# LOCATING, LEVELLING AND FIXING METHODS.

This E.I. details methods for:-

(i) Locating all classes of internal plant in buildings.

(ii) Fixing positions of holes for bolts, drop tie rods, etc..

(iii) Marking out cable runway and power distribution openings in walls or floors.

(iv) Marking out auxiliary beam supports, for M.D.F.s or for mezzanine platforms.

INDEX TO SECTIONS



## 1. GENERAL.

1.1 This E.I sets out the methods to locate datum lines, fix dimensions, stencil points of reference and locate drilling positions; it also describes templates and their uses and the installation of plinths and other fixtures to position equipment.

1.2 The structural strength of a building can be seriously affected by indiscriminate action in forming holes. Cable and power distribution holes in a building must only be made by the Buildings Branch. Only in exceptional instances should action be taken by officers of the Engineering Branch to form or cut a hole in any building and, in all cases, the approval of the Divisional Engineer must be obtained. The practices detailed in this E.I. for the correct location of holes must be followed when additional holes are required.

2. DEFINITIONS.

2.1 Reference Point or Level is that point or level in the plan and equipment area to which all Datum Lines and subsequent measurements are related.

Datum Lines are those lines from which all measurements to equipment positions are made. They are struck at right angles to each other and intersect at the reference point.

Stencilling is a method of permanently marking positions and measured distances.

Centre Lines are those upon which all drilling points are marked.

Dimensions are stated measurements and are indicated as either fixed or variable values. The use of a bracket enclosing a dimension, for example (7' 3"), indicate that the dimension stated is a variable measurement and is to be adjusted to varying wall conditions.

Rack or Equipment Outlines are chalk marks used to indicate the actual location and dimensions of specific items of equipment. The outlines can be used to locate drilling points which should be stencilled or punched.

Fig. 1 illustrates the above definitions.

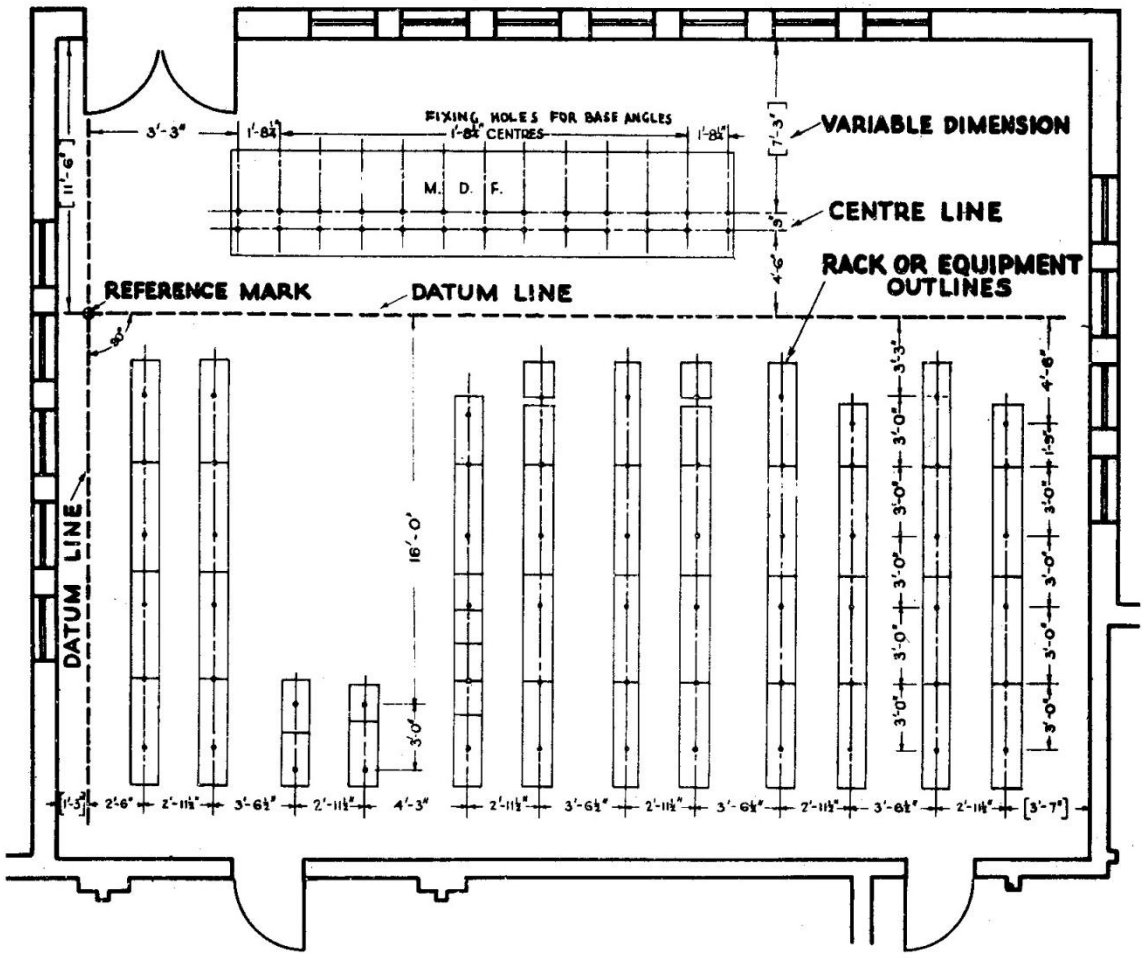



FIG. 1. FLOOR DRILLING DETAILS.

Templates are used to provide a ready means for stencilling or punching where repetition operations are involved. Types of templates used are shown later in this E.I.

3. PRELIMINARY INSPECTION – PROCEDURE FOR FIXING POSITIONS OF EQUIPMENT.

3.1 A Preliminary Inspection must be made of the area to be used -

(i) after advice from the Buildings Branch that a new building or floor area is available for equipment installation; or

(ii) Before installations are started in an existing available area.

3.2 A record must be made of obstructions, such as air ducts, doorways, stairways and other items which may interfere with or vary the initial equipment layout, and to check that all openings for cable runways, cables or power distribution have been provided.

3.3 After the preliminary inspection, arrangements must be made for -

(i) a check of the building dimensions against the architectural working drawings to determine variations during its construction;

(ii) an outline of the ultimate equipment to be marked out on the floor area made available;

(iii) a survey of floor levels.

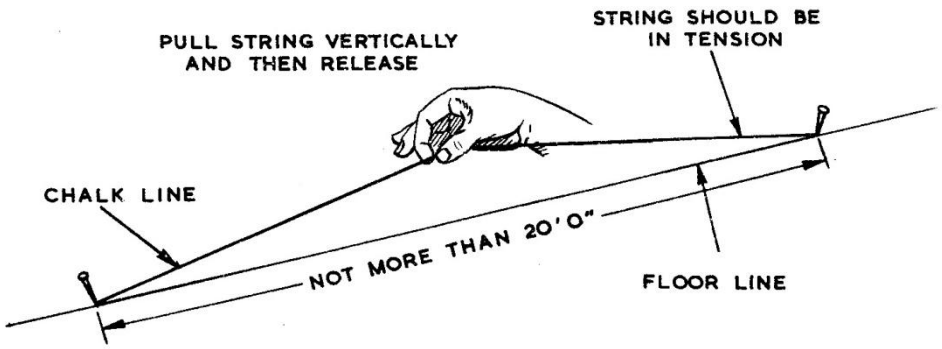
3.4 Wherever possible, these operations should be done by a surveyor from the Drafting Section. In certain installations, where the services of a surveying officer are not available or desirable, the marking out of the floor area and the determination of levels must be done by an Engineer before the installation of the equipment.

4. MARKING OUT FLOOR AREAS, WALLS OR CEILINGS.

4. 1 Accurate marking out of the floor area, walls or ceilings is essential to correctly locate equipment. All measurements in the setting out of datum lines, centre lines, drilling points, etc., must strictly conform to those shown on the installation lay-out floor plan. (See Fig. 1 for typical plan).

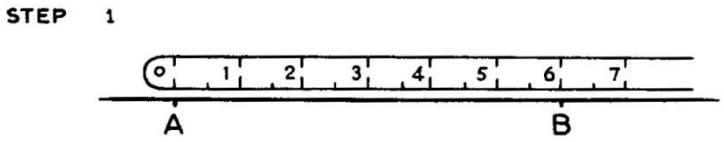
4.2 Setting Out Datum Lines should be established in relation to walls and equipment so that their point of intersection, the reference point for the area, is conveniently placed for present and future surveying operations. As equipment is generally arranged in a rectangular form the two datum lines should be at right angles to each other. These datum lines are fixed by measurement from the adjacent walls or from the centre line .of supporting columns. All measurements must be made with a steel tape. From these lines it is necessary to check for any variation in dimensions between the plan and the actual building; any variation must be reported to the Engineer. The final fixing of these lines is then made and the drawing suitably amended~

4.3 Striking Chalk Lines. The datum lines are first marked on the floor, using a chalk line stretched over the full length of the floor. When striking chalk lines, take care that the string is raised vertically and, if the length to be marked exceeds 20 ft., the string must be "pinned" in sections to preserve accuracy. See Fig. 2.




STRIKING CHALK LINE.
FIG. 2.

4.4 Setting Out Lines at Right Angles. The right angle between the datum lines may be fixed by the use of a theodolite or by the application of the theorem commonly known as the 3-4-5 rule. The 3-4-5 rule is applied as follows:-




Measure from the point of intersection A a length which has a multiple of 3 or 4 along each datum line respectively, say, 6 ft. to B and 8 ft. to C, and verify that the distance apart of the two points B - C is 10 ft.. If so the angle BAC is a right angle.

