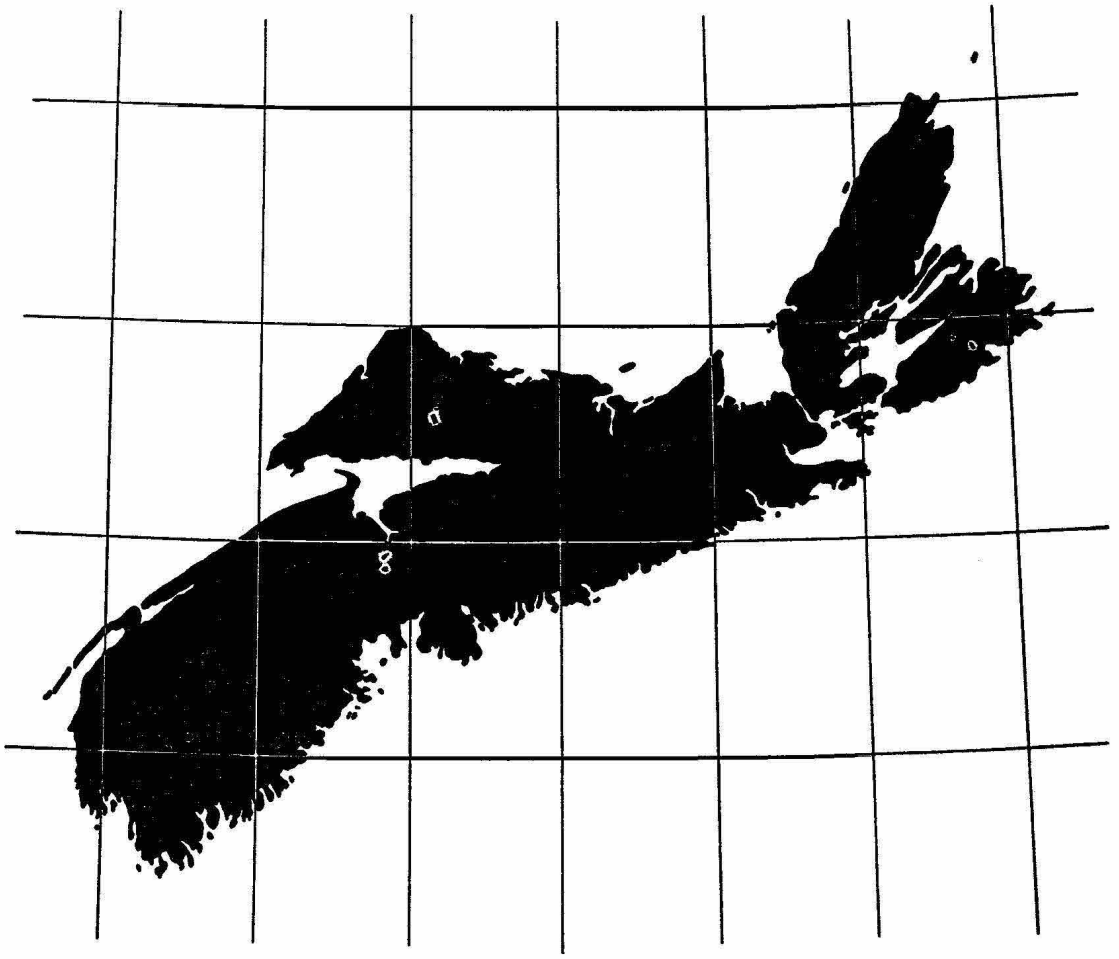
The NOVA SCOTIAN SURVEYOR



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ASSOCIATION OF PROVINCIAL LAND SURVEYORS

OF

NOVA SCOTIA

FRIDAY, NOVEMBER 4 and SATURDAY, NOVEMBER 5, 1966

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The Relationship of Legal Surveys to Coordinate Systems

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The significance of horizontal control has been the subject of considerable technical discussion. Its relationship to legal surveying has received much less attention. This paper outlines some of the broad implications of coordinate systems, when used in conjunction with legal surveys, and attempts to clarify and place in perspective their fundamental technical and legal implications. It shows that mutual benefit can be derived from such a marriage, provided that basic concepts are treated in accordance with certain established principles. The inception of a provincial control grid, capable of being utilized in title documents and existing registration systems, is discussed.

Introduction

A legal survey defines the extent of any right, title or interest in land, establishes the bounds of a unit of land or re-establishes an existing boundary. The proof or test of any such survey is its capability of withstanding successfully cross-examination in any court of law.

If a surveyor, in the witness box under cross-examination, can show that his methods are valid and in accordance with not only the statutes that exist in his jurisdiction, but also the Common Law, which forms the legal fabric upon which the statutes rest, then recognition by the court that the survey is in fact valid, permits the surveyor to apply the word 'legal' to his survey.

This is an important point, and one which many surveyors are apt to forget. Often when the delineation of a boundary appears to hinge on the evaluation of conflicting evidence, or when adverse possession and conflict cloud the determination, many surveyors are all too ready to leave the problem to a lawyer.

True, these are legal problems, but land surveyors are supposed to be trained in the law affecting surveying. Land surveyors in Canada have the exclusive right to define or re-define boundaries of land. The assessment of survey evidence is at times a difficult task and requires experts specializing in this particular problem. Consequently, surveyors are the experts in evidence assessment and boundary positioning: they certify the plans correct, and they are the parties who must stand in court as expert witnesses and testify that surveys conform to the law, both common and statute. Only when their daily practice, survey regulations and survey statutory principles conform to the law, are their methods and principles valid. A legal survey is then capable of withstanding cross-examination in any court of law.

Defining coordinate systems is perhaps a little easier; not too much conflict is involved. A coordinate system is a pattern of correlated physical survey monuments, established on the surface of the earth to a predetermined precision and then assigned "X" and "Y" coordinates in accordance with a particular grid and projection.

