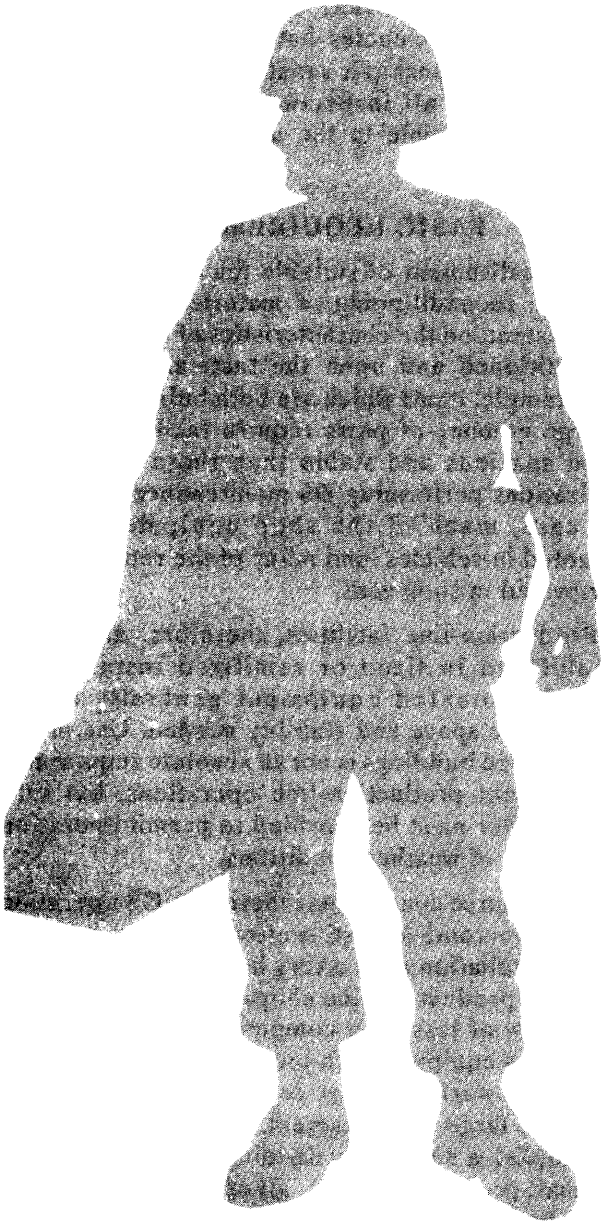
CHAPTER 5

PRODUCTION-LINE OPERATIONS



GENERAL

Complex repair jobs can usually be performed more efficiently when they are broken down into a number of simple tasks. It has been found that the production- line method is normally the best method to use when repairing large numbers of similar items. Each task is assigned to a workman or team especially equipped and trained to perform the operation. This division of labor and work is practical only when it is possible to work continuously on the same type item for considerable periods of time.

Workmen develop speed and dexterity through repetition of the same operations, attaining high work output per man. In addition, personnel training problems are simplified, since workmen with little mechanical expertise can learn to perform simple tasks in a minimum of time. Skilled technicians are used on the more intricate tasks and for supervision as well as inspection.

It is usually more convenient to move the item to be repaired pasta series of workstations. This technique is usually referred to as the “production-line” method. However, many of the advantages of the production-line method can be realized without the use of a moving line. If the materiel is too heavy or bulky, it can be placed in a fixed location and the workmen perform their assigned tasks in the most logical order.

Production-line techniques are ideally suited to depot maintenance activities; however, they can be profitably employed in many GSM operations engaged in the repair or reconditioning of like items of materiel. For definitions of repair and reconditioning, see AR 310-25 and AR 750-1.

Efficiency in production line methods of operation requires careful planning of shop operations, personnel assignments, and supply actions.

LIMITATIONS

Fixed facilities are usually required for a maintenance operation organized on a production-line basis. If the threat of enemy action requires units and activities in the theater to maintain mobility for defensive purposes, production-line operations may not be practicable.

In addition, the sections of a production-line installation cannot be dispersed to any appreciable degree without serious loss of productivity or security. Frequent movement of the installation will involve so much time for dismantling and reconstruction that savings effected through operating efficiencies will be canceled.

REPAIR STANDARDS

The ability to perform maintenance and to comply with standards is affected by resources. The standard established for each situation must be based on such factors as the requirement for materiel, availability of personnel skills, supplies, and the ability of the enemy to interfere with maintenance operations.

