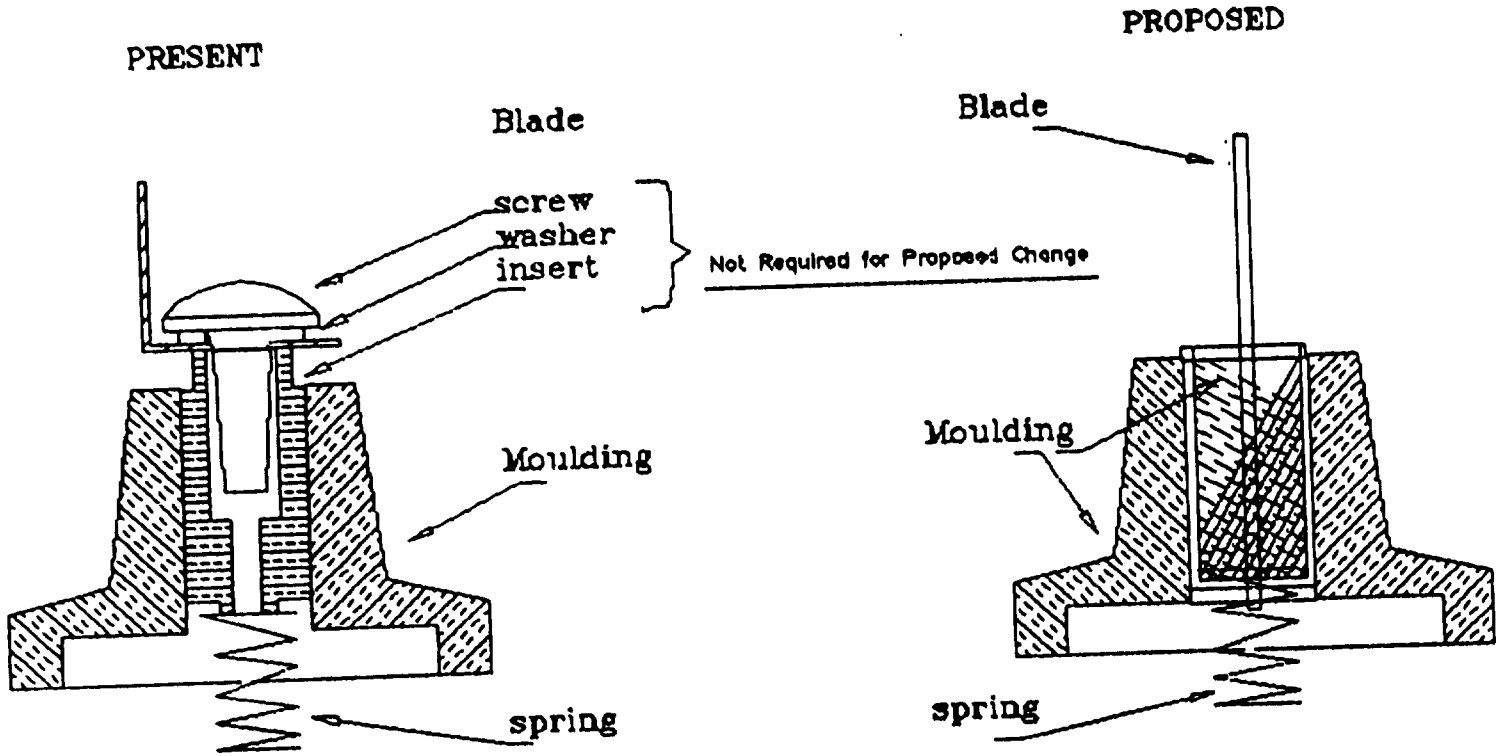


Fig. 12

Fig. 13

LCA Concept: Fish Hook Welding

A Special Purpose Machine Solution

FOR ONE TYPE OF HOOK ONLY

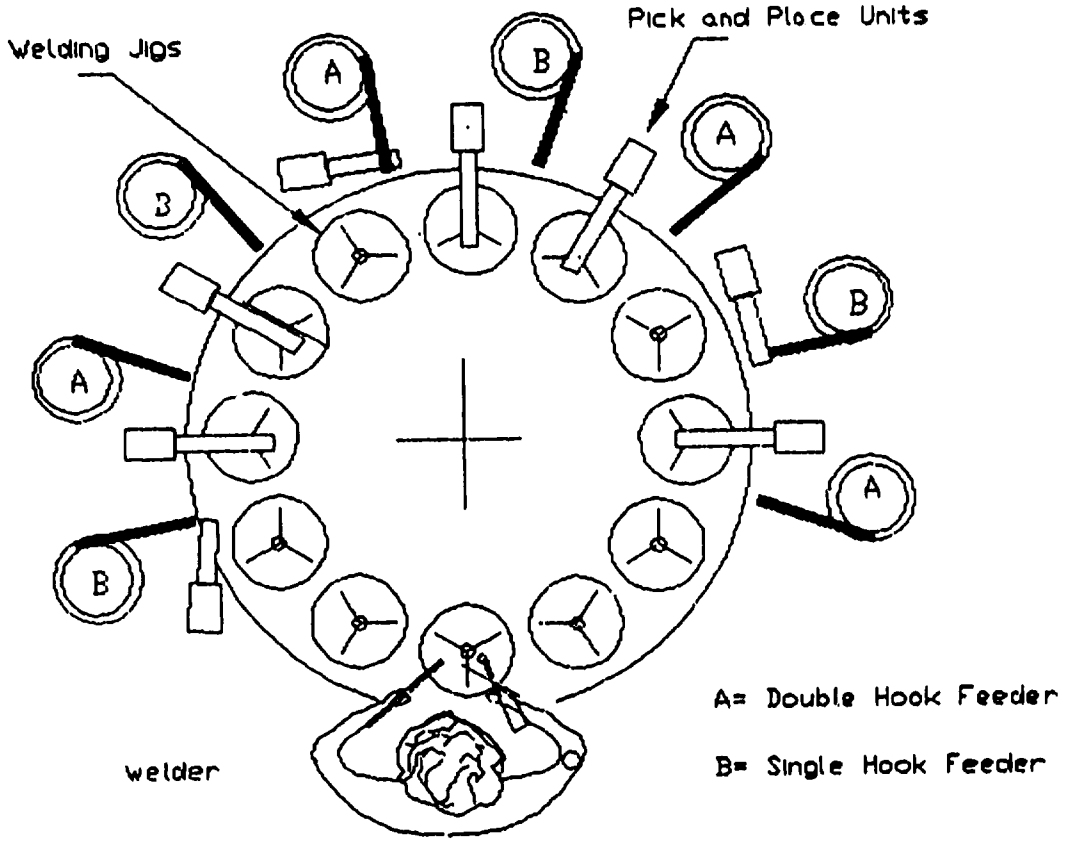