The average surveyor in most areas today, particularly in the densely populated areas, appears at times to be a most frustrated individual. He feels that he is burdened by problems from the past—inadequate monumentation and poor survey standards, and faced with current regulations and principles, which attempt to mend the problems of yesterday at the financial expense of his current client. His reaction to the idea of a coordinate system appears to be: "Well, anything has got to be better than what I am doing", or perhaps, "Well, it would be a dandy idea to get rid of stakes and just use coordinates". Such a reaction, if allowed to go unchallenged and if permitted to filter into the thinking of government officials and officials of surveyors' associations who will design new legislation and survey methods, could have a disastrous effect on legal surveys and coordinate systems. In the enthusiasm for coordinate systems and control surveys, certain matters are apt to be assumed as facts without close examination. This is especially true in the relationship of legal surveys to coordinate systems. The tendency is to accept, without question, that, because the theory of the coordinate system is indisputably sound, the resulting product is technically reliable. In other words the feeling of security engendered by knowledge of the precision and care with which first, second and third-order coordinate points are established, is extended unthinkingly to the local network, the very meat of any coordinate system from the standpoint of boundary definition.

Encompassing first, second, and third-order nets may be assumed to meet their specifications. However, in extending control to a local coverage, indeterminate standards of accuracy may appear. This problem arises, first, from errors created in the accurate determination of the coordinates of a new or unknown point from established known points in the coordinate net, i.e., the projection from the known net to the new survey, and secondly, in the accurate reproduction of any point by measurement from other known coordinated points. The only means of limiting such errors lies in the proper connection of the local coordinates and third-order work with the second-order net by self-checking field methods and adjustment of the normal errors whereby a definite accuracy specification, say third-order, applies to all local coordinate values. The need for machinery to set up and check general third-order and local control survey data and the examination of returns is problem number one.

The question of accuracy within a coordinate system affects legal surveys in two aspects: the reproduction of a point from coordinate data, and the determination of a bearing and distance from coordinated points. For legal surveys, the former is by far

the more important. In a choice between a legal survey plan, showing monumented property corners without dimensions, and a plan, showing only the dimensions without monuments, the former would have, by far, the greater legal significance. In legal surveys, the monuments are of prime importance, as they fix the corners and boundaries of divisions of land, while the distances between the corners, though important, are nevertheless secondary information.

In the few areas of the province of Ontario where control surveys exist, general use has not been made of the available data and the systems themselves have often been allowed to fall into disuse.

Each year the office of the Director of Legal Surveys of the Department of the Attorney-General of Ontario performs some 5.000 to 6,000 legal survey plan examinations in the province's Land Titles or Registry Office Systems. Coordinates appear on only a few of these, although increased use is anticipated when the government networks have been in effect longer.

The Legal Surveys Division also examines legal survey plans prepared under Ontario's Boundaries Act and Certification of Titles Act. These also indicate a reluctance to use coordinate data at any level, local or otherwise, despite the great advances made recently in electronic computing for the rapid and inexpensive translation of data between course measurements and coordinates.

The problem of making the surveying profession familiar with coordinate systems and bringing about their use is problem number two.

Common Law Effect

For legal surveys, coordinates provide one item in the list of evidence, which can be used in the re-establishment of a missing monument. It cannot be considered as unqualified best evidence if any better evidence exists.

For example, in re-establishing a corner, a search must be made, of course, for the original monument. This, if found in an undisturbed condition, can be deemed to mark-the original corner, whether or not the actual measurement to the point, or its coordinates, are the same as their theoretic values.

If the original monument is missing, the existence of coordinate values for the point does not remove the onus upon the surveyor of searching and sifting all other forms of evidence that would lead to the true re-establishment of the corner in its original position. A cairn or the hole that originally held a bar or post may be the best evidence of the missing monument, in spite of measurements or coordinate values that indicate that its position should, in theory, be elsewhere.

In other words, coordinates are a form of evidence of roughly the same class as course measurements, although generally superior from a technical point of view, and as in the case of other evidence, not necessarily the best. It remains with the land surveyor to assess, judge and determine the best available evidence in each case.

Unless present methods of evidence assessment are changed by amendments to existing laws, the rules of priority that the surveyor must follow are quite clear. The Common Law states that possession is nine points of the law. This applies equally to Torrens Systems lands and Registry Office lands. In the Torrens System (if the statutory principles of the particular system are sound), monuments constitute the best evidence of possession. Reference is not, of course, to adverse possession. The Common Law

further states: "The onus of proof lies upon he who insists, and not upon he who denies". This is translated in boundary court cases to "The onus of proof lies with the party seeking to disturb settled possession". The Common Law states further that, in assessing survey evidence, greatest priority must be given to those things about which man is least likely to make a mistake, giving the greatest weight to physical things and least weight to theoretical things. These three ancient and established Common Law principles are the supporting fabric upon which rules of retracement stand. Thus, in retracement, priority must be given in order to:

1) natural boundaries (that is, if a property is described as being bounded by a river and it can be proved that the river has not moved, then the river will forever control the position of the boundary, notwithstanding any other definition quoted, such as stakes or measurements);

2) original monuments;

3) fences or secondary possession that can reasonably be related back to the time of the original survey, and

4) measurements.

The division of land pre-supposes monumentation. Boundaries are real objects in accordance with which real, i.e., physical, improvements are made. There is nothing theoretical about the wall of a skyscraper or the reinforced concrete wall of a three-story underground parking garage. Boundaries, in reality, are physical and the laws of estoppel, acquiescence, peaceful settlement, agreement, possession and indeed military might, all reinforce the legitimate and practical fact that boundaries must be physically monumented in accordance with real identification.

Measurements always have been, and, except in certain limited instances, always will be, a method of finding the true location of physical boundaries. As techniques of measurement improve and ability to position accurately is refined, an original monument can be located with greater certainty. Measurements within coordinate systems will assume greater importance than in the past. No longer will they need to remain always at the bottom of the list of priority of evidence assessment. Within the coordinate systems, measurements will take precedence over unclear or ambiguous secondary evidence, where it becomes reasonable to presume that the secondary evidence may, in fact, be disturbed, and reasonable to presume that the accuracy of the coordinates is more likely to provide a true repositioning of a lost corner.

If existing legislation remains unchanged, the introduction of coordinate systems will further extend measurement technique and scientific progress. Coordinates will take their place with such tools as geodimeters and tellurometers.

If, however, an attempt is made by legislation to make coordinate values paramount rather than original monuments, serious problems will develop.

It is not possible to legislate Common Law principles out of existence unless it can be proven beyond all reasonable doubt that the established law is in error or out of date. It is important to remember that the onus of proof will lie on the party attempting to disqualify the Common Law. It is not sufficient to stand and say, "Well, prove my new idea to be wrong". The onus is reversed. The existing law will be deemed to be correct, appropriate and legitimate, unless the contrary is proven. In support of this, it may also be said that it is equally impossible to suppose that a mathematical solution is indefeasibly the best or only evidence in re-establishment.

