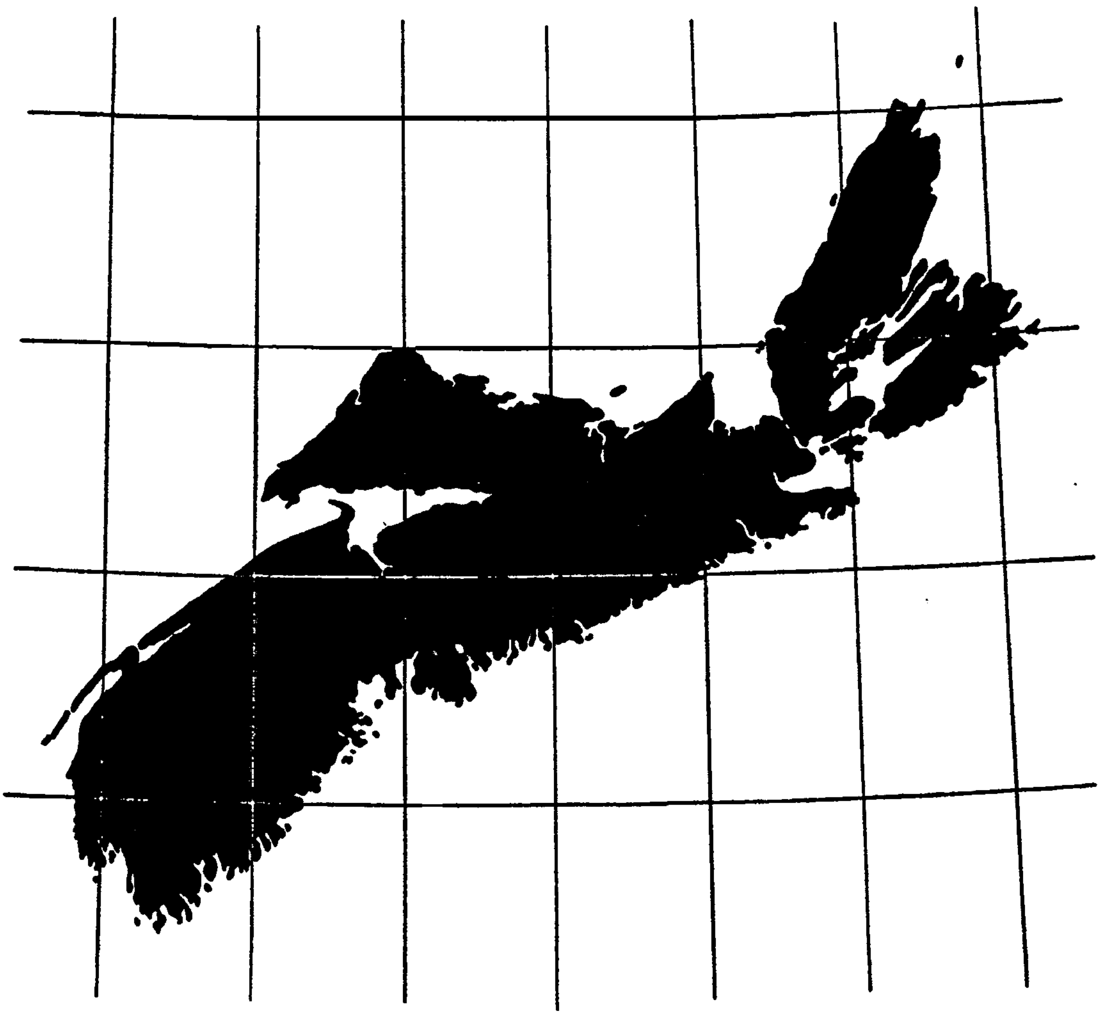
The NOVA SCOTIAN SURVEYOR



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J. F. ARCHIBALD
President

EDWARD P. RICE
Secretary-Treasurer

R. E. MILLARD
Editor

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PLANE CO-ORDINATE SYSTEM USAGE IN NEW BRUNSWICK

by Col. W. F. Roberts, Director of Surveys, Department of Lands and Mines, Fredericton, N. B.

Introduction

The establishment of the New Brunswick coordinate system of Surveying has been the topic of a series of papers, and for the benefit of those not familiar with our project, a list of the publications is attached for reference purposes.

We can assure you these publications were not initiated within New Brunswick, but in response to demands for information from many parts of the world. This renewed interest in the age-old coordinate survey system rests on the fact that the once time-consuming and, therefore, expensive procedures and calculations inherent in the system can now be performed simply and economically with the use of electronic instruments.

Progress at the end of 1963

At a cost of around $200,000 we now have established 2,425 coordinate monuments covering 3,675 square miles or 15% of the province. The area, mostly suburban and rural, contains one-quarter of our population and is 70% freehold land. The density of monuments averages one monument per one and one-half square miles. Because of the large rural area covered and our policy, to date, of not placing monuments in urban areas to the designed density, the density figure has little statistical value.

Last summer we inspected 840 of the 963 or 87% of the monuments placed during 1960 and 1961 and found 25 or 3% destroyed and an additional 7 or 8% damaged but still usable — an average of 4% loss owing mainly to ignorance of their purpose and lack of knowledge of their position by construction personnel.

The cost per monument of $80.00, as given in some publications, has increased slightly, mainly owing to the permanent employment of three survey engineers in 1963 as compared to one in 1961. This is more desirable for a responsible operation. Our experience also shows that the cost per monument is in an inverse relation to the density; as the density decreases the cost increases owing to the time lost and extra cost of transportation from monument to monument.