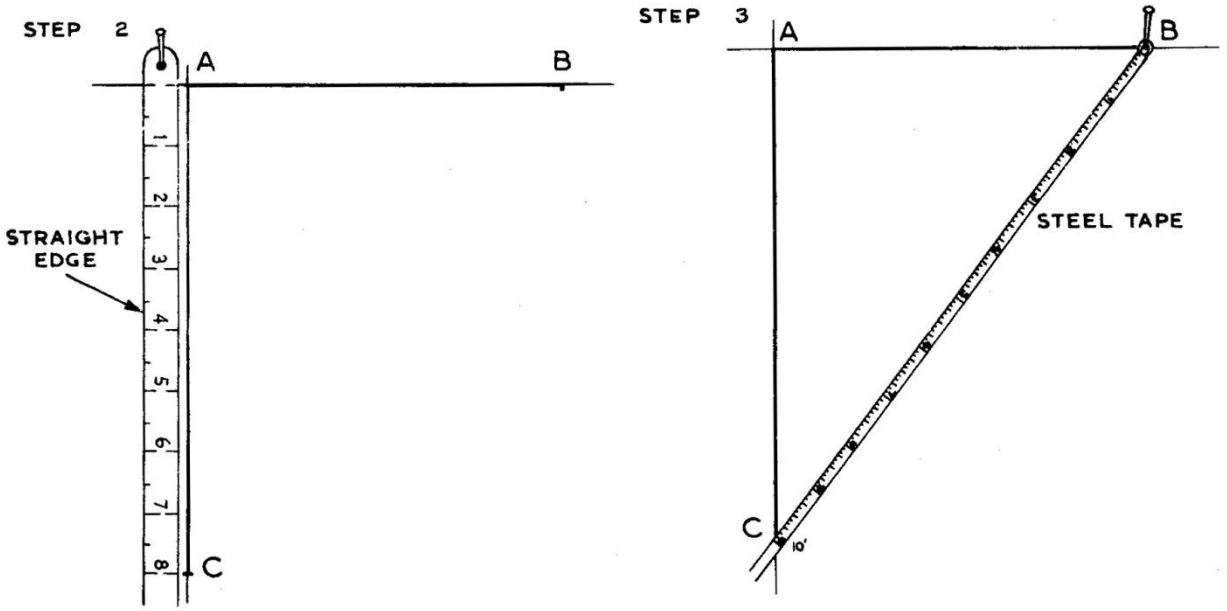



FIG. 3. APPLICATION OF 3-4-5 RULE.

4.5 Location of Equipment.

(i) Long Line Equipment. Aisle measurements are made to the centre line of the racks. See Fig. 4.

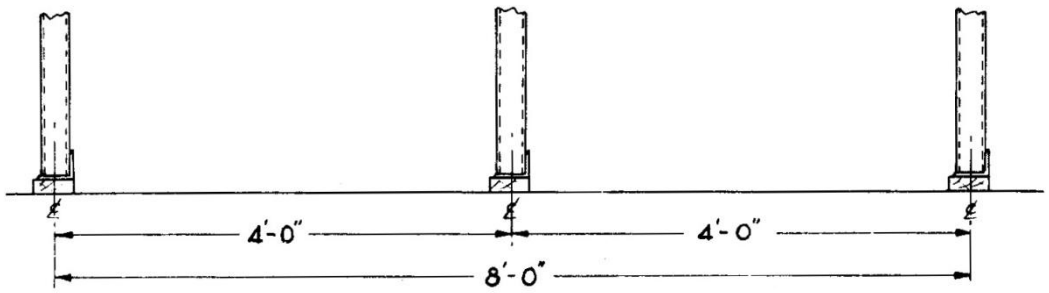



FIG. 4. STANDARD AISLE DIMENSION FOR LONG LINE EQUIPMENT.

(ii) 2000 Type Rack Equipment. Measurements are made to the vertical face of the base angle only. This is shown in Fig. 5 which also shows the plinth centre centre line.

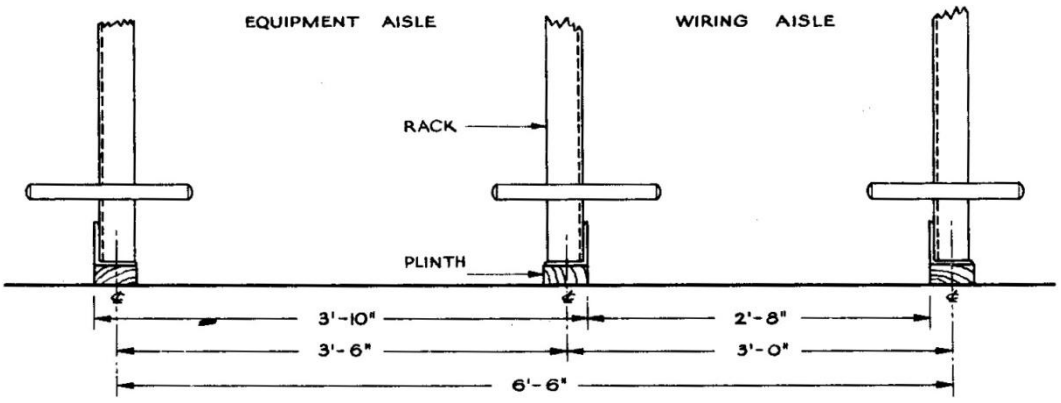



FIG. 5. STANDRAD AISLE DIMENSIONS 2000 TYPE EQUIPMENT.

4.6 Setting Out Aisle Spacing and Equipment Lines. The aisle spacing must be located along the relative datum line in accordance with the plan.

To avoid accumulative error in measurement, the locating marks must be made as the sum of succeeding measurements as indicated in the example hereunder:-

Mark a = 2' i.e. = 2' from datum or reference point.
Mark b = 2' + 2' = 4'. " " " " "
Mark c = 4' + 2' = 6'. " " " " "
Mark d = 6' + 2' = 8', and so on.

This method ensures that the overall measurement is correct.

The steel tape must be held at the point of intersection of the datum lines and run out for its full length, end the points marked for the equipment lines at the appropriate distances along the datum line. The measurements to be used must be adjusted to preclude the displacement of the datum line from the "first-in" unit of equipment.

The individual equipment positions must now be similarly measured along the other datum line and the end points for each located.

The furthest equipment line must now be squared off and its end points located, and the correctness of the rectangle checked by measurement of the diagonals which should not differ by more than ¼ in..

When measurements are satisfactory, a chalk line joining these end points must be made and all end points measured and located on these lines. All equipment lines must now be marked on the floor.

4.7 Stencilling of Outlines. When all lines are correctly positioned, the end points of each suite must be permanently stencilled on the floor with a triangular stencil (see Fig. 6) and stencil ink. Take care to see that the triangles are stencilled strictly according to plan so as to correctly locate the plinth. Drilling line positions must also be indicated by the stencil. (Fig. 6 shows a typical stencil.)

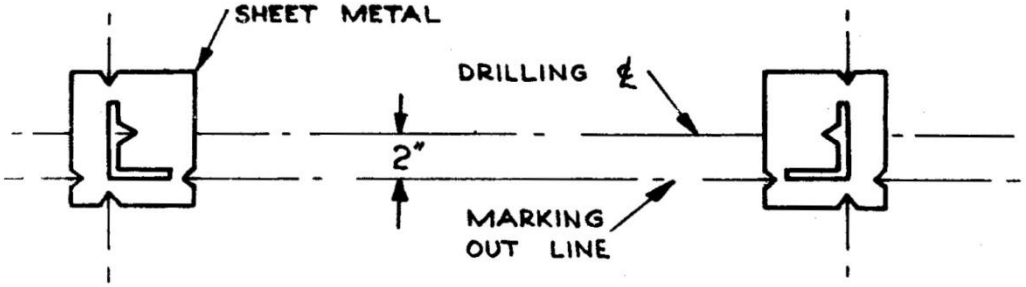



FIG. 6. USING A TYPICAL STENCIL FOR 2000 TYPE RACK.

4.8 Setting Out Drilling Points. All drilling point lines must now be marked and all drilling points stencilled or punch-marked along such lines, a template being used when repetition is involved.

5. SURVEYING FLOOR AREAS.

5.1 Details must be obtained of the variation of floor level over the whole of each line along which equipment is to be installed, by taking a level at each rack intersection, and recording of these levels on a key levelling plan.

The level points are located by chalk lines set out at right angles to the suite lines at each rack intersection.

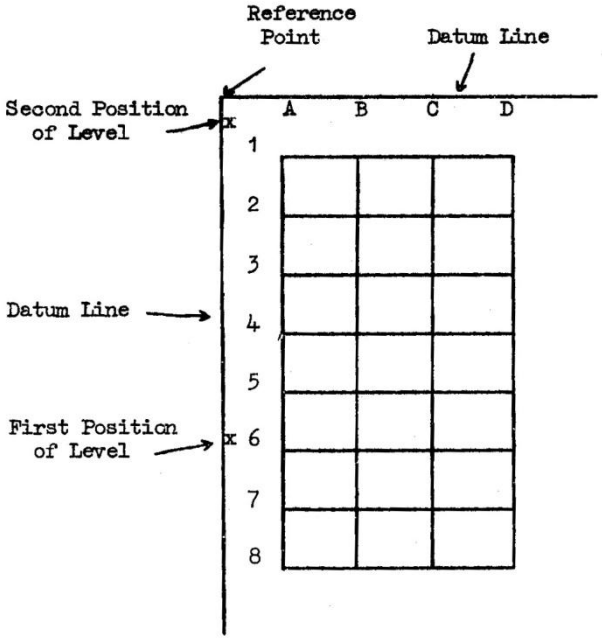



FIG. 7. PLAN OF SURVEYING OPERATIONS.

5.2 Taking Levels. A theodolite, or other suitable level, is used; a level being faster and easier to use.

The instrument should be set up at some position remote from the reference point, and preferably at a position from where all level points can be seen. The levels are then taken in an orderly sequence commencing at the reference point; when the last level has been taken, a second level is taken at the reference point to enable a check to be made on the survey.

If all the level points can not be seen from a single instrument position a change point must be introduced when moving the instrument to another position as follows:-

A level is recorded for the last available level point for the first instrument position., and the staff is not moved until the instrument is set up in its new position and a second level recorded for that point. The remaining level points are read in sequence and a last reading back at the reference point.

