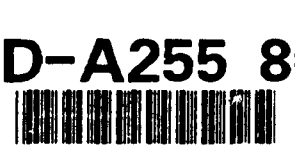

June 92 Final Technical, May 91 - May 92

Comparison of Cost and Production Between a Traditional Bundle System and a Unit Production System Installation; Installation of a Modular Sewing Station Carousel.

C-DLA900-87-D-0016-0003/ 000302/000303/000304

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The Educational Founlation for the Fashion Industries
227 West 27 Street
New York, NY 10001

000302

Defense Logistics Agency
DLA Manufacturing Engineering Branch
Cameron Station (DLA-PRM)
Alexandria, VA 22304-6100

NONE

Unrestricted

The objective of this project was to study the impact of a 3 to 4 sewing-station carousel unit on apparel productivity, with special emphasis on the impact in a flexible (Unit Production System) environment.

Upon installation the unit's operation was observed and analyzed. The following conclusions are drawn:

The unit is best suited for performing a series of sequential operations; cost, production time and space savings are possible if the unit is used; Installation costs are justified if the unit replaces at least two UPS stations; Adoption of the unit is dependent upon ingenuity of production management; and operational safety of the unit needs enhancment.

The project has been completed.

Cost, Production, Modular, Flexible, Carousel, Unit Production System, Apparel Manufacturing, Sequential Operations, Safety

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INSTITUTE

OF TECHNOLOGY

RESEARCH REPORT

ANALYSIS OF GARMENT PRODUCTION METHODS

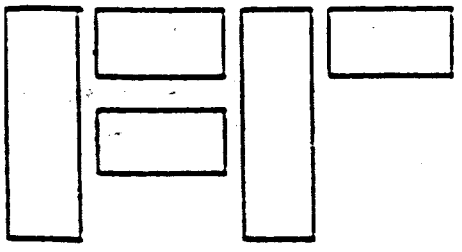
PART III

INSTALLATION OF A

MODULAR SEWING STATION CAROUSEL

MODULAR MANUFACTURING

Fashion Institute of Technology



DLA900-87-D-0016/0003

MAY, 1992

ADVANCED APPAREL MANUFACTURING TECHNOLOGY

FASHION INSTITUTE OF TECHNOLOGY

DLA900-87-D-0016-0003

INSTALLATION OF A MODULAR SEWING STATION CAROUSEL

FINAL TECHNICAL REPORT A008

JOSEF KORNGRUEN
Project Leader

May, 1992

This project has been sponsored by the
DEFENSE LOGISTICS AGENCY
CAMERON STATION
ALEXANDRIA, VA 22304-6100

This research report is the result of work performed under sponsorship of the Fashion Institute of Technology and the United States Department of Defense, Defense Logistics Agency (Contract DLA900-87-D-0016).

It is hereby submitted to the DLA office (DPMSO), Cameron Station, Alexandria, VA 22304-6100 in accordance with the Contract Data Requirements List, sequence A008.

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Noah Brenner
Aaron Schorr

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INTRODUCTION

The new Kansai Super Indexer SR-240 carousel unit, an innovative product of Kansai Special Engineering Corporation, is the result of linking an existing but relatively unused garment production concept with the newest electronic programming capability. In this new production system several different assembly operations can be performed at a single work station that is equipped with three or four different sewing machine heads. The heads are mounted, merry-go-round fashion, on a turntable. The turntable motion, clockwise or counter-clockwise, can be sequentially programmed so that each head can be separately rotated to the operator's position upon command to allow specific operations to be performed as necessary. The Super Indexer can easily be programmed to accomodate up to 99 different sequences as might be required by product or style changes.

The system is primarily intended to be used in a modular manufacturing environment. Our study, however, focused on the integration of the Kansai carousel unit into a Unit Production System (UPS) environment.

The carousel unit is very capital intensive. This factor weighs heavily in the evaluation of its integration into the UPS environment. The question is, can the combination of the two systems, carousel and UPS, generate production gains on a scale that would make the Kansai carousel installation cost effective. Our study shows that under certain circumstances the integration of the two systems offers an acceptable return and can be justified. We also found that adoption of the Kansai carousel provides some meaningful manufacturing advantages but without necessarily creating any measurable payback.

TECHNICAL ASPECTS

The term "carousel" is a very apt description of this piece of equipment which is much like a computerized lazy-susan. The working surface is round and is composed of four separate quarter sections. The entire surface is capable of rotating to the left or the right as one unit. Each quarter section can hold a separate sewing unit complete with it's own drive motor. The work surface assembly is supported by a center column which is mounted on a heavy, square, welded steel base. The base has heavy duty casters and adjusting posts at each corner for leveling the work surface. Exhibits 1A and 1B provide top and side views of the Kansai Super Indexer SR-240 carousel unit.