Materiel may be disassembled for detection and repair of all deficiencies. All parts, assemblies, and components which do not meet minimum serviceability standards are replaced, providing the operations involved can be performed without cutting or grinding the basic parts based on the appropriate technical manual MACs.

Repair operations may include resizing of basic parts, such as the reboring of engine cylinders to specified oversize dimensions. TOE tool and equipment sets do not include all of the equipment for this type of operation, and the special tools must be obtained through the supply system or by local purchase.

Materiel may be rebuilt (when rebuild is authorized, IAW AR 750-1) to standards approximately equal to new conditions. It is unlikely that the extensive facilities required for such operations could be installed or defended in a theater where modern weapons such as missiles and tactical nuclear devices are extensively employed.

Maintenance standards for support maintenance are included in equipment technical manuals. These may be updated or supplemented as appropriate by technical bulletins, modification work orders, and other equipment publications.

QUALITY CONTROL

Adherence to repair standards prescribed for each production-line shop depends largely on adequate inspection before, during, and after processing. Members of the inspection section examine materiel prior to repair to determine its condition and the work that must be performed on it. Qualified inspectors are stationed throughout the shops to determine the serviceability of questionable parts and assemblies and to ensure that repairs in process neither exceed nor fall below prescribed standards.

Repair in excess of specified limits tends to cut production rates below necessary levels, Substandard repairs reduce the life expectancy of reconditioned materiel. Final inspections determine whether all deficiencies have been corrected and whether workmanship is satisfactory. A chief inspector supervises all inspection activities and he is directly responsible to the maintenance unit commander.

BASIC REQUIREMENTS

The establishment of suitable facilities for production-line reconditioning of materiel depends, to a great extent, on the characteristics of the items to be reconditioned and upon the tactical environment. For example, items which are both bulky and contain a large number of parts require facilities that are more spacious and stable than those used by organizations performing DS maintenance, In the latter case, much of the shop equipment can be mounted in vehicles, and many of the repairs can be performed in shop vans.

Production-line facilities, therefore, are usually established in fixed or semi fixed installations. Vehicle-mounted equipment generally cannot provide the space and stability needed. Use of permanent type buildings is not an absolute requirement for efficient production-line operations, but sufficient shelter must be provided to permit operations regardless of weather conditions.

The resource constraints inherent in GS operations can be overcome almost as effectively in a relatively small installation as in a very large one. Many highly efficient production-line shops have been operated by a crew of less than company size in improvised structures equipped with locally fabricated fixtures. In modern warfare, where conditions prohibit operation of a large establishment, it may be possible to accomplish a mission by dividing it among a number of small production shops, all of which are similarly equipped.

Enough protected storage and work space should be provided to permit layout of all operations in efficient patterns and in proper relationship to each other. The various sections of a shop need not be housed under the same roof so long as convenient distances are maintained and traffic flow between sections is unimpeded.

Shelters must be adequate to protect personnel and materiel under prevailing climatic conditions. They are no more elaborate than necessary to serve this purpose, since they are subject to loss through destruction or abandonment if a position becomes untenable.

Fixtures such as workbenches, engine cradles, and conveyor lines must be designed to prevent unnecessary handling and to facilitate movement of items from one work section to another. Rough fixtures, simply constructed, are preferable to elaborate fixtures, as long as they serve the purpose. All design and construction refinements which do not substantially increase efficiency should be avoided. Whenever possible, buildings and fixtures should be designed so that they may be dismantled in transportable sections and erected elsewhere if a location must be abandoned.

SHELTERS

Production-line maintenance operations are sheltered to the extent necessary for materiel protection and crew efficiency. Certain items, such as disassembled major components, require protection from dirt and weather. If existing shelters are not available, adequate facilities are constructed.

In a favorable situation, standard engineer buildings may be erected. However, under conditions of modern warfare, many maintenance activities may have to operate in temporary shelters. Building activities are not undertaken until it has been determined that no suitable tentage is available. If adequate tentage cannot be obtained, temporary shelters may be built from materials normally available in the theater.

Unless wind or snow loads are excessive, frames of light timber or poles, roofed and sided with tarpaulins, will suffice. Roofs should be reinforced with canvas, plywood, or other sturdy screening material. Side tarpaulins should be applied so they can be rolled up in good weather for light and ventilation. Planking, packed gravel, or other suitable material will serve as flooring.