5.3 Recording and Reducing Levels. All levels should be reduced as shown in Fig. 8 and recorded on a plinth layout drawing (see Fig. 9).

| BACK SIGHT | INT. Sight | FORE Sight | RISE | FALL | R.L. | Position | REMARKS. |
|---|---|---|---|---|---|---|---|
| 4·250 | | | | | 10·000 | | REF. POINT |
| | 4·125 | | ·125 | | 10·125 | A1 | |
| | 4·250 | | | ·125 | 10·000 | A2 | LOW POINT |
| | 4·000 | | ·250 | | 10·250 | A3 | |
| | 3·875 | | ·125 | | 10·375 | A4 | |
| 5·250 | | 3·750 | ·125 | | 10·500 | A5 | CHANGE POINT |
| | 5·125 | | ·125 | | 10·625 | A6 | HIGH POINT |
| | 5·250 | | | ·125 | 10·500 | A7 | |
| | 5·125 | | ·125 | | 10·625 | A8 | HIGH POINT |
| | 5·250 | | | ·125 | 10·500 | A9 | |
| | | 5·750 | | ·500 | 10·000 | | REF. POINT |
| | | | ·875 | ·875 | | | |

FIG. 8. REDUCED LEVELS. RISES AND FALLS.

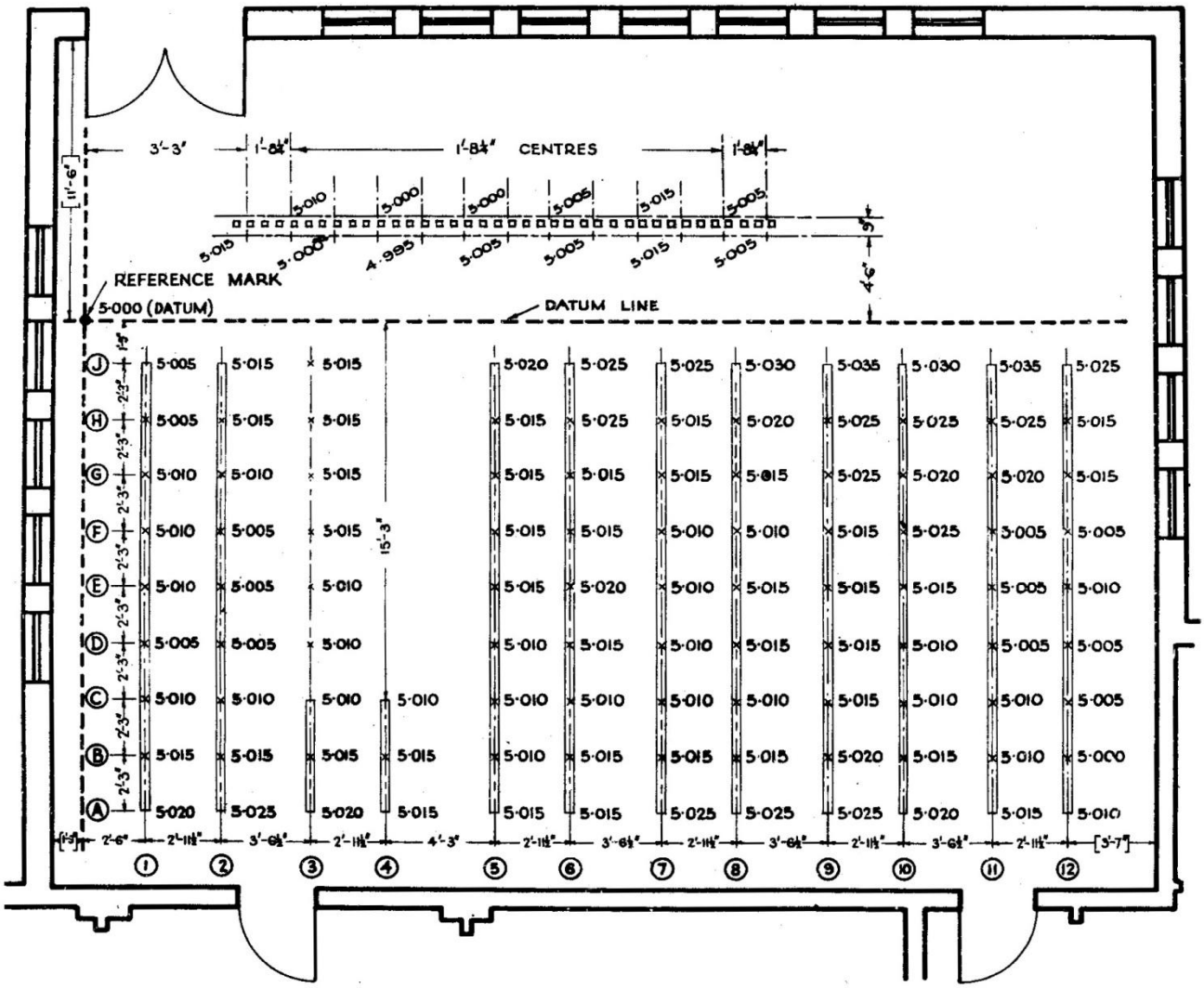



FIG. 9. PLINTH LAYOUT DRAWING.

5.4 Readings are measurements of staff height. These are tabulated, showing the inches portion only, e.g. 5 ft. 4⅛ in. becomes 4.125. The rise, or fall, between successive readings is then shown.

5.5 The reference point is allotted an arbitrary reduced level value (in this case 10.000) so chosen so that all other reduced levels are positive. With the aid of the Rise and Fall Table (Fig. 8), all other points are now given their reduced level values.

5.6 A Check of the calculations should be made as follows:-

(i) Sum of all rises = Sum of all falls.

(ii) Last reduced level at reference point = First reduced level at reference point.

5.7 A plinth drawing should be prepared as shown in Fig. 10. Levels are here converted to fractions of an inch to indicate plinth contour.

| PLINTH Nº | LENGTH REQUIRED. | DIMENSION. | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | A | B | C | D | E | F | G | H | J |
| 1 | 18'-0" | 1 15/16" | 2" | 2 1/16" | 2 1/16" | 2 1/16" | 2 1/16" | 2 1/16" | 2 1/8" | 2 1/8" |
| 2 | 18'-0" | 1 7/8" | 2" | 2 1/16" | 2 1/8" | 2 1/8" | 2 1/8" | 2 1/16" | 2" | 2" |
| 3 | 4'-6" | 1 15/16" | 2" | 2 1/16" | | | | | | |
| 4 | 4'-6" | 2" | 2" | 2 1/16" | | | | | | |
| 5 | 18'-0" | 2" | 2 1/16" | 2 1/16" | 2 1/16" | 2" | 2" | 2" | 2" | 1 15/16" |
| 6 | 18'-0" | 2" | 2" | 2 1/16" | 2" | 1 15/16" | 2" | 2" | 1 7/8" | 1 7/8" |
| 7 | 18'-0" | 1 7/8" | 2" | 2 1/16" | 2 1/16" | 2 1/16" | 2 1/16" | 2" | 2" | 1 7/8" |
| 8 | 18'-0" | 1 7/8" | 2" | 2 1/16" | 2" | 2" | 2 1/16" | 2" | 1 15/16" | 1 13/16" |
| 9 | 18'-0" | 1 7/8" | 1 15/16" | 2" | 2" | 2" | 2" | 1 7/8" | 1 7/8" | 1 3/4" |
| 10 | 18'-0" | 1 15/16" | 2" | 2 1/16" | 2 1/16" | 2" | 2" | 1 15/16" | 1 7/8" | 1 13/16" |
| 11 | 18'-0" | 2 | 2 1/16" | 2 1/16" | 2 1/8" | 2 1/8" | 2 1/8" | 1 15/16" | 1 7/8" | 1 3/4" |
| 12 | 18'-0" | 2 1/16" | 2 3/16" | 2 1/8" | 2 1/8" | 2 1/16" | 2 1/8" | 2 | 2 | 1 7/8" |

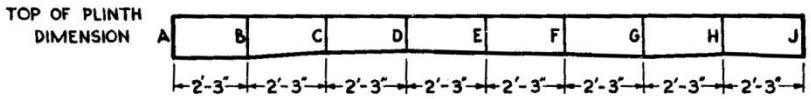



FIG. 10. PLINTH CONTOUR DETAILS.

5.8 Walls. When the variation in levels of the floor are being read and the arbitrary reduced level referred to in 5.5 has been selected, this level will be transferred on to each wall face surrounding the floor area. Each wall will be marked and stencilled or pin-punched to record this sighting. See Fig. 11.

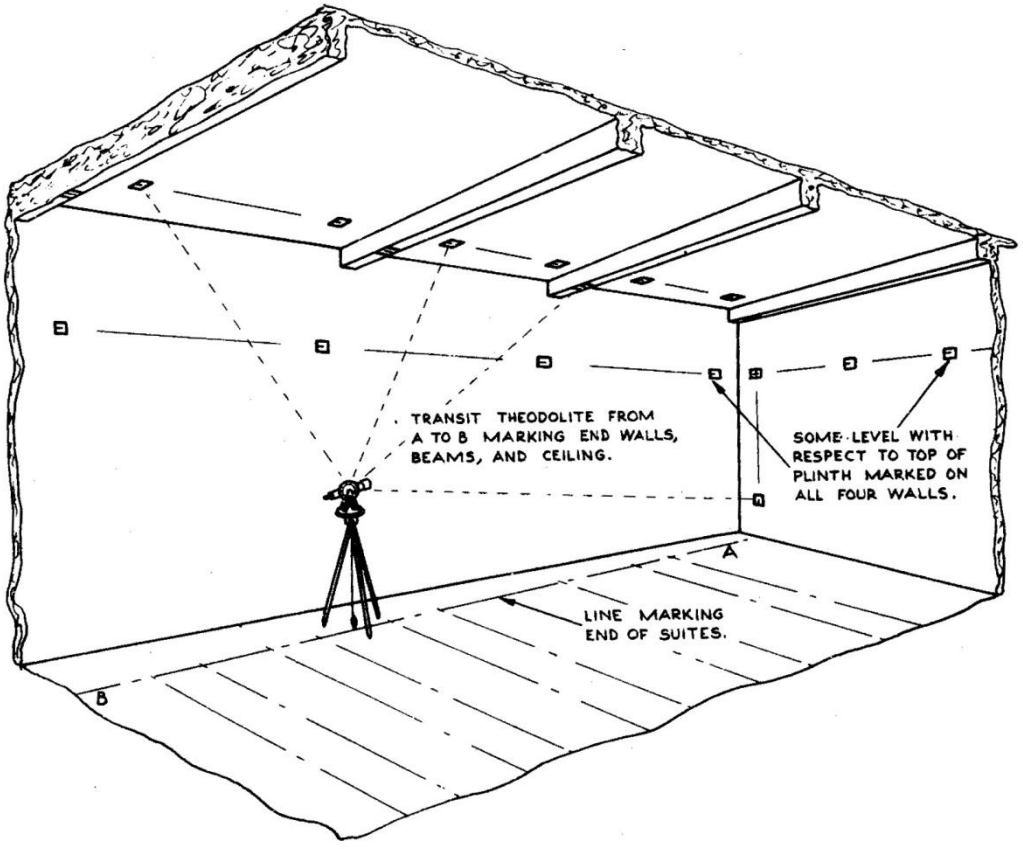



FIG. 11. METHOD OF TRANSFERRING LEVELS TO WALLS AND OUTLINES TO CEILINGS.