The height of the unit's work surface (38.75 inches, 98.4 cm) makes it mandatory that the unit's operator stand erect in order to accomplish the work to be done. The top of the turntable has a 61 inch (154.8 cm) diameter. The system's controls and the programming board are both mounted in a cabinet which is placed to the side of the carousel turntable. Exhibit 1A shows the standard four-position configuration of the unit.

Compressed air, needed for some presser foot lifters and thread trimmers, is fed to an inlet on the system's center post. Power is brought to the carousel via a four wire heavy duty cord and is fed directly into the control and programming console. The operation of the unit is controlled by a foot pedal system on the floor.

Each sewing machine that is mounted on the turntable must have its own drive motor. All the drive motors on the carousel should be of the same make and style so that each machine's basic functions such as start, stop, presser foot up, thread trim, etc., can be controlled with a single, one-pedal system. If the drive motors of the sewing machines are of different makes a three-pedal system must be used. Operationally, the one-pedal system is much simpler and easier to use than is a three-pedal system. The mechanics of the carousel unit are such that only the machine in position at the operator's station can be operated. The other sewing units on the carousel are inoperable when they are not in position at the operator's station.

The sequencing of the sewing machines is programmed on a control board which is mounted in the top surface of the control cabinet. Exhibit 2 offers top and side views of the control cabinet which contains the unit's power distribution system and electronics. The top view also shows the position of the programmable control board.

The layout of the control board is shown in Exhibit 3. Inasmuch as the programming keys are skin switches the programmed display has to be carefully examined to make sure that the proper switches have been activated since the programmer or operator cannot feel such activation. Programmed sequences show up on the control board in a low-light red display which is difficult to read under most bright light conditions. A shaded, tilted or brighter display would offer better visibility. The control system has the capacity to hold 99 different sets of sequences, but since there are a maximum of only four stations on the carousel unit the probability of ever filling the system to capacity is low. The sequencing of the sewing machines brought to the operator's station is controlled by a switch which can be triggered by the operator's hand or foot.

Note must be made that the system is furnished with only one emergency shut-off button. We feel this is not sufficient and recommend that two hand buttons and one foot switch be supplied with the unit.

The standard configuration of the unit, wherein the operator stands to the right of the console, was found to be inconvenient for our use at F.I.T./AAMTD. Because of its position, the console interfered with the operation of the Unit Production System. It was necessary, therefore, to make some changes. We "flipped" the console so it was now to the right of the operator's position and we were thus able to align the turntable unit with the UPS system. This seemingly simple change made the interaction of the carousel unit with the UPS work quite well.

The transfer of the console from the left to the right of the operator's position proved to be far from simple and required a great deal of work. The original cabling between the carousel and the control cabinet was too short and had to be extended. The programmable control board was now very inconveniently located for easy use and we had to construct a new top for the cabinet in order to change the board's position. To make the control board and its displays more accessible and visible we pivoted the programming board 90 degrees and reset it so that it became parallel with the long straight side of the cabinet.

It was also necessary to make some adjustments to the UPS work station. The garment carrier chain had to be raised to match what now became a standing work station, and the station's UPS terminal had to be relocated for better visibility and access. As a result of this work the unit is now more comfortable to work on.

On the whole, the Kansai Super Indexer SR-240 carousel unit is well constructed and should serve a user for a long time. However, we feel that the addition of certain features would enhance the system.

1. At start-up the system should automatically go to point zero. At present the operator has to line up two locating marks before the system can be turned on.

2. The tabletop part of carousel is made up of four sections or wedges, each one covering one quarter of the disk. These wedges are not set side to side. Rather, there are small spaces between them and garments can easily get caught on the sharp outside corners of the wedges. This is a potential problem which can be easily eliminated by placing an edge trim completely around the outer rim of the turntable disk.

3. For the sake of safety, the operator should be able to activate an emergency stop motion with either the left or right hand or either foot. To accomplish this, however, would require adding a second hand activated button as well as a foot-activated device. Cables long enough to enable proper location of all emergency stop devices would be coincident to their provision.

4. The programming board is very hard to read under most bright lighting conditions. A more readable display would be very helpful.

See Appendix A for a detailed safety analysis of the Kansai Super Indexer SR-240.

