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Technical Meeting on the Selection
of Woodworking Machinery

Vienna, 19 - 23 November 1973

DUST CONTROL AND WASTE EXTRACTION[1/]

by

Allan Smith
Hitchin, Herts., England

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SUMMARY

The introductory chapter compares the volume of waste produced related to the time element between handcraft production and machine production emphasizing the economic necessity for mechanical extraction of waste. Safety and health reasons are mentioned in relation to production efficiency and the need for fume extraction from certain processes is pointed out. The various categories of wood waste arisings are mentioned.

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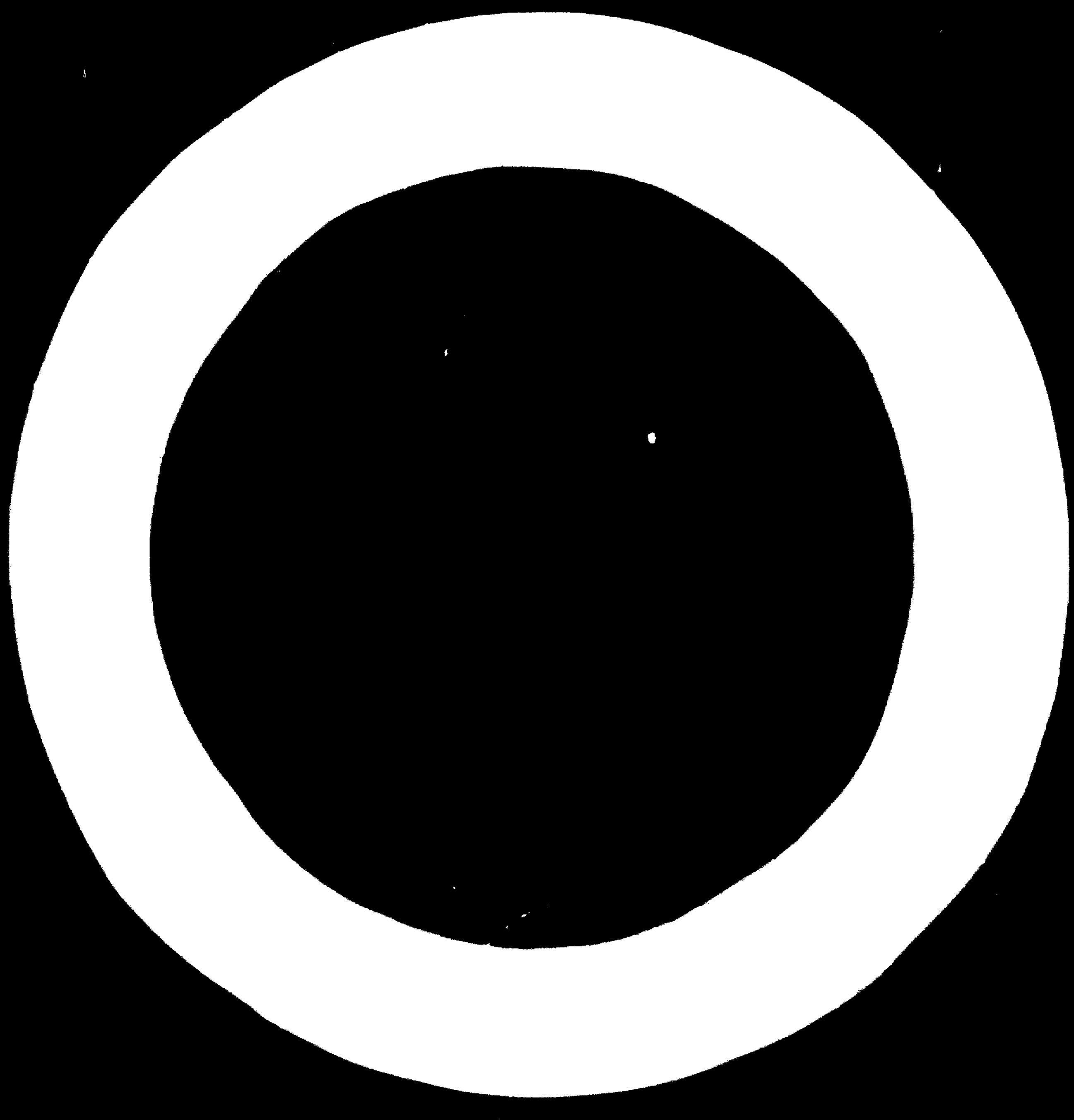

The design of chip collection hoods on individual machines play an important part in the efficiency of any extraction system. The principles of hood design are dealt with and related to the individual basic machines.

The design of ducting to transport waste from the machine to the separation unit and storage are dealt with and details of duct sizes and air velocities for specific machines and types of waste are given. A short chapter deals with extraction fans, their location and essential properties.

The various types of separators are mentioned with reasons for selection of types for individual installations leading to methods of selection of types of installation for the particular capacity of manufacturing unit.

Based on a progress chart the planning specifying and installation of a plant is dealt with in detail with particular emphasis of the need to introduce a qualified extraction engineer at a specified point in the programme.

The penultimate chapter deals with possible outlets for disposal of waste and stresses the need for early planning of this. Outlets must be related to the needs of the country and location of the factory. Equipment is mentioned for the further processing of waste to provide a more easily marketable product or to improve its value. The need to reduce the volume of waste and to limit transportation to the minimum is stressed.

The paper concludes with a review of methods of extracting solid wastes which cannot be handled by a pneumatic extraction system.

DUST CONTROL AND WASTE EXTRACTION

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The author wishes to express his gratitude to the following:

The Institution of Heating and Ventilating Engineers, London, for permission to reproduce Fig. 1 and Tables (I) and (II), and to Thomas Robinson & Son, Rochdale, England, for permission to reproduce the photograph Fig. 8.

DUST CONTROL AND WASTE EXTRACTION

I INTRODUCTION

1. The need for efficient mechanical waste extraction is dictated by the economical operation of modern high speed woodworking machines. If we relate the volume of waste produced to time in a comparison between the original manual production methods of working wood and the present mechanical methods the need for continuous removal of waste from machines will be obvious.

2. Let us take a simple example in the surfacing of 100 lineal feet of timber 1ft wide and removing ⅛in of material in the process. This would represent a full day's work for the hand craftsman and would convert to shavings rather more than 1cu.ft. of timber. It would probably only be necessary to clear this waste at the end of each day and the time taken would represent an insignificant proportion of the total time for performing the task.

3. Now let us see the result of performing this task on the overhead surface planing machine. With manual feeding a feed rate of 20ft per minute may well be maintained and the 100ft of timber would take five minutes to complete. The volume of timber converted to chips would be similar to our first example but the time taken to remove these chips manually, related to the total time for performing the task becomes highly significant. The economics of this simple comparison and the need for mechanical extraction are self evident.

4. In our simple comparison we considered a single cutting unit and a very modest feed speed. With the modern four side planing and moulding machine we may have 4, 5, 6 or 7 working units and a feed speed ranging from 50 to 500ft per minute. It would be impossible to operate such a machine economically without the aid of mechanical extraction of waste.

5. The other aspect of inefficient waste removal is that of safety. Accumulations of waste constitute an obstruction to operators in moving around the machine and may well be a direct cause of accidents. Waste may also foul the revolving cutters and be dispersed into the atmosphere becoming a danger to health. This is particularly significant with hardwoods the cutting of which produces a fine dust in addition to the chips or sawdust and this fine dust remains suspended in the atmosphere to be inhaled by workers and cause irritation to the respiratory organs and eyes. Some species of hardwoods are significantly noxious in this respect.

6. Accumulations of this fine dust on horizontal ledges and static machinery parts present another hazard, that of fire. When this dust is mixed with certain proportions of oxygen it assumes an explosive nature and may easily be ignited by an occasional spark. This has been the cause of many disastrous fires.

7. The conversion of trees into timber products results in various forms of waste at each stage. Waste arises in four distinct forms each of which demands individual consideration for its removal.

8. Solids are created whenever the sizes in which timber is supplied have to be converted into smaller sizes. This applies to natural timber, board materials and veneers. With natural timber and veneers much waste is created by eliminating natural faults in the material and faults which arise in the preliminary process of drying. These materials vary in dimensions and shape between each individual unit and conversion into uniform and regular sizes and shape produce varying amounts of waste.

9. Board materials being uniform in size and shape, with natural faults eliminated produce a much smaller quantity of waste.

10. Sawdust is created whenever a piece of timber has to be divided into two or more pieces. Arisings of sawdust are greatest in the sawmilling industry by the conversion of logs into boards or planks. This sawdust being of high moisture content represents a special problem in its extraction.

11. Planer chips arise from the necessity of having to create a satisfactory surface on timber and to bring the pieces to more exact dimensions. They also arise in moulding and routing operations where a rotary knife tool is used.

