The NOVA SCOTIAN SURVEYOR

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THE ASSOCIATION OF NOVA SCOTIA LAND SURVEYORS INCORPORATED

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NOTES FROM THE SECRETARY'S DESK

Congratulatiors go out to the members of the Editorial Board for the printing of this issue and I would like to thank all those who are personally responsible for making it a success.

Your 19th Annual Meeting Committee is presently hard at work organizing the meeting to be held Nov. 7th and 8th. On behalf of the committee members I urge everyone to make a great effort to attend. The By-laws are up for amendment and a new suggested schedule of rates is to be approved by the membership. Also we have three new exhibitors coming this year who I'm sure you will enjoy meeting.

Since writing my last edition of "Notes from the Secretary's Desk" I had the opportunity to attend a regional meeting for the Cape Breton area in Sydney. I enjoyed attending this meeting very much and wish to thank the chairman, Bernie Campbell, and also John Pope, for the invitation. The meeting was well attended and the enthusiasm shown was terrific.

On Oct. 23rd the ballots and list of candidates seeking election to the council will be mailed out. In the past approximately 85 out of 240 were returned. Let's have a greater return this year.

In closing, may I say I am looking forward to seeing you at the annual meeting. Come and have a good time.

Ed Rice
Secretary-Treasurer.

Oct. 19, 1969.

Mr. Eric Millard,
Editor,
"The Nova Scotia Surveyor"
Liverpool, Nova Scotia.

Dear Eric:

Enclosed are reports from the meetings that I have attended and I would appreciate their inclusion in the next issue of the "Nova Scotia Surveyor".

Yours very truly,

Roy A. Dunbrack,
President.

MASSACHUSETTS

Dedham, Massachusetts, from Oct. 9th to 11th, 1969, was the scene for the 15th Annual Convention of the Massachusetts Association of Land Surveyors and Civil Engineers.

The Convention theme, "From Deed to Field to Certificate of Ownership" was well carried out in that the two main speakers, Mr. Willis F. Roberts, Technical Director of the Atlantic Provinces Surveys and Mapping Program, and James A. Thigpenn III, Vice President of the American Congress on Surveying and Mapping, both dealt with and provided solutions to the ever mounting problems surrounding "Land Titles".

The progress that has been made in the research on the Computer Based Land Titles System in New Brunswick prompted me to make arrangements with Mr. Roberts to speak at our upcoming annual meeting.

Another topic of interest was a talk by Mr. Llewellyn Schofield on the Control Survey he had recently completed on East Caicos Island in the British West Indies. Mr. Schofield also was moderator of a panel discussion and conducted a field demonstration on the uses of the Geodimeter.

Other Canadian delegates to the Convention included Mr. & Mrs. Michel Corriveau from Quebec, Walter Servant, Al Daykin and George Bates from Nova Scotia.

NEW BRUNSWICK

The 16th Annual Meeting of the Association of New Brunswick Land Surveyors was held on Jan. 21 and 22, 1969 in Saint John. Speakers included:

(1) Mr. J. G. Greenough from Bathurst
"Some Problems of a City Engineer"

(2) Mr. T. J. Jellinek
"The Surveyor and Municipal Planning"

(3) Mr. A. W. McLaughlin
"Interim Report on Land Titles"

(4) Mr. Laurier Bosse
"Photos and Orthophoto Mapping"

A panel discussion by representatives from private and Provincial and Federal Government fields of surveying proved the versatility of the computer in many phases of their survey operations.

The major item on the business agenda was the revision of the Minimum Standard Tariff first adopted in 1956 and amended in 1957, 1960, 1963 and subsequently 1969. The members approved two systems, first , the payroll basis, i.e., actual payroll cost plus 100%; second, a daily and/or hourly rate. Also approved in conjunction with the two systems were unit fees for such work as re-staking of lots, certificates, descriptions, preparation of plans, etc.

Mr. John C. Trainor, formerly from Cape Breton, was elected their new President.

NEWFOUNDLAND

The Association of Newfoundland Land Surveyors held their Annual Meeting in St. John's on May 1st and 2nd,1969 and elected Mr. E. Carl Granter as their President.

The programme listed the following speakers:

(1) Mr. Sybren H. de Jong, President of the Canadian Institute of Surveying.

(2) Mr. Willis F. Roberts, Technical Director of the Atlantic Provinces Surveys and Mapping Program.