KANSAI CAROUSEL APPLICATION ANALYSIS

The combination of the Kansai carousel system and a Unit Production System becomes most cost effective when the carousel unit replaces two or more UPS work stations. Such a combination of systems would fit into any UPS manufacturing program where there are several short cycle operations and the person or persons who perform these operations has/have to float between several work stations in order to balance the UPS work flow. The carousel unit will eliminate the need for the operator to move from work station to work station and the time saved would be rechanneled into output. Also, the company will save the cost of the two or three UPS work stations which it does not have to install. This saving alone will tend to offset the initial cost of the Kansai carousel system.

The combination of systems can be applied in two ways and both can be cost effective. One application method is the performance of two, or preferably three or four, sequential operations on the carousel unit. If a company produces the entire garment on the Unit Production System there is a greater likelihood for the existence of such sets of sequential short cycle operations in the production process than if subassemblies, such as trouser flies and skirt zipper assemblies are produced off-line. Sequential sets of operations suitable for performance on carousel units exist on many products. For example, in boys pants the front pleats have to be sewn down with a lockstitch machine and then the pockets have to be closed with a safety stitch machine. Both are short cycle operations and they are sequential. Similar combinations of sequential operations can be found in many styles of slacks, skirts, dresses, etc., etc.

The Kansai carousel unit probably will find wider acceptance with the second type of system application: non-sequential short cycle operations. While a single UPS loading rail can accommodate a mix of operations, a mixed rail would present difficulties to the carousel work station operator. The operator would first have to determine which operation has to be performed and then switch to the machine needed for that operation. This lengthens the operation time. Of course, there is always the possibility of devising some sort of signal which will tell the operator in advance what has to be done to the next work piece. At present there are no such signalling methods available commercially and, therefore, potential users will have to design their own methods of signaling. This situation was discussed with several members of the sewn products industry who are familiar with training multi-operation workers. It would appear that most carousel operators very quickly learn how to rapidly and without any loss of time determine what work has to be done on a product. Under such circumstances the addition of a signaling or interfacing system would not be required for the UPS/Kansai carousel systems application.

Undoubtedly, the best way to use the combination of a Unit Production System and a Kansai carousel unit for non-sequential operations is to install sorting rails or sorting stations which will allow the Unit Production System itself to sort by operation. The carousel work station operator can quickly release the work pieces on any one of the rails and switch to the machine needed for that operation. The whole switching process takes .065 minutes

(less than 4 seconds) for a 180-degree turn of the carousel table top, less for a 90-degree turn. Four seconds is about the same or less time than it takes to pick up a work piece from a bundle. It is also much less time than the operator would waste going from one work station to another. Additionally, the sorting rails require much less floor space than a full size UPS work station.

With the non-sequential type of application the combination of the two systems offers a wide range of applications and makes the combination very flexible. This type of application also eliminates the need for operators to bounce between two or three work stations, which is much more time consuming than working on the carousel. Also, by having more than one operation to perform at the work station the operator has the ability to influence the subsequent flow of work pieces. He/she can control subsequent line balancing by concentrating efforts directed towards feeding work to those operations where there are no backups and only feeding into backed up line sections when the other sections are in good shape.

COST JUSTIFICATION FOR THE KANSAI CAROUSEL

The economic justification of the carousel depends on the timing of the installation. If a company installs the carousel at the same time it installs the Unit Production System the cost justification can be very simple. Since the carousel can replace two or more UPS work stations and the carousel cost is about $9,100 and the average UPS work station cost is about $5,000 the calculation of capital costs is very straight forward. The dollar value of the time saved by the operator not having to go from one machine work station to another eight or ten times an hour should also be factored in. A worker can easily lose an hour a day moving between two or three machines. On a 48 week per year basis this would amount to 240 hours per year. At $6 an hour this translates into $1,440 per year in direct labor costs spent for "travelling". Add to this an average manufacturing overhead of 85% and there is a potential yearly labor cost savings of $2664 per carousel work station.

A similar cost justification approach would be valid if a company needs to expand the production capacity of their present Unit Production System. Installing a carousel unit would be far simpler and less costly than adding work stations to the UPS. This would be especially true if manufacturing space is limited: a Kansai carousel/UPS workstation takes up an area of 72 inches by 84 inches (42 sq ft; 1.83 m x 2.13 m; 390 sq m) and the average UPS work station uses an area 84 inches square (49 sq ft; 4.54 sq m). Since one carousel/UPS workstation with three sewing machines requires 42

sq ft of space, this is 105 sq ft (9.72 sq m) less than three UPS work stations. While this does not save many dollars it does conserve floor space which is a very precious commodity. Floor space has become a major concern of the garment industry. Companies are having to constantly and quickly change styles and very often have to insert appropriate new specialized machines into the workflow in order to produce those new styles. The carousel offers a space conserving alternative.

