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Practical details of mine surveying in certain mines of Northern Mexico

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PRACTICAL DETAILS OF MINE SURVEYING IN CERTAIN MINES OF NORTHERN MEXICO.

By

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A

THESIS

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1917.

Approved by _____

Professor of Mining.

Foreword:

The name of this thesis is suggestive of its character. The writer has endeavored to present in a general way some of the most important details of mine surveying as he has found them in actual practice.

For the sake of uniformity the engineering staff in which he worked prepared a set of instructions to be used by the engineers at the various mines. The methods and illustrations described in this paper have been adapted from these instructions and they afford a thorough foundation ready to receive the minor details best adapted to each particular mining district.

CONTENTS.

LIST OF ILLUSTRATIONS.

PART I. EQUIPMENT.

Equipment for Work in the Field.

1.- Transits. Keuffel and Esser, Gurley and Berger mountain and mining transits with full vertical circle and auxiliary telescopes.

2.- Measuring Tapes. (a) One-hundred meter steel tapes one-fourth inch wide and graduated to .5 cm., the first decimeter to mm. The tape is easily wound by means of a metal reel provided for this purpose. As the whole tape is exposed to the air while on the reel, it is easily dried and kept clean.

(b) Fifty-meter steel tape same as above except in length.

(c) Steel pocket tapes with spring winding and subdivided to millimeters.

(d) Metallic woven tapes in bent leather case with folding handle.

Clamping handles are provided for the steel tapes as well as tension handles which enable the engineer to apply the tension at which the tape is standardized.

3.- Leveling rods.- The leveling rods are of the latest designs and the divisions in the metric system.

The target is devised to insure the rod being held perpendicular to the observer's line of sight by giving him full control of its positions.

Miscellaneous.- The equipment also provides plumb bobs, acetylene lamps, field books, reading glasses, and all other paraphernalia used in surveying.

Drafting Room Equipment.

The equipment comprises blue-printing apparatus, drawing tables, chests of drawers, filing cabinets, etc., all of the latest designs. The equipment being that of a modern drafting room, it comprises the most complete line of instruments and accessories used by the drafsman.- Precision pantographs, beam compasses, proportional dividers, straight edges, German silver protractors with movable arm, drawing sets, drawing papers, inks, pencils, erasers, etc., are but a few of the things that go to make a complete equipment for a modern drafting room.

PART II.

SURFACE SURVEYING.

Location of Base Line.- Accurate surveying operations should always be preceded by the location of a permanent surface base line to which must be tied all important surveys. The most important factors controlling the length and location of the base line are: the nature of the work contemplated, and the limitations and difficulties met with in surveying such as topography in mountainous regions. The length of the base line should be not less than 300-500 meters and if it is intended to be used in minor triangulation its length should be accurately determined. Obviously, the stations at the ends of the base line must be firmly set in solid rock or concrete, and tied to three or four definite objects readily found.

Method Used in Grading Base Lines.- For the purpose of grading the base line stakes cut to a convenient size, varying with the grade, were lined up all along the length of the line leaving an interval of six meters between them. Every hundred meters measuring posts were set in line and cut to grade on either side of each a tension post being securely set in the ground ready to receive the tension apparatus.

Measurement of Base Line.- A one-hundred meter steel Lufkin tape standardized by the Department of Commerce Bureau of Standards, Washington, D. C., was used for the measurement of the base line. A copy of the certificate as issued by the Bureau will be found on page 16.

The tape was stretched over the grade stakes and the tension applied as shown in figure I. On the top of each measuring post a piece of tin was securely nailed, on which was marked a fine line to measure to. Four sets of readings were taken over every course a different man reading the ends of the tape in each case.

Two thermometers were fastened to the tape, thirty three meters apart from either end and the temperature taken immediately after each set of readings. A uniform tension was maintened through out the measurements by means of a balance arranged as shown in same illustration. By means of careful levelling the difference in elevation between the measuring parts was determined and the original measurements corrected for temperature, sag and pull.

Observations for Meridian.- When the meridian has been accurately determined in adjoining property and can be easily transferred without much labor to the established base line it is best to do so; otherwise it must be

determined by astronomical observations.

Three methods are available for observation of the meridian: (1) By observations on Polaris, (2) by observations on the sun by means of the solar attachment, and (3) by direct solar observations.

No attempt will be made here to describe in detail these different methods, as they are given in most text books on surveying. The true bearings of all other surveys are computed from that of the base line.

Topographical Surveying.- The methods used in making the survey of a region for a topographical map are many and varied, and their choice should be dependent on the desired degree of accuracy and on the purpose for which the map is being made. Topographic details may be located from triangulation points or from stations in the traverse or traverses, whichever way is more convenient.