(3) Mr. J. H. Burridge, member of the Nomenclature Board of Newfoundland.

Unfortunately, the Air Canada strike took its toll with only Mr. Burridge able to present his paper "Place names in Newfoundland".

The strike also had a profound effect on delegates from other provinces. Mr. Robert Thistlethwaite, the Surveyor General of Canada, and I were the only representatives from outside the Province.

A very interesting part of the programme was the presentation of papers by the students of the Surveying Technology Course of the College of Trades and Technology. The papers covered the results of studies on survey equipment, with comparisons being made between the manufacturers' claims and the findings of the students.

It would appear very significant that of the 83 people registered, 40 were students. It must be very gratifying for the members to not only have the students' interest, but to have their participation.

QUEBEC

The 86th Annual Meeting of "Les Arpenteurs-Geometres de la Province de Quebec was held at Mont Gabriel (40 miles North of Montreal) from May 23rd to 25th, 1969.

Out of province delegates included Mr. Sybren H. de Jong, President of the C.I.S., Mr. Robert Thistlethwaite, Surveyor General of Canada, Mr. Neil Simpson, President of the Ontario Surveyors Association, Mr. Phillip Bill, American Congress on Surveying and Mapping, and the writer.

One hundred and fifty members were registered for the meeting and twenty-five new members were sworn in.

The focal point of the meeting was the responsibility of the Land Surveyor and all sessions were well attended.

An increase in dues for membership in the Corporation was approved at the business session, which now puts them up to $150 per annum. Is it any wonder, when we consider that the Corporation, in order to maintain its high standard, recently settled a disciplinary matter at a cost in the vicinity of $7,000.00!

The Board of Directors elected Mr. Michel Corriveau as their new president and earlier in the year, appointed Mr. Jean-Marie Chastenay as their full time Secretary-Treasurer.

THE CHANGING FACE OF SURVEY INSTRUMENTS

A. H. Ward, Heerbrugg, Switzerland

"Changing face" is a procedure with which all surveyors are familiar. When this simple action of reversing, or transitting, the theodolite telescope is made and readings are taken on both faces, the mean of the two values will be free from the small residual discrepancies that exist in all theodolites. It is, therefore, an essential operation when the maximum accuracy is required.

Changing face, however, is an expression that is not limited to the physical relationship between the telescope's position and the vertical circle. All designers and makers of modern equipment are continually producing instruments with new shapes, performances and functions. These constitute a different, but vitally important, manner in which survey instruments themselves have changed face over the years.

For the first real break through from the old-fashioned open type theodolite, we must go back to the period at the beginning of this century when Heinrich Wild began his distinguished career as an instrument designer. Dissatisfied with the existing theodolites, which were particularly unsuitable for his triangulation work in the mountains, he abandoned his career as a surveyor and took on the task of developing an instrument that would stand up to rugged field work, that would be easier to use and that would provide a higher reading accuracy.

Although many new ideas and refinements have been incorporated into theodolites and levels since the remarkable Dr. Wild's death in 1951, the success of his efforts can be seen in virtually every present day theodolite, level, tacheometer and alidade. The story of Heinrich Wild's career is given in detail in Dr. Strasser's article in the Survey Review ("Heinrich Wild's contribution to the development of modern survey instruments", G. J. Strasser, April, 1966).

His main objectives were to reduce the size and weight of the instrument and its container, to provide protection and stability to all parts and to improve operational and reading efficiency. These aims were to be achieved by a simplification of design that would enable the observer to work without superfluous movement, whilst allowing him full control and easy manipulation of all knobs and screws.

It is difficult for a young surveyor to appreciate exactly what was involved in the handling of the classical open theodolite. He is accustomed to a compact, light, easy-to-handle instrument and this bears little resemblance to the vernier model of fifty years ago.

When using a present day theodolite, there is no need at all for the observer to move his position when sighting to a target and then reading the circle values. With Wild's well-known coincidence reading system, the diametrically opposite values of the horizontal and vertical glass circles are meaned by the simple turning of a micrometer knob. This ingenious invention is now taken for granted, but it was not really so very long ago that the "A" and "B" verniers of the metal circles had to be read (with the aid of a magnifying glass) and this involved walking around the instrument after the target had been fine-pointed. The time needed to do this was quite considerable and, of course, the danger of knocking something on the way round was always there, particularly when the set-up was a difficult one on a slope or a rocky outcrop. The booking errors and subsequent meaning errors were also serious drawbacks to this old type of instrument.