CONCLUSIONS

The Kansai Carousel Super Indexer SR-240 provides the sewn products industry with an interesting new production tool. It is more capital intensive than most of the general production work stations the industry is accustomed to dealing with. It's use requires concentrated management study and imagination and it's success or failure in the marketplace will depend on the results of just such efforts. In the competitive garment production environment every potential production improvement must be investigated and evaluated without prejudice.

EXHIBIT 1A

KANSAI SUPER INDEXER SR-240
TOP VIEW

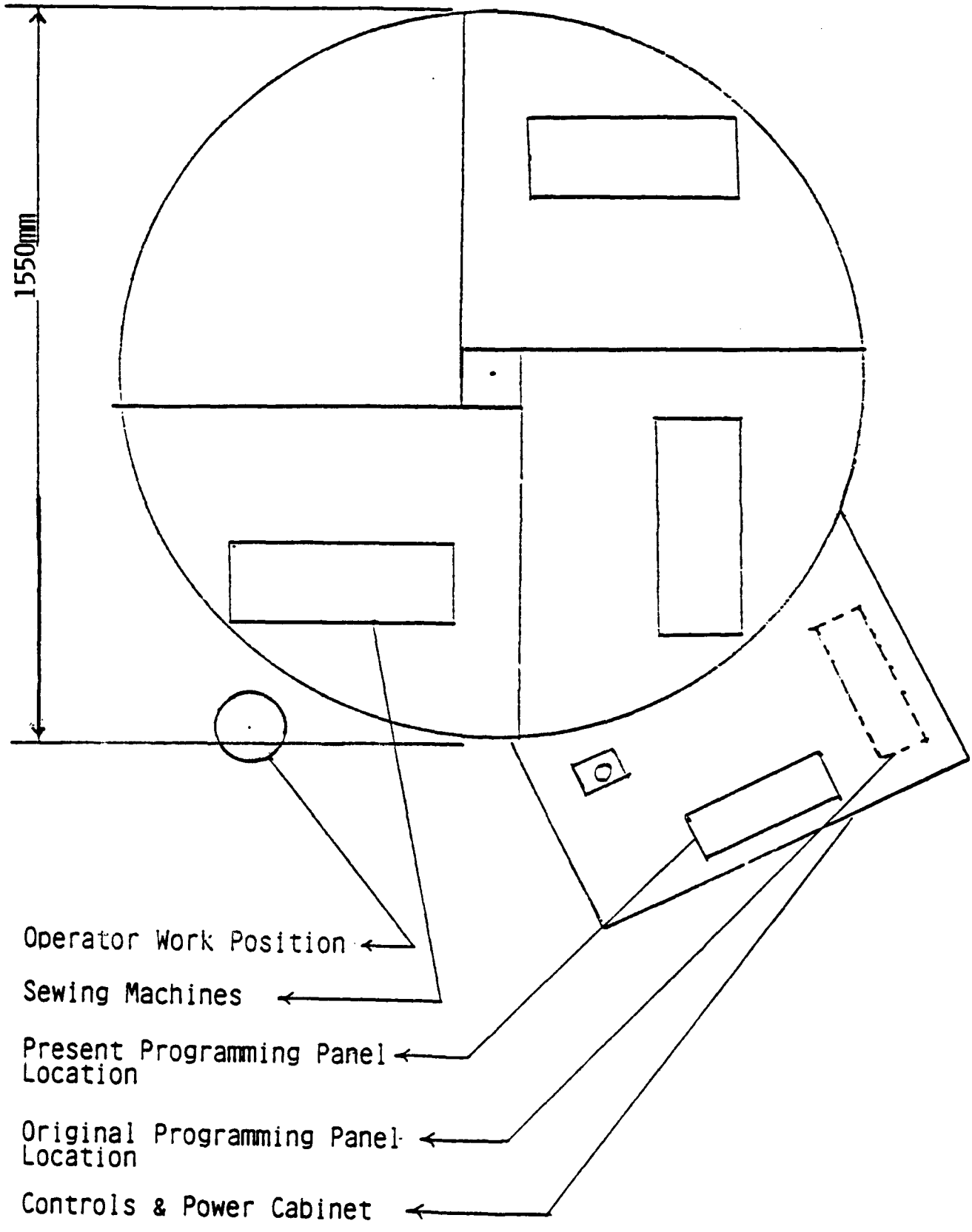


EXHIBIT 1B

KANSAI SUPER INDEXER SR-240
SIDE VIEW

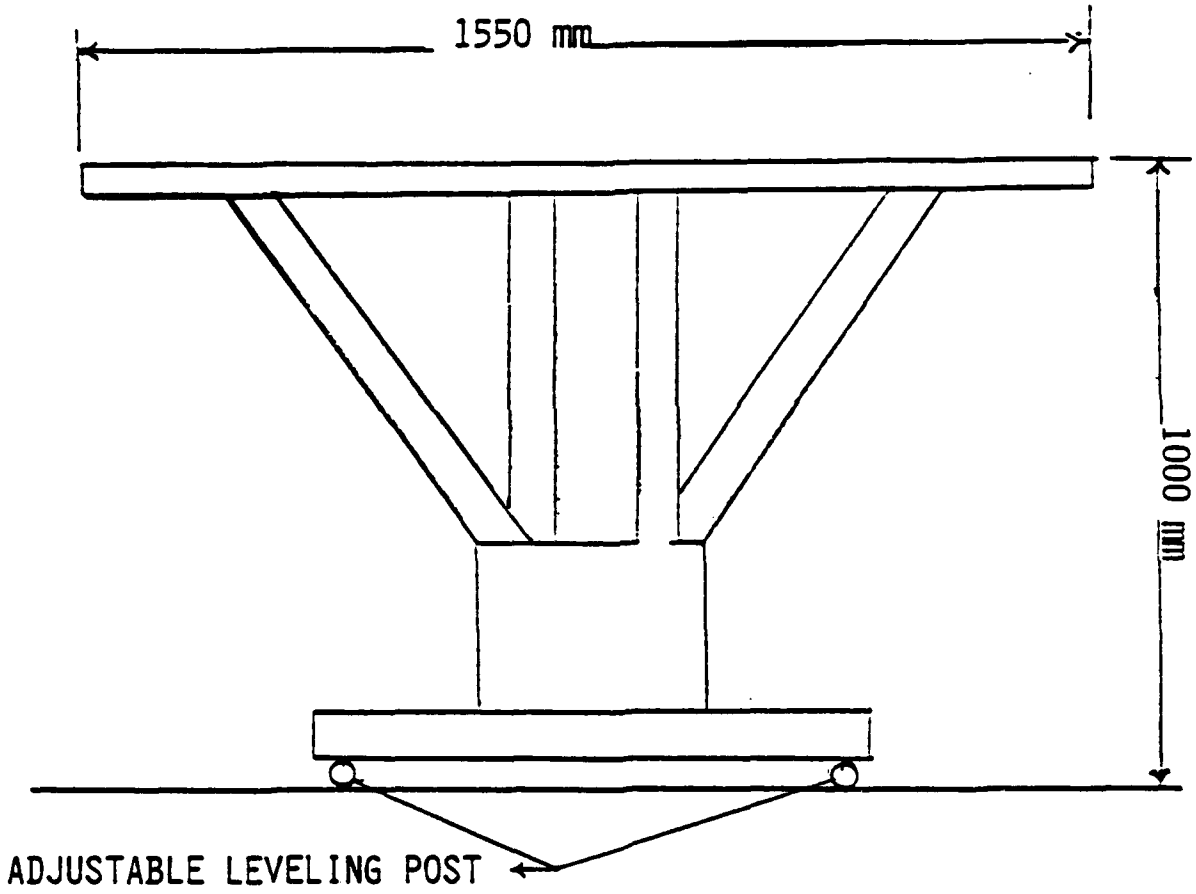


EXHIBIT 2

KANSAI SUPER INDEXER SR-240
CONTROL TABLE AND CABINET

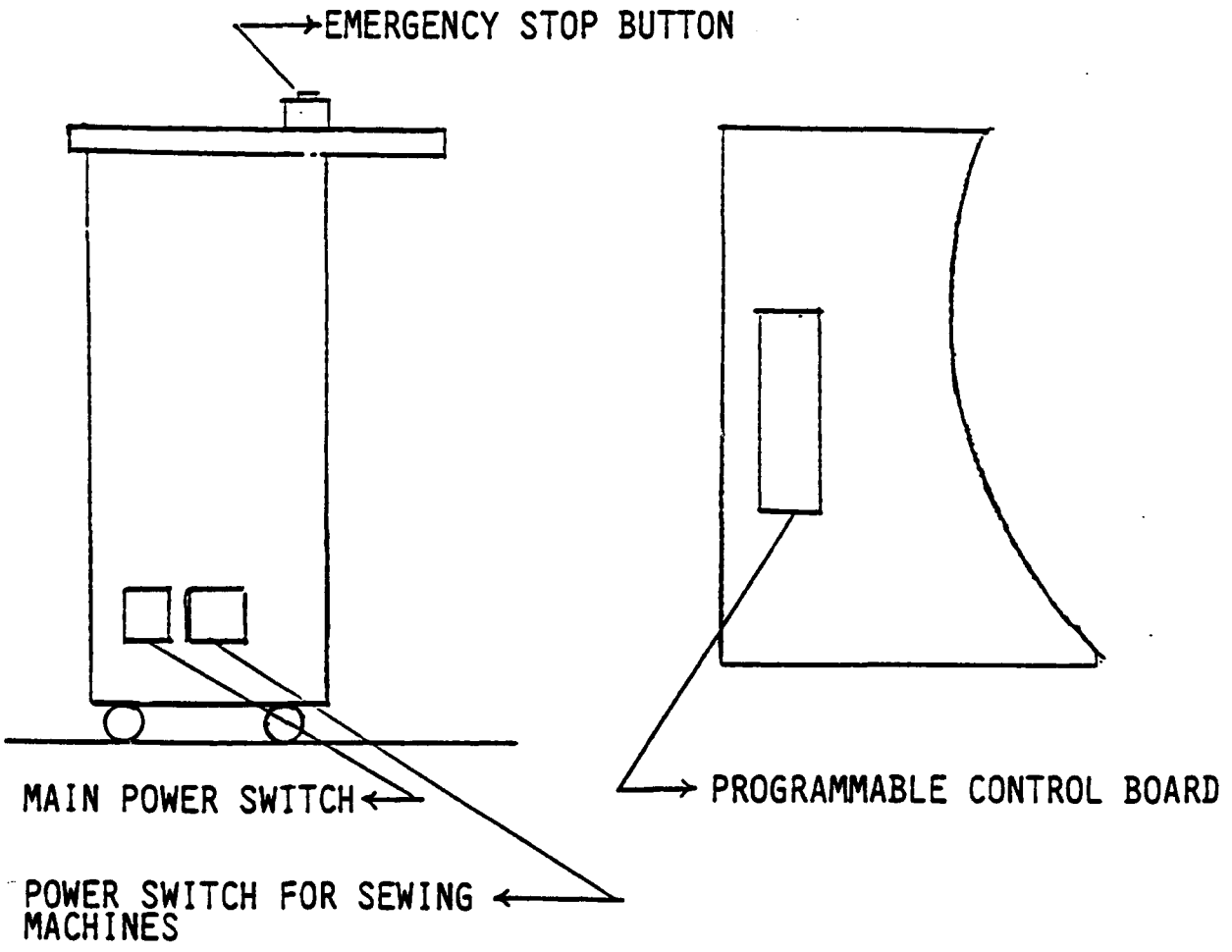
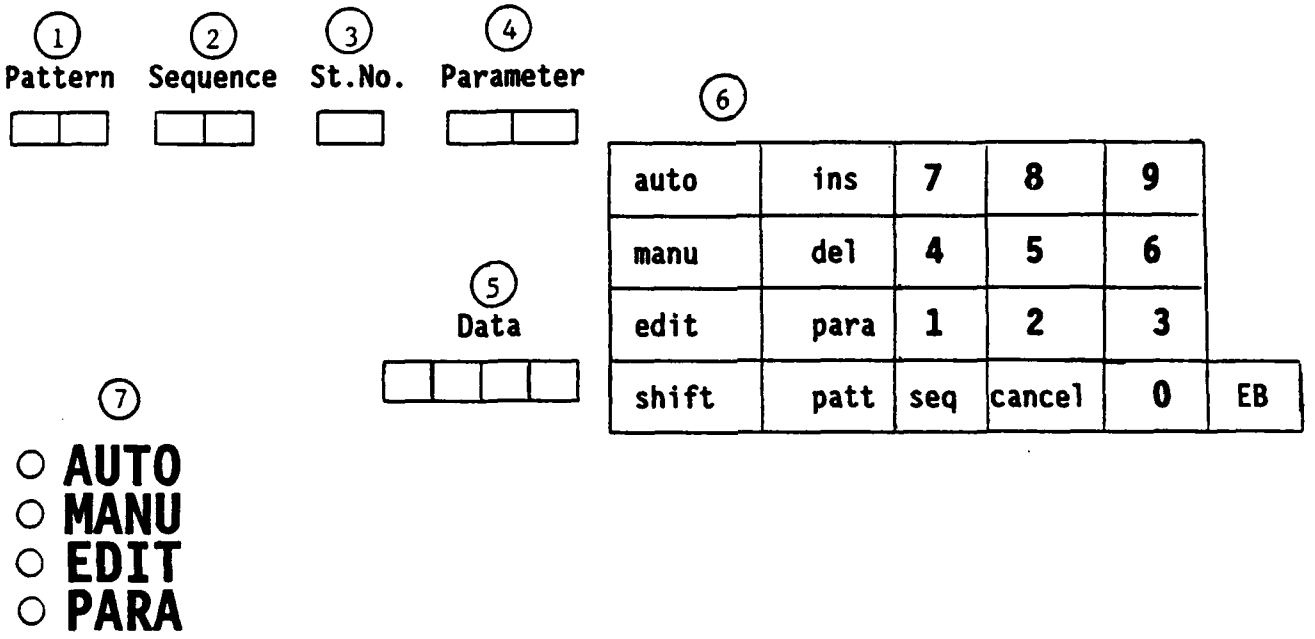