Uses of Coordinate System

In 1959 the Surveys Branch of the Department of Lands and Mines was authorized to establish coordinate monuments in New Brunswick for the purpose of permanently establishing the bounds of Crown Lands. We have continued to operate under this policy, but public usage of our coordinate monuments indicates the need to recognize a much wider usefulness for them. A few examples of usage to date will illustrate this point.

1. The Department of Public Works, Canada, is using the monuments as the basis of control for continual dredging of the Miramichi River and Miramichi Bay, a distance of 34 miles.

2. The Research and Productivity Council of the Province of New Brunswick has made available a $25,000 research grant to the University of New Brunswick for a gravitational survey of southwestern New Brunswick. The gravitational survey relies on our coordinate monuments not only for horizontal control but, more importantly for, the vertical control available at each monument.

3. The Department of Public Works, Province of New Brunswick, is using the monuments for preliminary study and location of an International Bridge and preliminary layouts of certain stretches of the Trans-Canada Highway.

4. The University of New Brunswick is using them to plan development of its campus and especially the legal survey and the accompanying services and utilities for Teachers College and St. Thomas University now being built on the campus.

5. The New Brunswick Electric Power Commission is using them as a basis of planning for all control, design and purchase of property for the Mactaquac Power Development Project. It is interesting to note here that a well known Canadian Photogrammetric Company made the large-scale maps for initial planning of this project. We were fortunate in being able to recover several of their control monuments and on computation found an error of one tellurometer wave length, 49.5 feet, between certain control stations. This was brought to the attention of the Commission who in turn brought it to the attention of the Photogrammetric Company. The company was able to locate the line in error and has replotted the sheets concerned. The company has honorably rectified this error. The Commission is pleased with the immediate cooperation of the company and the benefits derived from our coordinate System. What might have been a nasty situation became one of renewed confidence in each party concerned.

6. The New Brunswick Telephone Company is using our monuments for preliminary location of telephone cables and microwave stations in the Woodstock area.

7. The Surveys Branch used them for

   (a) retracement of 24 miles of county line originally run in 1822 without the necessity of running trial lines, this work was done by private surveyors on a per diem basis, and

   (b) the legal survey of two city blocks adjacent to the Parliament Buildings in Fredericton for the Play House and the proposed Provincial Office Building.

Planning for 1964

This year we are tentatively planning to establish coordinate control in the Bathurst Area to assist in the locating of mining leases and surface rights of the mining development complex of a concentrator and smelter.

We also intend to assist in further planning of the Mactaquac Development in supplying additional monuments for relocating highways and railroad from Fredericton to Woodstock.

The coordinates will be used in controlling and recording all future legal surveys executed under authority of Surveys Branch in the areas included in Forest District Number Four.

Photogrammetric aero-triangulation and block adjustment will be applied to forested areas to see if coordinates of established lot corners can be economically obtained. We would then be able to retrace any established boundary without the necessity of running trial or tie lines. This may seem like a dream to legal surveyors, but we feel it well worth immediate investigation and expenditure of Provincial Funds.

We are looking forward to an interesting but busy year.

Coordinate Steering Committee

The Coordinate Steering Committee is made up of professional people from the Lands and Mines Department, Highways Department, Municipal Affairs, Attorney General's Department and the N. B. Electric Power Commission of the Province of New Brunswick with additional representatives from the University of New Brunswick, City of Fredericton, pulp and paper companies, New Brunswick Land Surveyors Association and the Federal Department of Public Works. This committee has been meeting seven or eight times each year, and the success of our coordinate system must be credited mainly to this dedicated body.

The committee now is studying the possibility of integrating all surveying and mapping within our province. This study must of necessity be guided by a few well established factors. First, the presentation of all survey data on plans and maps should be correlated. In fact, we are close to approval of a plan whereby a system of map units at a scale of 2,000 feet to the inch is being considered to cover the entire Province of New Brunswick. This scale is thought to be adequate for the requirements of the majority of the province and topographic maps can be produced as necessary at multiples of this scale. For example key areas could be mapped to a scale of 100 feet to the inch with other breakdowns at 200 feet, 400 feet and 1,000 feet to the inch, according to the order of importance. Thus 25 adjacent maps at a scale of 400 feet to the inch would comprise one major map unit and so on. We visualize a standard map 25'' x 38' with map content of 20'' x 30'' regardless of scale. Different sections of the province would then be mapped at the desired scale of the initial job and reproduced at the other scales when required.

Secondly, we have agreed that the finished map or plan must:

(1) accurately reflect the topographical and physical details,

(2) permit the accurate correlation of property boundary line information, and

(3) map the lines than can readily and accurately be reproduced upon the ground.

Planning for the future

With the availability of coordinate monuments and correlated mapping both meeting the three conditions of a finished plan or map, we can then have integrated surveying and mapping in the true sense. Let us take a few minutes longer to represent graphically what we now have and what we are aiming at.

Given coordinate monuments we can produce planimetric and topographical maps or plans; legal surveys, once the bounds have been determined, can be referenced to coordinate monuments and represented on or as planimetric plans. Guarantee of title must come from the legal profession, but when available, together with legal survey and planimetric plans or maps, will give present-day ownership maps. To the land surveyor, present-day ownership maps plus guarantee of title become the basis of a land titles system.