The positions marked will be recorded on the plans prepared to show the various readings taken. The marks will be used subsequently for determining the position of any angle bracket or fitting which may be required.

5.9 Ceilings. After transferring the reduced level, i.e. 10.000, pare 5.5, to the walls surrounding the equipment floor, the surveyor will also transfer the following floor outline details on to the ceiling:-

(i) The outline depicting the end of equipment rows.

(ii) Other selected dimensions in multiples of 4' 6" from the end of the equipment rows, such as 13'6", 18', etc..

(iii) Selected centre lines of plinths.

(iv) M.D.F. or other equipment outlines requiring ceiling support.

The details so transferred will be stencilled or pin-punched to permanently record this information.

The reference marks will, with the use of chalk lines centred on selected marks, define the equipment outline and will aid in locating suspension fittings such as drop tie rods, angle offset, brackets, etc..

6. POSITIONING AND FIXING OF PLINTHS.

6.1 Use of Plinths. The inequalities of the average floor make it difficult to level a rack or equipment without packing, particularly as each item has to level up with adjacent items.

The levelling of equipment involves the laying of timber plinths (oregon for preference) under racks or equipment to provide level surfaces and aid in the location of equipment between the floor and overhead structures.

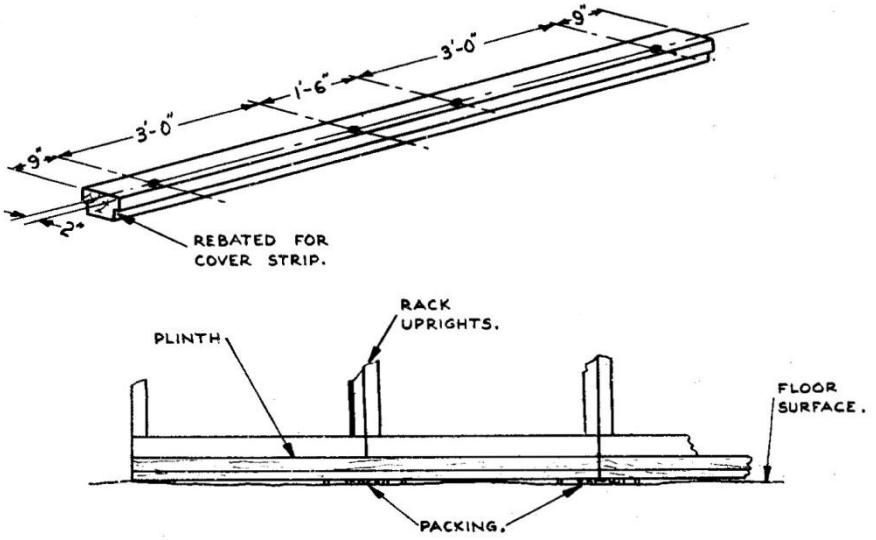
6.2 Height of Plinths. Levels are taken and recorded at points along each plinth line, and the highest and lowest point in each line established. These levels are reduced in relation to the highest point in the floor layout and a drawing is prepared indicating the height of the plinths required. See Fig. 10. It is imperative that the minimum height of plinth allowed is inserted at the highest point in the floor layout. The height of plinth which determines the size of timber required for the plinth is obtained from the lowest point in each plinth line.

For 2000 type equipment the minimum plinth thickness is 1⅛ in.. This is dictated by the necessity to subsequently manoeuvre other racks under the rack tie-bars.

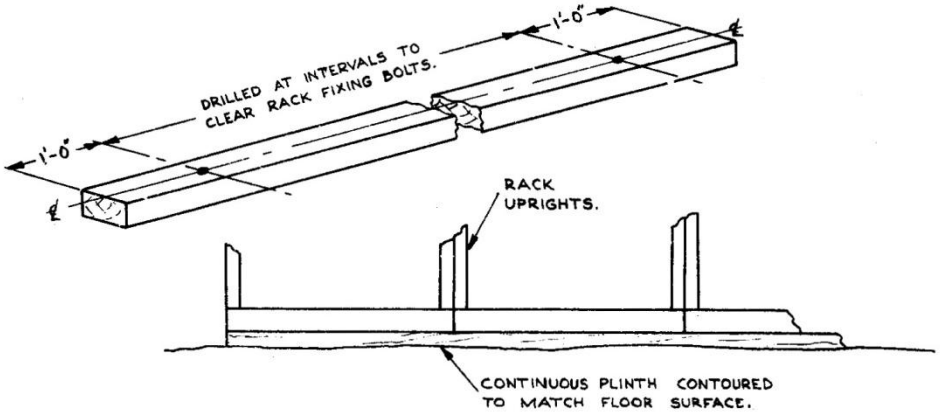
6.3 Methods of laying Plinths.

(i) Where variations in floor level are negligible, fixed dimensioned plinths may be fitted in position after drilling the floor. These are packed or wedged with a selected thickness of timber to obtain the correct level. The plinth is then securely fixed to the floor and is not contour treated. When this method is used, the packing pieces are inserted at the junction point of racks or other selected positions.

(ii) When there is considerable variation, the plinth should be contoured in the carpenter's shop. The timber stock is marked in accordance with the floor variation shown in the plan and a contour line drawn. The plinth is then machined to the contour line, the floor is drilled, as detailed in para 6.5, and the plinth is temporarily fixed. When necessary, any remaining high spots should be removed with a plane and the plinth is then permanently fixed to the floor.




(a) Using Packing.




(b) By Contouring.

FIG. 12. METHODS OF LAYING PLINTHS.

(iii) When a contour drawing is not prepared, the plinth may be marked, cut and fixed as described in para 6.4

6.4 Fixing Plinths when a Contour Drawing has not been prepared. The plinth, dressed on the top and on both sides, is laid in position on the floor, which has been previously drilled, and then temporarily screwed in position. The top surface of the plinth is levelled by packing with wooden wedges. When level, the minimum thickness of the particular plinth is measured from its top surface at the highest floor point for the plinth. The scriber and gauge are then set to this mark and the floor contour is scribed along the side of the plinth.

Each plinth is treated in this way, and numbered on its top before the plinths are sent to the Workshops for machine cutting to contour.

When cutting to contour in the Workshops is not practicable, the plinth can be shaped to the scribed contour by making, at right angles to the contour 1Lne, a series of saw cuts at suitable intervals and the excess timber adzed or chiselled away and the final contour achieved by planing.

The plinths when finished to the contour, are permanently secured in their proper positions.

6.5 Drilling of Floor. The floor is drilled at points along the centre line of each plinth to secure the plinths to the floor. "Rawl" plugs, "Scruins", "Tampins" or other approved masonry anchors can be used for this purpose.

Tungsten carbide tipped drills with a portable electric drilling machine are most suitable to make the holes in the floor for the plugs or anchors.

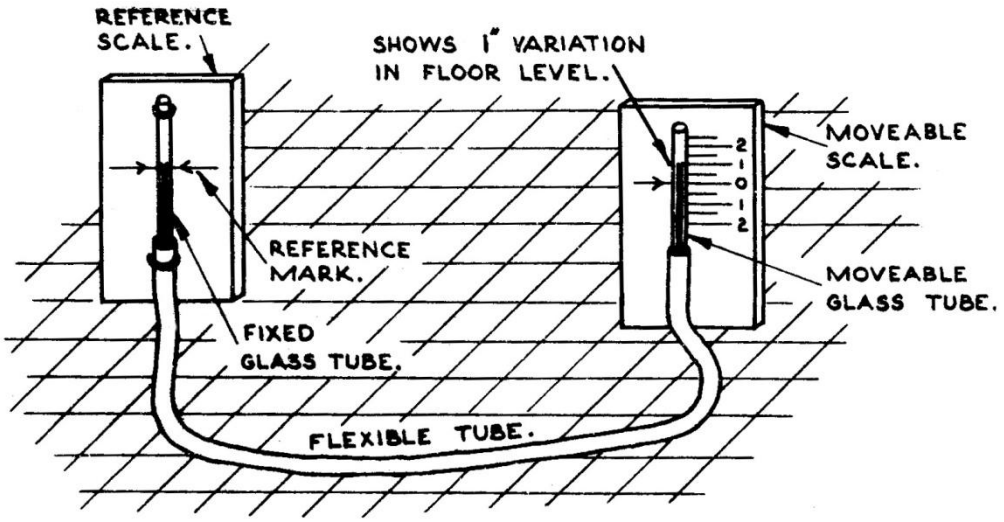
6.6 Checking of Levels. When all plinths are laid they should be checked for variation in level:-

(i) throughout their lengths;
(ii) at right angles across the plinths.