Electricity for light and power is provided by power generation equipment if no commercial source is available. In cold weather, the heating of facilities may present a serious problem. Flimsy structures dissipate heat rapidly. Stoves, possibly built from drums, may be the only heat source available. Such heaters are hazardous and are used only if there is no alternative. Standard, high-output devices should be used, if available. Whatever the method used, temperatures will probably be no more than tolerable, unless a steam plant can be obtained or constructed, or suitable standard heating equipment can be obtained through the supply system. The latter is the most satisfactory and least dangerous of all methods in such applications.

FIXTURES

Shop-made fixtures required for the various repair operations must be carefully designed and built. They will probably be made of wood, since this is usually the most readily available material. These fixtures must be sturdy to stand up under the hard and continuous use to which they are subjected. They must also be portable so they can be transported if the installation must be dismantled and reerected elsewhere. Too much valuable time and material are invested to permit abandoning them unnecessarily. Nails, bolts, or screws are used as fasteners whenever possible. Most of the fixtures mentioned below require 2-inch lumber:

- Workbenches must be solid, well braced, and no larger than necessary. Few benches need be wider than two feet; 18 inches is sufficient for most.

- Pallets are designed for each specific job. Size is held to a minimum. Since they must hold the heaviest items, such as power train components, 2-inch lumber is required. Bolted construction is desirable.

- Parts bins are designed so that partitions can readily be inserted and removed. One-inch lumber is sufficient for storage of most parts. Since these items are bulky, unnecessary strength and weight are undesirable.

- Trestles for conveyor lines are designed in sections so that they can be dismantled for movement. Individual sections are heavily braced and should be as small as practicable to facilitate movement.

CLEANING

Manual cleaning of bulky, heavily soiled components is a very time-consuming operation which can create a serious bottleneck in production-line operations unless unskilled local labor, employable only for rough work, is available in quantity. Cleaning equipment capable of quickly removing grease, heavy soil, and corrosion is most desirable. A steam cleaner is suggested as the best kind of equipment for this type of operation.

PACKAGING AND PRESERVATION

As most materiel repaired in a GS maintenance installation is released to supply stocks, it must be properly preserved and packaged after repair. Items are preserved to the extent necessary to protect them from damage and deterioration in the circumstances under which they will be handled and stored. Certain components have openings which must be sealed tightly to protect machined surfaces from dirt and moisture.

EXPOSED SHAFTS AND OTHER PROTRUDING ELEMENTS MUST BE PROTECTED AGAINST BENDING OR BURRING.

Exposed shafts and other protruding elements must be protected against bending or burring. Many items require crating or packaging. Reusable boxes and shipping containers should be used if available. If available quantities are not sufficient, additional crates must be obtained from outside facilities or manufactured in the maintenance installation. If large-scale crate production is necessary, power equipment must be obtained.

GENERAL SHOP LAYOUT

A production-line shop can be operated in improvised shelters using simple, locally fabricated fixtures. The principles of the production-line method, described in the following paragraphs, may be applied in the reconditioning of most materiel items which are complex enough and used in sufficient quantities to warrant production-line processing. The sample layouts are designed to provide general guidance in the application of those principles and may be varied to suit specific situations.

Information available in technical manuals pertinent to the various items of materiel is used to supplement the general guidelines. The production lines described in the following paragraphs, in common with most operations of this type, can be more effectively manned and equipped by using TDAs than by employing troop units using TOE equipment.

ENGINE RECONDITIONING

Figure 5-1 illustrates an engine disassembly line suitable for the complete dismantling of the item. However, before dismantling takes place, it is recommended that the engine be tested on a dynamometer or similar device and tested after assembly to ensure acceptable serviceability.

On arrival at the line, each unserviceable engine is drained of oil and placed on a holding fixture or pallet. When engines are received at the line with transmissions attached, the transmissions are removed at the first station and sent to transmission disassembly. All parts and accessories are placed in cleaning baskets immediately on their removal to minimize handling.