EXHIBIT 3

KANSAI SUPER INDEXER SR-240
PROGRAMMABLE CONTROL BOARD

MAIN CONTROL PANEL



1. PATTERN NUMBER DISPLAY:
A TWO DIGIT DISPLAY OF THE PATTERN IN USE OR BEING ENTERED. IT CAN RANGE FROM 01 TO 99.

2. SEQUENCE NUMBER DISPLAY:
THIS DISPLAY SHOWS THE OPERATION SEQUENCE NUMBER WHICH IS BEING WORKED ON OR WHICH IS BEING PROGRAMMED IN.

3. STATION NUMBER DISPLAY:
THIS SHOWS THE WORKSTATION NUMBER ON WHICH THE WORK IS BEING PERFORMED OR WHICH IS BEING PROGRAMMED FOR THAT PURPOSE.

4. PARAMETER DISPLAY:
THIS DISPLAY SHOWS THE SYSTEM PARAMETER. EACH PARAMETER IS EXPRESSED IN A TWO DIGIT CODE. IT IS USED TO SET THE TURNING SPEED AND THE TURNING ARC WHICH CAN RANGE FROM 90 DEGREES TO 180 DEGREES.

5. DATA DISPLAY:
THIS DISPLAY TELLS THE USER HOW MANY OPERATION CYCLES WERE COMPLETED.

6. TOUCH KEY PAD:
THIS PAD IS USED TO PROGRAM THE SYSTEM AND FOR PATTERN SELECTION.

7. SELECTION INDICATORS:
THE INDICATOR LIGHTS ON THE LEFT TELL THE SYSTEM USER WHAT FUNCTION MODE THE SYSTEM IS IN.

APPENDIX A

KANSAI SUPER INDEXER SR-240

SAFETY ANALYSIS

KANSAI SUPER INDEXER SR-240

SAFETY ANALYSIS

INTRODUCTION

This analysis was conducted with the understanding that the manufacturers of the Kansai Super Indexer SR-240 and its components have each taken precautions to make their products safe. However, it is also necessary to study the potential hazards that may arise from the use and interaction of the components in an operating system.

It is well confirmed that accidents and injuries occur largely due to machine misuse and/or momentary operator inattention to proper safety procedures. While it is possible for machines to be faulty, this is the exception rather than the rule. This safety analysis was conducted from the viewpoints of operator usage and operating conditions that would normally prevail in apparel factories. In effect, we developed worst case scenarios and describe safety devices which should lessen the severity of their effects or prevent them from occurring entirely. Undoubtedly some misuse or subversion of safety rules will occur and the adoption of our safety recommendation are expected to minimize the effects of these actions.

SAFETY ASPECTS OF THE KANSAI SUPER INDEXER SR-240

At first glance the Kansai carousel unit does not appear to pose any severe hazards even though there is no visible sign of any safety regulatory agency (UL, CSA, VDE, etc.) approval or design goal. Upon inspection it is noted that the Kansai unit lacks a built-in shut down switch that would be automatically activated in the event that forward or reverse progress of the carousel is impeded. This is potentially hazardous to the operator if the garment in process is not fully cleared from one of the sewing machines or should the goods being worked on or the operator's clothing be snagged by the equipment. Should this happen the operator could be tugged toward the microprocessor control unit, the UPS work station structure or storage units provided for work in process or finished goods. This potential hazard can be reduced by providing a built-in automatic shut down switch and/or safety trip switches on either side of the operator's station which, when activated would cut off power to all parts of the unit, including servo and sewing functions. The separate emergency cutoff switch that is provided with the unit is not sufficient to serve this purpose because in its present position it would be unreachable should a snag occur while the carousel is operating - the operator's hand would be dragged away from the control's location.