We can now regroup again not forgetting the three conditions a map must meet. A topographic or planimetric map with coordinate or recoverable control and a present-day ownership map can be combined to give us a town planning map that will enable the town engineer to reproduce map lines on the ground. Very few town planning maps meet these requirements.

The combination of town planning maps and land titles gives the statisical information needed to produce a proper assessment map.

My main interest is in legal surveying but to those interested in economic or resources planning or development there are similarly valuable possibilities. I have shown this trend in general form to stress one further advantage of integrated surveying, namely, that a number of single purpose maps or plans can be overlaid to provide many combinations of information since all are made from the same control, projection and standard map sheet sizes .

We will also be able to supply the necessary information for continual revision of the National Topographic Series and other published smaller scale maps.

Conclusions

Our progress in coordinate monumentation is of necessity slow, but it is making integrated surveying and mapping possible. Our aim is to achieve, in practice, complete integration and, thereby, eliminate duplication of effort.

List of Publications

"Plane Coordinates for Surveyors" by J. E. Lilly, **Canadian Surveyor,** 1960, pp 100-106.

"Plane Coordinates for New Brunswick, Stereographic Projection". Geodetic Survey of Canada, 1959.

"The Need for a Coordinate System of Survey Control and Title Registration in New Brunswick" by W. F. Roberts, **Canadian Surveyor,** 1960, pp 302-308.

"The Moncton Adjustment" by H. Klinkenberg, **Canadian Surveyor,** 1962, pp 11-23.

"The Use of the Model 4 Geodimeter in Establishing Basic Control in the Province of New Brunswick" by W. F. Roberts and G. Konecny, International Congress of Surveying, Vienna, 1962.

"The Use of Tellurometer Observations in Establishing a Coordinate Survey Control System in the Province of New Brunswick, Canada" by G. Konecny and W. F. Roberts, Tellurometer Symposium, London, 1962.

"Electronic Surveys in New Brunswick, by G. Konecny and Willis F. Roberts, **Journal of Surveying and Mapping Division,** ASCE, Vol. 89, No. SU 3, Proc. Paper 3666, October, 1963, pp 17-36.

"Data Processing for the New Brunswick Coordinate Survey" by A. W. McLaughlin, paper presented at 1962 Annual Meeting C.I.S.

"Control Surveys by Geodimeter and Tellurometer in Canada" by G. Konecny, paper presented 43 Annual Meeting of Highway Research Board, January 1964, Washington, D. C.

Closing Address -- May 22, 1964

Nova Scotia Land Survey Institute, Lawrencetown, N. S.

By Professor H. L. Cameron, Nova Scotia Research Foundation

Mr. Chairman, Distinguished Guests, Fellow Students, Ladies and Gentlemen:

Let me say first that I feel greatly honored to have been asked to speak to the graduates of the Survey Institute at these Graduation Exercises. Having struggled with a number of branches of Surveying and Photogrammetry for some years now, I do at least feel qualified to sympathize with the students in their past struggles with Pi and other indigestible elements of trigonometry. I can say also from personal experience, that you are entering a most exciting and rewarding field.

In the distant past I have often wondered why graduation exercises are collectively known as Commencement, but, after being present at seventeen spring convocations it is finally brought home to me that exercises marking the close of a training period are in every sense a Commencement of ones active career in the world. The world of work and achievement is before us and we go forward bravely — carefully concealing the doubts and fears.

The group whom we have just seen receive their diplomas and certificates have been variously labelled, surveyors, photogrammetists and cartographic draughtsmen. I propose this afternoon to briefly review the history of surveying and its development up to the present, and to even take a peek into the future, as a slight assurance to these young people that they are not in a field likely to go the way of the buggy whip holder makers, or the moustache cup manufacturers.

Surveying covers a very wide range of activities, for example, the accurate measurement of a parcel of land, with establishment of corner markers: the whole being shown on a piece of paper to proportional scale, is probably the commonest and best known of all "surveys". However, surveys can consist of the plotting of colored rings or fringes produced by the refraction and interference of light through the thin layer of air between an optically flat glass plate and a metal surface. In this case the unit of measurement is one-half the wave length of light. Other surveys show what is happening within the ocean of air in which we live: we call them weather maps, and they largely control and influence our activities. Some maps show the shape of the earth's surface above sea level while others the shape beneath the seas. Surveys are now made from high flying air craft and orbiting satellites. We survey the stars by radio and radar — and so on to infinity.

Surveying is one of the oldest of man's scientific endeavours, and was developed to fill a practical need. In Egypt sometime about 3000 B.C. — note that is nearly 5000 years ago . . . agriculture and social development reached the point where each farmer or land proprietor owned a section of the Nile River valley. Unfortunately for owners. but luckily for farmers, each year the river overflowed its banks and deposited a blanket of river silt over the cultivated bottom lands of the Egyptians. This renewed the soil but played havoc with the field markers and boundary lines. As the population increased it became absolutely necessary to devise a means of re-establishing these marks in order to avoid arguments and litigation, which in those days might take the form of armed attack. Here was born the science of surveying: The Egyptians devised permanent markers on the high banks of the rivers and by sighting from these could re-establish any corner of any field in jigtime. Note here that the surveys were in the hands of the educated, which in those days meant the priesthood of Egypt's numerous Gods. No doubt the mystic rites of turning angles were accompanied by appropriate gestures to the Gods, with libations and toasts. Rumor has it that these customs persist to the present day though it is difficult to prove!