Most problems in retracement today in the province of Ontario are the direct result of a Surveys Act that presupposed that all lot corners and lot lines would be capable of mathematical resurrection at any time in the future. It did not take into account limitations of mathematical and human accuracy of any sort and did not accentuate Common Law rules of evidence. It was evidently an error to ignore land and boundary law in the original theoretical township systems in Ontario. The same mistake must not be made again as it applies to coordinate systems. For many years, the training of surveyors has emphasized the mathematical retracement principles of the Surveys Act at the expense of the Common Law or common-sense approach to the problem of re-establishing corners and lines in their original positions. No attempt should be made to override Common Law principles and legal precedent in a misguided attempt to strengthen the legal status of control surveys.

This is not to denigrate the technical value of sound coordinates. They are a form of measurement more useful and more sophisticated than regular traverses or ties.

Use In Evidence Assessment

It has already been stated that there are certain priorities in evidence assessment and that it is possible, of course, to alter these priorities by a statute stating that they are invalid or outmoded and substitute new rules. This is apparently what happened in Upper Canada and the further division of land in Ontario. There is then a fundamental question that all surveyors must answer before they use coordinate systems, that is, to settle in their own minds the relative importance and priority of corners positioned by monuments and corners positioned by coordinates. Should they recommend to the legislatures that the Common Law relating to the peaceful possession of land be set aside and that theoretical coordinate values of points, shown on plans of record, take precedence over the posts themselves?

Coordinate systems themselves, as far as first, and normal third order is concerned, are a series of known monuments set firmly in the ground and then related to each other by precise measurement, which, when referred to a particular grid and projection, can provide an identification for each monument in the form of coordinates. The coordinated monuments themselves will be treated with extreme care. They will be located in areas where they are not likely to be disturbed and will be built with foundations, capable of withstanding frost movement. In addition, they might be referenced to permanent structures nearby, such as buildings, so that their positions could be re-established easily and accurately should they be disturbed. There would be no thought of re-establishing them from neighboring monuments, whether these neighbors are thirty miles away or two miles away. Every lost monument would be re-established, if possible, according to the best available evidence of its original position, namely, from a series of local ties in the immediate area of the monument itself.

Is it not possible, then, that, in the coordinate systems themselves, the technical difficulty of precise relocation will cause a return to site repositioning in accordance with secondary evidence?

Surveyors are not perfect. After the coordinate systems have been established and the surveyors in practice are required to use them and extend the coordinate coverage to their own surveys, there will be many instances of errors, caused by technical difficulties, economics and, unfortunately, dishonesty. Consequently, the coordinate values stated on a plan may not be true.

Lastly, and perhaps most significantly of all, the past history of land development, settlement and measurement, leads to the belief that the mathematical definition of property boundaries is not in the public interest. Land surveyors have been charged by governments with the responsibility for defining the extent of ownership. Their professional services are of a public nature and valid and correct only as long as they contribute to the public interest. It would seem that, if the Common Law principles relating to peaceful possession were set aside, and theoretical corners substituted for rnonumented corners, organized chaos would be perpetrated on the community. The community would continue to live, own and build in accordance with real boundary markers—of course, they have no option—and would accept, at face value, the monuments planted by surveyors to indicate certain absolute coordinate values. In this half of the twentieth century, the same mistake that occurred in Ontario in the first half of this century and in the last century would be repeated. In the words of justice Cooly of the Michigan Supreme Court, "We would do the community a disservice. We would move within peacefully settled boundaries, indicating acquiescence and acceptance, and take it upon ourselves to establish points with which the peaceful occupation and settlement of the community could not harmonize". Now, for what reason and to what end? Surveyors would abort their public responsibility in favor of a neat mathematical solution. They would give up the very reason for their exclusive privilege of defining boundaries of land. They would turn away from the laws of evidence assessment and the specialization in boundary law, which is the basis of our exclusive privilege, and become specialists in measurement alongside their colleagues in the engineering profession. It would not take the courts too long to decide that their new statutory principles, relating to theoretical points having absolute value, are without legal precedent and invalid.

It must not be overlooked that coordinates will give, on a legal survey, the geodetic position of corners and boundaries within specific limits of accuracy. This more rigid location of legal points will become increasingly important with the increased value of land and with more intensified use (an example of which is the condominium concept of land holding), the impact of which is lust beginning to be felt. The condominium principle, of course, is the ownership in fee simple with certain easements and reservations of cubes of air, varying numbers of feet above the ground. This allows individual mortgages of apartments in apartment blocks and permits the absolute ownership of interests in "land" at varying elevations above the surface of the earth. The Legal Surveys Division of the Department of the Attorney-General (Ontario) will not hesitate to recognize retracement based on coordinates in any legal survey in the province where it appears to be the best available evidence of the original position of property corners or limits. It will, however, question the position of any corner or limit placed according to coordinates when better evidence may be available.

Better evidence of a missing point, in certain cases, are such things as cairns, bearing trees, ties, fences, buildings or other possessory evidence, which may have been located in accordance with the missing monuments and may be in conflict with the position determined by coordinates.

Title Documents And Registration

Ontario has two land registration systems, one under the Land Titles Act, based on the Torrens-type System, and the older Registry Act System. The Land Titles Act

requires, in almost all cases, and more recently, the Registry Act permits, graphic descriptions in which parcels of land are described as numbered lots or parts on plans of subdivision or on description reference plans. The metes-and-bounds description may disappear completely in Ontario. However, with the ascendancy of the graphic description, the value of coordinates at the corners is more apparent and of a more practical value to anyone dealing with the land and can only further enhance the value of the plan data and further extend the principle of the graphic description of land.

A coordinate system will achieve its greatest utility in the field of legal surveying when it is accurate within set standards, when the data are readily available and its points are accessible in sufficiently dense coverage. The full development of legal surveys, related to control systems, will not come about until more provincial or other comprehensive networks are brought into existence. Any key monuments in a third-order system that are damaged or lost should be replaced and the survey fabric, based on control surveys, should not be allowed to deteriorate in the manner of the early township surveys. A coordinate system is an extension of the technical science available to the land surveyor in the determination of evidence and in supplying technical data. It remains with the land surveyor to exercise his judgment in their use and in arriving at the legal significance of evidence, obtained through these technical aids.