Triangulation System- When the district to be surveyed covers a large area the best method to determine accurately the position of important points is by means of a triangulation system. The degree of accuracy desired is the one controlling factor which determines the methods to be followed in the various operations involved such as the measuring of the base line and

and the determination of its length, the manner of laying out the triangles, the reading of angles, computations, etc. If important underground surveys are dependent on the surface triangulation, an accuracy of 1 in 50,000 should be carried out.

Before laying out a triangulation system a reconnoissance survey of the district should be made to determine the best method of procedure. Such a survey would show the best locations of the base line, the approximate length of the sides of the different triangles, the included angles, and much other valuable data indispensable to a careful and systematic arrangement of the various operations involved as affected by the existing conditions.

Location of Points from the Transit Line.- The position of points of minor importance such as buildings, water and steampipe systems, transmission lines, etc. is best obtained from stations in the transit line.

Location of Monuments.- In districts where a triangulation has been established the claim monuments are usually more easily located by traverses. A degree of accuracy of 1 in 5,000 should be attained in these traverses which must be closed to eliminate any possible error.

PART III.

UNDERGROUND SURVEYING.

Stations for Transit Surveys.- In order to make the stations as permanent as possible they should be placed whenever it is possible in the solid rock of roof. In many instances this is not possible in which case the station will have to be placed in a less permanent place such as a timber or on the floor. The station point should be always so chosen as to permit the setting of the transit either above or below it, the reading of the angles and the taking of the necessary measurements.

To establish a station, seasoned wood should be preferred for the "plug" which is driven in the hole previously drilled in the solid rock. For spad an ordinary horseshoe nail may be used by making a small hole or groove in its flattened head from which to suspend the plumb bob string. For the purpose of numbering permanent stations brass tags with numbers 5/16 of an inch were used, the tag being secured to the plug by driving the spad through a hole on the tag.

In addition to what has been stated before, it may be said that the engineer should use his good judgement in the selection of places for station points

and that these should always be placed in all important winzes, raises and similar workings.

Hanging Compass Stations.- Whenever possible they are to be placed in the solid wall, using an ordinary nail which is driven through the tag into the wooden plug. Some hanging compass surveys require a considerable number of stations. When this is the case only enough permanent points are put in to serve as points of reference from which to run future surveys. For the rest of the stations a nail driven in the wall is sufficient.

Surveys in General.- The importance of closing transit surveys is self evident and should always be done when possible, all surveys being started from known stations not two of which are to have the same number.

Details of Underground Surveying.- See illustration II.

"Station Occupied" is the point under or above which the transit is set up.

"Height of Instrument" is the distance from the point occupied to the center of the telescope. It is positive when the transit is above the point; negative when below it.

"Point Sighted".- Under this heading come: "Back

Sight", which is the sight on the station previously occupied and "Fore Sight" which are all other sights located from the back sight.

"Vernier Readings"- With a fairly good instrument in general practice it is sufficient to read one of the verniers, preferably the A vernier. In transit surveys the angle to be read is always turned to the right and in every case repeated.

"Compass Readings" to be taken to the nearest five minutes will serve as a check on the computed bearings.

"Vertical Angle" is the angle recorded by the vertical arc on the point sighted.

"Measured Distance" is the distance of the line of sight measured from the center of the instrument to the point sighted. For this work a 50-meter steel tape being commonly used; all measurements and angles on the back sight being recorded.

"Height of Point" is the vertical distance from the point sighted to the station point. It is positive when the station point is above the point sighted; negative when below it.

Elevations are computed from the angles and measurements recorded in the foresight and are always

checked in the backsight. All elevations being referred to a permanent bench mark.

Offsets are measured in any desired direction, this direction being recorded in the note-book

Note-books.- Neatness and clearness are the two most important considerations in note-taking. The field book should contain at the top of every page what part of the mine the notes refer to, the name of the engineer and the date when taken; the notes being accompanied by sketches showing all important details.

Allowable Error. All transit traverse work should be done with an accuracy of not less than one in five thousand. (1/5,000)

Transit Compass Surveys.- When it is decided to make a rapid survey of certain workings in a mine where there is no magnetic attraction, the following method, known as the "leap frog" method, is used.

The survey is continued from the last numbered station, say 105, then at some convenient distance the transit is set up at what will be station 106. A back sight is taken on station 105 and the vertical angles, bearing, distances, offsets and all other necessary details recorded. A foresight is then taken on station 107 and the vertical angle, bearing, and all

other data recorded as before. The instrument is then taken to station 108 and the same process continued.