12. Sander dust a product of all abrasive machining operations has increased in volume considerably in recent years. It is the most difficult form of waste to dispose of and also presents dangers of explosion both in extraction plants and in burning operations.

II PRINCIPLES OF HOOD DESIGN AND THE RELATIONSHIP TO CUTTING TOOL TYPE

1. The first stage in every waste extraction system is the scavenging of the cutter region and introduction of the waste into the conveying system. The efficiency with which this is accomplished will depend to a large degree on the design of the chip collection hood and its location relative to the point of generation of the chips.

2. Taking a point source of suction air will flow towards this point from all directions and velocity contours will form as concentric spheres around this point. (Fig.1). It will be seen that the velocity of the air stream decreases with increasing distance from the point of suction and can be calculated by the formula.

$$\text{VELOCITY} = \frac{\text{Volume flow into suction point}}{4\pi r^2}$$

where r is the distance from the suction point.

The hood performs two functions the first of which and the most obvious is to act as a receiver for the airborne chips and dust and to direct these into the trunking. The second function is to generate a stream of air over the cutter area of sufficient velocity to entrain all the chips and dust produced by the cutter.

3. The volume of air required by a hood will depend upon several factors:

(a) Density of the chips or dust.

(b) The shape and size of particles.

(c) Whether it is necessary to change the direction of the particles.

(d) The density of the air.

(e) The distance of the hood from the source of generation.

The nearer the hood is to the point of generation of the particles the smaller will be the volume of air required and the cost of operating the system.

4. With the exception of band and reciprocating saws mechanical woodworking tools have a rotary cutting action and the chips produced are ejected in a path roughly tangential to the cutting circle and within a limited arc of that circle. (Fig. 2). At this point chips have an initial velocity depending on the cutting force and surface speed of the cutter. If the stream of extraction air created by the hood follows the same path it

will require a smaller volume of air than it would if the path of the chips had to be diverted.

5. When a cutter block is revolving at high speed it tends to create a boundary layer of air travelling with the block and at approximately the same speed. A proportion of the chips formed will be trapped in this boundary layer and carried along with it until some obstruction disturbs the boundary layer and releases the chips.

6. Looking again at Fig. 2 it will be seen that replacement air is moving in the opposite direction to the cutter block at the lower entry to the hood. If the hood is located close to the cutting circle the velocity of the replacement air will be sufficient to disturb the boundary layer and to reverse the path of the chips, returning them to the confines of the collection hood thus performing an efficient scavenging operation. The greater the distance between hood and cutting circle the lower will be the efficiency of this scavenging operation.

7. With circular saws hoods can be arranged to enclose almost completely the lower half of the blade below the workpiece and in close proximity to the sides of the blade thus reducing the volume of air required for efficient extraction. (Fig. 3). It is also usually possible and desirable that the hood be attached to the rise, fall or tilting mechanism of the saw spindle where this exists thus ensuring a uniform standard of efficiency.

8. Bandsaws whether these be band-mills, re-saws or narrow bandsaws do not generally require special hoods. Since it is now necessary to enclose both wheels and the free length of the saw blade except for the actual cutting part of the blade within secure and substantial casings to comply with safety requirements the casing covering the lower wheel forms an excellent dust collection hood. It is only necessary to provide a suitably sized outlet and spigot for attachment to the extraction

system. (Fig. 4)

The vertical frame saw still very much in use for conversion of logs poses a rather different problem. The vertical movement of the frame inhibits the attachment of a hood in close proximity to the cutting point. The occasional sliver of solid timber which breaks away in the milling process also presents a problem since this would foul the trunking of the extraction system and must be separated from the sawdust. This is accomplished by a vibrating tray or chute placed beneath the saw frame. At the exit of this chute a series of fingers extend in the plane of the chute and allow the sawdust to pass through but carry the larger slivers beyond the extraction duct to be removed by other means. (Fig. 5)

9. Standard surface planing machines and thickness planing machines offer no great problems in hood design since the relative position of cutter block and work surface is constant.

In the case of combined machines it is not possible to have permanent hoods and special provision has to be made by providing hoods which can be placed above or below the cutterblock relative to the function being performed.

10. The provision of suitable hoods for the vertical spindle moulder and for vertical and horizontal moulding units on the four side planer and moulder presents problems and compromise solutions have to be adopted. The reasons for this are the degree of adjustment for rise and fall and for transverse adjustments and the variable size of cutting circle diameter. It is necessary to make allowance for these in the size of the hood consequently the surface area through which air enters the hood is greater and an increased volume of air must be removed to maintain a satisfactory velocity. (Fig. 6)

11. The three basic types of cutting tools dealt with in the foregoing paragraphs represent almost the entire range of woodworking machine tools and the principles of design mentioned should be observed in dealing with variations of these basic units.

12. Most reputable machinery manufacturers are now supplying hoods as a standard fitting. They are usually designed in conjunction with dust extraction engineers to obtain maximum efficiency and to connect up to the appropriate size of duct. Since these hoods almost totally enclose the cutter block it is essential that they should be easily detachable to reduce maintenance time for sharpening and setting of cutters. Since they have to be removed frequently they should be of robust construction but not unduly heavy hence most are made from castings in light metal. They must also be provided with a means of quickly detaching them from the ducting and have a good leakproof connection. (Fig. 7)

III TRANSPORTATION OF WASTE

1. To transport dust and chips by means of a stream of moving air it is necessary that this stream of air should be maintained at a certain velocity. The necessary velocity will vary with the composition of the dust. In order to attain this velocity the stream of air is confined in a tube or duct, the cross-sectional area of which related to the volume of air removed per minute will determine its velocity.

2. A dust extraction system is a composite construction of a number of branch ducts leading into a main duct and it is essential that the system should be so designed that the velocity is uniform throughout the entire system. The ideal cross section for ducting is circular since this offers least resistance to air flow and inhibits the collection of dust which would take place

in the angles of a quadrilateral cross section. It is also advantageous in the manufacture of the ducts.

3. There are many factors to be considered in the designing of ductwork in order to maintain this standard of uniformity so essential to efficient operation. The total resistance of an exhaust system is equal to the sum of losses due to the following factors:-

(i) The entrance into the various hoods in the system.
(ii) The resistance of any bends and branches either in the branch ducts or the main duct.
(iii) Friction between air and dust particles with the walls of the duct.
(iv) Insufficiency of replacement air.

It is not within the scope of this paper to deal with methods of calculating these pressure losses since this would be accomplished by a competent ventilation engineer and would have to be related to each individual installation.

4. In constructing ductwork for woodwaste extraction galvanised sheet steel is considered a suitable material requiring no further surface protection internally or externally. Recommended gauges for ducts up to 8in diameter 18 gauge, 8in to 20in 16 gauge, 20in to 30in 14 gauge and over 30in 12 gauge.[1/] Bends which are subjected to greater abrasion should be of heavier gauge than that recommended for the size of duct.

5. The length of ducting should be kept to a minimum to reduce the losses related to the distance travelled by the air stream. There may also be losses arising at a point beyond the extraction fan created by back pressure if the escaping air is restricted by the separating medium whether this be a cyclone or fabric filter.

1/ Corresponding to thicknesses (approximately) of 0.049, 0.061, inches or 1.2, 1.5, 1.9 and 2.6 mm respectively.

6. It is difficult to estimate the exact volume of chips or sawdust produced by a saw or cutter since this is affected by many variables.

A set of recommended branch duct sizes have been established by practice and are generally accepted throughout the industry. Table 3 (1) gives these sizes and the number of pipes for each machine. Table 3 (2) gives the recommended air speeds for conveying some types of wood waste.

7. In the foregoing paragraphs only permanent fixed ducts have been considered. There are situations where it is not possible to connect the chip collecting hoods to a rigid pipe or duct. Such situations arise when the cutting tool travels over a given path as in cross-cut saws and some panel-sizing machines. In some machines cutter heads are adjustable over a wide range of positions, a good example of this is the double-end tenoning machine. Originally these situations were catered for by inserting articulated joints in straight ducting. This often resulted in sharp angular bends which reduced the efficiency considerably. The present method is to use a flexible metallic pipe between the chip hood and the permanent trunking. With this the bends are curved and more gradual and the pipe diameter remains approximately constant in any position. A point to be watched is that the flexible pipe is long enough to adapt to all possible positions of the tool. (Fig.8).