A most advantageous feature of control surveys is the ability to provide astronomic bearings, referred to a common meridian, in any given locality without astronomic observations. The accuracy of bearings so derived is, of course, dependent on the accuracy of the coordinates, but to date, bearings on legal-survey plans in many areas have been unrelated owing to a multiplicity of bearing references and a lack of integration. A cure for this would be most welcome to the public and to the legal profession, which is continuously puzzled, for example, by the variety of bearings which can be credited to a single line. This is another reason, of course, why written or graphic description must be controlled always by the real boundaries they attempt to illustrate.

Traverse data from field notes, reduced to coordinates, can be a worthwhile aid to plotting. Coordinate plotting is preferable to other forms in which scaling errors can accumulate. The mathematics of reduction, balancing and calculation of coordinates are basically analytic geometry and outside the direct legal field, but any flaw in such mechanics can automatically render survey work invalid from a legal viewpoint. Another auxiliary advantage is that areas of properties may be computed readily by coordinates.

There remains problem number three—the skill of the surveyor and his staff to accurately determine and reproduce coordinate values within a local system and to use them in a suitable context with legal retracement.

Creating A System

Omitting the question of new legislative principles to change the existing law, three main problems have been enumerated.

Problem Number One—instituting the necessary machinery for setting up and checking third-order or local coordinate networks

Problem Number Two—familiarizing and encouraging the surveying profession to provide and use control coordinates

Problem Number Three—establishing sound technical and professional quality in determining and reproducing coordinates with specific orders of accuracy.

In Ontario, the Department of Lands and Forests is carrying out a study, under the direction of the Surveyor-General, R. G. Code, to implement the design, establishment and maintenance of a province-wide horizontal control system including a third-order network, initially in the major urban areas of the province. This will be the first step in implementing the 1962 brief of the Ontario Land Surveyors' Association, directed to the Government of Ontario through the Minister of Lands and Forests. This brief, recommended the establishment of province-wide horizontal control to a practical degree of density, suited to legal or cadastral survey work.

When this study and the necessary organizational set-up are completed, it is hoped that problem number one will be solved. This is essential before any regulations or legislation on the subject can be drawn. The details of the project must be set down, studied and any necessary proceedings drawn up only after a careful study of all its aspects.

Undoubtedly a degree of inspection and government jurisdiction must he utilized on surveys of this nature to ensure that the necessary standards of accuracy are consistently met and that the monuments and the system are maintained in the future. Many acts and regulations have already been passed, both in Canada and abroad, providing for the administration and maintenance of control systems, and it remains a problem of government and finance to organize similar legislation in Ontario.

Problem number two is to make the surveying profession familiar with coordinate systems and implementing their general use.

A current opinion among some practising surveyors is that the cost of incorporating coordinates renders surveyors' fees uncompetitive, and, unless all surveyors engaged in legal land surveys agree or are required to include coordinate data, coordinated legal surveys will not come into general use. This is certain unless local surveyors agree among themselves or unless a statute or government regulation, requiring coordinates to be shown on legal survey plans used for land transfer or other purposes, is-enacted.

It may become necessary, as provincial, municipal and local control systems become available, that legislation, such as exists in some of the United States and other foreign countries, be passed requiring the use of coordinates on all legal surveys where a coordinate net is available. There is ample legislative material that can be used in the drawing up of such a code.

I hope that as third-order and local control systems are developed and become available, their use will grow naturally, while the advantages of ease and accuracy of measurement and of re-establishment inherent in the control theory will become self-evident. Coordinates should then be as familiar as conventional ties or traverses are now. There is little doubt that the permanence and reliable accuracy of a properly set up, adjusted and maintained control network will be quickly appreciated.

The increased use of electronic computer programs, working on Cartesian principles, has already done much to turn thinking to coordinates. This is a factor that will grow along with the increased use of computers, which are becoming more and more practical in smaller jobs as well as large projects.

The continued emphasis and attention that will be focused on horizontal control will also render the subject familiar. The matter of acceptance and use of horizontal control systems is also tied to problem number three, the matter of education.

The instruction of surveying candidates must feature horizontal control as a major element in the curricula. It should not be treated as addenda to the traditional concepts of measurement as in so many surveying texts.

For the qualified surveyor, technical journals should include articles on the subject of control in conjunction with legal surveys. Seminars, demonstrations and papers at local group meetings would also greatly assist in the dissemination of knowledge in this field. Such work has considerably furthered the general understanding and use of the electromagnetic measuring devices. Similar programs aimed at furthering horizontal control surveys will prove equally effective.

Technical assistance is also available from the various government agencies and electronic computing firms, engaged in coordinate work, which can be most beneficial to the land surveyor in handling controlled legal surveys.

The technical aspect must be appreciated: the theory of strength of figure, triangulation, trilateration, relative error, comparison of method, the mechanics of measuring, and so forth. A working understanding of such principles and an accompanying technical proficiency will be essential if an excessive or impractical degree of government inspection and checking is to be avoided and the coordinate idea strengthened in the minds of the public and the profession.

The technical aspect of coordinate surveys is stressed because it is essential to correct mathematical results and, therefore, correct legal significance. Coordinates cannot he popularized by inaccuracy, either in their determination or their use, and a third-order net would be wasted without accurate application. But the technical science is only one aspect of legal land surveying.

In surveying education and training, instruction and correct practice in the legal sector of surveying must be emphasized in surveying law.

It is not possible to achieve absolute mathematical accurlcy, much less absolute human accuracy. Training strictly along technical lines has, in the past, tended to orient surveyors towards measurement without sufficient regard to monumentation or evidence of monumentation. This has often led to entirely erroneous concepts of evidence upon which legal surveys should be based.

A land surveyor must be prepared to accept and recognize certain inaccuracies in previous legal survey work and govern his actions accordingly. He must be prepared to accept a stake as a legal monument, defining real property, even though measurement, whether from coordinates or otherwise, indicates that it *should* have been planted elsewhere. If a monument is gone, the surveyor's duty is not to replace it where it *should* have been, but to replace it where it was.

The sole use of measurements in replacing a stake or monument is a presumption that may be overcome by any satisfactory evidence showing that, in fact, it was placed elsewhere. The important duty of a surveyor is to search for all the evidence available of the particular corner, boundary or limit he is called upon to redefine. He must then assess the evidence, determine the best evidence and define his boundaries and corners according to this determination.