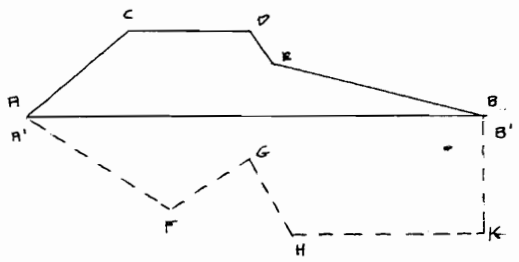
Transferring a Meridian into a Mine.

The method to be used in transferring the meridian down into a mine depends on the existing conditions. Of the several methods available to the engineer that will be used which gives the most accurate results regardless of labor and expense, provided the work is of sufficient importance to warrant such procedure.

Two-Shaft Method.- Accessibility to two shafts or to a shaft and an adit both on surface and underground are an indispensable prerequisite of this method, which is the most accurate way of transferring the meridian into a mine.

Method of Procedure.- A soft steel or piano wire to which a plumb bob of sufficient weight has been attached is suspended at each shaft, the plumb bob at the bottom of the shaft being immersed in a viscous liquid in order to bring it to rest in a shorter time.

A traverse ACDEB is run on surface and the length



and bearing of the line AB (see figure on page 11) are computed. The points A and B having been plumbed down the shaft, their corresponding points A' and B' are established underground. A traverse A'FGHKB' is then run underground to connect points A' and B'. Since the meridian in the mine is unknown the bearing of A'B' is assumed thus enabling the computation of the traverse underground. Having computed the traverse A'FGHKB' the difference between the true and assumed bearings of A'D' is determined and the corresponding correction applied to all the lines of the underground traverse.

Plumbing the Meridian Down a Shaft.- No effort should be spared in securing the most accurate results in shaft plumbing, as upon this most delicate operation depend to a great extent future connections.

A number 20 steel piano wire is well adapted for plumbing purposed and for convenience in handling, two reels firmly supported on a suitable platform may be used.

To lower the wire down the shaft a plumb bob of light weight is to be used and the regular plumb bob attached at the bottom. As mentioned before the wires are brought to rest by immersing the plumb bob in a

bucket containing some viscous liquid. A code of signals for a good understanding of the two parties above and below the shaft, greatly facilitates the work.

PART IV.

MAPPING.

Under this heading will be given an extract of the general scheme used in the various mines operated under the same management.

Details of System Used in Laying out Maps.- In laying out a map the O-O of coordinate is so fixed on the map that it will render the location of the workings of the mine to the north and east of this point.

Coordinate lines are light lines of black color, and separated from one another by an interval of ten centimeters.

Every map must have an arrow indicating the astronomic and magnetic north with the declination and date. This arrow being placed where it will not interfere with present or future workings.

All maps must have the standard tittle from that style of map placed in the lower right hand corner.

To make all the maps uniform, a system of conventional signs has been devised. For conventional signs see list of llustrations.

General Scheme.- When the importance of the mine or mining district warrants it, the scheme provides for the following distinct sets of maps: (1) Main De velopment. (2) Main Level. (3) Stope. (4) Slice. (5) Composite. (6) Pocket Maps. (7) Topographical. (8) Surface Maps.

Main Development Maps.- This set of maps consists of one plan and two sections on a scale of 1 to 2,000 on mounted paper. The sections are made North and South and East and West except in cases where veins or ore bodies follow a well defined strike, in which case the sections are made along the strike and at right angles to it.

Plan.- The plan which covers all the claims owned by the company shows all important geological features; property lines, claim monuments, main levels, cross cuts, tunnels, shafts, etc., with their names and elevations.

To accomplish all this without confusion or overcrowding conventional signs and different colors are used, thus giving to the plan a very neat appearance

most pleasing to the eye.

Topographical Map.- The purpose of this map is to show at a glance all important topographical features such as contours, woods, claim monuments, streams, etc. A scale of 1-2,000 being generally used.

Surface Maps.- This map which is drawn to the scale of 1 - 500 shows the location of buildings, shafts, telephone system, pipe lines, sewers, and all other important transmission lines.

DEPARTMENT OF COMMERCE
BUREAU OF STANDARDS

CERTIFICATE
FOR

100-Meter Steel Tape
B. S. No. 2693

Makers Identification:
Lufkins Rule Co.,

Submitted by
The Lufkins Rule Co.,
Saginaw, Mich.-

This certifies that the above described tape has been compared with the standards of the United States and, for the intervals indicated, has the following corrections at 20° centigrade when supported horizontally throughout its entire length under a tension of 10-1/2 kilograms.

Interval:	Correction
0 to 50 meters	+11.8 mm.
0 " 100 "	+23.3 mm.