In addition to the easier and more accurate circle reading, a modern theodolite can boast of its short, powerful telescope with its coated lenses and internal focussing. This allows much speedier operation, dispenses with the problems caused by having a variable or moving measuring point (which changed with every re-focussing) and provides complete protection for the telescope tube and its contents - a glance at the triangulation theodolite of less than 50 years ago will show how necessary such changes were. The amazing thing is that, even today, it is possible to find manufacturers who still make the old-fashioned open type of instrument and proudly advertise them.

The facility with which adjustments are made also represents a great advance, together with the simple method of testing and correcting the residual collimation errors. The cross or similar pattern that is etched so finely and with mathematical precision on the reticule plate of a modern telescope requires only the minimum of adjustment and the manufacturer's guarantee that the "horizontal" and "vertical" cross hairs are exactly at right angles to each other overcomes the difficulties associated previously with the alignment and setting of real hairs - it was no joke when the hair broke and a new one had to be substituted.

The protection of the footscrews against dust and moisture, together with the smoothness of their run, enables the levelling-up of the instrument to be made much more easily than with the old type of open screw which did not always allow an even, regular movement to be made. It is interesting to note, in passing, that there is still a tendency in some countries to use four footscrews instead of the logical three. It is difficult to understand the reasoning behind this strange relic of antiquated instrumentation. It is so much easier to level up with only three footscrews, the initial pre-levelling being an especially simple procedure. For this, the observer soon masters the technique of centering the circular bubble by means of the virtually simultaneous manipulation of the three screws. This becomes such a routine task that it is almost "automatic" and is completed more or less without thought.

This mention of an unusual means of levelling a theodolite brings to mind a method which has failed to find general approval, the use of a ball and socket fitting for levelling-up an instrument. There are various types and, although they may facilitate slightly faster levelling (even this has been disproved by tests), they certainly go completely against the accepted maxims of instrument design.

Another idea which has received a mixed reception has been the system of "centering above the footscrews". In principle, this is an excellent feature as it can be annoying, on steep slopes particularly, to set up the theodolite, pre-level, centre with the optical plummet and then, after the accurate levelling with the plate level, to find that the instrument is not exactly over the ground mark and needs to be shifted slightly over the tripod head to compensate for the small difference between the approximately vertical line of sight of the optical plummet and the exactly vertical one obtained by the correct levelling of the instrument. By separating the movements so that the instrument slides over the already precisely horizontal levelling head there is no need for the repetitive steps that are needed with standard theodolites. The "above the footscrews" method achieves its purpose but it does so by adding weight and height to the instrument, thus making it slightly top-heavy and losing some of its required stability and rigidity. There is always the tendency for dust and sand to come into contact with the sliding surfaces, which must be plane and smooth for the system to work properly. This may also occur with the ball and socket type of fitting, already mentioned.

To be perfectly fair to all types of instrument, it must be stressed that no existing system is completely satisfactory and there is no doubt at all that the question of developing an efficient but robust system of levelling-up is one of the biggest problems facing instrument manufacturers and it is difficult to visualise a solution that will be completely satisfactory. This may, in fact, be one part of instrument design that will bear the mark of "compromise" for many years to come.

To revert to Dr. Wild's contribution to the changing face of survey instruments and to continue with the items he introduced to the theodolite, mention must be made of the cylindrical axis in place of the classical conical type. This was a great step forward, as there was no need to adjust this new type of axis. The use of glass for the circles was also a milestone in the progress made since the First World War. It is possible to obtain - and retain - the high uniform quality of the circle graduations only when glass is used. The added safeguard of projecting the circle images through the hollow parts of the instrument so that they are seen in a reading microscope placed alongside the telescope, offers the double advantage of improving the simplicity and comfort of reading and also enables the circle housing to be sealed tightly.

It is an accepted feature nowadays to have the plate level placed centrally between the standards, so that it will not run-off rapidly when the alidade is rotated. This was not always so, however, and it was in 1923 that such a positioning of the plate level was first made - when the T2 made its appearance. Some time before that Dr. Wild made the first use of his famous split-bubble system, in which the two ends of a spirit bubble are projected through a system of prisms so that they are viewed simultaneously.