In the past, differences and errors have been, all too often, extremely large and inconsistent. Control surveys and coordinates are an element of measuring, and their proper use and improved mechanics will reduce and limit such inaccuracies in measurement. Evidence, based on measurement, then logically may acquire greater significance in relation to other forms of evidence. In certain instances, it may be the best

evidence in the re-establishment of a lost monument, as conventional measurement is on occasion. But the drawback of inherent error, however small, will continue to make measurement subordinate to occupational evidence. Measurement ma provide more accurate determination of a point which is located generally by occupational evidence, while the measurement itself is subordinate and consequential to the occupational evidence.

These principles are borne out in many of the laws enacted concerning control surveys and the use of coordinates in legal survey work. For example, Article 91 from the Maryland Code, entitled "Surveyor and State Survey", one of the more recent American bills, is most circumspect in stating. "Nothing contained in this Act shall he interpreted as requiring any purchaser or mortgagee to rely wholly on a description based upon the Maryland Co-ordinate System, as defined in this Act". And elsewhere in this law, although there is requirement that legal surveys he connected to at least two stations of the system and show coordinate values, there is no attempt made to legislate the value of coordinates as *prima facie* evidence of corners.

To reiterate, it is not possible to legislate Common Law or legal precedent out the window. No matter how accurate methods of measuring become, legal surveys will continue to follow established legal principles and, in reality, there is no conflict. No one seriously contends that searching for monuments will become obsolete or that all retracement will consist of is setting points solely by coordinates from other points on the grid.

To recapitulate, the important points in implementing coordinate systems are

1) the need for adequate machinery to set up and cheek third-order and local control.
2) encouragement of the profession to use coordinates and
3) education to assure sound technical ability.

Reasons have been given why coordinates must be judged and considered against the history of legal surveying and not permitted to dominate or usurp retracement law.

Finally, sonic of the principles involved in legal surveys and their mutual relationship with measurement have been outlined. The subject can only be discussed in a paper in terms of principles. Every eventuality or individual case of control survey practice with legal elements cannot be studied, but the principles mentioned will stand as guideposts, which can be useful to the profession.

SURVEYING IN NEW ZEALAND

R.P. Gough, Surveyor-General.

1. The topography of the country and the early history of European settlement are two factors which have considerably influenced the survey system which operates today in New Zealand.

2. Topography

New Zealand lies between Latitudes 34° and 48° south and Longitudes 166° and 179° east and consists of three major islands - North, South and Stewart Island.

The North Island (44,281 square miles) is largely hilly with a major mountain chain running from the southern extremity to East Cape and varying in height from 3000 to 5700 ft. On the west of the North Island is Mt. Egmont (8260 ft) and in the centre of the island there is the high mass of Mts. Tongariro (6517 ft), Ngauruhoe (7515 ft) and Ruapehu (9175 ft).

The South Island (58,093 square miles) is largely mountainous with a major backbone range - the Southern Alps - running the length of the island. The highest point is Mt. Cook (12,349 ft), there are seventeen peaks over 10,000 ft, and a very large number 5,000 ft and over.

Stewart Island (670 square miles) is partically all hilly and bush covered and even today has only one small fishing and tourist village. The highest point is Mt. Anglem (3214 ft).

3. History

The earliest European contact with New Zealand was in 1642 when Abel Tasman charted part of the western coastline.

James Cook, in 1769-1770, formally took possession of the country in the name of King George III and charted its coastline. His chart is a remarkable piece of work.

Except for the Canterbury Plains and Central Otago in the South Island and parts of Hawke' s Bay and the central volcanic plateau in the North Island, the country was almost wholly covered by forest. It was sparsely inhabited by Maoris around the coast and on some of the inland waterways. With the establishment in 1788 of settlement in Sydney, New South Wales, 1200 miles to the west across the Tasman Sea, there developed a trade in seal skins and flax between the two countries. Whaling bases were established around the coastline with a limited amount of European settlement, and in 1814 New Zealand was proclaimed a dependency of New South Wales.

It was not however, until 1837 that systematic settlement of the country planned by Edward Gibbon Wakefield had its beginnings with the formation of the New Zealand Company. This Company purchased land from the Maoris, subdivided and sold it to the settlers.

From 1840, settlements were established at Wellington, Auckland, New Plymouth, Nelson, Christchurch, and Dunedin, and from these coastal areas settlement spread quickly into the more accessible back country. By 1853 the European population of New Zealand was 27,633. The New Zealand Company and its subsidiary settlement organisations each provided their own surveyors and staff who proceeded to subdivide the land and establish their own survey records.

In 1840 when New Zealand was created a separate colony, the Royal Instructions provided for the appointment of a Surveyor-General and it appears that, for some time, there were two controlling authorities directing surveys. However, on the dissolution of the New Zealand Company in 1851, the Surveyor-General had complete control. When provincial government was shortly afterwards established, each province appointed its own Chief Surveyor and the need for a Surveyor-General disappeared. Following the abolition of the provinces in 1876, the position was re-established and has been retained since that date.

The end of the provincial government era is a convenient time to review the progress in survey during a period when each provincial Chief Surveyor was responsible for the surveys within his province and an inspecting surveyor was responsible for the surveys of the General Government - largely of Maori and Confiscated land.

There appears to have been a growing realisation among the various officers responsible for survey of the need for a reliable triangulation over the country, and a conference of Chief Surveyors in 1873 made a series of recommendations to the central Government outlining, in essence, the basic principles of the present survey system. The Government, in 1875, obtained an independent professional opinion on the state of surveys from Major H.S. Palmer R.E. who was in New Zealand observing the transit of Venus. A few extracts from the summary of his report are worth quoting:

> "about 20,631,200 acres or three tenths of the whole (of N.Z.) has been covered with triangles trustworthily observed..... they (the triangulations) are spread in six or seven detached pieces over parts of the Provinces..... In various parts the base-lines and angles were measured with commendable care. A good deal of pains was taken in determining geographical positions ..... In its present state it rests on a multiplicity of bases and standards and on the eight or nine determinations of true meridian and geographical position ..... In Otago alone there have been already at least seventy base lines and seventy small triangulations. You have a number of disjointed details of good enough quality in themselves but as yet no means of piecing them together ..... it will be necessary to bring the whole within the grasp of one exact and comprehensive system and to refer them to a single standard of length and a single starting point..... The state of section surveys however is much less encouraging. Piecemeal work and want of unity of plan have been introduced wholesale. Ten different departments have been at work in as many different parts of the colony and following systems so various that scarcely any two are exactly alike..... Out of the 11,136,400 acres returned as finished under this head 4,730,900 acres mainly in the triangulated area may be said to come up

to that standard of accuracy which fits them to form the kind of map required by the country - that is to say a cadastral map on the correctness of which all man may agree. Of the remaining 6,405,500 acres (which has been surveyed) a very large portion has been inaccurately done and is next to valueless."