From land surveys to national surveys is but a step, and throughout the Mediterranean area and Asia Minor today we find the traces of the Roman Empire in the "Centuration" or division into "hundreds" which shows where their colonists dwelt. It is fascinating to read of new areas of Roman occupation found in aerial photographs taken during the 2nd World War.

The next great step in surveying was in the development of sea navigation. This was linked with astronomy and the two still go hand in hand. With the final realization that the earth was spherical we enter modern times in terms of survey. With compass and sextant in hand, and chronometer in the cabin, sea captains were ready to sail anywhere. But, just to keep us in line, before we begin to think we are pretty good — the early Navigators in the South Seas of the Pacific: Cook, Magellan, Drake and others, found that the Polynesian natives did not consider their voyages as anything remarkable. These canoe navigators indicated that they commonly made voyages from the Marshall Islands to the Hawaiian Islands, a distance of 2000 miles. The Europeans could make nothing of the queer "maps" of the natives — curious collections of straight sticks tied together with fibre. We now know that these "maps" show the direction of prevailing wave trains in the South Pacific and that the natives could tell when they were approaching an island group by the secondary waves produced by the refraction or change in direction of the primary waves around island masses.

It is of interest that these maps have recently been checked by air photo and visual observations and found to be very accurate.

Modern developments in survey include the use of radio, radar and light beams for the accurate measurement of distance and the location of a place or object relative to others. Map detail is now obtained from air photographs. We have all heard of Shoran and Loran, Decca and Nigh Fix. These are radio broadcast methods whereby ships and aircraft can tune in on fixed stations and thus locate themselves. They have revolutionized the science of oceanography where the main difficulty has always been "where are we?" when out of sight of land. On land, radar has been put to work measuring lines in an instrument called a "Tellurometer". Light is used in one called a "Geodimeter". Contours to show the shape of the land are now drawn directly from air photos in formidable instruments by photogrammetrists, and it looks as if the days of the transit may be numbered.

To our immediate times — in 1957 when Sputnik I "beeped" its way around the earth, a revolution in earth surveys began. Using all the satellites to date, new measurements of the earth indicate that it is pear shaped rather than oblate spheroid. Again, using moving satellites as survey points, the distances between the continents have finally been determined accurately. They are now working on satellites which will act as survey points for anyone who wants to know where he is on the earth's surface. The well-known Tiros weather satellites, eight in number to date, are being used at this very moment to obtain photographs of the earth from 500 miles in space. Not only clouds but ice have been photographed and not only weather maps, but ice cover charts have been produced.

Now for our glimpse into the future. At this time the United States, and probably the USSR, are constructing maps of the moon. These are not just for scientific speculation but are to be used by the first man to land on the moon — scheduled for 1970. I cannot resist the temptation to tell the story currently going the round in U. S. space circles. It goes like this — "What will the first Russian and the first American astronaut say to each other when they meet on the Moon?", "Wie Gehts".

So in conclusion, if there be any son or daughter of a surveying Alexander among you weeping because there are no new worlds to survey — we are surveying the moon, next will be Mars, then Venus — then, who knows, infinity?

A Modern Approach To The Survey Of Electric Power Transmission Lines

By L. Kiernan, B. C. Hydro and Power Authority

INTRODUCTION

The most interesting and promising development in the survey field over the past few years has been the advent of the Electronic distance measuring apparatus and associated instruments. These include the Geodimeter, Tellurometer, Hydro-dist. and others. This paper is concerned with the practical use of the Tellurometer in conjunction with Wild Transit and Wild "R.D.S." instruments as applied to a typical Transmission Line survey in British Columbia.

DESCRIPTION OF INSTRUMENTS USED

(1) Tellurometer:

The Tellurometer consists of two portable units for transmitting and/or receiving a Radio wave one to the other. Power is supplied to each by a 12 volt battery and the operators are in constant communication by means of built-in Radio-Telephone.

The electronics involved are relatively simple and consist of a continuous carrier wave of 10 cm in length at 3000 megacycles per second modulated by 4 fixed measuring frequencies transmitted from the master unit which are received and re-transmitted by the remote unit. The return wave is intercepted by the master set and the phase shift is indicated on a Radar like scanner (C. R. Oscilloscope). This gives a measure of elapsed time in milli-microseconds and the final computation for distance is based on one-half (½) the values obtained. As the velocity of microwaves varies slightly due to changes in atmospheric conditions, a wet and dry bulb therometer and a barometer are read and recorded at every station for adjustment purposes. The accuracy of measurements when used for the surveys described in this paper varied from 1/25000 to 1/250,000 dependent on length of line measured.

(2) Transit:

The final correct distance by Tellurometer is the measurement between any two stations point to point and in nearly every instance it is a slope distance. To obtain the horizontal distance and the vertical difference in elevation to provide X, Y, Z co-ordinates, a Wild 1-second reading instrument was used to complement the high order of measure obtained by Tellurometer. Both horizontal and vertical angles were observed to a refinement of plus or minus two seconds of arc.

(3) R. D. S.:

The Wild "R. D. S." is a self-reducing Tachymeter (stadia) instrument and for those not familiar with it a brief description appears warranted here. Basically the R. D. S. is a Transit with an optical micrometer reading to 6 seconds of arc and can be used as such. The principal advantage this instrument has, however, is that the Stadia cross hairs are not fixed as with normal Transits but (except for the lower cross hair) are free to move proportionately to the degree of elevation or depression of the telescope.