8. A further provision in the permanent ducting is that of inspection or cleaning doors. There are occasions when off-cuts of solid timber or other objects enter the extraction system and become lodged in some part of the ducting possibly at a bend or entry of a branch pipe. It will save much time and inconvenience to be able to free such obstructions without dismentling sections of the ducting. Doors should be located close to those positions mentioned and should be held in position

Table 3 (I) General list of machines and recommended exhaust pipe sizes

Machines		No. of Pipes	Inside Diameter
Saws under 15in diameter		1	4in
" over 15in diameter		1	7in
Belt sanders	6in wide diameter	1	4in
	up to 9in wide - top	1	4½in
	up to 9in wide - bottom	1	4½in
	10in to 14in wide - top	1	5in
	10in to 14in wide - bottom	1	5in
	Over 14in wide - top	1	5in
	Over 14in wide - bottom	1	7in
Disc sanders	up to 12in diameter	1	4in
	12in up to 18in diameter	1	4in
	18in up to 24in "	1	5in
	24in up to 32in "	1	6in
	32in up to 38in "	2	4½in
	38in up to 48in "	2	5in
Planers (single)	up to 20in wide	1	5in
	20in to 26in wide	1	6in
	26in to 36in wide	1	7in
	over 36in wide	1	8in
Planers (double)	up to 20in wide	2	5in
	20in to 26in wide	2	6in
	26in to 36in	2	7in
	over 36in wide	2	8in
Sweep-ups (small workshop)		1	4in
Sweep-ups (large workshop)		1	6in
Sweep-ups, heavy cuts and high loadings		1	8in
Mouth of sweep-ups to be a minimum of 10in by 4in			

Table 3 (II) Air speed in pipes

Material	Air Speed
Dry sawdust	2000 ft/min
Green sawdust	3000 ft/min
Dry wood chips	4000 ft/min
Green wood chips	5000 ft/min

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with quick release attachments and be reasonably leak proof.

9. A further desirable feature is the provision of blanking shutters on branch pipes. Often on multi-cutter machines some of the cutters will not be in use and there will be no requirement for extraction. The blanking or sealing of these idle ducts will improve the efficiency of the system and reduce the cost of operation by reducing the total air requirement.

IV FANS

1. The usual type of fan employed in wood-waste extraction is the centrifugal paddle-blade fan of simple but robust design. Since the blades of the fan are subjected to a continuous bombardment of chips and often of larger pieces of wood and occasionally metal objects the reason for its robust design will be obvious.

2. The total air requirement of the installation will determine the size and rating of the fan and the horsepower of the driving motor. It is essential that these characteristics be carefully calculated to ensure that the fan will be capable of dealing with the maximum loading of the system but will not be over-calculated resulting in excessive power requirements and high cost. Alternatively under-estimating may save money on initial cost but will result in loss of efficiency and premature breakdown.

3. The method of driving the fan is usually by belt drive from an electric motor. This system gives greater flexibility than direct drive and enables the motor to be isolated from the rugged conditions to which the fan bearings are subjected.

4. The fan is usually located before the cyclone separator in which position it exerts a suction force on the input side and a

smaller blowing force on the output side sufficient to overcome the natural resistance of the cyclone.

5. With some modern systems which employ a bag filter unit in addition to the cyclone to improve the standard of separation, it is not uncommon to place the fan behind the cyclone and between it and the bag filter. With this arrangement it becomes possible to use the fans of more sophisticated design with higher efficiency since the heavier waste will have been separated from the air stream before this enters the fan chamber.

V. SEPARATION OF WASTE FROM AIR

1. This is the final stage in all types of pneumatic extraction systems. The most commonly used method in permanent installations is the use of a cyclone separator. The short cone cyclone of large diameter has been used effectively over many years, it is easy and cheap to construct and maintain. It consists of a conical shaped vessel with the largest diameter at the top.

2. The dust laden air is fed in tangentially at the largest diameter and immediately adopts a cyclonic motion inside the cone. This propels the chips and dust by centrifugal force outwards to the walls of the chamber where frictional resistance and the lower velocity cause the waste to fall to the lower part of the cone and out to the storage container whilst the cleaned air passes upward and out at the top of the cyclone.

3. This method of separation is not 100% efficient and quantities of fine dust remain entrained in the exhausting air. This has not been considered unacceptable until recent years. A greater awareness of environmental pollution is now necessitating a higher standard of efficiency. To obtain

this the exhausting air from the cyclone can be transmitted to a bag filter which will remove the remaining dust and make the exhausting air more acceptable.

4. A recent development is the long cone, small diameter cyclone creating higher air speeds and greater separating efficiency. With these cyclones it becomes necessary to have some form of air lock at the base of the cone to prevent the escape of air at this point. It is usual to find this type of cyclone mounted over a storage silo from which the waste can be extracted by mechanical means.

5. It will perhaps have been noted that in the foregoing methods of dust separation the cleaned air is exhausted to atmosphere. Where factory heating or air conditioning is necessary it will be obvious that exhausting of these large volumes of air from the factory area will necessitate replacement of the same volume of heated or conditioned air at considerable cost.

6. A more recently devised system of dust separation in which cloth bag filters are used giving a high degree of efficiency enables the exhausting air to be re-circulated inside the factory. The result is that less than 20% of the heat is lost and the provision of make-up air is almost eliminated. With these systems the separator unit is usually mounted inside the factory thus shortening the length of ducts and making a further contribution to the general efficiency of the system.

7. Another great advantage with these systems is the unit method of construction. Each unit is entirely self-contained with its own fan and is designed to serve a limited number of machines. If new machines have to be installed it is only necessary to add a new unit to serve the additional machines and the main installation is not disturbed.

8. With the more permanent type of installation the addition of further machines or the re-location of machines could necessitate a complete replanning of the whole system. With the rapid advance of technology the modern woodworking unit is becoming much less permanent and it is not uncommon to find replanning necessary about every two years where highly automated production is involved.

9. In the smaller manufacturing unit it may be found acceptable to have a small self-contained waste extraction unit in which collection and separation of waste is effected by the unit. These can be arranged to serve a single machine or a small group of machines where all machines are not in continuous use. They have the disadvantage of having to be cleared periodically since the storage space is of limited capacity.

10. A few notes on chip storage may be of interest. If the waste has to be transported by some form of vehicle it is advisable that the storage unit should be elevated to allow the vehicle to be loaded from above. If chips are to be burnt on the premises then location of the storage unit is of less importance since some form of mechanical extractor will have to be provided. The same would apply if baling or briquetting of the waste was envisaged.

VI PLANNING AND SPECIFYING A DUST EXTRACTION SYSTEM

1. The progress chart (Fig. 9) sets out the procedure to be followed when planning a wood waste extraction system. Such a system is an added expense to what may already have been an expensive installation.

2. Justification on economic grounds can be achieved by a simple comparison with the alternatives which was clearly expounded in Chapter I. It would be difficult to envisage any alternative except in the smallest of workshops with a minimum machine requirement.

3. Environmental considerations may need a considerable amount of research. Most countries now have some form of planning authority and there may be legal requirements regarding the siting of cyclones, noise from extraction fans, dust emission from cyclone separators. Inside the factory conditions may be controlled by various Factory Acts which demand certain standards of cleanliness for safety reasons. The efficiency of dust filtration may be subject to regulations where filtered air is to be re-circulated inside the factory.

4. The provision of a clean and healthy working atmosphere is often an important aspect of staffing considerations since employees will not work in dirty or unhealthy surroundings longer than they are compelled to. This also has a bearing on lost man hours through illness and should be considered as an economics matter as well as environmental.

5. Many factors will need consideration at the next stage of decision in selecting an appropriate system. In the smaller unit where only the basic machines are installed and where these are only used intermittently the use of unit dust collectors either for individual machines or larger units serving groups of machines may provide the most economic solution. These can be moved around when re-planning a lay-out and the addition of extra machines offers no particular problem.

6. The storage capacity of these units shou_d be considered since these will have to be cleared manually. They should be

large enough to keep clearing time to a minimum and to allow clearance at production breaks rather than during production hours.

7. Permanent installations have certain limitations which have been mentioned in earlier chapters. Perhaps the most significant is the difficulty of subsequent modification. There are however woodworking processes where modified layouts are rare. Sawing and planing mills once established are seldom modified in layout and increased capacity is usually provided by further complete units rather than by modification of existing plant. These situations lend themselves to permanent extraction systems.

8. The most difficult type of manufacturing unit to cater for is that of secondary production such as furniture manufacturing, joinery production and the many other wood products. It is in this field that rapid technological advancement and developments in production planning necessitate frequent changes of plant and factory layout.

9. This is the most difficult field in which to plan extraction equipment. A flexible system is essential and possibly the use of several individual systems each designed to serve a production line or unit. It is in this field that the bag filter system may be found most useful since units can be added or removed as required without disturbing the general installation.

10. The next stage of quantifying requirements will invariably involve a competent dust extraction engineer since at this stage the design of the installation will be evolved. This means either involving possible contracting firms or employing an independent consulting engineer.

11. The first step is to produce a scale plan of the factory and a fairly accurate layout of the machines to be installed. The approximate position of the collection hoods on the machines should be indicated as must the location of the extraction fan and separator unit especially if this location has been the subject of a decision by a planning authority. (Fig. 10).