Other important features which distinguish modern theodolites from their earlier counterparts are the more or less general use of the optical plummet and the various devices for ensuring forced-centring interchangeability between theodolites and their auxiliary equipment, such as traverse targets, subtense bars and the many accessories that are used to aid the surveyor. The optical plummet is a most popular feature of a theodolite, provides an excellent functional service and is infinitely preferable to the plumb bob, which has a tendency to sway, especially in windy conditions. The use of a plumbing or centring rod is another device that is finding more support amongst some surveyors, particularly when working in broken and sloping ground. The majority of surveyors, however, seem to prefer the optical plummet and this device is suitable in most situations.

The interchangeability of instruments and accessories is a comparatively new innovation and there is no doubt that this facility has revolutionised the art of traversing. Whereas it was necessary previously to plumb the instrument or a target over each traverse point at each and every change of instrument station, it is now commonplace to use the forced-centring three tripod system. After observing, for example, from station 2 to targets set up in tribrachs in tripods at stations 1 and 3, respectively, the surveyor releases the theodolite from tribrach number 2 and walks forward with it to station 3. Here the assistant releases the target and the surveyor replaces it with the theodolite. As the tribrach remains locked to the tripod, the instrument takes up exactly the same position that the target had done originally. In the same way, target 1 is set up in the tribrach at station 2 and the original tripod number 1 plus the target from 3, are carried forward and set up at station 4. Work progresses in this way, with the theodolite and the targets always progressing forwards by one station at a time and the rear tripod and tribrach being leap-frogged forward. Additional speed and convenience can be obtained by using an extra tripod and tribrach. One big advantage of this system is that there is no need to mark each station on the ground. As the instrument or target or subtense bar is always positioned over exactly the same point the traverse measurements and calculations can be made without permanent marks being placed and it is only at the stations that are to be used for future work that pins need be placed.

With regard to the form that the forced centring device should take there is little doubt that the best method is the three stud system, in which the three receptive holes in the tribrach match the studs on the bottom of the theodolite. The fit is perfect and provides for complete and absolutely safe interchangeability between the instrument and its accessories.

The most striking differences between new and old theodolites are in the basic dimensions of the instruments and their containers. The neat, compact and robust models of today are far more convenient than the cumbersome open type of single second theodolite, which weighed 24 lbs. and was packed in a wooden box with the same weight. The T2 weighs only 12 lbs. and is carried in a strong metal container, weighing 5 lbs. - a total of 17 lbs. as compared with the previous 48 lbs.

The changes that have been made to levels are equally impressive. A level's accuracy was once judged in terms of the length of its telescope - the longer it was, the better it was! All of the bad features that existed in the open theodolite were present also in the open type level - and all have been corrected in more or less similar ways. Telescopes now have coated lenses and internal focussing arrangements. The axes are cylindrical and the footscrews protected and adjustable. Cross-hairs are etched on the reticule plate and collimation errors are simple to adjust. There is no longer any need to remove the telescope from its "Wye" standards in order to reverse its position as a means of making collimation test measurements. Simple techniques have been evolved for such tests and, with the Wild N2 level, provision is made for the telescope to rotate about its longitudinal axis, thus allowing staff readings to be made in two "face" positions, for easy checking.

Apart from the constructional alterations, however, which have been made in keeping with the parallel changes in theodolites, the most important improvement in spirit levels has been the introduction of the split-bubble coincidence system. No matter how sensitive a spirit bubble may be it is impossible to "centre" it unaided more accurately than to one fifth of the normal 2mm division on the vial. With a split bubble system, however, in which the observer sees the two ends of the bubble side by side and has to bring them into coincidence so as to form a smooth, regular curve, it is possible to make an 8x improvement in this setting accuracy. With the N3 level, the sensitivity of the tubular bubble is 10" per 2 mm. By means of the split bubble viewing system the line of sight can be levelled up (using the tilting screw until coincidence of the bubble ends is obtained) to within the equivalent of one fortieth (one eighth of one fifth) of the 2mm division - i.e. one fortieth of 10", which is one quarter of the second. If such a split bubble device is not incorporated in the instrument it will be possible to reach this high degree of accuracy only by increasing the sensitivity of the bubble. This would mean a bubble with a sensitivity of about 1 1/4" per 2mm. Not only is this more difficult to produce but it also takes much longer to centre, as each movement of the tilting screw produces a correspondingly larger movement of the bubble.