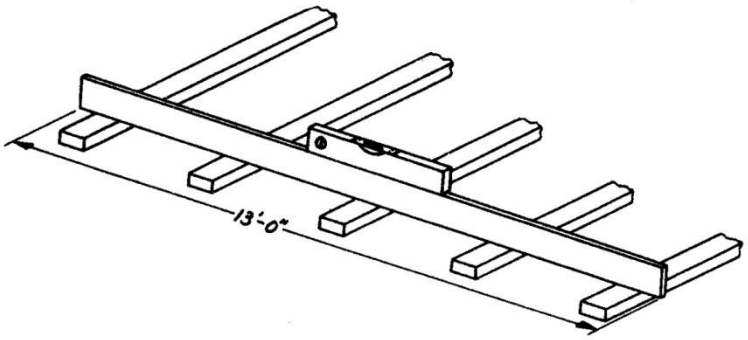
The locations and levelling of the plinths must be approved by the Engineer before any equipment is placed thereon.

6.7 Methods of Checking Levels.

(i) A level may be used in association with a measuring staff.
(ii) A spirit level may be used on a 13 ft. straight edge. Fig. 13(b).
(iii) The device shown in Fig. 13(a) may be used. This consists of two open glass or clear plastic tubes connected together by a flexible rubber or plastic tube of suitable length and of sufficient diameter to avoid the formation of air locks. The tubing is filled with water to the zero marks on the scales when these are placed side by side. In use, the reference scale is fixed at the appropriate reference point, the moving scale is placed at the measuring point and the tube moved in relation to this scale until the bottom of the meniscus returns to zero on the reference scale. The level variation is then read on the moving scale. The tubes should be corked when not in use.




(a) Using Glass Tubes and Fluid.




(b) Using Spirit Level and Straight Edge.

FIG. 13. METHODS OF CHECKING LEVELS.

7. DRILLING MATHODS - PRECAUTIONS.

7.1 All reference points marked or stencilled on the floor must be pin-drilled for permanent fixing of reference.

7.2 Types of Drilling Tools. All Fixing holes for equipment must be drilled with one or other of the following tools, according to circumstances, and the number of holes to be drilled:-

(i) hammer and rawl drill;
(ii) an air or power-driven percussion drill; or
(iii) a power-driven tungsten-carbide tipped drill.

7.3 Selection of Drilling. The circumstances of each situation must be examined to determine the method of drilling. For example; in a new building any of the drilling tools listed in para 7.2 can be used since noise from the operation will not interfere with any other staff.

In buildings. which are occupied, the type of drill to be used should be that which will cause the least amount of disturbance to normal working conditions in the building. Alternatively, the selection of a time outside that when other staffs are working may permit any of the tools listed in para 7.2 to be used for the drilling operation.

In buildings occupied by other staffs for the whole of the 24 hours, for example, in an exchange building in. which manual operators are on continuous shifts, precautions must be taken to avoid disturbance of their working conditions. Preference must be given in this case to the use of drilling tools which create least noise.

Tungsten-carbide tipped drills used with a slow speed drilling machine will cut holes with a minimum of noise. If this type of drilling tool is not available, then special arrangements must be made with other operating staffs to enable short periods of drilling at determined intervals or, alternatively, some method of sound proofing must be attempted.

7.4 Drilling Precautions. When a number of men are drilling by hand, using hammer and hand-drilling techniques, care should be taken to prevent the setting up of a synchronous motion, the reaction of which could have the effect of fracturing a concrete floor. This precaution applies particularly to multi-storey buildings. It should be the practice to stagger such operations as widely apart as possible and never, in any circumstances, should the drilling of a complete line be done as a single operation.

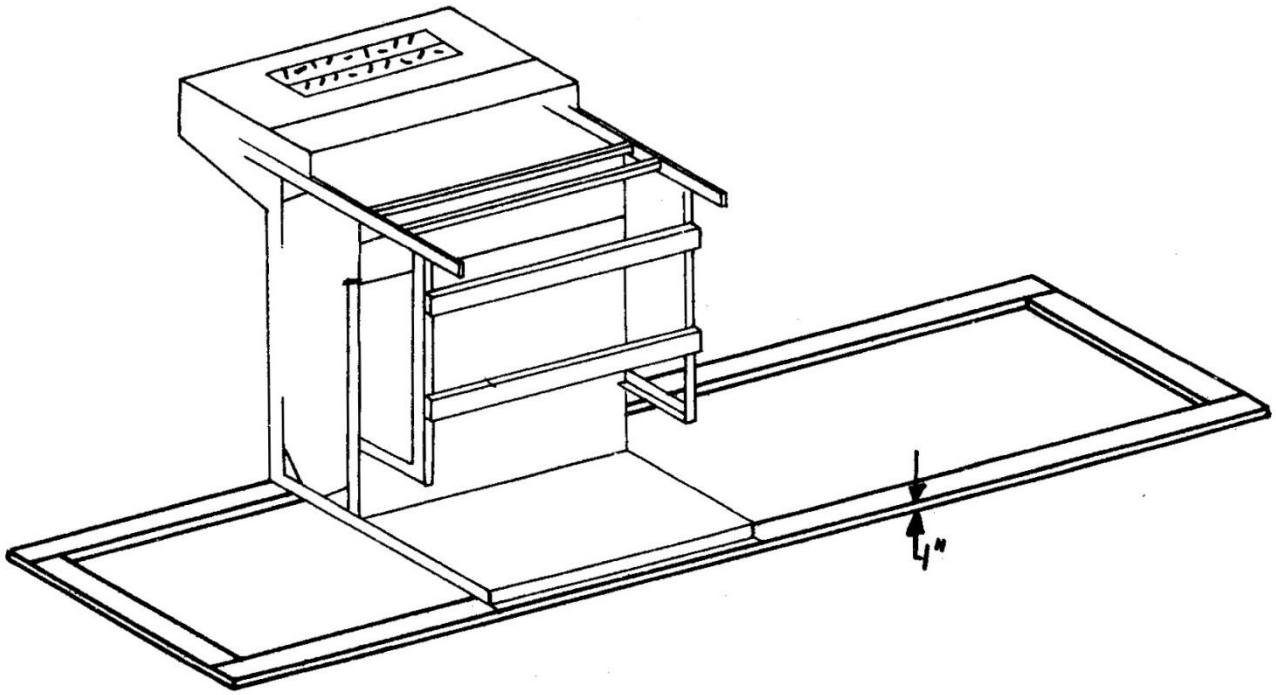
7.5 If a "cartridge-powered" fastening device is used as an alternative to drilling, the precautions in Section 12 of this E.I. must be followed in all respects.

8. POSITIONING OTHER FIXTURES.

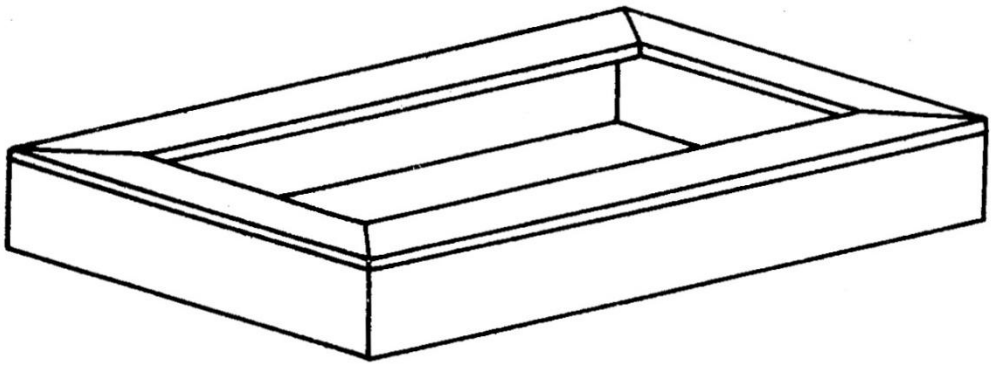
8.1 Plinths for Switchboards. Fig. 14.

(i) C.B. Local and Trunk Positions are essentially a steel framework to which is fixed a jack and lamp field, key shelf, etc., the whole structure being mounted on steel base angle irons set up on a one-inch thick wooden plinth. When installing this type of switchboard, the floor must be checked for level and the plinth contoured.

(ii) C.B. Non-Multiple and Magneto "A" and Trunk Positions where a built-up plinth is required to give additional cord length; this also provides a foot rest for the operator. This plinth should be framed to form a hollow platform, packed to a level position, scribed and then cut to the contour of the floor to obtain a level base for the switchboard positions.




(a) Positioning Steel Framed Switchboards.



(b) Positioning Wooden Framed Switchboards.

FIG. 14. PLINTHS FOR SWITCHBOARDS.

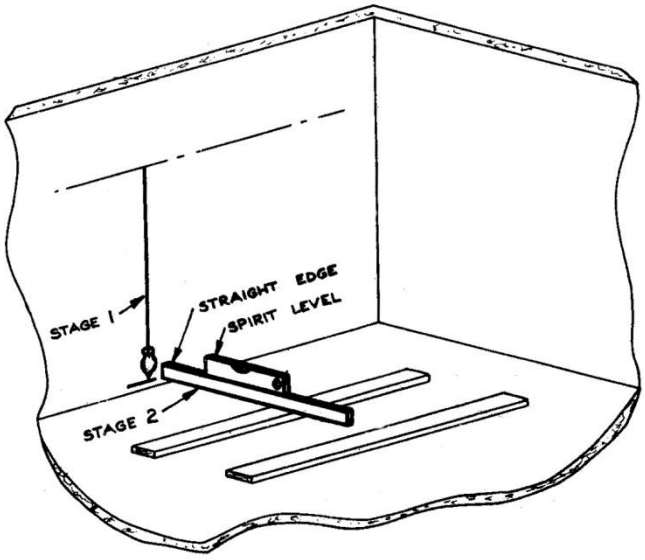
8.2 Ironwork Structures. The method of fitting and levelling ironwork structures, such as M.D.F.s, I.D.F.s, prefabricated frames, is in E.I. INTERNAL PLANT INSTALLATION Practice F 7010..

8.3 Angle Iron for Fixing Tie Bar Assemblies on Walls.

(i) Where reference points setting a horizontal plane on a building have been premarked by a surveyor, the anchoring line for the tie bar support angle must be determined from this line. See Fig. 11.