12. On this scale plan can now be inserted suggested routes for trunking and branch ducts, alternative schemes can be tried until the most economic plan is arrived at. It is now possible to commence adding quantative information to this plan. Starting with the branch duct farthest away from the extraction fan the diameter of duct suitable for this machine can be inserted together with the volume air requirement and pressure losses created by any bends and the entry point into the main duct.

13. This procedure is then repeated progressively with each machine and the values indicated at each point. The increasing diameter of the main duct must also be indicated at each branch entry. As this operation progresses it will probably be necessary to make adjustments to the original plan in order to obtain a balanced system.

14. When all machines have been dealt with in this manner the values shown on the sketch plan must be arranged in tabular form and totalled. After making due allowance for friction losses the total air requirements indicated will dictate the size and capacity of the extractor fan and separation equipment.

15. Having now established and quantified the requirements of the system it will be possible to approach selected firms for submission of tenders. When these tenders are received they will need careful comparison. It may be necessary to have further

discussion with contracting firms regarding details of the tender especially if further modifications have been suggested. Final comparisons will be on a like for like basis with careful attention to details.

16. Having made a decision and placed an order nothing further can be done until the installation is complete. It will then be necessary to run acceptance trials to ensure that the plant fulfils the original specification. It will also enable any guarantees to be checked. It now only remains to operate and maintain the plant in accordance with the maker's instructions and advice.

VII WOODWASTE DISPOSAL AND UTILIZATION

1. The disposal or utilization of woodwaste is often omitted from the planning of a factory unit with the result that confusion and emergency measures result in failure to obtain the maximum value of the waste. Methods of waste disposal range from simple incineration which absorbs further capital and gives no return to the inclusion of waste as raw material for particle or fibreboard production in which use perhaps the greatest value is obtained.

2. There are many properties of waste which affect its value and determine whether further processing is necessary. Moisture content which in sawmill waste is high whilst in furniture production is low. Waste of high moisture content will invariably have to be subjected to a drying process. Solid waste will almost certainly need to be reduced to chips except when it is used as fuel. This process would mean installing either a knife chipper or hammer-mill.

3. In the developed countries the main outlets for waste are

determined by the economies of the country. If board processing plants exist within reasonable distance of the waste producing unit then considerable quantities of selected waste will be absorbed. If the unit is located near to an agricultural or horticultural area then considerable quantities can be disposed of as animal litter and afterwards as a soil conditioner or mulch. Certain types of waste may be used as packaging for certain types of horticultural produce.

4. Probably the greatest volume of waste is ultimately used as fuel for heat generation. The reason for this is the high cost of alternative fuels and saving on transport costs by using waste at source when process and factory heating are required. In countries where coal and oil are scarce and expensive a useful form of domestic or industrial fuel is briquetted woodwaste. In this form waste is easier to store because of reduced bulk and the process of briquetting improves the thermal properties of the waste and renders it almost smokeless. Briquetting will necessitate a hogging process to reduce the waste to a suitable and uniform size, it may also need a drying process to reduce moisture content below 15 percent and will require a briquetting press. To operate a briquetting plant effectively a sufficient volume of waste must be available to keep the plant in full operation.

5. Whilst on the subject of woodwaste burning the possible use of heat produced for the generation of electricity should not be overlooked. Most standard woodworking machines are designed for electric power. If alternative methods of drive have to be provided for them the cost of machines would be considerably increased and in some cases this would not even be possible. If electrical supplies are limited or none existent it may be an advantage to install a woodwaste fired boiler and a steam driven electrical generating plant. This should only be

considered if woodwaste is available in large quantities and alternative fuels can be utilized for emergencies. There are, however, a number of such plants in operation in Western Europe where electricity is generally in good supply.

6. Earlier in this and preceding chapters mention has been made regarding cost of transportation of woodwaste from the producing unit to further processing. This cost can be reduced by reducing the bulk of the waste and improving the handling. This can be accomplished by baling in which waste is compressed and bound with wire or plastics in bales of a convenient size. A simple baling press is the only equipment required.

7. In conclusion the planning of waste disposal must be carried out in the early stages of a project. It must be related to the possible outlets in the country concerned and to the location of the factory to confine transportation costs to a minimum.

VIII REMOVAL OF SOLID WASTE

1. Some woodworking machines produce solid waste in the form of off-cuts which cannot be handled by pneumatic extraction and it is therefore necessary to provide other means of removal. The form which this takes will be decided by the volume produced related to time. In some instances a box pallet adjacent to the machine would be sufficient but where a number of cross-cut saws or edgers are being operated continuously it would be necessary to provide some form of mechanical conveyor to remove the waste as produced.

2. Sawmilling produces two forms of solid waste; slabs which are of considerable length and weight and slivers which are smaller and usually fall into the pit below the saw. The most suitable method of removing slab wood is by powered roller conveyor

arranged conveniently by the saw carriage to receive the slabs as they fall. This conveyor would remove the slabs directly to a docking saw to be reduced to a convenient size for feeding to a hogging unit.

3. Slivers which would accumulate in the pit as indicated in Fig.5 would be difficult to remove manually. The most suitable means of extraction would be by scraper chain or drag link conveyor located beneath the vibratory chute. In the case of vertical band mills it is not uncommon to fit an inclined deflector plate around the blade below the log to prevent slivers from falling into the pit; this would direct the slivers onto a drag link or belt conveyor.

4. Waste from cross-cut saws is in the form of short ends and defected pieces which can conveniently be handled either by belt or drag link conveyor. A good system to serve a bank of cross-cut saws consists of a trough arranged above and linking the whole bank of saws with a belt conveyor running along the base of the trough. The operator throws the offcuts into the trough and the conveyor transports them away to a storage point. This elevated conveyor provides no obstruction to the free use of floor space.

5. Offcuts from edgers are usually longer pieces of relatively small cross-section and comparatively light. A belt conveyor again arranged to serve a number of edging saws would be most suitable.

6. The most difficult machine from which to extract solid waste is the double-end tenoning machine. Waste may take two distinct forms depending on the type of work being performed. In tenoning operations short offcuts are produced but when the machine is being used for panel trimming the offcuts are usually long thin pieces. The most effective method of dealing with

this waste is to fit a hogging cutter on the waste side of the trim saw blade. A hogging cutter is a cylindrical block of a diameter equal to or slightly smaller than the diameter of the trim saw at the base of the saw tooth gullet, to which is attached a series of cock's-comb cutters arranged helically round the circumference and across the total width of the block. This hogging unit reduces the solid waste to a form which can be removed by the normal dust extraction system.