There is, however, no point in increasing the sensitivity of a level, and the precision with which it can be levelled-up, if the observer is still obliged to estimate staff divisions beyond the usual 0.01 ft. graduations. For this reason instruments such as the N3 make use of a parallel plate micrometer. After the line of sight has been made absolutely horizontal, it is unlikely that the "horizontal cross-hair" will be seen at an exact staff graduation line and it will be necessary to estimate the portion of an interval by which the hair is displaced from the graduation. With a metric staff the graduation is usually in centimetres, so estimation will be to the nearest millimetre and with a foot staff the graduation is usually in hundredths of a foot, with estimation to a thousandth. By activating the N3's parallel plate, by means of the micrometer knob, the horizontal line of sight can be displaced slightly above or below, but always parallel to itself. If the knob is turned until the cross-hair is set to an exact staff graduation the combined sum of this staff value plus the reading on the micrometer scale will give the required staff value for the pointing. With the metric model of the micrometer, readings can be made in this way to the nearest hundredth of a millimetre, as compared with the estimation to a millimetre without the micrometer. The foot model allows direct reading on its scale to 0.0001 ft. (which is the graduation interval) and estimation can be made to half an interval. If the utmost precision is to be obtained from a first order level, it is quite pointless to use a wooden staff, which is subject to significant changes because of varying temperatures and humidities.

To overcome this difficulty it is essential that observations with a precision level should be made to invar staves. The upper end of the invar strip is connected to the staff by means of a tension spring, which absorbs any small changes in the length of the frame, so that the strip always retains the same overall length. The co-efficient of linear expansion of the invar is virtually nil, so that the individual graduations on the strip always retain the same absolute positions.

It is easier to "straddle" a line graduation with a wedge-shaped cross-hair than it is to set a single hair on to the normal type of staff graduation. The wedge is set so that its limbs are symmetrical about the line graduation and, if preferred, this setting can be made so that the wedge lines are tangential to the rounded ends. Experience has shown that it is easier, and more accurate, for the observer to use this method of straddling a definite mark than it is for him to set a single line (which is black) to the almost imaginary division between a white section and a black section of an ordinary staff.

The overall precision that can be obtained when using the wedge-shaped reticule lines of the N3 to straddle the line graduations of the PNL invar staves is so high that levelling of this order becomes almost free from error. In one mile of double run levelling the attainable m.s.e. is $\pm$ 0.0008 ft. (or $\pm$ 0.2 mm in one kilometre) - about one hundredth of an inch. Clark quotes figures for the English Geodetic Levelling (1912 - 21) of a maximum closing error of 0.4771 ft. in a perimeter of 290 miles and the smallest of 0.0073 ft. in a perimeter of 60 miles. The m.s.e. of $\pm$ 0.0008 ft. per mile is equivalent to $\pm$ 0.0008 $\sqrt{290}$ and $\pm$ 0.0008 $\sqrt{60}$ feet, respectively, for these two circuits - i.e. $\pm$ 0.0135 feet (as compared with 0.4771) and $\pm$ 0.0062 feet (as compared with 0.0073). These figures relate to the attainable m.s.e., of course, and the actual results could be up to three times these amounts - with the likelihood, however, that they would be within the limits given. If the 290 miles circuit is taken as a fair example, then the 0.4771 feet misclosure actually obtained about 50 years ago and the $\pm$ 0.0135 feet that the modern precision level can give indicates the enormous progress that has been made in the construction of levels and their auxiliary equipment.

Whilst the almost incredible accuracy of the large, powerful levels represents a standard that is essential for primary work or for the increasingly high demands of industry and constructional engineering, it is not always needed and, in many fields of use, the observer prefers speed to absolute precision. For such a user, the automatic level, with some form of compensating device to ensure that the line of sight is always horizontal, is the solution to his problems. The saving in time that is made with an automatic level is rewarding in itself, but the added security given to the observer, as he no longer has to centre a tubular level bubble, enables work to proceed with considerably less mental strain in addition to the reduction in eye fatigue.

An increase in attainable m.s.e. is normal with all automatic levels, which are now accepted as being capable of more precise work than classical levels in their own class. For the observer who wants speed of operation combined with almost geodetic accuracies, it is now possible to attach a parallel plate micrometer to the objective end of the NA2 and to obtain results only a little below those obtainable with the larger instrument.