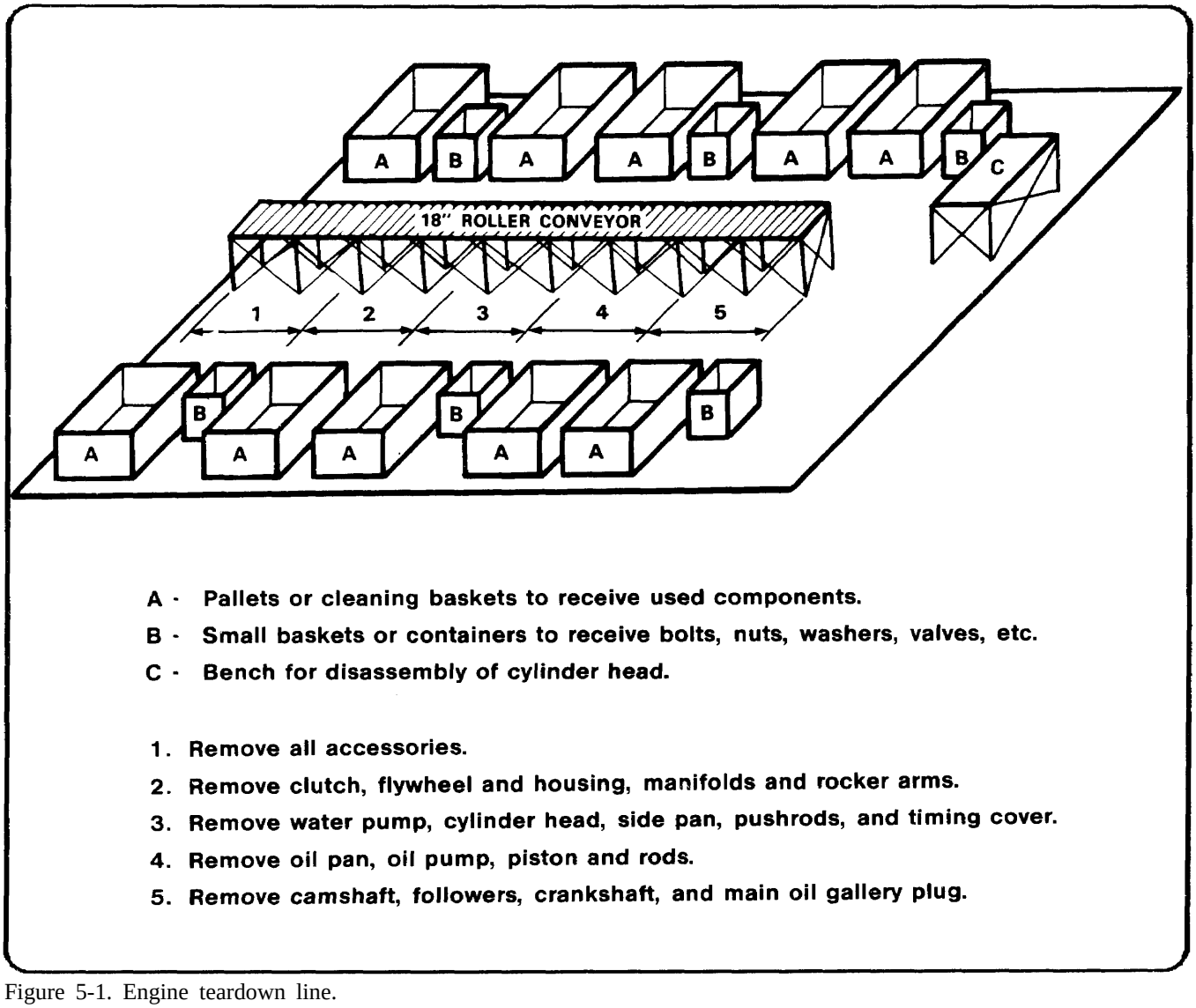


Figure 5-1. Engine teardown line.

PARTS ARE CLEANED AND DELIVERED TO APPROPRIATE RECONDITIONING FACILITIES IN BASKETS IN WHICH THEY WERE ORIGINALLY PLACED

Parts are cleaned and delivered to the appropriate reconditioning facilities in the baskets in which originally placed. Unless cylinders are to be prebored and bearing surfaces reconditioned, all internal parts removed from the engine block are tagged, since they must be reassembled into the same engine. Cleaning may be accomplished at the central cleaning facility or may be done by hand in the solvent vats.

If the shop is operated on a repair-as-required basis, complete disassembly may be reserved for those engines having a large number of defects. Others may bypass certain stations in the line. This determination is made by the inspector. If defects are few and obvious, an engine may be removed from the line for repair in a job shop. Such a shop is shown in Figure 5-2.