Note:Assuming the coefficient of expansion to be as given below the corrections at 0°C will be:

Interval	Correction
0 to 50 meters	+ 0.2 mm.
0 to 100 "	+ 0.1 mm.

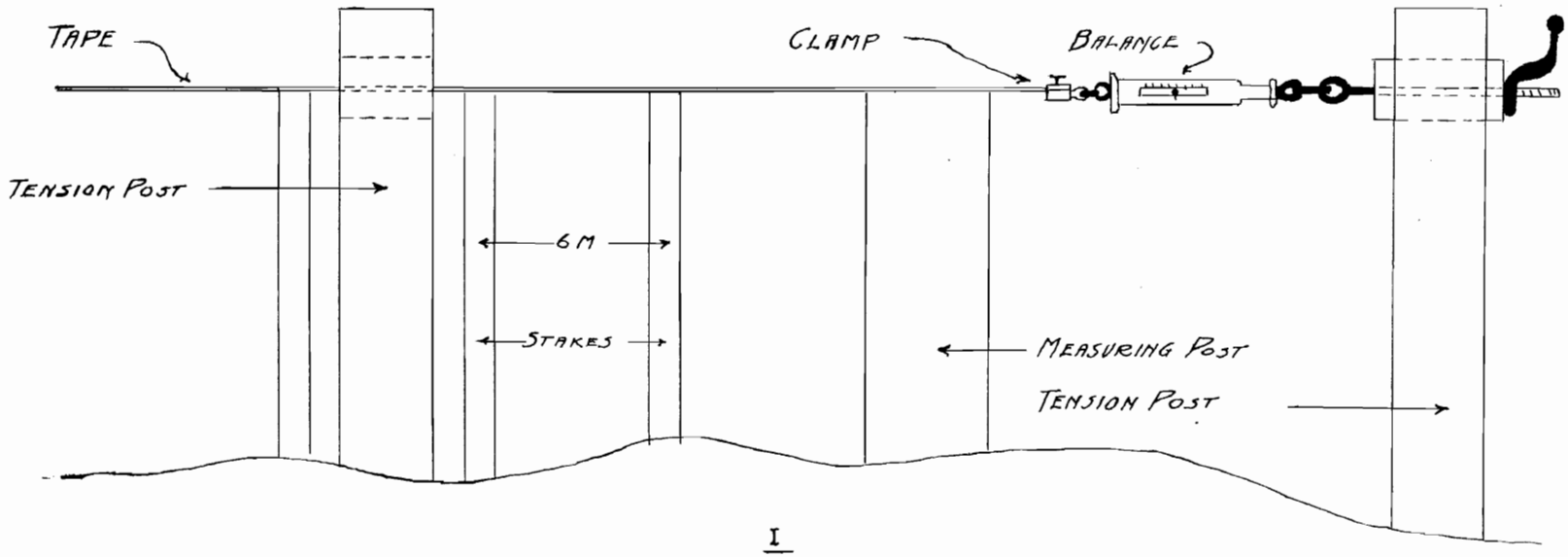
Test No. 18407

Signed: S. W. Stratton.

Washington, D. C., Oct. 28,1915.