A similar saving in time, combined with a convenient dispensing of one of the easily forgotten tasks of theodolite surveying, is obtained by using a theodolite with an automatic vertical index. Whenever vertical angles are read it is essential that the index be set to read 90° with horizontal sights. It would be interesting to find out just how many times in his career the average surveyor fails to use the index setting screw when reading a vertical angle! The use of a liquid compensator, through which the circle image is seen, provides an ingenious solution to this important problem. After the instrument has been levelled up, there is no further index setting required. The vertical circle image is viewed, therefore, after it passes through the equivalent of an optical wedge, formed by the liquid. The circle reading is the required value automatically compensated by the elimination of the index setting error. Other instruments successfully employ pendulum type compensators.

To revert to the modern level, the improvements in design and operator comfort have not been restricted to the larger and very precise instruments used for high order work. The trend, in fact, has almost revolutionised the appearance of the small level, which is now a compact, robust and light instrument. For everyday levelling tasks the engineer has a wide choice of dumpy and engineers' levels, with or without a horizontal circle, and he now has the most useful alternative of having a telescope giving either an inverted image or an upright image. The high quality of modern lenses makes it possible for the optics required to produce an upright image to be added to the telescope without causing any lowering in performance. The same facility is also available for many types of theodolite. To the engineer who uses his instrument occasionally and who is unaccustomed to the traditional inverted image the erecting eyepiece is a great boon.

Another innovation that should be mentioned is the widespread use of a friction-braked action, which has replaced the horizontal clamp in many levels - particularly in the smaller, builders' type and in the automatic models. The action is adequate to hold the instrument from unwanted movement and it is possible to make slow motion settings, as the horizontal tangent screw is still included in the design.

A new feature which has made an appearance in the Wild range of levels is the incorporation of a directional arrow in the "split-bubble". When the tilt of the level is such that the ends of the bubble are out of the field of view an arrow appears indicating in which direction the tilting screw has to be turned. This almost ridiculously simple idea, it could be called a gimmick, is a great time saver.

Two similar points need mentioning here, although they are actually incorporated into theodolites instead of levels. Both are simple ideas that do nothing to increase the accuracy of the instrument but merely provide a time-saving and a convenient aid. The first is once more a simple arrow on the telescope focussing sleeve, indicating the direction of turning to obtain focussing to infinity (there being an infinity sign, ∞, also). This, by implication, shows how to turn the sleeve for longer sights, with a turn in the opposite direction helping to focus down to the shortest distances. The second is an improved version of the change-over or inverter knob - the device whereby the observer switches over to viewing either the vertical or the horizontal circle when using an instrument of the T2 or T3 type. Until now, the knob has had a line engraved in it - when the line was horizontal it was the horizontal circle that was being read and, when vertical, it was the vertical circle. To avoid confusion, particularly at night, this knob is now made with a raised bar on it, so that the circle in use may be identified by touch.

The trend in the past 40 to 50 years has been to reduce the weight and size of levels and theodolites, to improve their basic design and to make them easier to use and maintain. These objectives have all been attained and there has been no lowering in the precision of the instruments - quite the reverse in fact. This face changing has not been restricted to the appearance and performance of the classical type of instrument, however. Developments just as startling have been made in the auxiliary equipment used with the theodolite and level and many completely independent instruments are now available.

The optical plummet, for example, which is itself an innovation to the theodolite, has already progressed to the status of being an instrument in its own right. With a powerful telescope and a changeover prism allowing either upward or downward sighting the plummet can be centred accurately above or below a mark well beyond the very limited range of the device built into a theodolite. The device can then be removed from its tribrach and a theodolite set up in its place, without any loss of centring accuracy. The advantages of such a system are enormous and can be put to good use when observations on a survey tower are required or for building purposes, when it is essential that the construction lines are absolutely vertical - to quote two examples.

For more limited ranges it is possible to mount an optical plummet to the telescope housing in order to plumb beneath a roof mark (or to place such a point). A similar attachment, only this time a split bubble level device, enables an ordinary theodolite to be used as a tilting level. The vertical tangent screw is manipulated until the ends of the split bubble are in coincidence, which indicates that the telescope itself is absolutely horizontal.