This proportioning is adjusted so that the stadia intercept on the rod between the lower and upper cross hairs when multiplied by the usual 100 will indicate the **horizontal** distance between ground points. Similarly, the intercept between the lower and center cross hair will give the differenc in elevation when multiplied by a small factor visible at the time of reading the rod, and times the usual 100. This factor is either plus or minus 0.1, 0.2, or 0.5 (½).

It will be readily appreciated by the many persons who have spent hours reducing standard stadia notes, either by slide-rule, tables, or computations, exactly how rapidly R. D. S. notes can be reduced for plotting purposes with the minimum of mental effort and consequently less liability for error. This instrument is the perfect complement to the Tellurometer for centreline profile work and was used specifically for that purpose.

(4) Wild T16 Transit rading to 6 seconds.

APPLICATION TO GROUND SURVEY

(1) Requirement:

The B. C. Hydro and Power Authority Executive Management Committee approved the construction of a transmission line between Chetwynd and Portage Mountain Damsite area on the Peace River near Hudson Hope, B. C. to supply construction power to the Peace River Development. The Power supply was Diesel generated and transmitted at 138 kv, with line insulation for future 230 kv, over a distance of some 40 miles.

The preliminary reconnaissance for location purposes consisted of a visual inspection of the area from the air, supplemented by an examination of an uncontrolled mosaic from which the tentative location was traced and marked on a route map, the governing factor being to follow as closely as possible an existing gravelled access road.

Due to the urgency of this project right-of-way clearing and line construction was due to start within two weeks of commencement of survey and a thorough ground reconnaisance although desirable, was not possible.

The terrain consisted of medium to heavy timbered hills 1000 to 1500 feet in elevation with no high ranges within immediate vicinity to offer any advantages to "con" the intervening ground as is desirable for the use of the Tellurometer. It was decided, however, to utilize it to control the whole survey and a field party moved into the area immediately. This party was arranged as follows: —

PARTY CHIEF (SURVEYOR)

(1) Instrumentman — R. D. S. Operator	Instrumentman — R. D. S. Operator
(2) Chainman — Rodman	(2) Chainman — Rodman
(1) Power-saw Operator	(1) Power saw operator

Clearing-Marking Crew (2 men)
((2) Tellurometer Operators)
((2) Assistants)

(The Instrument-R. D. S. crews were expanded to Four within 2 weeks of of commencement of survey).

The Topographic Branch of the British Columbia Department of Lands, Forests and Water Resources supplied the X. Y. Z. co-ordinates of 3 Provincial control stations in the vicinity of Chetwynd and these were adopted as a Base origin for our work, each being intervisible and readily accessible. From this Base our initial station was established directly in the yard of the Diesel Generating Plant by Tellurometer (for distance) and Wild T2 for astro-bearing and elevation.

The first tangent of Transmission line right-of-way centre line from the initial station ran Northerly from the Diesel yard over a steep, densely wooded hillside involving a difference in elevation of some 1300 feet over a distance of 2 miles. The Tellurometer crews traversed 5 miles along the access road to establish a point near the end of the tangent, carrying Bearings and X, Y, Z, co-ordinates as they moved. The surveyor immediately selected a suitable ground location within 250 feet of this control point for a structure and the co-ordinates were transferred to this centre-line (P. I.) by transit and tape. Hence we had our first tangent established between points (not intervisible) the true bearing and distance between them being known.

This initial Tellurometer traverse involved 3 days of work due to travelling and climbing to Base origin stations. During this period the 2 field crews were occupied in running some 6 miles of pre-selected tangents in two locations about 10 miles apart, the nearest being 5 miles from point of commencement of centreline survey. The tangents were selected after a rapid field reconnaisance along proposed route and were established by offsetting from intervisible points on the center line of the access road and all bearings were assumed.

At this time no attempt was made to co-ordinate the center-line hubs and no measurements taken, the crews simply cut the line through and set 4" x 4" x 14" hubs every 500 feet by estimate and each was marked by a numbered metal tag 1½" x 1". The hub numbering in each of the 2 locations although run in sequence, was started at 201 and 501 respectively for identification purposes for subsequent profiles and structure staking. We did not anticipate a continuous numbering sequence from start to finish, nor was it considered necessary, as indeed it was not. As center line was cut through the clearing-marking crew flagged the clearing bounds of the right-of-way from center-line hubs. These clearing widths varied in orderly fashion to contain strips of danger trees and the spacing of the center-line hubs greatly assisted in this.

At the time the Tellurometer party had established the first tangent (3rd day) the 2 field crews had completed the 6 miles of uncontrolled center-line. One of these was brought back and commenced the same procedure over the first tangent. The other field crew started R. D. S. profile work which will be described later.

The Tellurometers moved rapidly at this stage establishing control points every ½ to 1 mile and particularly near expected bends in line (points of inter-section), under guidance of the surveyor in charge who continued his physical reconnaissance throughout. At the end of the 5th day Tellurometer control covered 10 miles of line and included the pre-run cut line of the 1st field crew. This involved simply a direct tie to each end of the tangent.

We now had a secure lead over construction forces and expanded the center-line crews to 4 deployed on both controlled and uncontrolled portions of line location, both running line and profiling by R. D. S.

Leaving the Tellurometer for a moment, an account of the use of established control appears warranted here, in detailed sequnce of operation.

(1) As explained, the center-line clearing crew established numbered line hubs every 500 feet (by estimate) and where necessary at intervening critical points for the benefit of profile crews. The instrument used in our work was a Wild T16 Transit, and line was cleared 3 feet each side of center line produced.