THE CAROUSEL TABLETOP

The four section tabletop of the Kansai carousel provides flexibility in allowing a variety of machines to be attached quickly without taking the entire unit out of service for an extended period of time. This, however, presents a potential hazard from snagging on corners of the quarter sections which may be at different heights and which may be spaced up to 3/16" (4.75 mm) apart. Further, since the tabletop is covered with a formica-type laminate, chipping may occur at the edges and corners, further increasing the potential for snagging.

A new method of providing thread to the sewing machines should be considered. The thread stands, one for each machine, currently rotate with the table and could, while moving, contact any part of the operator's body that was inside the periphery of the system. Possible alternatives include but are not limited to plastic covers, elevation of the spindles in umbrella-like structures (such as those used on some circular knitting machines), or a thread bank device similar to that used on automatic embroidery machines.

Presently, the outer edges of the tabletop quarter sections are in a raw, relatively rough, unfinished state. It is recommended that the perimeter of the table top be edged with a continuous smooth plastic bumper strip to minimize abrasion on the operator's clothing and eliminate the possibility of snagging on the quarter section corners.

MICROPROCESSOR CONTROL UNIT

A potentially hazardous condition is created when the carousel unit is powered up initially or restarted after an emergency stop. The microprocessor will not take over control of the carousel unless two arrows, one marked on the stationary base and the other on the bottom of the rotating structure, are properly aligned. To align them now the operator must look under the table in order to see the arrows and an unexpected start of the equipment could cause serious injury. This hazard can be eliminated by moving the alignment markers to the top of the table and the top of the control cabinet so that the carousel can be aligned while the operator is standing clear of the entire unit.

The top of the control cabinet is shaped with a half moon cutout to accommodate, at the same height, the curve of the carousel table top. The net effect is to create a sharp projection at each of the cusps which may be a continuing cause of snagging of work-in-process. It is suggested that both projections be rounded.

It is also suggested that the top edge of the control cabinet should be faced with the same type of smooth plastic bumper strip as is recommended for edging the carousel tabletop.

CONTROLS

The operator-actuated controls, other than the microprocessor panel, consist of two switches: one moves the carousel to the next programmed position; the other is an emergency stop switch. The first switch, which can be activated by either foot or hand, presents a potential hazard to the operator if it is inadvertently depressed by being stepped on or accidentally having some work-in-process or other item fall on it. It is recommended that the present switch be replaced with one needing a double depression to work.

At present, one push on the emergency stop switch activates it and another push deactivates it. It is recommended that it be replaced with a switch that can be activated with one push to shut down all power, but which must be manually released by the operator before restarting the unit. This will eliminate the possibility that a fall by the operator, falling material or inadvertent action by someone other than the operator could accidentally reactivate the unit.

The positioning of the emergency stop switch is critical. It should be permanently positioned close to the operator's post and should be capable of accommodating operators of all sizes who may be required to use it. This still will not answer the problem of the operator's hands being dragged away from the switch when the carousel is moving. It is suggested that emergency stop devices capable of being activated manually or by sound (voice) be located next to each machine.

USING THE COMPLETE UNIT

If the carousel is part of a UPS work station the problem of work-in-process is minimized. If it is not, and provision has to be made for the storage of work-in-process, complications may arise. Work-in-process cannot be stored flush up against the working area because of the danger of being snagged by the moving carousel. Storage space must, therefore, be provided outside the perimeter of the unit which may create traffic hazards and problems.

Items that operators normally keep on their work tables, whether job related or not, cannot be left loosely on the carousel tabletop: they will be thrown off by centrifugal force and create their own hazards. An alternate storage area must be provided.

Aisle space must be provided around the entire carousel operating area. It is suggested that a three foot wide clear aisle be kept open and that this space be clearly and appropriately marked with OSHA approved materials.

ERGONOMIC CONSIDERATIONS

The machines mounted on the tabletop do not have individual lamps to illuminate the needle working areas. Consideration should be given to supplying sufficient lighting.

Since this is a standing operation machine, consideration should be given to providing appropriate fatigue reducing floor mats. Also, because operators are of varying heights and it is impossible to adjust the tabletop height, platforms may have to be constructed to suit the needs of the operators. These platforms may present additional hazards of falls, missteps and trips and these must be addressed also.

SUMMARY

As with any sewing machine, there are hazards involved in the operation of the Kansai Super Indexer SR-240. These hazards, whether to the operator, the goods which he/she is working on or to other employees, usually are a result of operator misuse, poor housekeeping or inattention. If the recommendations made above are implemented and good housekeeping practices are followed most of the hazards will be minimized.