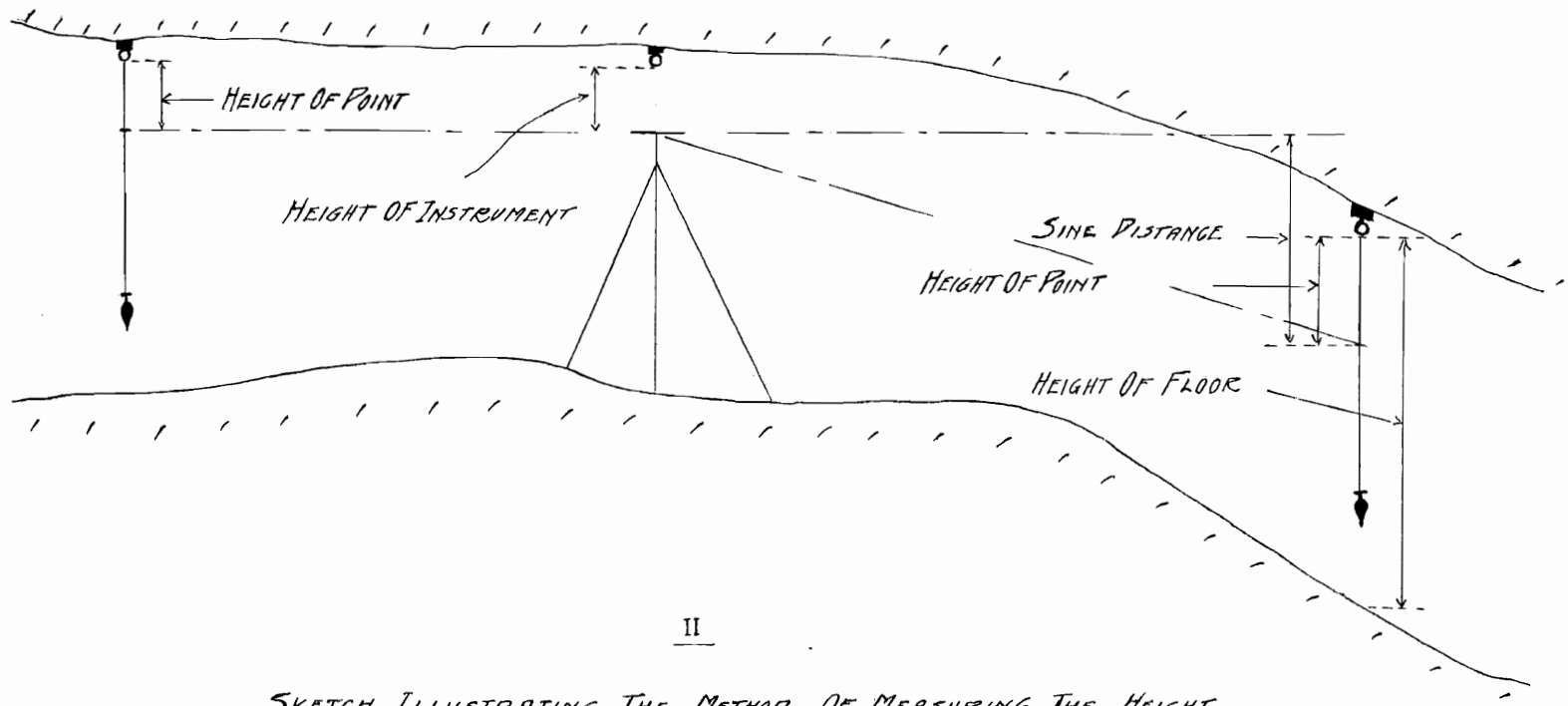
The comparison of this tape with the United States standard was made at a temperature of 29° centigrade, and for reducing to 20° C the coefficient of expansion of the tape is assumed to be 0.0000116 per degree centigrade.