(ii) Where the walls have not been marked as in (i) a horizontal datum line must be marked on the wall to coincide with the plinth level. The height

of the centre line of the anchoring angle must then be measured from this datum line, thus enabling the drilling points for fixing details to be located in a level plane. See Fig. 15.




MARKING WALL FOR WALL ANGLES.

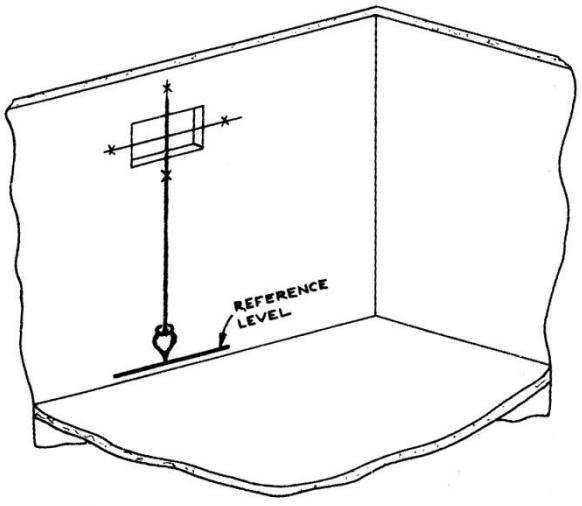
FIG. 15.

8.4 Locating Wall Holes.

(i) Wall holes for busbars, cable runs, should normally be provided in advance by the building contractor.

(ii) Where this has not been done, the holes should be marked as follows.

(iii) The centre line of the hole should be located from the datum line and marked at the base of the wall. A plumb line should be dropped to this point and the centre line transferred to the correct height. The hole should be squared off and marked from this line. It is essential that the horizontal and vertical centre lines be extended and marked beyond the material to be removed to ensure accurate location of the plaster, or other finish, and subsequent boxing-in of the hole. See Fig. 16.




MARKING OUT FOR WALL HOLES

FIG. 16.

(iv) For boxing-in and packing of wa11 holes against fire risk,, reference should be made to E.I. INTERNAL PLANT INSTALLATION Practice T 3010.

9. TEMPLATES.

9.1 When the installation of plant requires multiple drilling, a template conforming to the outline of the apparatus and suitably marked with drilling points will assist in locating the holes. The templates must be related to the datum lines or reference point of the internal plant area when being placed in position prior to commencing the drilling operations.

9.2 Construction of Template. The main requirements of a template are:-

(i) Rigidity.
(ii) Constructed to provide close contact with the surface to be marked to avoid inaccuracies in marking.
(iii) Suitably positioned reference marking to relate the drilling points to the datum, outline or centre line.
(iv) Should be suitably dimensioned to reduce to a minimum the number of template repositionings in any one area.

9.3 Operating Procedure. The template must be aligned with the reference point of the equipment area, or the associated datum lines, marked and the first set of drilling points firmly affixed and drilled, where necessary. It should then be removed to the next drilling point, carefully referring it both to the datum lines and previous markings before marking or drilling the holes. This operation is repeated until the whole area is marked or drilled.

9.4 Precautions. Cumulative errors must be avoided. To prevent errors, the whole equipment area must be marked so that each template can be positioned in relation to the datum lines and reference point and not to outlines placed on the floor, wall or ceiling.

9.5 Types of Template. (See Figs. 17.)

(i) A typical template is that for a pre-2000 type trunk board. This should be framed up from packing case timber firmly braced to prevent distortion. The template surface should be provided by thin plywood or suitable material positioned to give a fixed area of sufficient size to allow a grouping of holes in relation to the frame outline. The plywood should be of sufficient dimension to embrace only the area to be marked, for example, Fig. 17a shows pieces of plywood fixed for the power end, the centre post supports and the grading end.

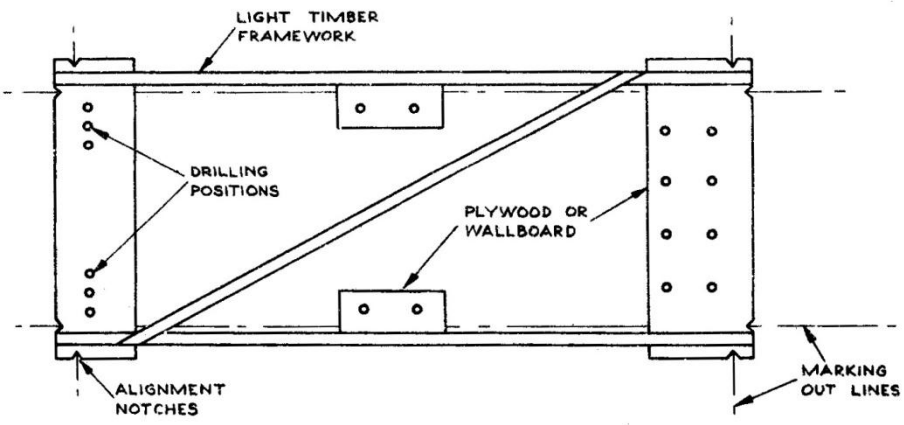



FIG. 17(a). FOR PRE-2000 TYPE TRUNK BOARDS.

(ii) A manual switchboard positioning template of similar construction but dimensioned to suit one or two positions with suitable reference points to relate one marking with the previous and subsequent markings.

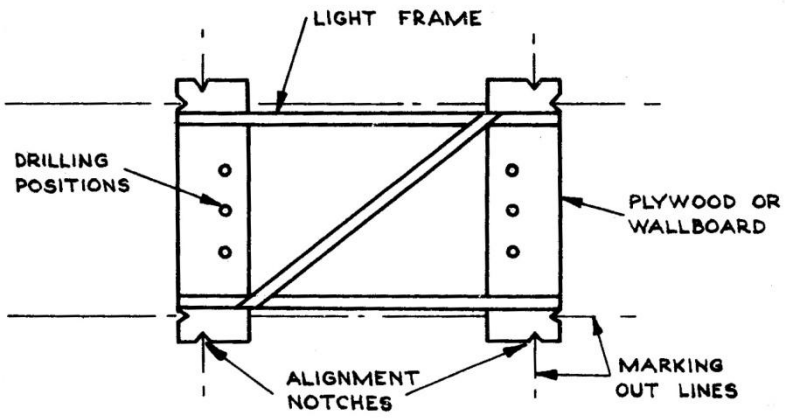



FIG. 17(b). FOR MANUAL SWITCHBOARDS.

(iii) 2000 type rack aisle spacing or rack rows template should be made from a piece of plywood with the fixing points marked for joining rows of equipment with the drilling points co-ordinated in relation to dimensions stated on appropriate layout drawing.

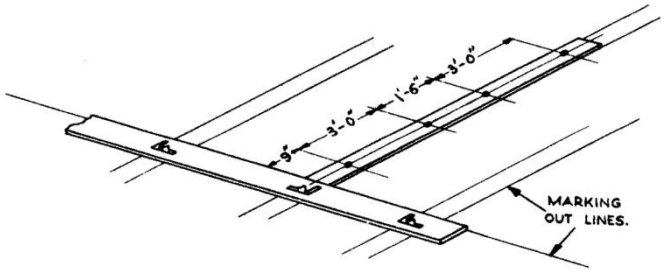



FIG. 17(c). FOR AILSE SPACING 2000 TYPE RACKS.

(iv) Cordless, Semi-Automatic Type Switchboards. An enclosed H-shaped template made out of framed timber is shown in Fig. 17d. It is suitably marked to pick up the centre line of the row with identification points on it to align it with the centre line of the assembly group.

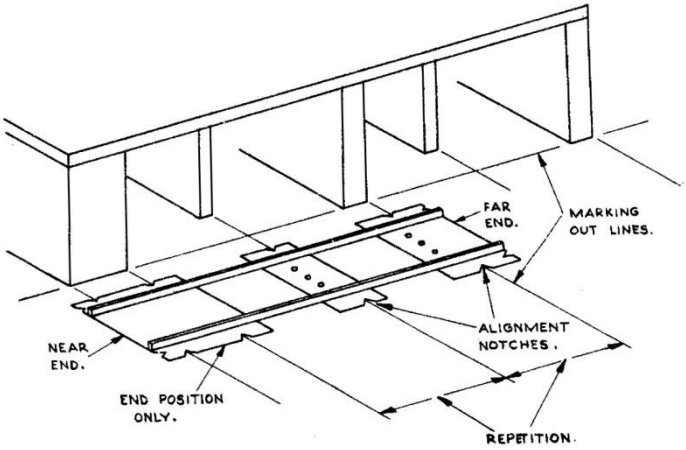



FIG. 17(d). FOR CORDLES SEMI-AUTOMATIC TYPE SWITCHBOARDS.

9.6 Special Marking of Templates. In many templates prepared for multiple operations, the marking at the beginning and the end of the row may differ from the marking at intermediate points of the assembly line. In these cases, the template marking points must be suitably coloured to distinguish the various types of markings.

9.7 Marking in Other Positions.

Marking Walls. It may be necessary to provide an additional staying device to retain a template against the wall while the marking operation takes place.

Ceilings. A template used for marking ceilings requires the use of a vertical extensible rod to hold and firmly position the template against the ceiling or, in the case of very high ceilings, scaffolding will be necessary (see Pig. 18). On the lower faces of girders and beams, clamps will be necessary to hold the template in position whilst multiple marking operations take place. The use of two operators, one holding and the other marking, may be a suitable arrangement but where the template is large in area it will be necessary, in order to prevent movement, for it to be braced to other fixings.

Tie Rods. Positions can be determined by the use of a plumb-bob centred to the fixing point. See Fig. 19.