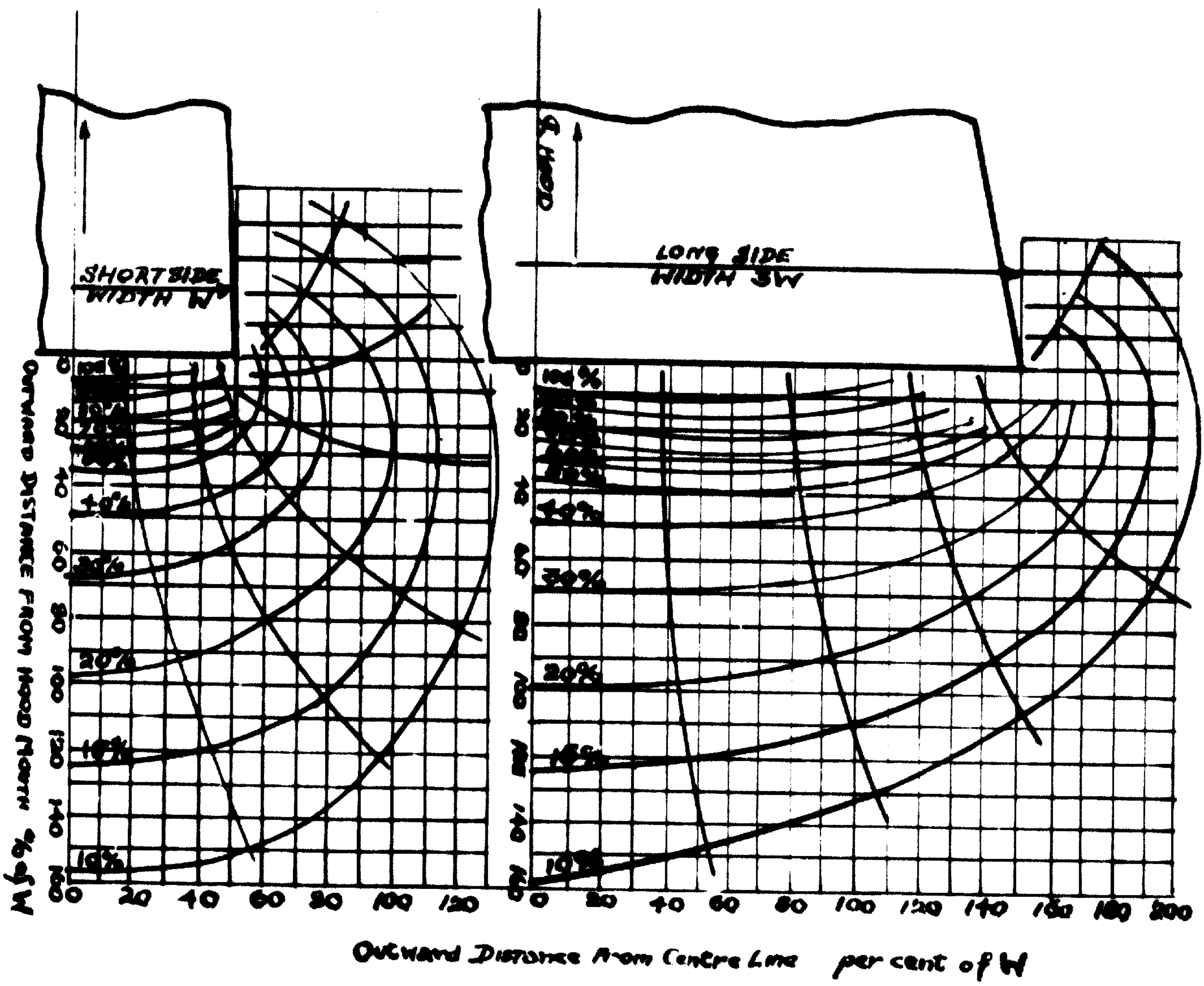

Fig. 1 Velocity contours and flow directional lines in principal centre-line planes of rectangular suction hood with side ratio 1 : 3. IHVE Guide 3rd Ed.

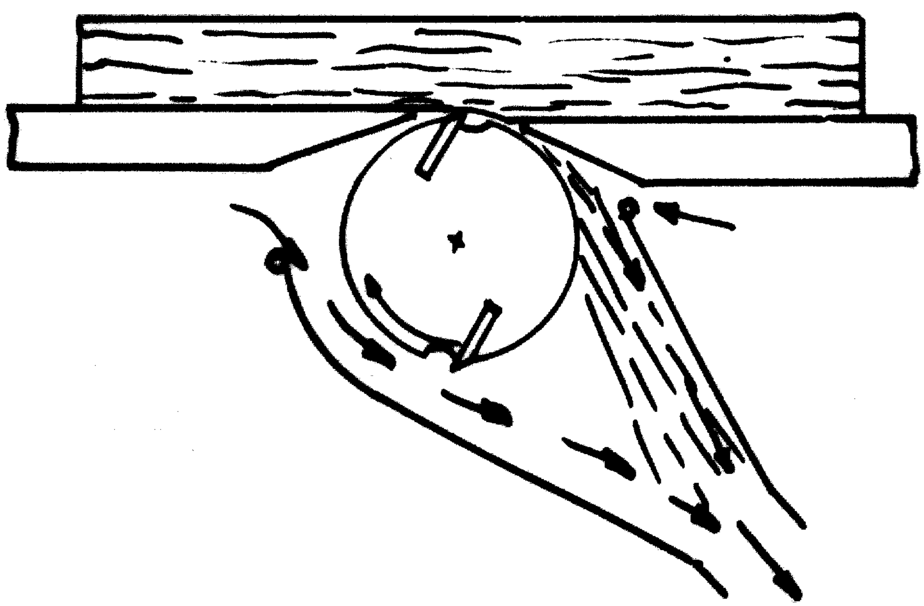

Fig. 2 Diagram of cutterblock on surface planing machine showing trajectory of chips and path of air currents.

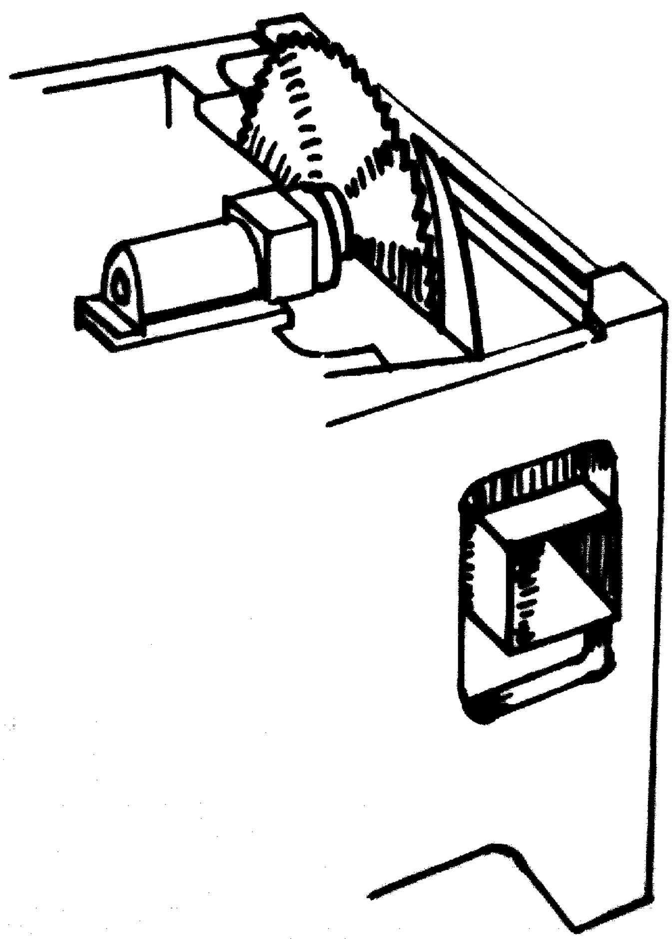

Fig. 3 Circular saw with table removed. Dust hopper also provides guard for sawblade below table and leads to connection to extraction duct.

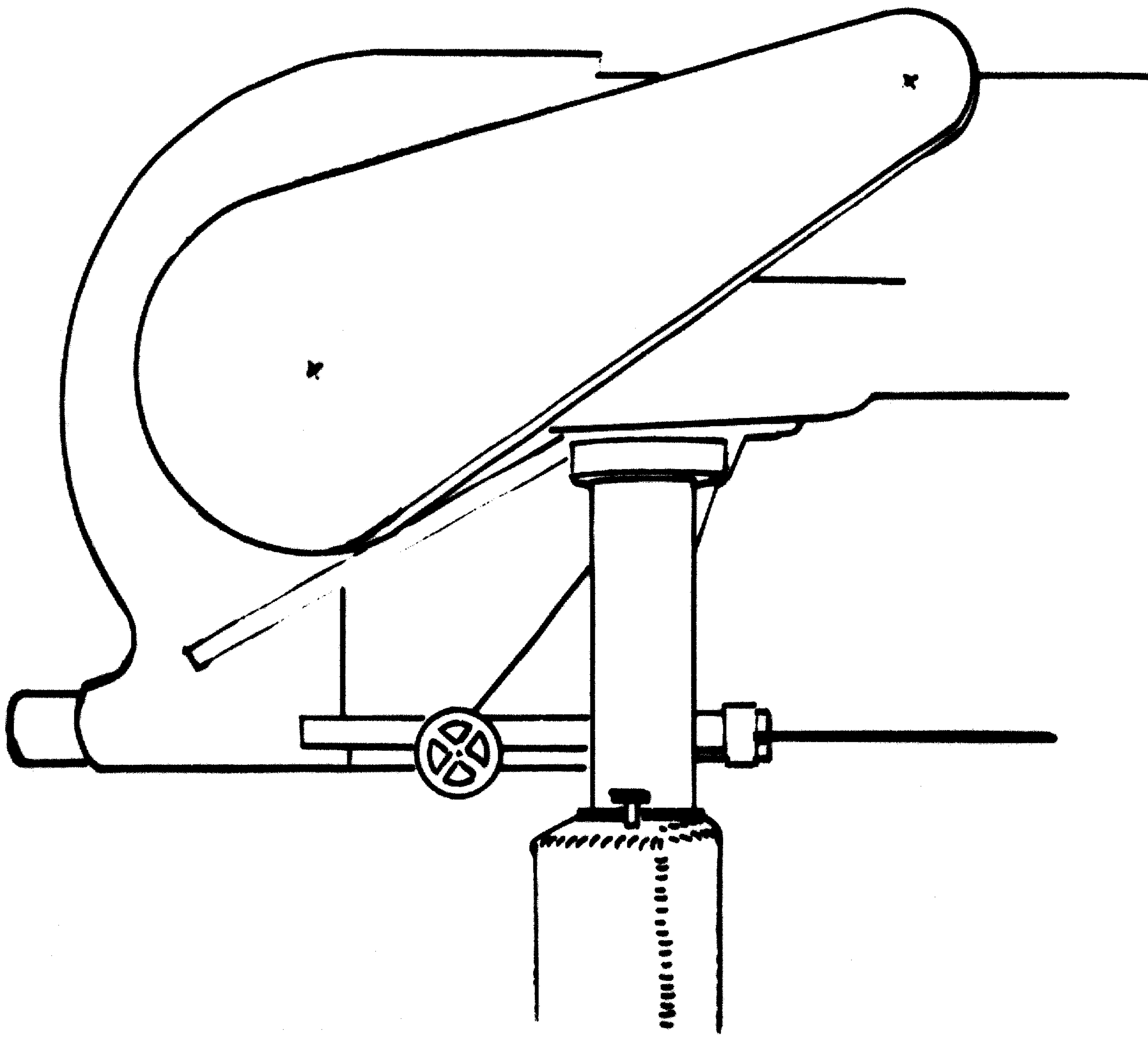

Fig. 4 Horizontal bandmill. Wheel guards provide hood and extraction duct is located at point where sawdust is released from the blade.