BASE LINE MEASUREMENTS



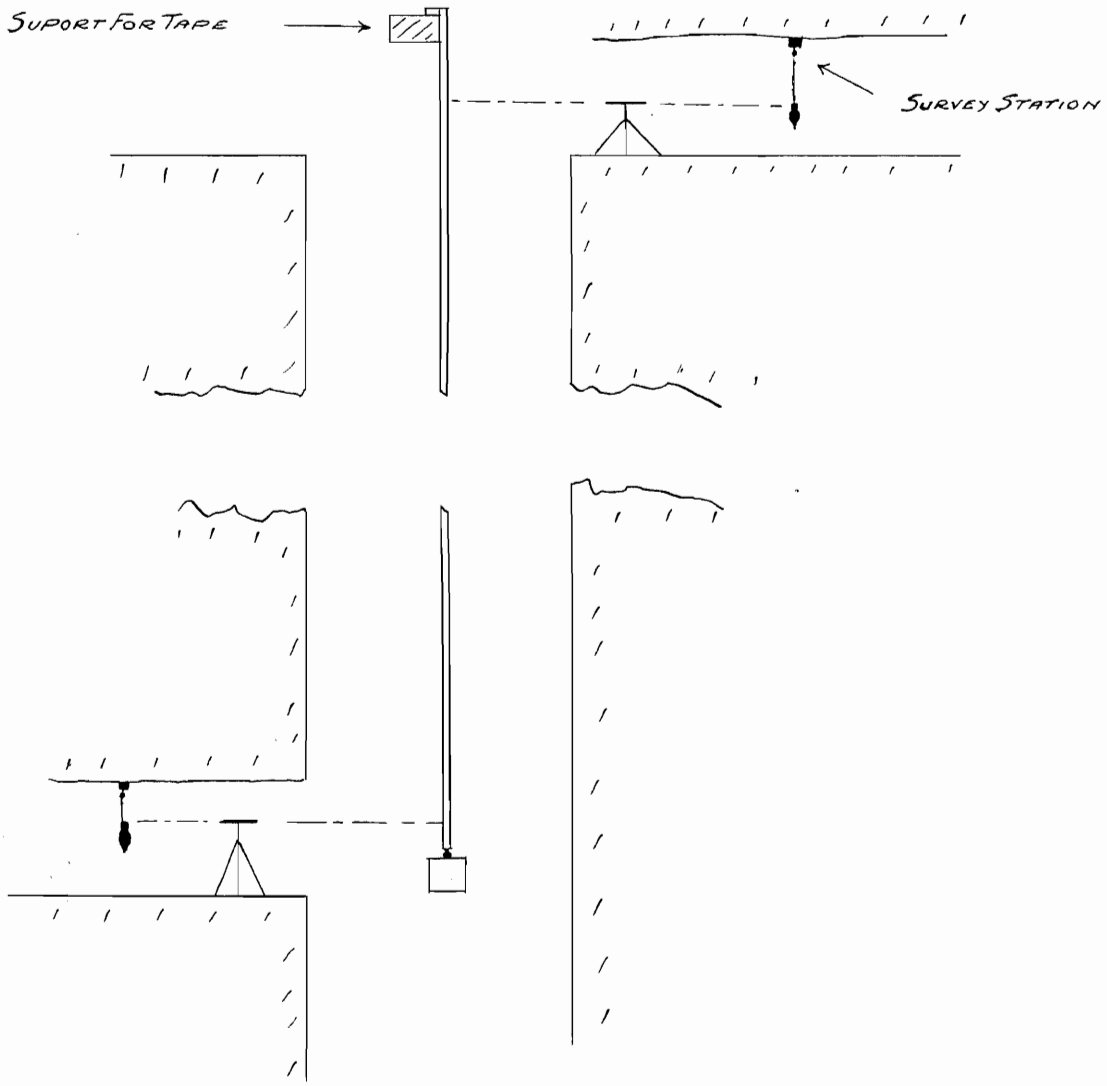
I

SKETCH ILLUSTRATING THE METHOD OF SUPPORTING AND APPLYING TENSION TO TAPE IN BASE LINE MEASUREMENTS



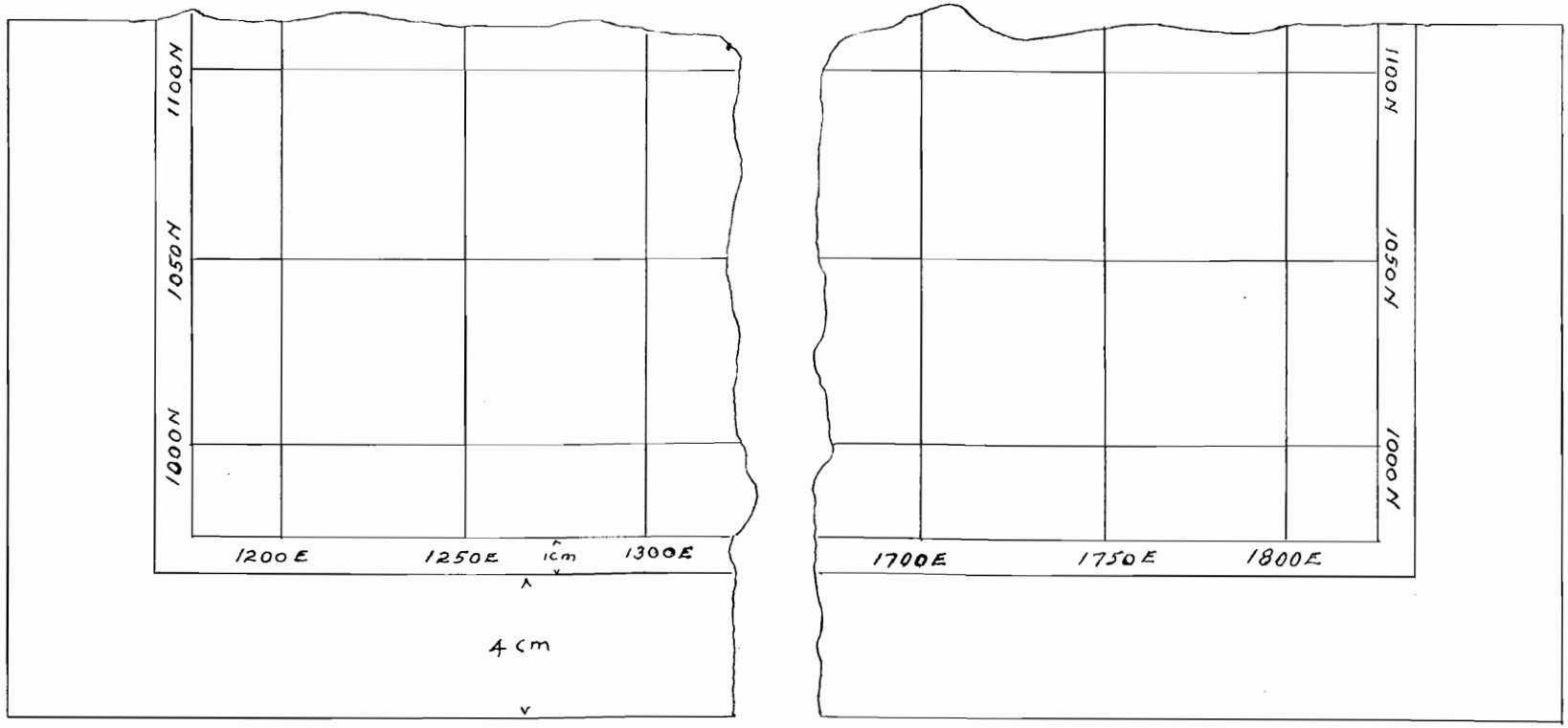
II

SKETCH ILLUSTRATING THE METHOD OF MEASURING THE HEIGHT OF POINT, HEIGHT OF INSTRUMENT & HEIGHT OF FLOOR



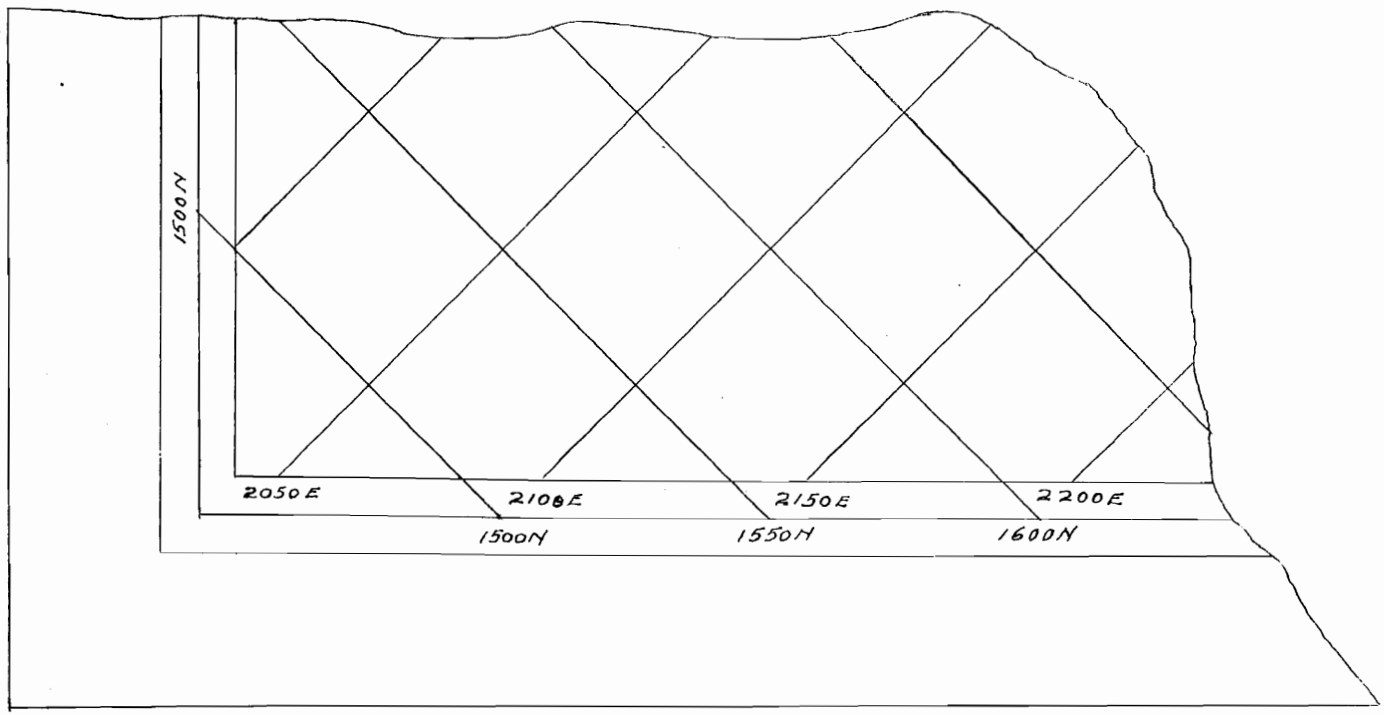
III

SKETCH ILLUSTRATING THE METHOD OF CARRYING ELEVATIONS FROM ONE LEVEL TO ANOTHER BY SUSPENDING A TAPE IN THE SHAFT AND READING DIRECT ON TAPE



IV

ILLUSTRATION SHOWING METHOD OF NUMBERING COORDINATE LINES AND THE TYPE OF BORDER FOR MOUNTED MAPS WITH COORDINATE LINES PARALLEL TO THE EDGE OF THE PAPER



V

TYPE OF BORDER FOR MOUNTED MAPS WITH DIAGONAL COORDINATE LINES SHOWING METHOD OF NUMBERING SAME

CONVENTIONAL SIGNS FOR MINE MAPS.