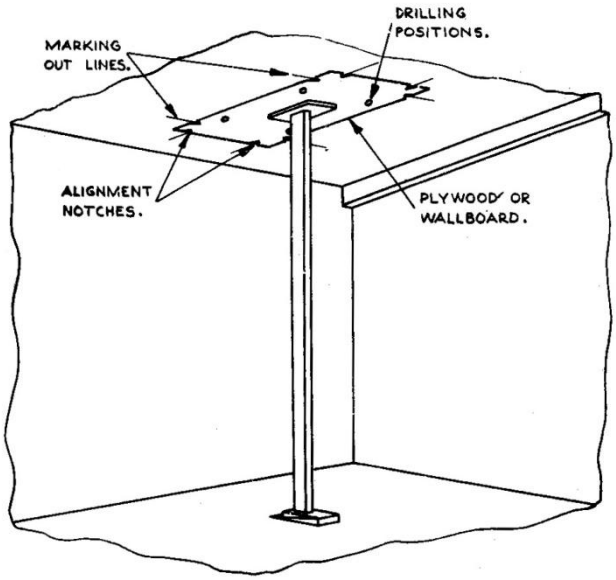



FIG. 18. USE OF TEMPLATE ON CEILING.

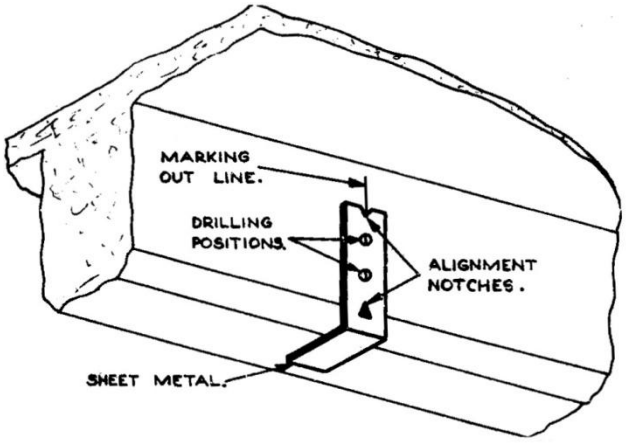



FIG. 19. MARKING POSITION FOR TIE ROD.

Beams. Fig. 20 details a type of template to be used for marking drilling points on beams.

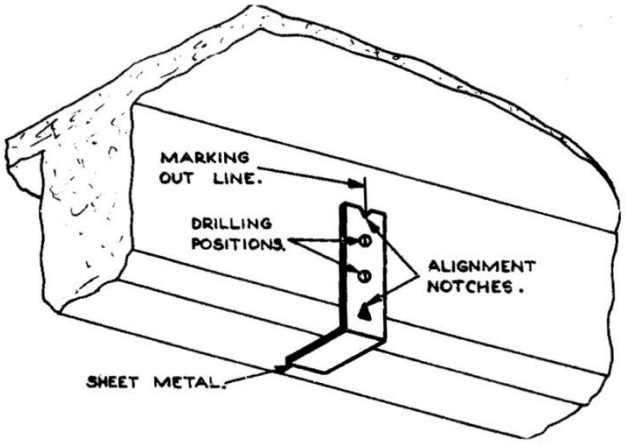



FIG. 20. USE OF TEMPLATE ON BEAM.

## 10. LOCATING MOTOR GENERATORS.

10.1 Motor generators require perfect rotational balance for smooth running.

10.2 Smaller Machines are usually supplied as a unit, comprising machine bed, motor and generator joined with a coupling. Provided that the machine is positioned in such a manner that the shaft and armature are horizontally in balance and that the ball bearings are not binding, difficulty should not be experienced in obtaining a smooth and perfectly balanced machine siting.

10.3 A spirit level can be used to check the level of the machine by placing it across and along the centre lines of the machined surfaces of the fixing holes as shown in Fig. 21. Any variation from level shall be adjusted by inserting shims.

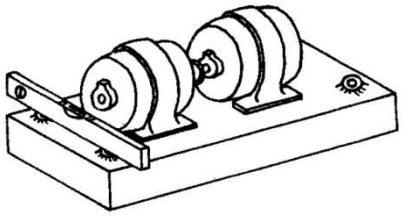


FIG. 21. CHECKING MACHINE BED FOR LEVEL.

10.4 The machine should then be connected to the power supply and run on load, gradually increasing to full load. Correct running will be indicated by:-

(i) a steady reading on the charge meter;

(ii) lack of noise and vibration.

10.5 A ready means of checking the machine for correct levelling is:-

Press against the coupling pulley and force the shaft longitudinally out of magnetic balance. When the pressure is released the machine must oscillate through and return to the position of magnetic balance.

10.6 In the event of lack of balance, the level of the shaft must then be checked as shown in Fig. 22 and levelled by adjusting with shims as necessary. If faulty running persists, the matter must be referred to to manufacturers of the machine.

10.7 The dynamic balance of motor generator sets is affected by the misalignment of the generator and motor journals and their bearings. The presence of an unbalance, due to such cause, can be detected by the vibration and noise which occurs when the machine is run at full speed.

10.8 larger Machines. The following procedure can be used to overcome noise and vibration in a machine where the normal practice of shimming is not effective.

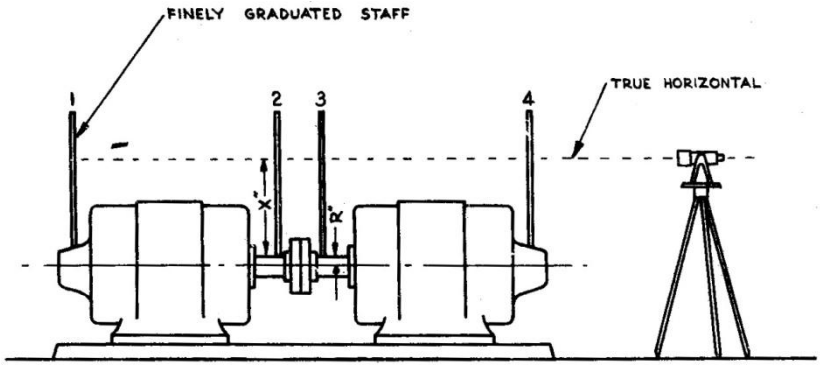
Horizontal alignment of the Journals can be gauged by using a surveyor's level, with the line of sight set in a horizontal plane. Readings are then taken with a finely graduated scale, the end of which is placed at selected positions along the journal of each machine and held in a truly vertical plane.

The radius of the journal at each measuring point is added to the distances recorded between the line of sight and the top of the journal.

The readings should coincide if the horizontal line is true. Differences in reading will indicate the need for levelling.

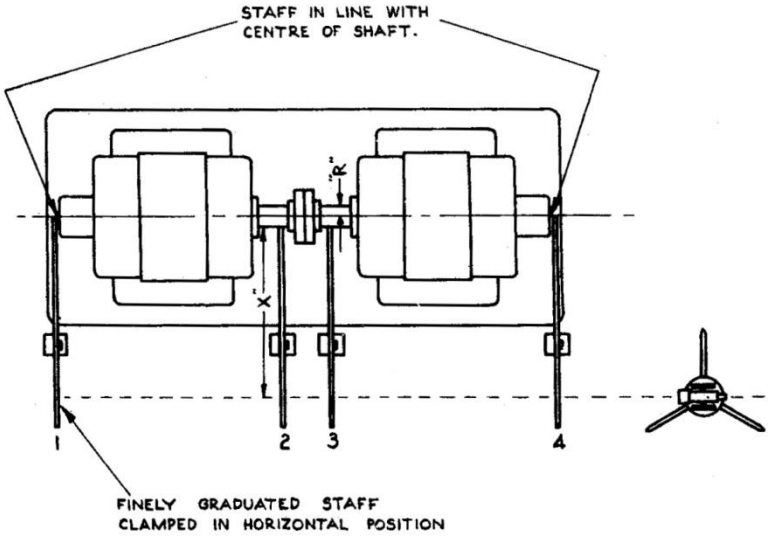
Vertical plane displacement of the journals can be detected by firmly positioning two steel straight edges in a truly vertical plane and at equal distances from the

lathe "pips" at each end of the machine. Sighting the surveying instrument in line with the two straight edges will permit a set of readings to be obtained at right angles to the first set recorded for horizontal displacement. The addition of the radius of each journal at the reading points will show where adjustment is required.




| POSITION | | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| STAFF "X" READING. | | | | | |
| SHAFT "R" RADIUS. | | | | | |
| ERROR | HIGH | | | | |
| | LOW | | | | |

(a) Vertical Alignment.




| POSITION | | 1 & 4 | 2 | 3 |
|---|---|---|---|---|
| STAFF "X" READING | | | | |
| SHAFT "R" RADIUS | | | | |
| ERROR | LEFT | | | |
| | RIGHT | | | |

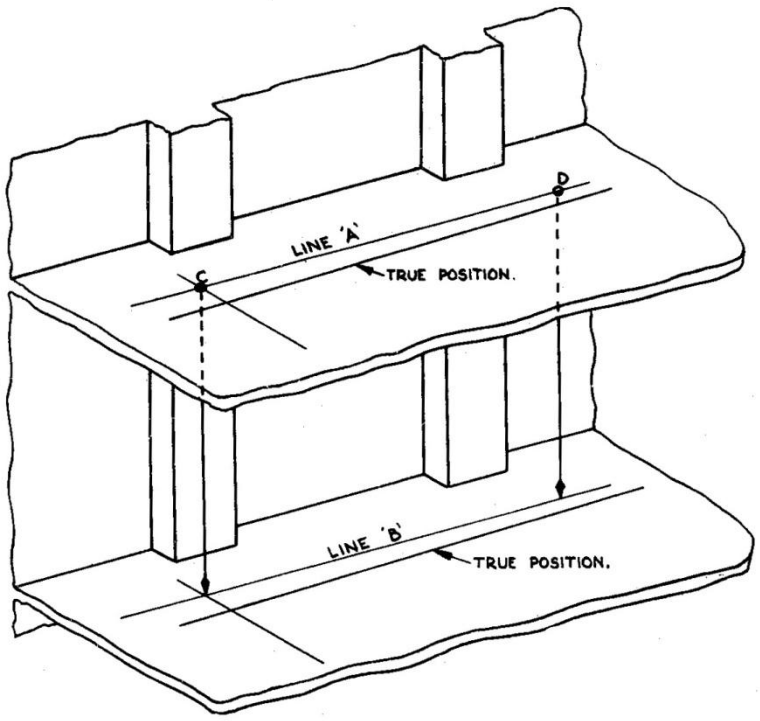
(b) Horizontal Alignment.