Major Palmer's recommendations were for a triangulation of the whole colony with, as the fundamental framework, a system of major triangles to be broken down afterwards to secondary and tertiary triangles as required and with detail (section) surveys to be grafted on the proposed trigonometrical framework.

Major Palmer's report was accepted by Government, the survey system was brought under the control of a Surveyor-General and an orderly system of survey was established., but no immediate start was made on a major triangulation system. Mucl. triangulation was, however, carried out but it was not of geodetic standard and was intended only for the control of local cadastral surveys. The country was divided, into 29 meridional circuits. A system of control bearings was run through the existing triangulation system and at least they could be brought into terms of one another for bearing - in general the standards of length were adequate for the purpose of the triangulation which was to control cadastral surveys. Each meridional circuit was treated as a plane surface, a true meridian was established at a more or less central station in the circuit, and all bearings were shown in terms of the central meridian. All cadastral surveys were connected to the triangulation and all survey monuments were coordinated in terms of the origin station of the circuit.

Between 1909 and 1913 a scheme of secondary triangulation was begun and five base lines in the North Island were measured to an accuracy sufficient for primary triangulation but it was not until 1921 that a triangulation of geodetic accuracy was begun. Field observations were carried out in the North Island from 1923 to 1931 and 1936 to 1942 when angular observations and much of the astronomical work was completed. In 1947 the three base lines in the South Island were measured and two of the five base lines in the North Island remeasured. Twelve Laplace stations were selected and observations for latitude, longitude, and azimuth completed in 1949, the adjustment and computation of the net on the International (Hayford) Spheroid being completed in the same year.

National Grid coordinates on the Transverse Mercator projection with one origin in each of the two main islands have been computed for all stations.

Second and third order triangulation has been carried out in various districts to control both cadastral and topographical surveys and much of the earlier triangulation is being readjusted into the geodetic network to provide triangulation of fourth order accuracy which is sufficient for most purposes in many parts of the country. As the triangulation is adjusted transverse mercator coordinates in terms of the meridional circuits are computed and it is hoped to gradually bring the cadastral surveys into terms of these more reliable values.

The Southern Alps prevented the development of a geodetic network of triangulation covering the whole of the South Island and it was intended to carry another chain of triangulation down the West Coast. The land in this area is of low value and except for a narrow flat area along the coast is mountainous and bush covered. In 1958 a tellurometer traverse was run along the north West Coast for 200 miles to

provide control for hydrographic surveys beginning and ending at stations of the first order triangulation net, the misclose being 5.87 seconds in bearing in 20 angles and 8.52 links northing and 27.38 links easting in coordinates. In 1960-62 further tellurometer traverses were run to link the West Coast traverse through Arthur's Pass with the triangulation in Canterbury and through the Haast Pass with the triangulation in Otago. Due to the mountainous nature of the country through which these traverses run there are possibilities of gravity anomalies which could account for some of the unexpectedly large miscloses in bearing and coordinates. However, the results are sufficiently accurate to control any survey work which it is anticipated will be carried out in this area for many years to come.

In the city areas and along a number of country roads, standard traverses have been established to provide control for cadastral surveys.

As is evident in this outline the major emphasis on survey in New Zealand has been on cadastral surveys to provide title to the individual land holders, control surveys having been carried out only to assist in this work.

Although some levelling had been done, it had usually been for some specific project and it was not until 1938 that an organised system of Precise Levelling was begun. Development activity has usually dictated where this work was to be carried out, but some 1850 miles of precise levelling has now been completed.

Reconnaissance topographical work had been undertaken in various parts of New Zealand from the earliest days of settlement, and much of it was of a very high standard but, at the outbreak of the Second World War, there was practically no topographical survey information as it is known today. Some defence and special land development areas which had been covered were usually on local datum and not connected in any way. In 1937 the Department of Lands and Survey had established a Photogrammetric Branch and was commencing the major task of obtaining topographical coverage on a scale of 1:25,000 over the country. With the threat of invasion during the last war, the whole of the available survey resources of the country were put into the task of producing 1:63,360 topographical maps. Fortunately the Geodetic Triangulation had by this time progressed to a stage where a provisional adjustment could be carried out and these values together with the cadastral information available were used as the basis for the work. The Photogrammetric Branch was fully occupied with the production of 1:25,000 mapping of important defence areas leaving the task of 1:63,360 mapping to field parties using plane tables and whatever other equipment and techniques they could command. The work in general was of a high standard and much of the information was adequate and in many areas remains in use today.

Following the war, the emphasis has been on cadastral surveys to cope with the rapid expansion in both rural and urban subdivision but throughout there has been a continuing increase in the effort to obtain topographical coverage. This work is carried out by the Department of Lands and Survey and, today, the Photogrammetric Branch of the Department is equipped with 3 first order, 5 second order, and 5 third order plotting instruments together with a radial line Secator and other ancillary equipment. All topographical mapping is done from aerial photography using the photogrammetric plotting equipment.

4. Cadastral Surveys

The major survey effort in New Zealand has been and remains in cadastral surveys. At the time of European settlement the country was in its, natural state

and the cover was largely bush and tussock, so that all boundaries had, to be marked on the ground. In the initial stages of settlement the survey methods for fixing boundary positions varied, from good to very interior. In some oases, compass traverses were employed or a magnetic origin used and the surveys were not connected to one another or to any form of triangulation so that much of the early work had to be done again. Land alienated from the Crown to an individual was Crown Granted and subsequent sales or subdivision of these parcels of land were registered under a Deeds system. In 1870 the Land Transfer Act based on the Torrens System of land registration was passed and in 1924 registration of all titles with a District Land, Registrar was made compulsory.

Under this system the Crown guarantees title and a survey must be made of every subdivision of land. The survey must define the boundary of the land under subdivision and the boundaries of the new allotments and it becomes the basis for the title which subsequently issues.