Commencing from the nearest Tellurometer control point the horizontal and vertical co-ordinates are transferred to pre-selected right-of-way centerline points at points of intersection and the bearing and distance calculated between them. This transfer was accomplished with transit and tape and seldom exceeded 200 to 300 feet and more often was less. True line location was commenced immediately and the line crews accomplished about 3000 to 6000 feet per day (7½ hrs.) When sufficient ground lead was gained (4 to 6 miles) the R. D. S. moved over the cleared line.

(2) This crew consisted of the R. D. S. operator and one rodman-chainman and moved in leap-frog fashion from center-line hubs. The elevation of the commencement point being known the profile was taken in detail and each intervening line hub elevated and identified in the field notes. Similarly the horizontal (R. D. S.) distance between hubs was established. Over long tangents the R. D. S. operator tied in to all the in-between control points as a check on this work up to that point and if necessary to renew the center-line elevation both to avoid accumulated errors, vertical and horizontal, and to enable the balancing of any error up to that point. It is to be understood that the R. D. S. operator although following a set procedure did not do any calculating in the field, he simply made standard notes. This method was continued throughout the whole of the survey with the need of accomplishment being some 5000 to 8000 feet per day.

(3) All calculations with respect to Transit and R. D. S. field work were carried out by one man in a field office trailer equipped especially for this type of survey. He reduced all the field notes and filed them in orderly fashion preparatory to plotting profiles, etc. Each field crew used a distinguishing mark for this field book pages, in this case we used each operator's initials, e.g. GWT 1, GWT 2, 3 etc. The field books used were the loose-leaf binder type in order that each day's work could be removed to a master book in the office. The Tellurometer calculations were carried out by the operators themselves.

(4) The normal standard of accuracy by the stadia method for distance is 1:1000. However, with constant checking into the control points we found our R. D. S. operators obtaining accuracies of between 1:1500 to 1:2,500. Also the elevation closures proved so good along each tangent that balancing the error was unnecessary. With

respect to the horizontal distance on tangents we accepted the Tellurometer measure as absolute and proportioned the closing error between center line hubs based on the distance between them as found by R. D. S. This of course assumed a constant error and we accepted it as such.

The Tellurometer party moved on towards the Peace River, tying in all uncontrolled cut line as they went along. The Peace River was crossed at a precise position and the terminal point of the traverse was reached in a pre-selected parcel of land required for Portage Mountain sub-station some 3 miles North-Westerly. During this final period a tie was made to Provincial Government station "BULLHEAD" on Bullhead Mountain for a co-ordinate closure and from Bullhead to a remote station for a bearing closure.

Over a distance of approximately 50 miles our closing error was 1 part in 40,000 and bearing misclose of 72 seconds. Considering that the Tellurometer shots varied from 800 feet to 8 miles and that 72 stations were established, this was very satisfactory.

The whole survey operation took only 3 weeks from start to finish and the party moved out of the area.

The field crews continued on center-line work in various locations and construction forces suffered no delays. Profile plans were plotted and structures spotted in the field office as the survey progressed, and as the office work increased the instrument operators assisted as necessary.

Within 6 weeks the whole location was completed and thereafter it was a matter of continuing structure staking by 2 field crews.

The whole survey operation was completed within 9 weeks and 1 small crew remained on an emergency standby as construction progressed.

The line was in service 3½ months after commencement of construction.

The legal survey of the right-of-way for acquisitions purposes commenced soon after completion of the line and it is well to note here that the control for the engineering survey greatly assisted the B. C. Land Surveyor in the course of his work. The control points were used for precise measure of center line and as take off points for the tying in of surveyed boundaries of all the parcels of land crossed by the right-of-way.

In order to relate (and utilize) the high order of Tellurometer measure to the taping method required to be used in legal surveys, the surveyor measured between 2 control points in 3 separate locations, using normal methods and procedures(Tension and Temperature corrections), and from this check-measure the relationship between measurements was established and a correction factor evolved. The factor was used in every instance when a Taping measure closed on and between control points and with extremely good results. The control points used for the survey were made official monuments by placing B. C. L. S. aluminum bars in the true position replacing wooden hubs, and all were shown on the legal survey plans together with their co-ordinates, on completion of the work. It is anticipated that these points will be of use to anyone making subsequent surveys in the area.

Conclusion:

(1) **Advantages:** A rapid accurate control eliminates laborious chaining and levelling, placing the whole of the line survey on a common co-ordinate datum which enables

work to be carried out over widely separated points and still remain related to each other. It reduces the margin for accumulated errors and blunders, and most of all the speed of accomplishment is practically doubled, which in consequence reduces costs.

Disadvantages: None apparent.

Recommendations: In connection with this particular survey there was no lead time between survey and construction which necessitated the Tellurometer operators having to burn the proverbial midnight oil calculating each day's work, in order to keep the center line crews moving. Based on our experience on this and subsequent surveys we are now arranging a programme for an electronic computer to carry out all the necessary computations from the basic Tellurometer field data. It is also intended to feed the R. D. S. notes into the same machine and obtain all the profile points on paper suitable for adding detail.

This may not always be convenient due to various circumstances but is very desirable.

Final:

On completion of the engineering survey the actual route was superimposed on photo-mosaics together with the legal land boundaries. These mosaics enabled the Land Division to perceive the relationship of the line location to any particular parcel and approximate acreage involved which greatly assisted in negotiations with various land owners in connection with the acquisition of Rights of way prior to completion of the legal survey.