Parts and accessories are delivered to the reconditioning line (Figure 5-2). Engine blocks are placed on pallets on conveyor lines as shown at the bottom of the diagram. Two lines are provided in order that blocks having many defects may be sidetracked while those requiring little repair proceed through the other line.

Due to the difficulty of turning engine blocks on the conveyors without jarring the entire line, blocks are removed manually to workbenches beside the line for inspection and repair. They are then returned to the conveyors.

Other parts and accessories are delivered to racks adjacent to the workbenches shown in the center of the diagram. These racks are divided into two main sections. One section is reserved for items awaiting inspection and repair; the other contains sufficient bins to hold required repair parts and space to receive items after repair. Repair parts stocks include such items as extra pistons and rods to replace those found to be irreparable.

Items which are combined into sets for installation in the engine are released from the repair bench in complete sets. Workbenches are equipped with vises and other suitable holding fixtures. Inspection and repair procedures for all items handled in this shop are covered in appropriate technical manuals.

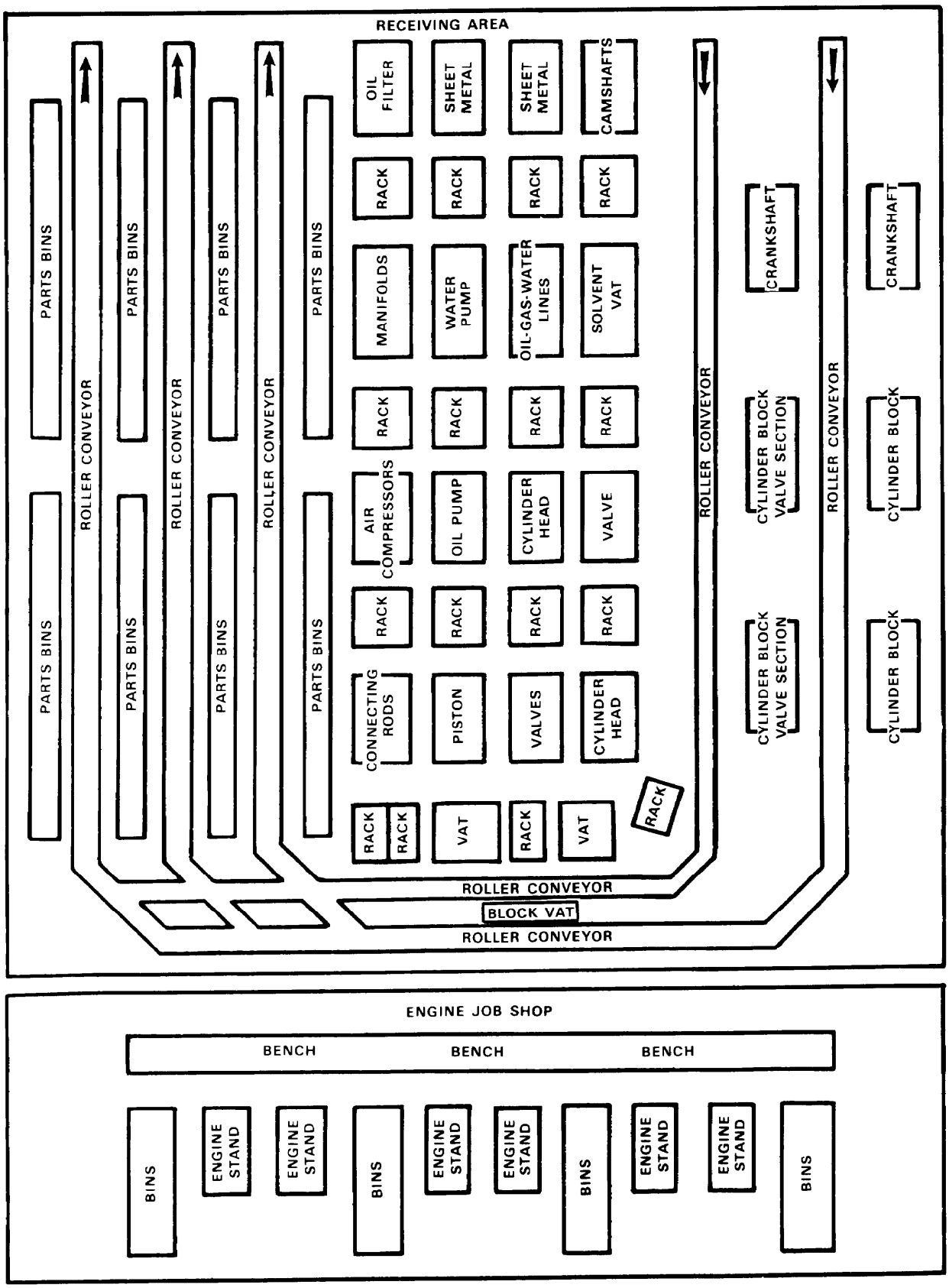


Figure 5-2. Engine job shop and production line.

Engine assembly lines appear at the top of Figure 5-2 and a blowup of a single line is shown in Figure 5-3. At least two lines should be provided so that blocks arriving at the line before their internal parts are ready may be sidetracked, while blocks for which mated parts are available proceed on the other line. Racks should be placed beside the lines to receive internal parts which will be tagged for specific blocks. Bins placed along other portions of the lines receive the interchangeable components and assemblies from the repair lines. These bins also contain the additional quantities required to replace those found to be irreparable and the small parts required for engine assembly.

Shop supply personnel are responsible for stocking all parts bins in the engine shop with predetermined quantities of repair parts and assemblies. They should transfer repaired items from the repair stations to assembly lines or to stock, whichever is applicable. Finished engines are transferred to the supply system, or to an end item assembly line if the Class VII end item is reconditioned on the installation. The supply section must keep accurate records of parts expenditures and losses of components through washouts. This data is vital to compute future supply requirements.