VI


SINGLE COMPARTMENT SHAFT


TWO COMPARTMENT SHAFT


WINZE UNCONNECTED WITH OTHER MAIN WORKINGS


RAISE " " " " "


WINZE CONNECTED " " " "


RAISE " " " " "


TIMBERED WINZE UNNCONNECTED WITH OTHER WORKINGS


" RAISE " " " "


TIMBERED WINZE CONNECTED " " "


" RAISE


CHUTE

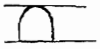

COMPASS STATION IN COLOR OF LEVEL


TRANSIT. " " " " "

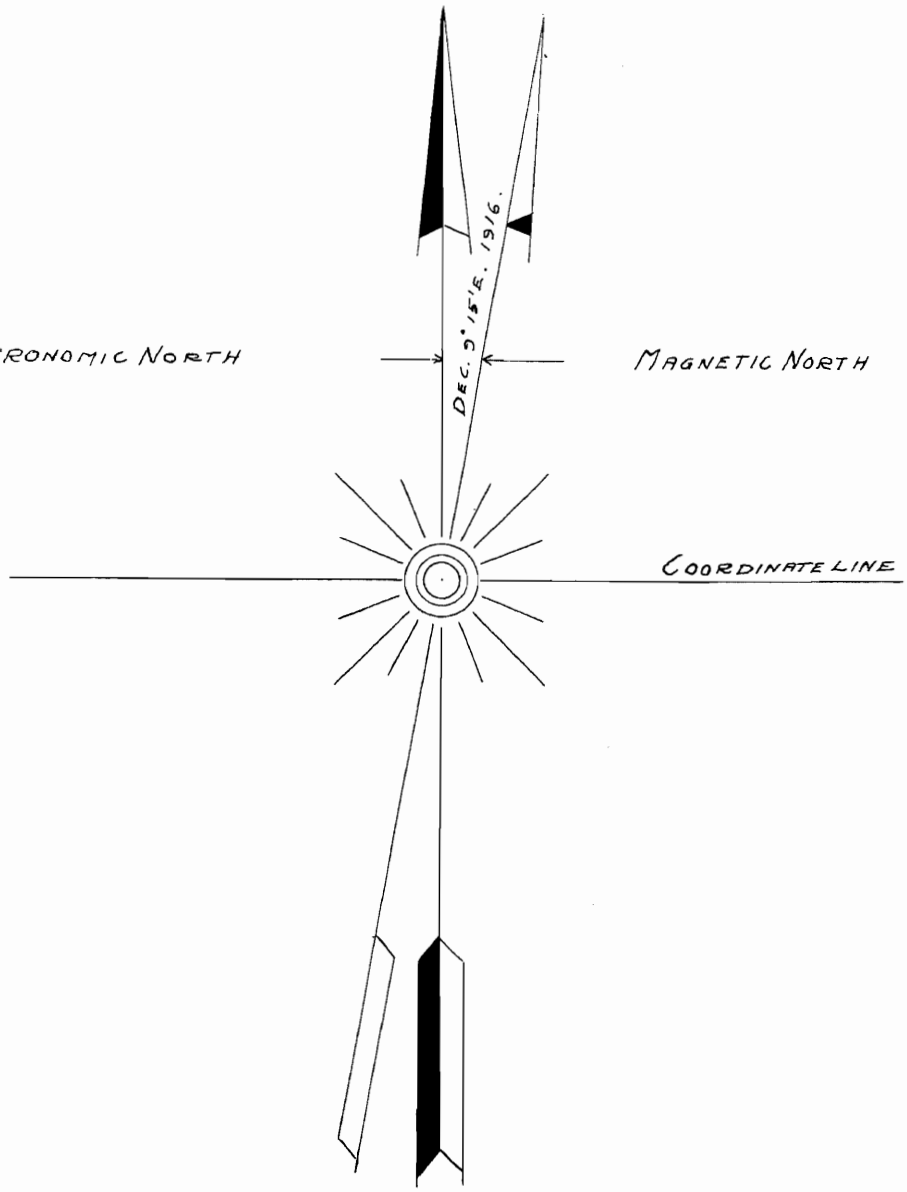
FILL IN FACE OR WALL


FILL ABOVE

FILL BELOW


CROSS CUT IN SECTION

INCLINED WORKINGS IN PLAN



VII

FULL SIZED SKETCH OF NORTH POINT USED ON ALL MOUNTED MAPS AND TRACINGS.