Application to Submarine Cable Transmission Surveys

This type of survey is more common in British Columbia than in any other part of Canada due to the servicing of the numerous well-populated Islands. The most recent undertaking by the B. C. Hydro and Power Authority Engineers in this particular type of Power Transmission was carried out during 1963 and consisted of laying of new cables from Vancouver Island to the offshore Islands in the Gulf of Georgia.

The Power source was on Vancouver Island and was routed as follows: —

(1) Vancouver Island to Saltspring over the bed of Sansum Narrows. Distance, 11,982 Feet.

(2) Saltspring Island to Parker Island over the bed of Trincomalee Channel. Distance, 11,829 Ft.

(3) Parker Island to Galiano Island over the bed of Montague Harbour. Distance, 1497 Ft.

(4) Galiano Island to Mayne Island over the bed of Active Pass. Distance, 5450 Ft.

(5) Mayne Island to Saturna Island over the bed of Plumper Sound. Distance, 8390 Ft.

The coastline of these Islands although not varying in elevation about M. S. L. more than 200 to 300 feet is quite steep and densely treed and access to all points concerning this project was by boat.

Method of Operation:

(1) Preliminary:

The project and design engineers, including the surveyor assigned to the job. made a thorough ground reconnaissance of the area involved and made a choice of suitable landing points for each crossing. All available survey maps, plans, Navigational charts and photographs, had been studied beforehand and a tentative route selected that involved little variance during the physical inspection. The principal governing factor being to move the power from source to consumer as directly as possible with due consideration for anticipated expansion.

(2) **Survey.** (Using M. R. A. 2 Tellurometer)

The field survey work was carried out by 2 Tellurometer operators (one being the surveyor-in-charge) each with one assistant. Suitable points in the vicinity of each initial and terminal structure position were occupied and the distance measured in both directions. The weather conditions during the course of this survey were ideal, calm and clear with steady barometric pressures throughout, and as the observation points were reasonably elevated the reading proved free of any interferenc from the water surface.

Each Tellurometer operator observed his vertical and horizontal angles immediately and also tied in a suitable location on the ground for the structure position. Sufficient topography was also observed for possible alternate sites and profile was run to High Water mark.

The surveyor required the precise and accurate horizontal distance between landing points for the Navigable Waters Protection Act application and plan for acquisition of a right-of-way from the Crown Provincial Authority. Equally important from the project and design engineers view is the actual profile distance over the bed of the waters in connection with the length of cable to be acquired. This latter requirement was achieved as follows: —

Immediately prior to commencement of survey the Hydrographic Service of the Federal Department of Mines and Technical Surveys, Victoria, B. C. was requested to supply all the trigonometrical data available in the areas of our intended operations, which they did. We received thorough coverage of all the established "trig" stations including bench marks together with Geographic Co-ordinates. Further enquiries revealed very recent Hydrographic surveys of the whole Gulf Islands area which indicated extensive sounding coverage.

This writer has had personal experience of Hydrographic surveys and knowing the value of the field data sheets decided to utilize them for the survey on hand. These field sheets from which the final navigational charts are compiled show a sounding coverage quite a lot in excess of the final chart coverage and we were kindly supplied with photo-negatives for all our Crossing areas.

Our field surveyors made ties to the Hydrographic control in the course of their work and also refined the inshore soundings at all terminal points for large scale plotting purposes. This latter was accomplished by means of a hand-lead used from a shallow draft vessel and tied in at each sounding from both ends of a Taped Baseline (200-300 feet) by Transits.

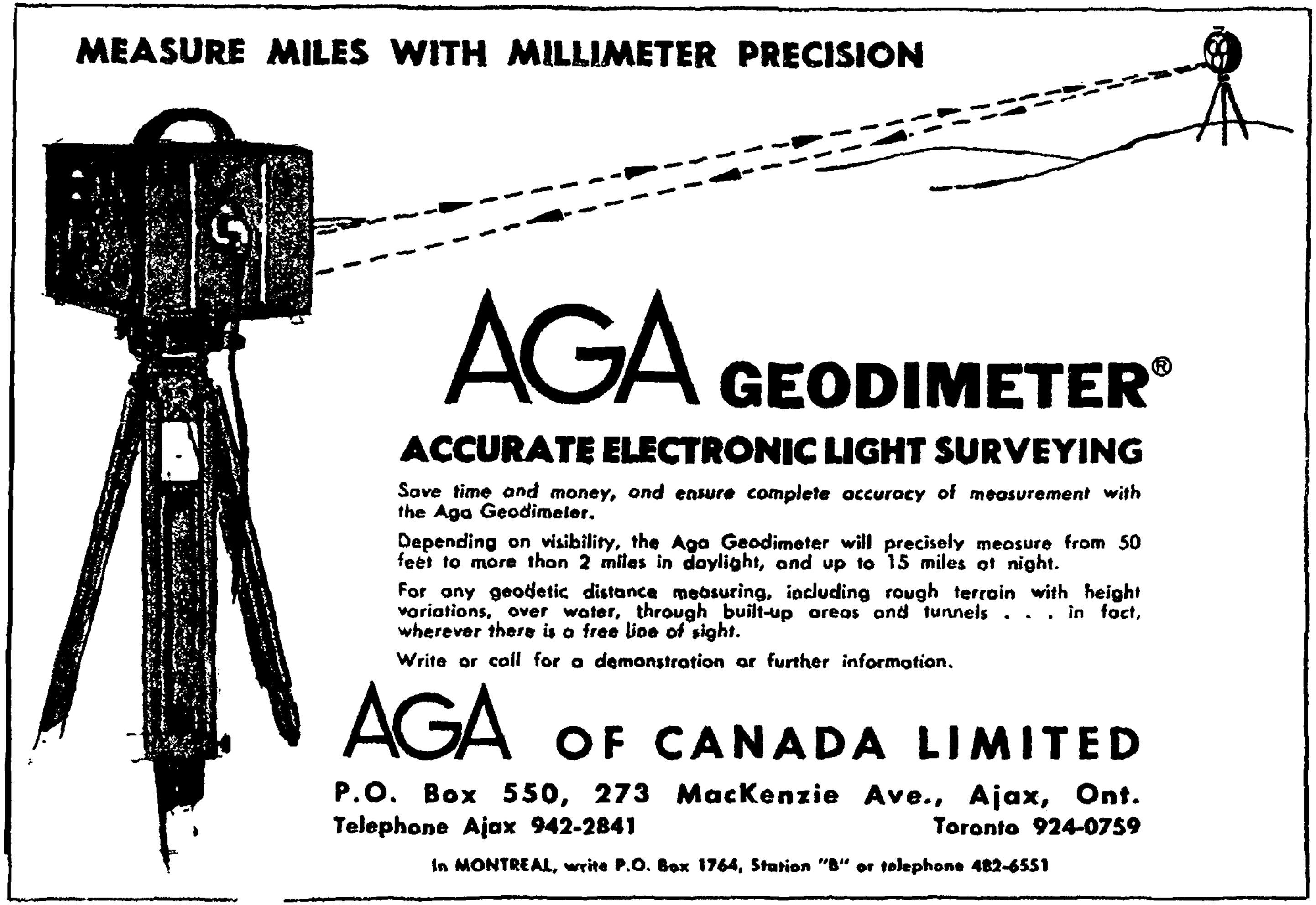
On completion of the field work all the survey data was processed and plotted at suitable scale depending on crossing length and the project engineers selected the final positions for structures from the plots and the center-line of proposed cable was drawn on them.