FIG. 22. CHECKING JOURNAL ALIGNMENT ON MOTOR GENERATOR.

## 11. MULTI-STOREY BUILDINGS - LOCATING HOLES NOT PREARRANGED DURING THE BUILDING CONSTRUCTION.

11.1 Co-ordinating Datum Lines. The method shown in Fig. 23 can be used when locating datum lines on two floors of a building so that the two lines are parallel and in the same vertical plane.

The method described also applies where more than two floors are involved.




1. STRIKE LINE A IN APPROX. POSITION.
2. DRILL THE HOLES AT C AND D.
3. PLUMB CENTRE OF HOLES TO FLOOR BELOW.
4. STRIKE LINE B JOINING THE PLUMB POINTS.
5. ORIENT LINES A AND B INTO TRUE POSITIONS AND STRIKE FIRM DATUM LINES.

FIG. 23. METHOD FOR CO-ORDINATING DATUM LINES.

## 12. "CARTRIDGE-POWERED FASTENING DEVICES.

12.1 This Section describes the use of "cartridge-powered" fastening devices for the:-

(i) fixing of light fixtures, mild steel brackets, support angles or metal frameworks;

(ii) firm positioning of wooden plinths,

to floor, walls and ceilings of solid construction materials, namely, concrete, brick, etc..

THE TYPE 0F TOOL USED MUST BE APPROVED BY THE ENGINEER-IN-CHEF.

Because of the explosive force of this device, it must not be used on wooden floors, plaster ceilings, partitions of hollow terra cotta, lath and plaster, plaster sheets or shy other w~!l, floor or ceiling of similar construction.

12.2 Precautions. The "cartridge-powered" fastening device incorporates the principles of firearms for its operation in that an exploded cartridge provides the force for driving the fixing device into the supporting structures. It is operated by:-

(i) releasing the safety control device by twisting and holding in release position; and

(ii) firmly pressing the muzzle of the tool against the work surface to operate the firing mechanism.

As serious injury may result from indiscriminate use of the tool, the following precautions must be enforced:-

(i) the Department must be responsible for registering tools of this type with the Police Department.

(ii) The tool must be operated only by a specially selected and trained operator who will be responsible for all precautions.

(iii) No trial operations shall be made other than against an approved working surface.

(iv) The working surfaces must be surveyed by the Divisional Engineer, Supervising Technician or Officer-in-Charge for strength, density and permissible construction.

(v) The strength of the charge used in any case must not be such as to penetrate beyond the depth required.

(vi) Any person employed nearby must be warned of pending explosions so that he will be prepared for the sudden shook.

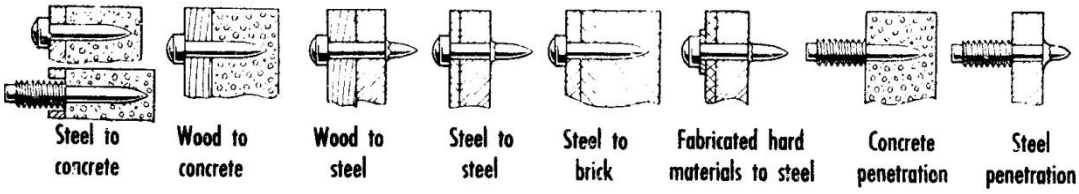
(vii) The tool, when not in use, must be kept in a looked container which shall include a register of explosive charges.

(viii) The issue and return rate of explosive charges must be countersigned by the Supervising Technician or 0ffioer-in-Oharge.

(ix) The tool must be replaced in its container immediately an operation concludes, and the container placed under seal until the next operation is arranged.

(x) IT MUST NOT BE LEFT LYING AROUND DURING IDLE PERIODS.

12.3 Types of Fixings. The types of fixings for which the tool is designed are shown in Fig. 24.




TYPES OF FIXINGS FOR WHICH "CARTRIDGE-POWERED" DEVICE CAN BE USED.

FIG. 24.

Fixing is effected by firing a special stud or pin through the item into the material to which it is being secured. This method of fixing obviates the preliminary drilling of the item and the drilling and plugging of the structure. The length of the bolt shall be such as to provide for irregularities in the wall or other surface.

When the tool is used to anchor large frameworks or long lengths of angle iron, etc., to walls, the framework must be firmly located in position before firing the charges.

The first few anchors must be secured at widely separated points as an added precaution against the displacement of the framework from its correct position by the fixing operation.

12.4 Types of Tools. The two types of "cartridge-powered" tools available for a variety of pins and studs are:-

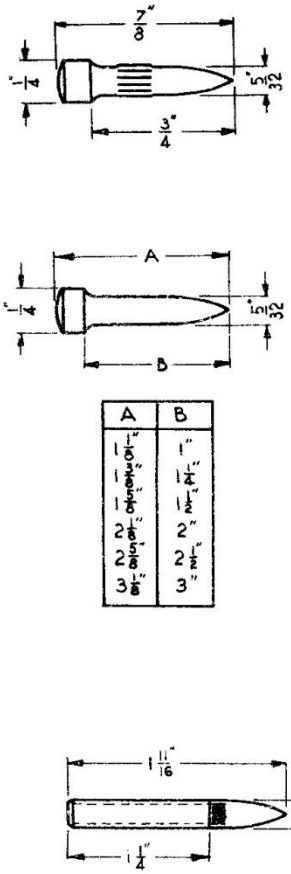
Model 1 - used to insert a 5/32" shank.

Model 2 - used to insert a 1/4" shank.

* 12.5 Fastening Pins and Studs. The range of fastening pins and studs available are shown in Fig. 25. Note that the pins are protected by a plastic cap which must NOT be removed before the pin or stud is inserted in the barrel.

When fixing timber, such as plinths, by this method, a washer must be placed on the bolt before firing to prevent penetration of the timber by the bolt head. The correct charge for the job must be used.

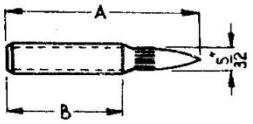
TYPE 1.



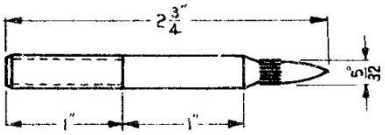

| A | B |
|---|---|
| 1" | 1" |
| 1 1/8" | 1 1/4" |
| 1 3/8" | 1 1/4" |
| 1 3/4" | 1 1/2" |
| 2" | 2" |
| 2 1/8" | 2" |
| 2 3/8" | 2" |
| 3 1/8" | 3" |

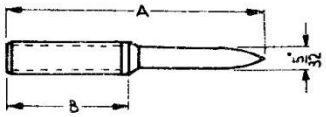



TYPE 2.



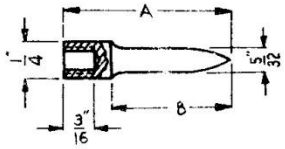

| A | B |
|---|---|
| 1 1/8" | 3/8" |
| 1 3/8" | 3/8" |
| 1 3/4" | 1" |
| 2" | 1 1/4" |



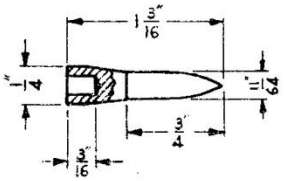



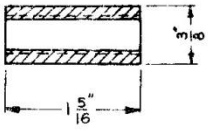

| A | B |
|---|---|
| 1 5/8" | 3/8" |
| 1 7/8" | 3/8" |
| 2 1/4" | 1" |
| 2 1/2" | 1 1/4" |
| 3 1/4" | 2" |

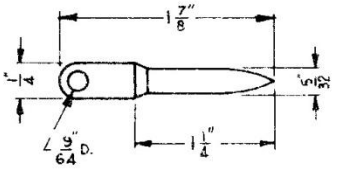
TYPE 3.

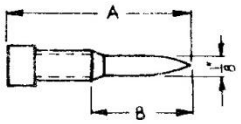



| A | B |
|---|---|
| 1 5/64" | 3/4" |
| 1 21/64" | 1" |




| A | B |
|---|---|
| 1" | 5/8" |
| 1 1/4" | 5/8" |
| 1 1/4" | 7/8" |
| 1 1/2" | 7/8" |
| 1 7/8" | 1 1/4" |

TYPES OF FASTENING PINS AND STUDS.

FIG. 25.

12.6 Strength - Mechanical and Charge. Table "A" shows the mechanical strength of the 5/32" and 1/4" shanks, respectively.

| | Light Standard Type | Heavy Duty Type |
|---|---|---|
| Tensile Strength | 4522 lb. | 8488 lb. |
| Strength in shear | 2335 lb. | 4325 lb. |
| Direct pull when in - | | |
| Concrete | 1390 lb. | 4100 lb. |
| Steel | 1080 lb. | 4200-7860 lb. depending on thickness of metal |
| Red brick | 1180 lb. | - |
| Mortar joints | 865 lb. | - |

TABLE "A".

It will be noticed that these figures are greatly in excess of the 150 lb. pull specified as the maximum weight to be carried by any plug or fixing.

Table "B" details the strength of the cartridge to be employed for the various conditions of use.

| Charge | Colour | | Conditions of Use |
|---|---|---|---|
| | Model 1 Light | Model 2 Heavy | |
| Sub-Charge | - | Brown | For pins or studs into old brick, cinder block, motor joints, etc. |
| Light | Green | Green | Material where resistance is relatively low due to less density or thickness. |
| Medium | Yellow | Yellow | For pins or studs into concrete, new brick, etc., and to fasten light M.S. (1/16" to 1/8") to these materials. |
| Heavy | Red | Red | Materials of greater density. To fasten 1/8" M.S. to concrete, etc., and through 1/8" to 1/4" M.S.. |
| Super | Purple | | To fasten 1/4" M.S. to concrete, etc., and 1/4" M.S. to steel. |

TABLE "B".

The plastic coloured caps are provided to indicate the value of the charge and, where instruction sheets issued with the tool vary from the colours included in Table "B", the manufacturer's instruction sheet colours must be used.

**END.**