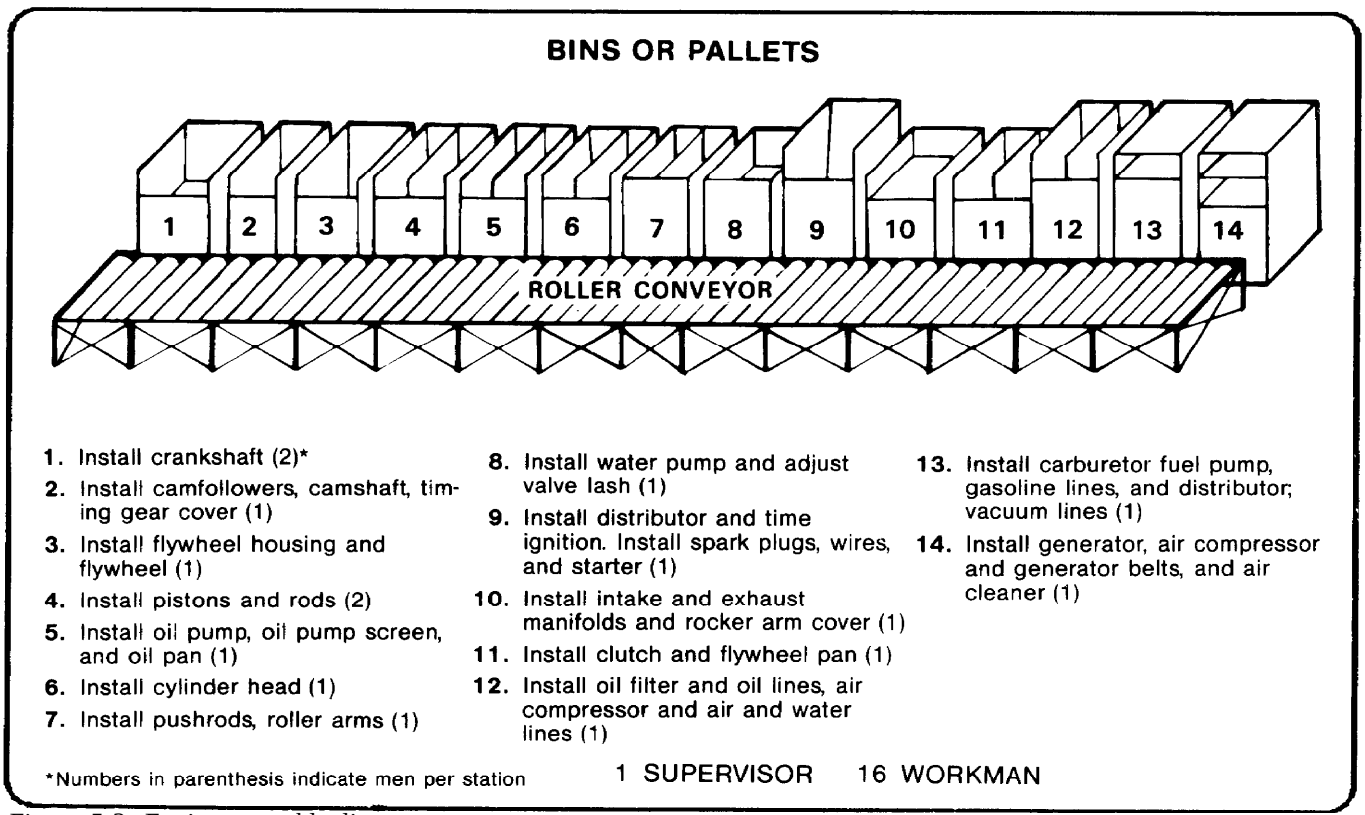


Figure 5-3. Engine assembly line

END ITEM RECONDITIONING

Addition of a shop facility of the type shown in Figure 5-4 is all that is required to give the above described installation an end item reconditioning capacity. Sheds may be built over the storage pallets on either side of the central shed if desired.

No component disassembly is performed in this facility. Unserviceable components are replaced with units reconditioned on the installation's assembly lines. Unserviceable components replaced are turned in to shop supply for reconditioning.

LINE STOPPERS

The orderly production of completed items from the end of a production line depends on the uninterrupted, timely flow of parts and supplies to all stations on the line. An empty bin (line stopper) has the same effect as a vacant station the line halts. When work on an item in a repair-as-received shop must stop for lack of parts, the crew on that job is assigned to another job for which parts are available. Thus, overall productivity of the shop is not seriously affected.

A line stopper due to a supply failure inactivates a sizeable portion of the shop's production capacity until supplies are obtained or the line is set up for a new job. Therefore, every possible precaution is taken to avoid supply deficiencies.

Certain refinements are added to the basic supply procedures prescribed in regulations and in Chapter 4 to satisfy the special requirements of a production-line activity.