The Hydrographic negatives were now photo-enlarged to the plot scale of each crossing and by overlaying our plot sheets we fitted the common control points and traced our center line sounding from the enlarged negatives, and by scaled interpretation our profile was obtained.

Conclusion:

Advantages: The use of the Tellurometer eliminated laborious base-line and triangulation work in rugged and heavily timbered areas. The use of the Hydrographic data eliminated the hiring of a suitably equipped vessel and competent personnel to carry out a program of soundings. The Hydrographic surveyors are professionals in their particular field and it would be difficult to improve on their findings.

The whole Tellurometer survey took 10 days as compared with an estimate of 2 months work for this particular project, by conventional methods. The measurements obtained for engineering purposes were used also for the legal survey work eliminating re-checking of all base line work as is common by conventional methods.



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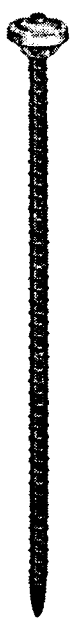


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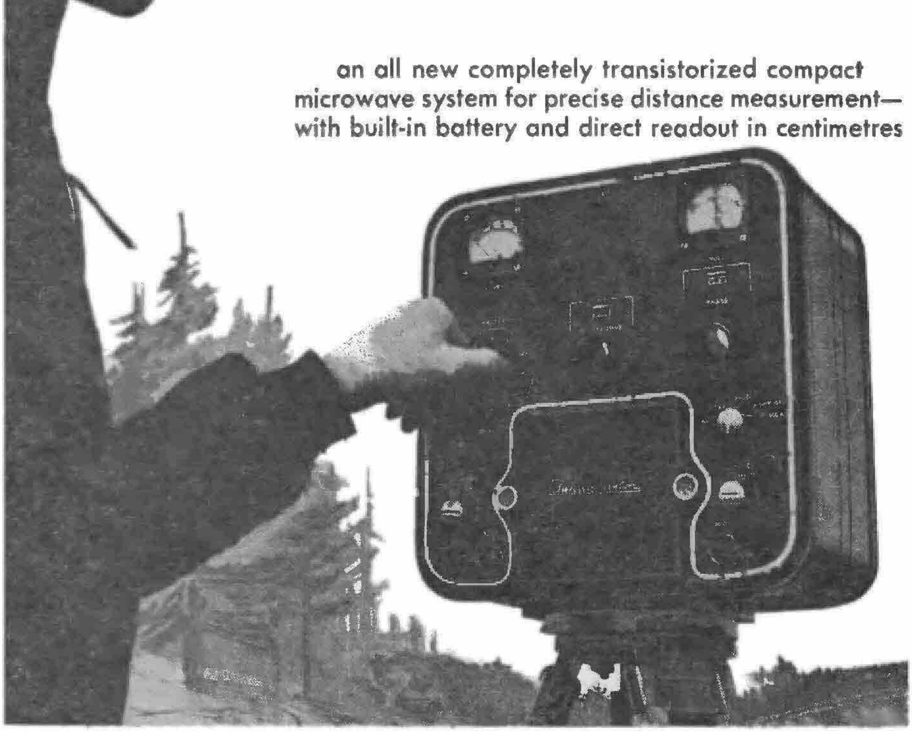

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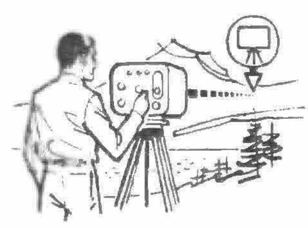

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