Except where they are natural features, the boundary corners of every allotment must be marked on the ground by a wooden peg 3" x 2" x 21" or by other approved marks, and all boundary corners and natural boundaries must be fixed by survey. They must be connected to the triangulation either directly or through approved surveys. Plans of all boundary surveys must be prepared and approved by the Chief Surveyor of the Land District before any title may issue. The plan must be accompanied by the field notes, and traverse sheets showing the coordinates of all survey marks in terms of the Origin of the Meridional Circuit in which the land is situated. The plans remain the property of the Crown; in the case of surveys of Crown or Maori lands they are lodged with the Chief Surveyor of the District and where they are surveys of private land they are deposited with the District Land Registrar.

The most common method of fixing boundaries is by theodolite and tape traverse. Angular measurements are sexagesimal with optical reading theodolites in practically universal use. Measurements for length are made in chains, links and parts of a link using long steel bands of either 6 or 11 chains in length. The tape is divided into chains, the last chain being divided into links and a finely divided link scale is used to measure the fractions of a link.

5. Survey Administration

The Surveyor-General is responsible to Government for the administration of all land survey in New Zealand and is Director of Surveys, Army. Registration of land title is the responsibility of the Registrar-General of Land.

The country is divided into twelve Land Districts and in each of these there is a Survey Office under the control of a Chief Surveyor and a Land Registration Office under a District Land Registrar.

All the survey records in a Land District are kept in the local survey office.

6. Survey Qualifications

Prior to 1876 there was no specific test of ability of a surveyor. In that year the Surveyor-General instructed all Chief Surveyors to examine the qualifications of all surveyors carrying out land boundary surveys in his district. Those who were

suitably qualified were then issued with a practising certificate by the Surveyor-General. Future candidates were required to have three years' practical experience and be examined by the Chief Surveyor before being issued with a practising certificate.

In 1896 a Board of Examiners was set up and this Board., later to become the Survey Board of New Zealand, has been the examining authority for Land Surveyors ever since.

The Survey Board of New Zealand, which consists of the Surveyor-General, two government nominees and two nominees of the New Zealand Institute of Surveyors, is also responsible for the survey regulations controlling land title surveys in New Zealand.

Since 1896 the Survey Board has had full reciprocity with the Survey Boards of the Australian States, the written papers of the examination being set by the various States and New Zealand in turn but marked by the respective Boards. The standard of the examination has progressed over the years and now includes the written subjects, Computations (2 papers) Engineering Survey (2 papers) Physics, Town and Country Planning, Astronomy, Geodesy, Land Classification and Utilisation, Mapping, Arial Survey and Photogrammetry, Principles and Practice of Land Valuation, and Laws and Regulations Affecting Surveys as well as a practical examination in the Use and Adjustment of Instruments, Levelling and Astronomy, and the submission of six different plans of the candidate's own work.

In 1962 the academic training of surveyors in New Zealand was handed over to the University. Future candidates to the profession are required to obtain a diploma or degree in surveying from a University then have two years' practical experience before being examined by the Survey Board in Laws and Regulations and the practical aspects of survey. In addition to reciprocity with Australia, the New Zealand Survey Board has reciprocity with the Royal Institute of Chartered Surveyors and with the Dominion Board of Examiners, Canada.

7. Institute

The New Zealand Institute of Surveyors, the first of such survey organisations in the British Commonwealth was established in September 1888 when 216 surveyors agreed to form an association - today the membership is 420 practising members, 180 non-practising members, 4 honorary members, and 360 students.

Surveyors in New Zealand are employed in either private practice, local bodies or with government.

The surveyor in private practice is mainly engaged in land subdivision, land title survey or some form of land boundary definition or redefinition. In land subdivision he is responsible for the scheme of subdivision, the engineering survey and construction of any necessary roads or access and landscaping where this is desirable. When the roading and services are complex and on large earthworks for landscaping a civil engineer must be employed. A number of surveyors engage in town planning for local authorities.

Surveyors in local body employ are mainly engaged in land title and other survey work for the authority and in checking surveyors' schemes of subdivision.

The Department of Lands and Survey is the major government employee of surveyors

and this organisation has 170 surveyors, survey cadets, survey assistants, and 447 draughtsmen and draughting assistants.

It is responsible for the control surveys, topographical surveys, and land title surveys for the Crown, for the correctness of all land title surveys, for the custody of all survey records and for the production of all topographical and cadastral maps, general maps of New Zealand and aeronautical charts and town planning maps.

The organisation consists of

Head Office - Surveyor-General, Asst. Surveyor-General, Survey Coordination Officer, Supervising Draughtsman, Asst. Supervising Draughtsman, a small group of Statutory Draughtsmen, the Map Library and the specialist Computing, Cartographic and Photogrammetric Branches.

District Offices (major) - Chief Surveyor, Land Transfer Surveyor, field staff, Chief Draughtsman and draughting staff the latter being subdivided into plan examination, cadastral, topographical and general draughting sections.

District Offices (minor) - Chief Surveyor and field staff, Chief Draughtsman and draughting staff subdivided generally as for a major office.

8. The Future

New Zealand, with a present population of just over 2,500,000, can support a much higher population. It enjoys a good climate and the land is fertile so that closer subdivision of land for urban and rural purposes will be a continuing task for the surveyor. As most of the better class land is privately owned, the great volume of this class of work will be done by the private practicing surveyor.