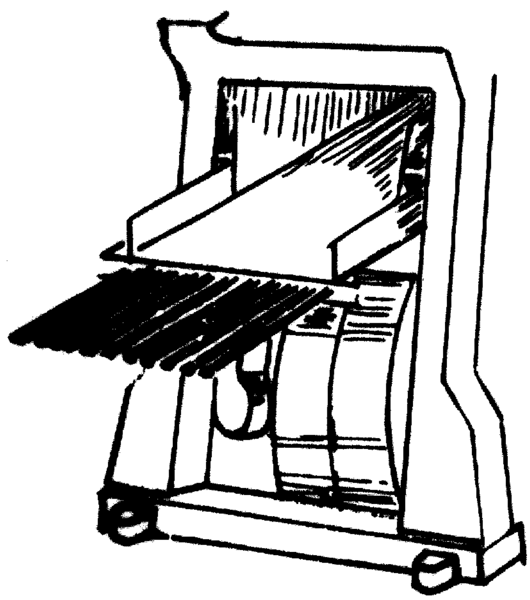

Fig. 5 Vicratory chute on vertical frame saw. Showing fingers to carry slivers beyond the dust extraction hood.

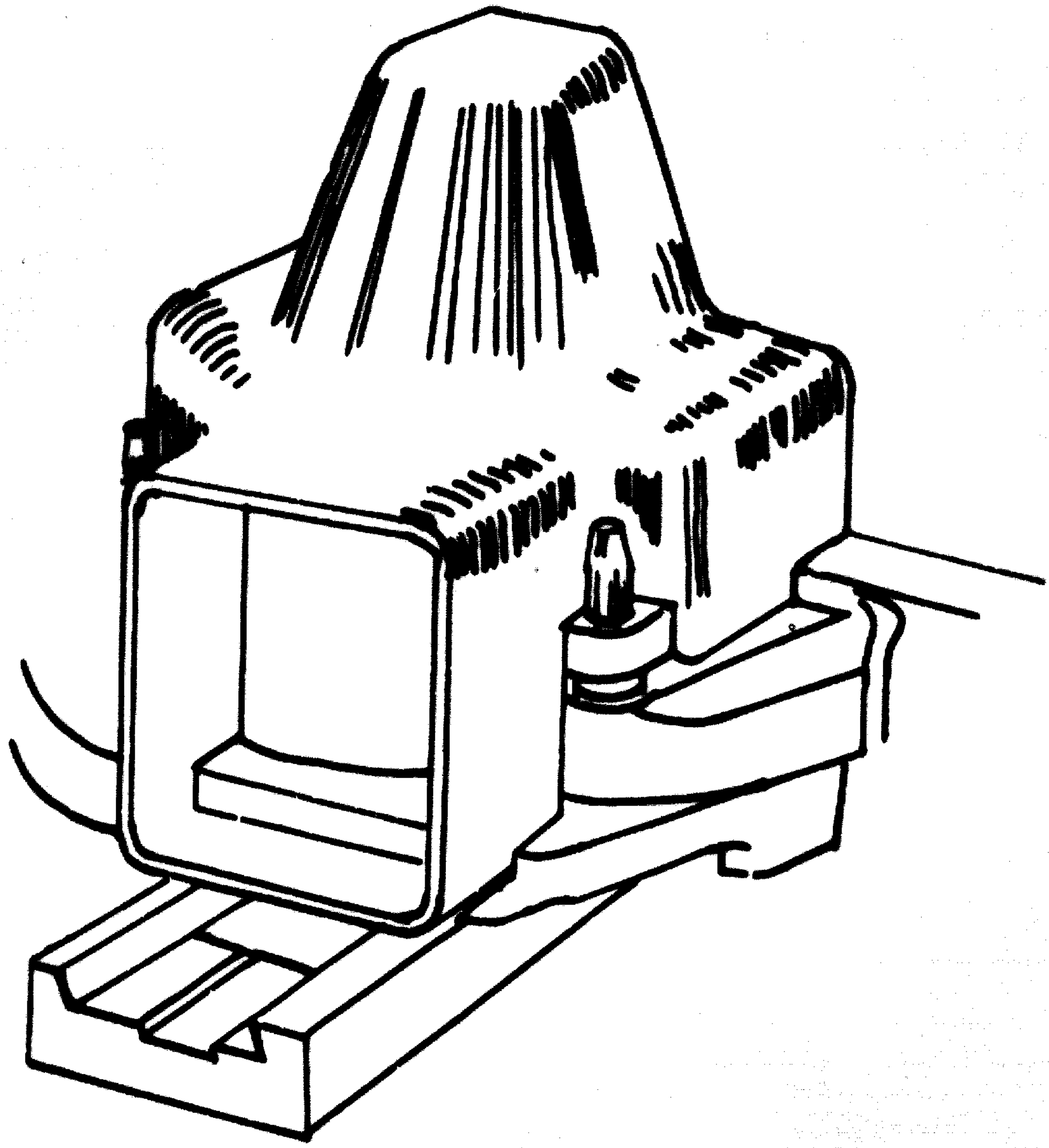

Fig. 6 Extraction hood for side head of planer-moulder

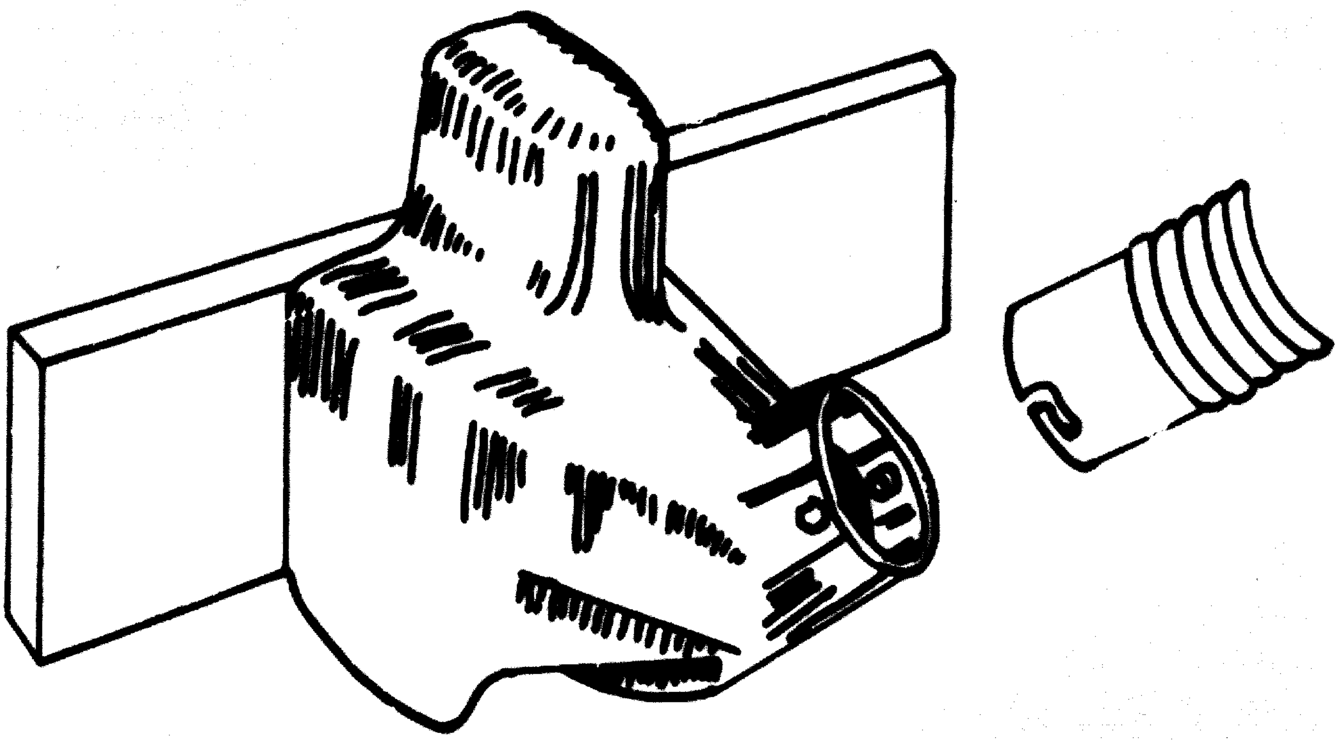

Fig. 7 Spindle moulder hood showing quick-release bayonet fitting for flexible duct.