Another device that can be used for plumbing purposes, although its main use is the transfer of bearings from one mine level to another, is the objective pentaprism. This merely clamps over the objective end of the theodolite telescope, with a counterweight at the eyepiece end, and its rotational housing provides a line of sight in a plane perpendicular to the telescope direction. The use of such an attachment naturally calls for special observational techniques but it is not difficult to imagine the convenience of establishing a line of sight and then, with the horizontal and vertical movements of the theodolite clamped, diverting that line of sight either upwards or downwards, as required. It is possible to plumb with an accuracy of 1/70,000 with a pentaprism of this type, although care has to be taken to eliminate the inevitable eccentricity between the instrumental axis and the deflection axis of the prism itself.

A wide variety of gadgets are available from all instrument manufacturers for use in astronomical work. These consist of eyepiece prisms and diagonal eyepieces to enable steep pointings to be made (and the circles to be read), by deflecting the line of sight to the observer's eye so that he can stay in a comfortable viewing position, together with various attachments with which observations or readings are actually made. These are items such as a prismatic astrolabe attachment, the Roelofs solar prism and the Horrebow and Striding Levels. Of these, the Roelofs prism is the most interesting. Fitting over the objective end of the theodolite, it produces four overlapping images of the sun, leaving a small diamond-shaped gap in the middle. As the prism has a built-in sun filter, it is possible to sight directly to the centre of the sun and to use the reticule cross-hairs to bisect the gap between the four images. This makes sun observations as easy as those to stars and, of course, the subsequent calculations are less complicated than when the sun is sighted by setting the cross-hair to each edge in turn. This involves the reduction of the observations to the sun's centre which, in itself, is a lengthy procedure liable to computing errors. The solar prism eliminates the hardship from solar observations, improves their accuracy and simplifies the office drudgery previously associated with this type of work. The added attraction that sighting is now direct, instead of slightly eccentric as with earlier models of the prism, makes this little attachment even more attractive.

For simple magnetic orientation a tubular compass can be screwed to the right hand standard. By a "split bubble" coincidence setting arrangement the two ends of the magnetic needle can be viewed simultaneously but only when the alidade has been rotated so that the telescope is pointing towards the Magnetic North will the two ends be viewed in coincidence. This is a very easy way to establish a single magnetic setting for the horizontal circle but, if it is intended to take independent compass bearings for each target pointing during a round of angles, it is necessary to use a circular compass. This rests on a bridge which fits on the theodolite standards which have to be modified slightly by the addition of a fixing bracket. This bracket has two holds into which the stud-like legs of the compass bridge fit, the other legs straddling the opposite standard. The circular compass is attached when required and a reading is made each time a target is sighted through the theodolite telescope. With each type of compass attachment, the needle is lowered to its pivot only when released by the observer - thus avoiding unnecessary damage to the pivot point. Neither type can be used with an all steel instrument, such as the Wild T2.

Other theodolite attachments which have provided new facilities recently, are the parallel plate micrometer and the autocollimation eyepiece. Similar in design and function to the parallel plate used with precision levels, the theodolite attachment is intended for use in industry for the accurate measurement of small lateral shifts parallel to the line of sight. An interesting feature of the new Wild model is that the attachment may be put on in three pre-set grooved positions - to measure shifts parallel to the horizontal line of sight, or parallel to the vertical line of sight, or at 45° inclined angle from the horizontal. It is also possible to hand set the inclination at 10° intervals, by reference to a graduated ring.

The autocollimation eyepiece is also intended mainly for industrial use and its applications include many types of alignment and measuring problems. The ordinary bayonet-type eyepiece is removed and replaced by the auto-collimation eyepiece, which is connected to a battery box as a power source for illuminating the reticule. By means of a beam splitter positioned between the eyepieces and the reticule it is possible to view not only the reticule cross itself but also an inverted mirror image of the cross, as reflected from a plane mirror placed in front of the objective.