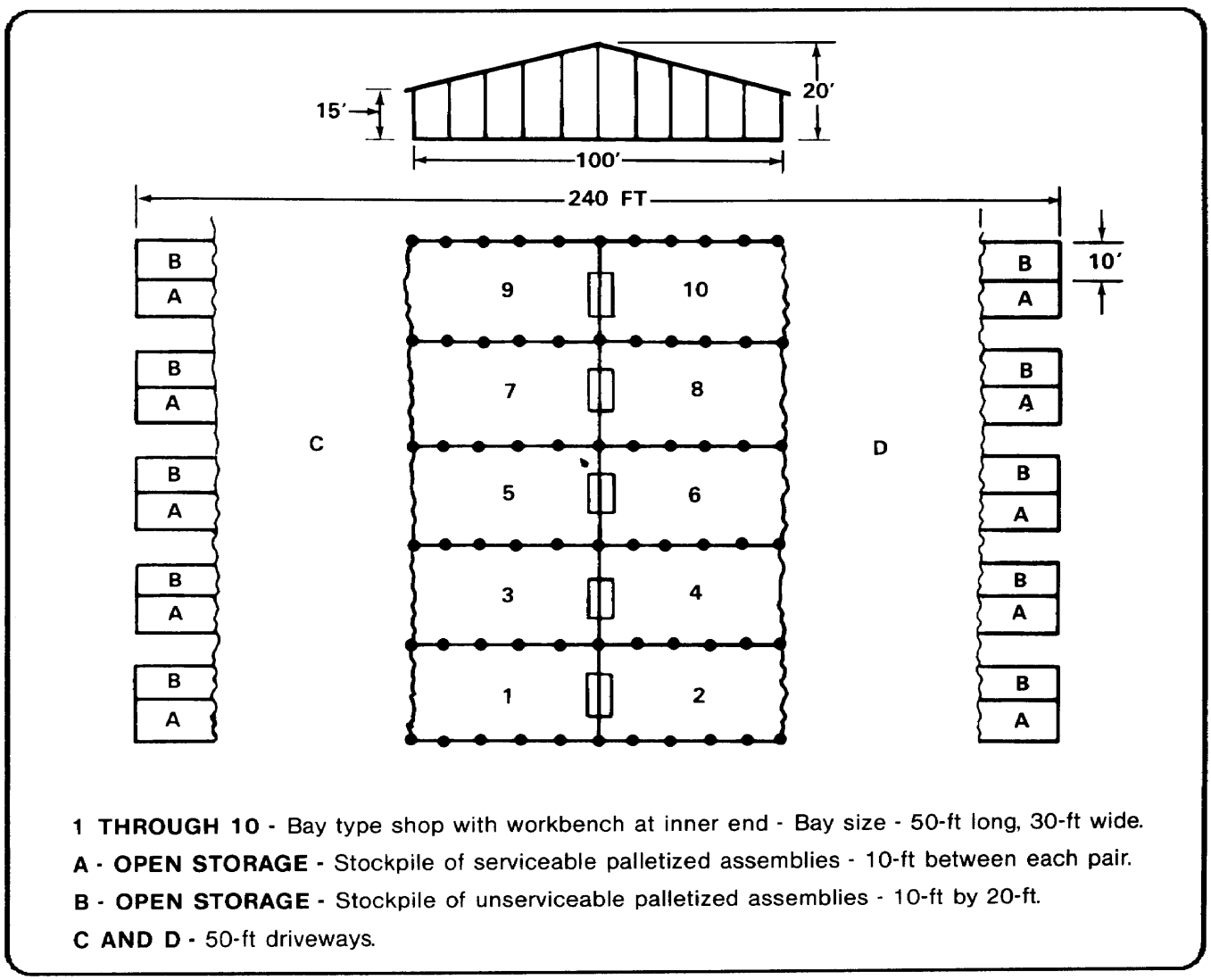


Figure 5-4. End item shop.

Production runs must be planned far enough in advance to allow for computing, requisitioning, and receiving the necessary supplies. A line is not ordinarily set up for a run until all the supplies needed to complete it have been received, checked, and stored by shop supply and are ready for movement to the line. Methods used to compute supply requirements depend, primarily, on the repair standards under which the shop operates.

Two general classes and the supply computation techniques appropriate to each are discussed in the paragraphs below. Regardless of the methods used, the margin allowable for error is small. Minor shortages will result in an incomplete run. A major oversight, such as failure to procure a single part which is required for a high percentage of the items in the run, will halt the entire job.

In a shop where items being repaired are completely dismantled for replacement of all parts subject to wear or deterioration, supply determination presents no problem. Requirements are computed by multiplying the quantity of each part requiring replacement in each assembly to be repaired by the total number of assemblies in the run. Error in computation is the chief hazard here.

When the need for parts replacement is determined by inspection on the line, the supply problem becomes more complex. If a fairly large number of like items are to be repaired, parts requirements may be estimated by inspecting a percentage of the total quantity. When this method is used, care must be exercised to assure that the sampling is representative of the whole. Any valid random sampling technique may be employed