Fig. 14

LCA Concept: Fish Hook Welding

An LCA Assembly System Solution

FOR MORE THAN ONE TYPE OF HOOKS

(mixed type assembly line)

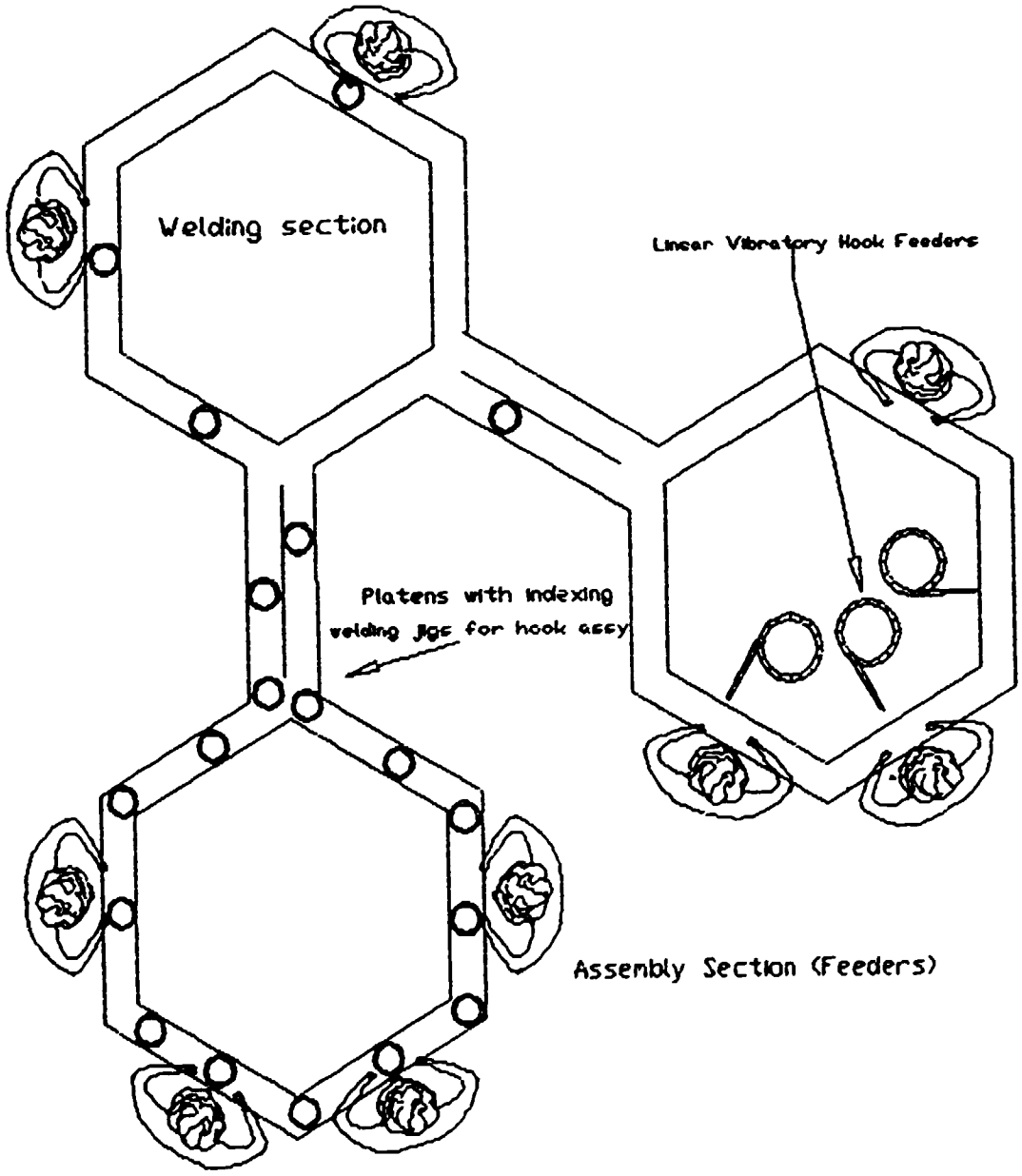


Fig. 15