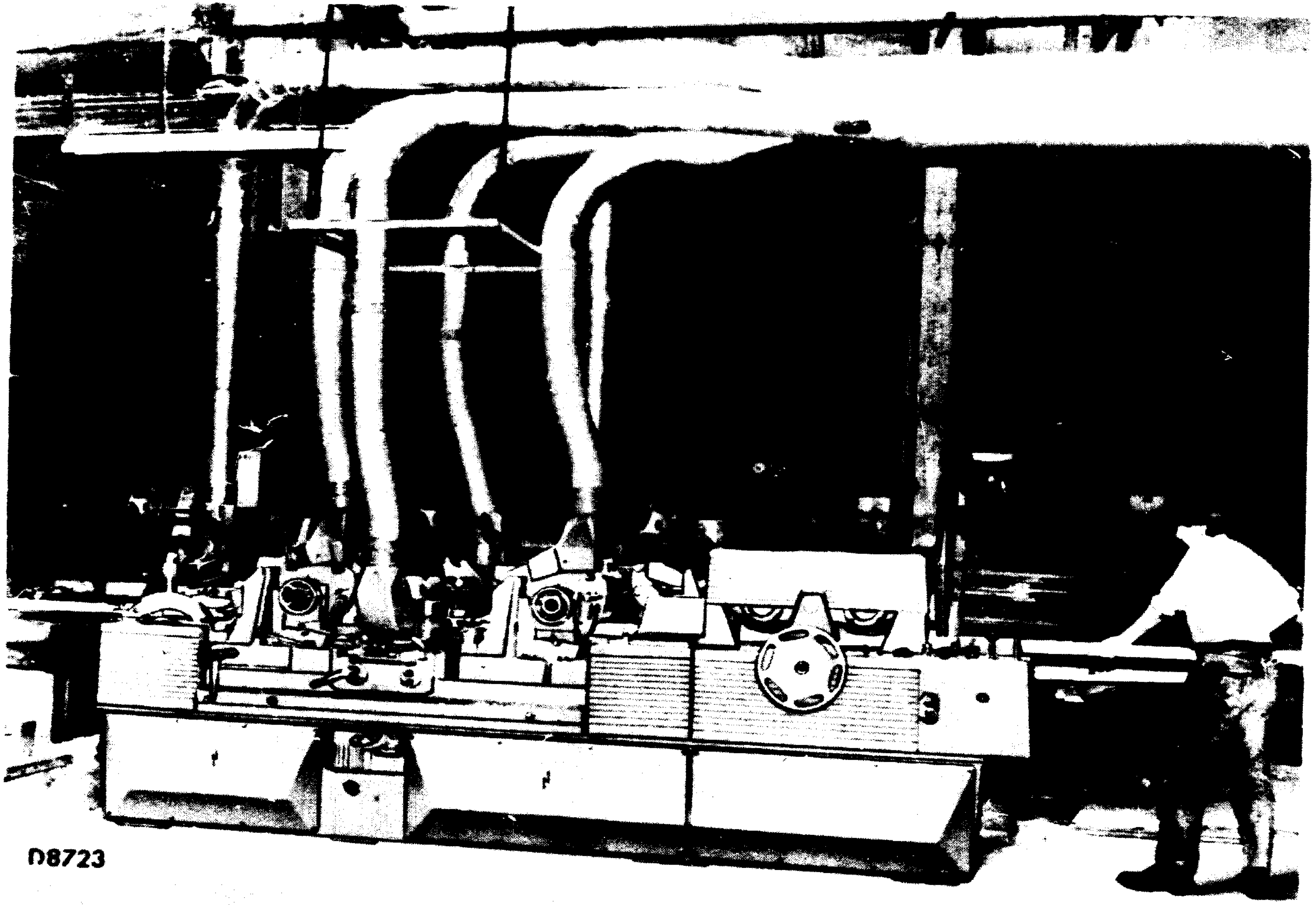

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Fig. 8 Dust extraction unit for a five head planer and moulder illustrating application of flexible ducts.

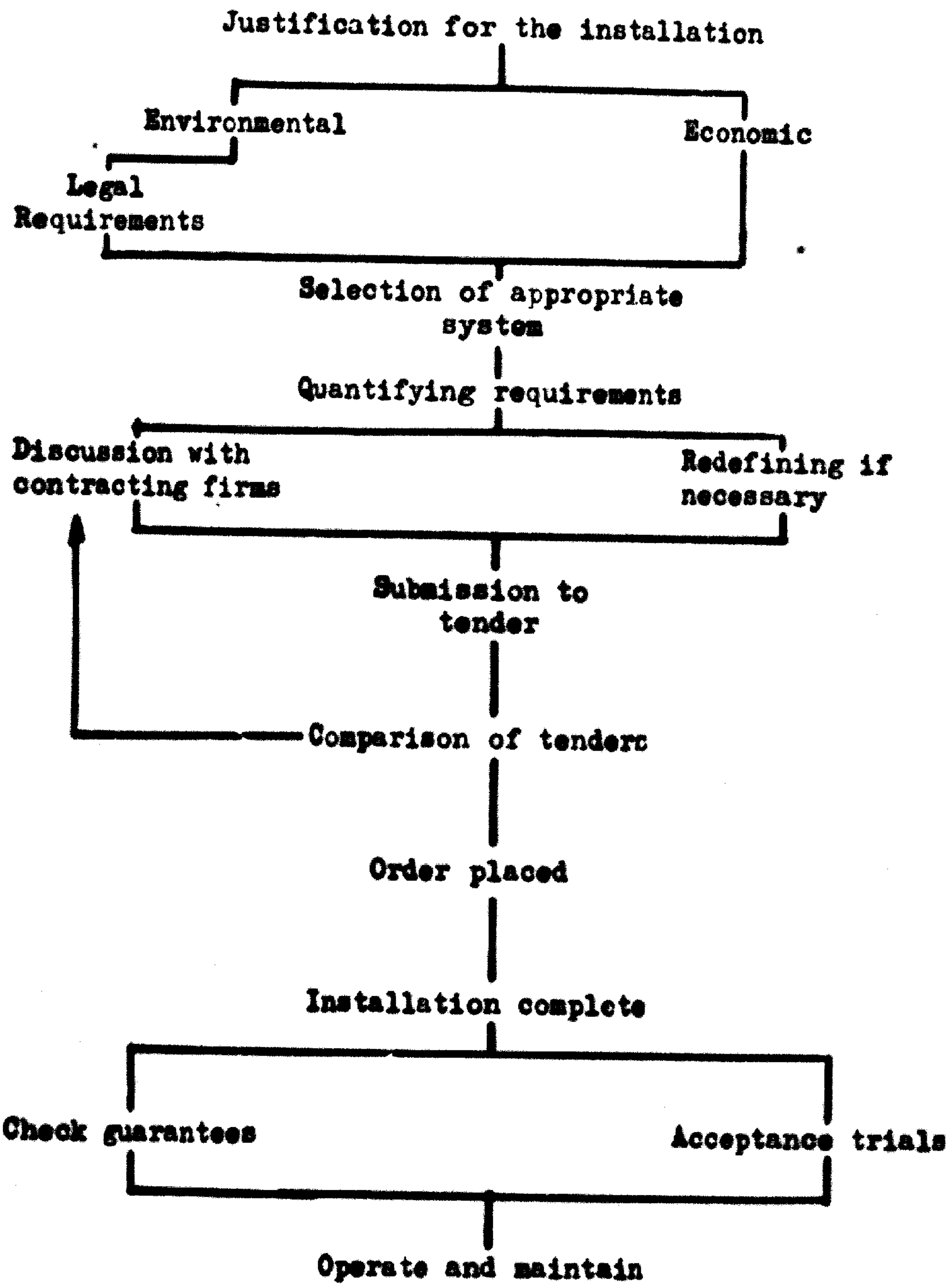


Fig. 9 Progress chart for waste extraction installation.