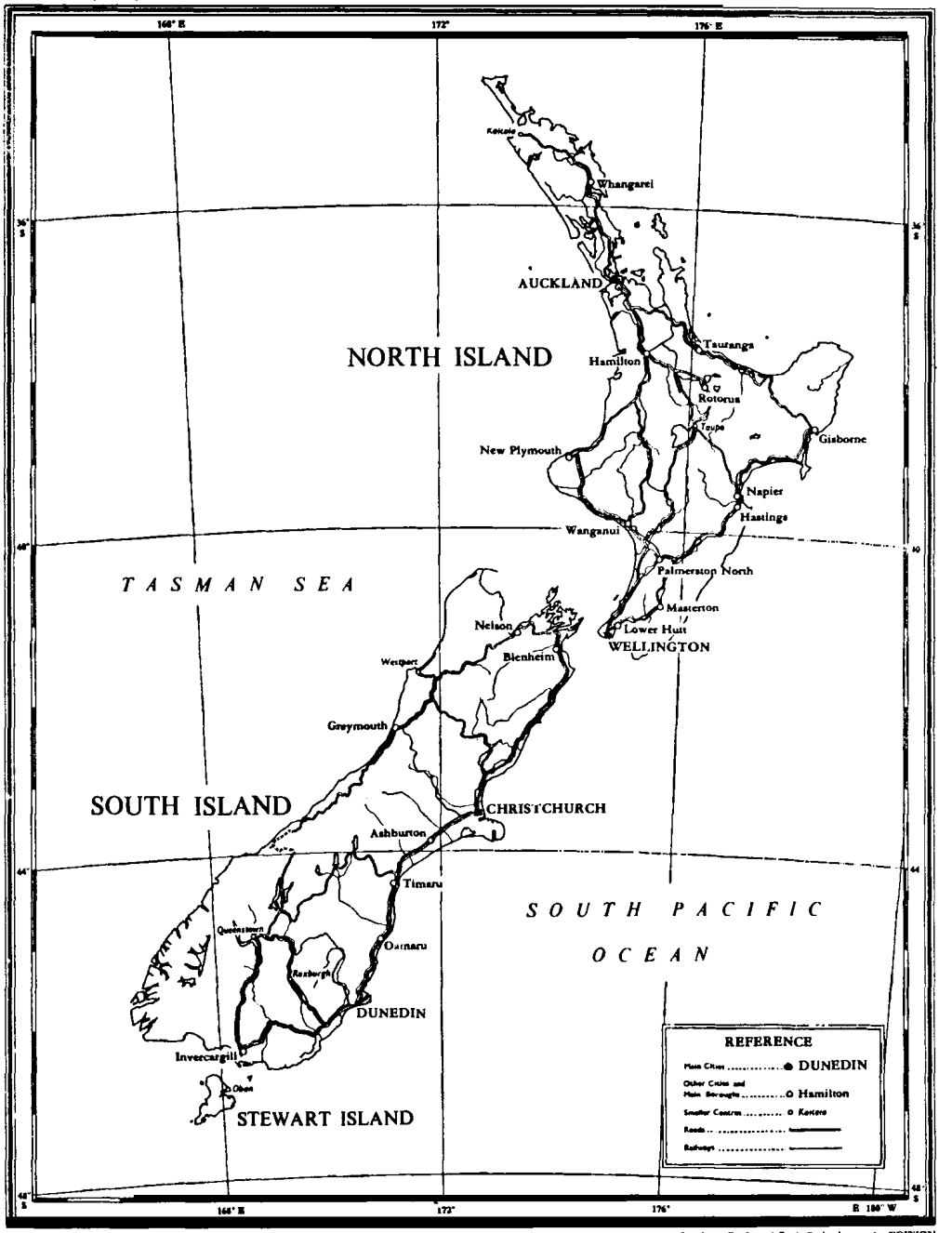
The economy of the country has been based almost wholly on its agricultural products but there is a change taking place with more industry being established. There are no known major mineral deposits but searches for these continue. Its greatest asset is cheap hydro-electric power and, while most of the more obvious and accessible locations have already been developed for this purpose, there still remains a tremendous store of hydro-electric wealth in the back country, particularly of the South Island. Topographical information to assess and plan the development of this wealth is urgently required and supplying this information will be the major task in the next 10 or 20 years. Initially the aim is to achieve full coverage on a scale of 1:63,360 with 100 ft contours, to be followed later by smaller scale surveys.

Control surveys will need to be strengthened and extended and a continuing programme of precise levelling will have to be pursued.

As in all developing countries survey information is essential and must precede development. Consequently the years ahead will see the surveyor making a continuing contribution to national development.

N.Z. 1:8,000,000

NEW ZEALAND



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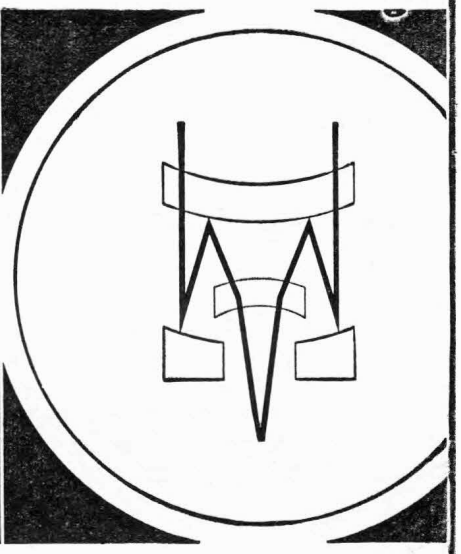

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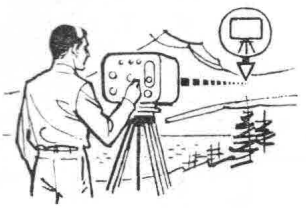

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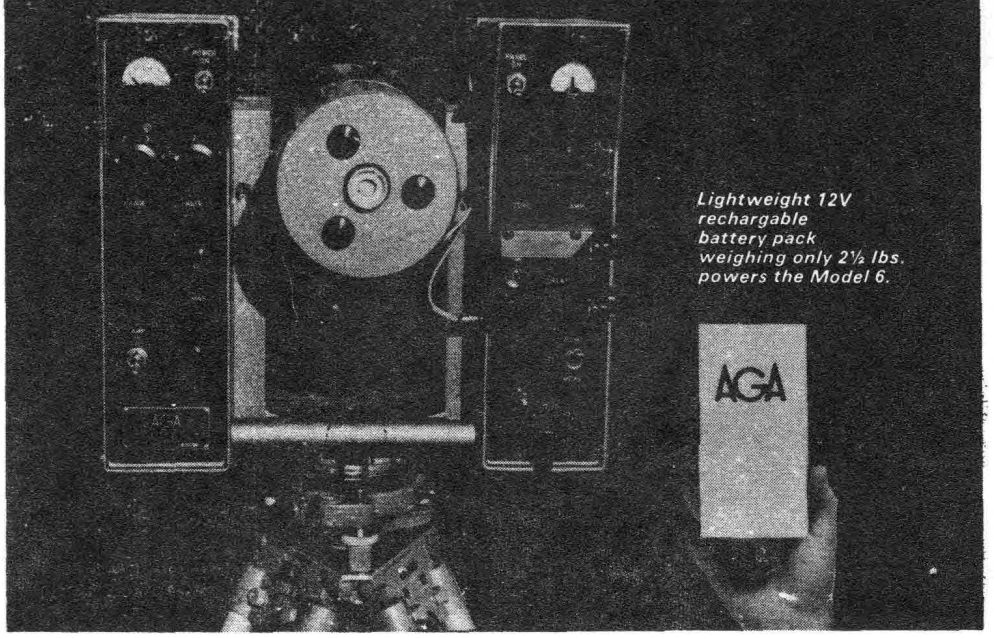

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