to select the items to be inspected. The probability of error decreases as the total number of items in the run and the percentage inspected increases. If the same type of item has been previously repaired in the shop, experience gained in the earlier runs can be used to determine requirements.

In a shop that processes a considerable variety of items in relatively short runs, it may be impractical to order parts for each job. This situation is most likely to occur when a number of small shops operate under a central control agency, and job scheduling is determined by the urgency of need for specific types of items rather than reparable quantities accumulated. Under these circumstances, heavy reliance is placed on the unit's maintenance shop stocks. If recurrence of runs on various types is not consistent enough, the additional expedients described in the following paragraphs, should be considered.

Certain auxiliary records are desirable in a production-line shop. Supply expenditure experience gained in each production run should be preserved for future use. A card of the type illustrated in Figure 5-5 offers a convenient means of recording such data. It may also be desirable to devise an extra insert to the standard stock record card to indicate the items in which the part is used and the average expenditure per quantity repaired (12 per 100, etc.). Many such expedients are possible. Their effectiveness depends on the ingenuity of the supervisor.

ASSEMBLY

PART	RUN NO.. (..ASSYS) QTY	AVERAGE PER..	RUN NO.. (..ASSYS) QTY	AVERAGE PER..	RUN NO.. (..ASSYS) QTY	AVERAGE PER..

NOTE: Average should be computed on completion of each run.

Figure 5-5. Supply expenditure data sheet.