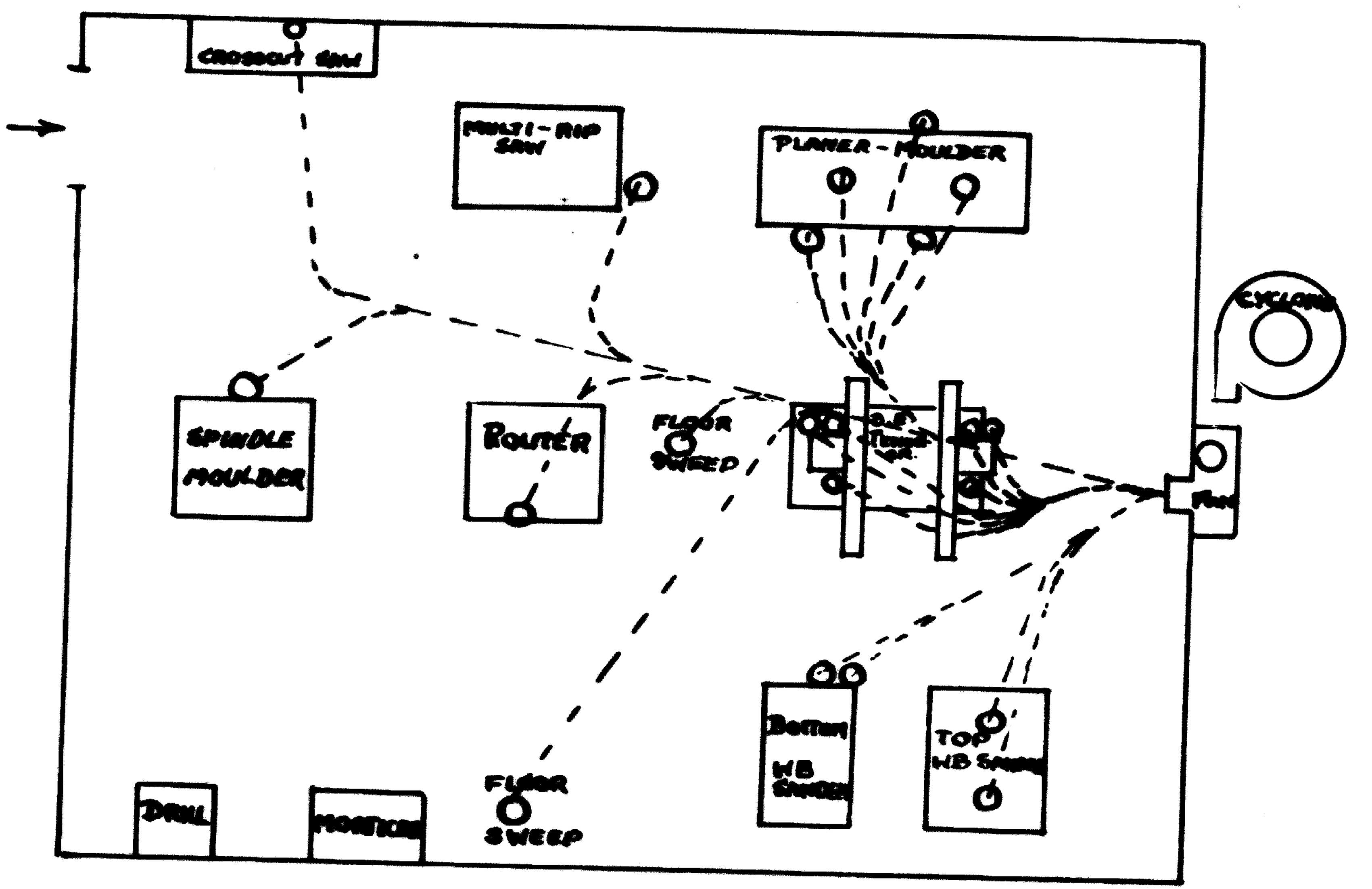
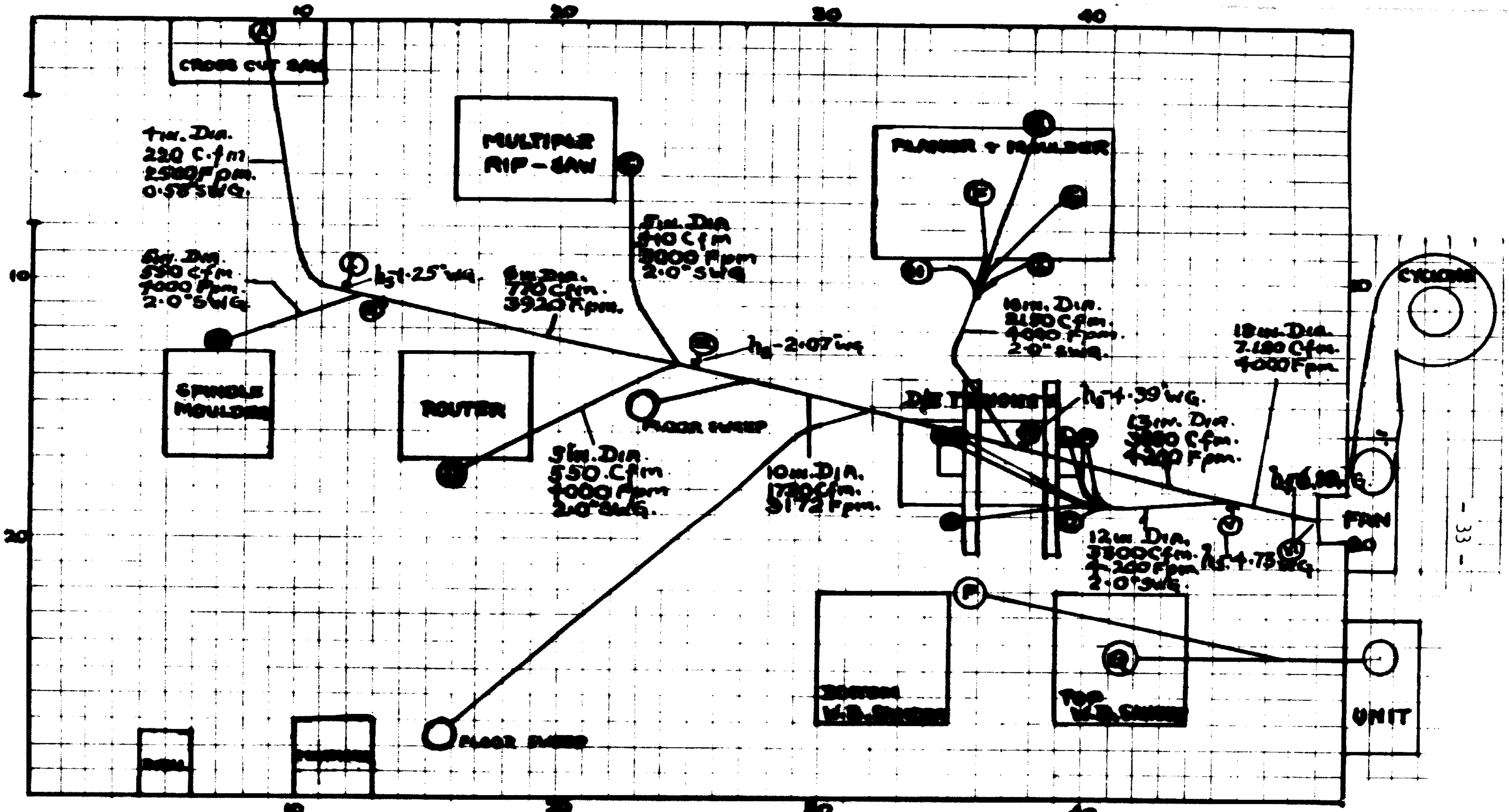


Fig. 10 Scale plan of factory layout showing position of extraction points.

Fig. 10 Scale plan of factory layout on 1ft square grid showing duct sizes, air volume, velocity and pressures.



FAN MUST MOVE 7190 Cfm AT 6·88" SWG.

$$\text{AIR HP} = \frac{\text{VOLUME} \times \text{PRESSURE}}{6346}$$

FAN EFFICIENCY = 60%

DRIVE EFFICIENCY = 85%

$$\text{MOTOR HP} = \frac{7180 \times 6{\cdot}88}{6346 \times 0{\cdot}60 \times 0{\cdot}85} = 15$$

CENTRELINE RAD. OF ELBOWS NOT LESS THAN 2 × DIA.

ANGLE OF INTERSECTION OF TEES < 45°

TAPERS TO BE AS LONG AS PRACTICAL

TWO WIDE BELT SANDERS ARE EXHAUSTED BY A BAG FILTER UNIT AS A SAFETY MEASURE.

CENTRELINE HEIGHT OF MAIN DUCT 9ft.

FLOOR SWEEPS ARE DISREGARDED BECAUSE OF INTERMITTENT USE

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