If the telescope is focussed to infinity and if the plane mirror is at right angles to the line of sight, the real reticule and its inverted, mirror image will unite symmetrically at the focal point in the plane of the reticule plate. This simple device has had a big impact in the interesting field of industrial surveying, where it has solved many problems connected with accurate positioning and alignment. It is also possible to build in a beamsplitter between the objective lens and the reticule plate. A second reticule plate is then fixed to one side of the telescope, parallel to its axis, in such a way that it lies in the focal plane and its image meets the mirror, together with the line of sight of the telescope. The second reticule has a negative cross, i.e., a translucent cross in an opaque setting, and this is illuminated by an outside lamp. The final image produced by this arrangement is of the reflection of the illuminated cross on the original reticule plate cross. The contrast permits easy viewing and facilitates the bringing into coincidence of the two crosses, which is achieved only when the telescope is aligned exactly at right angles to the mirror. This second arrangement is more convenient, especially as there is a complete absence of outside light; which can be disturbing, but the telescope has to be fitted at the manufacturing stage with two precisely adjusted reticule plates. The first system is easily fitted as it is merely a question of exchanging the bayonet type eyepieces.

For optical distance measurement there are several possibilities, which really narrow down to two principles - observation to a vertical staff or to a horizontal staff. "Normal" tacheometric work, using the stadia hairs of the theodolite, is well-known and understood by all surveyors and engineers and does not call for any description. There are, however, some interesting variations on this theme and they are worth discussing, as this field is one of great importance.

The distance measuring wedge (or double image prism) is clamped to the objective end of the theodolite telescope, with a counterweight at the eyepiece end to restore the balance. This wedge produces a parallactic angle, equivalent to the popular tacheometric multiplication constant of 100. As only part of the objective is covered by the glass wedge, a direct view of the special horizontal staff is obtained, together with the deflected view caused by the wedge. The intercept out on the staff is equivalent to 1/100 the slope distance between instrument and staff. The reading system is simple and, as the rays forming the distance measuring angle are at the same height, they pass through the same atmospheric layers, thus minimising the effect of differential refraction which is one of the big advantages of any distance measurement to a horizontal staff. At 100 yards an accuracy of 1/10,000 can be expected with such an attachment (about a third of an inch). For traverse work in congested areas, where taping is inconvenient, it has the advantage that distance and angle measurements can be made at one set-up. It is possible to obtain distances reduced to the horizontal by extending this system to make use of a pair of prisms, which, by rotational movement controlled by the tilt of the telescope, change the deflection angle so that the intercept is reduced to its "slope distance" value multiplied by the cosine of the angle of slope.

Also working with a horizontal target is the subtense bar method of distance measurement. This is an old method, involving the accurate measurement of the angle subtended at the theodolite by two points on the subtense bar which are spaced at an exactly calibrated interval. Instead of having a fixed parallactic angle giving a constant factor of 100 and measuring the intercept cut by this angle, the subtense bar works more or less in reverse and has a constant intercept (usually 2 metres) and a variable parallactic angle that needs to be measured. One very convenient feature of this old and trusted system is that the result (obtained by converting the angle subtended by the subtense bar into the distance from instrument to bar) is already reduced to the horizontal. Although old in principle there has also been a big face change given to the subtense bar and a modern version will be expected to have the interval between its carefully designed and easily observed aiming marks, rigidly controlled by means of an invar wire kept in tension by a coil spring. It will also have a levelling-up bubble, a sighting device so that the staffman can direct the bar towards the observer and a collimating device enabling the observer to check for himself that the bar is set up correctly. Fitting, with forced centring, into a tribrach it will also be fully interchangeable with the theodolite and other ancillary equipment that might be necessary for the survey in question - thus ensuring that every possible means of getting accurate results is used.

The theodolite itself has been redesigned by many manufacturers in order to make it more suitable for optical distance and height measurements. The main trend has been towards the development of self-reducing tacheometers using a vertical staff, although a few makers have produced instruments that use the horizontal staff principle. These double image self-reducing tacheometers have become very popular on the European continent, particularly for use in cadastral survey. The regulations of many survey departments do not allow such instruments to be used for cadastral surveys, although there are many non-title tasks that can be performed most efficiently with a double image tacheometer. Similar to the distance measuring wedge attachment already described, a prism system is built into the telescope. Whilst producing a double image of the special horizontal staff (one direct and one deflected in the relationship of 100 to 1) the prisms can rotate in opposite directions, proportional to the angle of slope of the line of sight. This proportional rotation reduces the staff intercept in such a way that the readings obtained are the required ones - namely distances reduced to the horizontal. Vernier settings of the staff graduation images, controlled by a micrometer drum, give readings to centimetres. The precision of these double image tacheometers is of the order of about 1:10,000 at a distance of 100 yards. The Wild RDH model has the added facility of a changeover device enabling height differences to be measured in a similar way.

For the average type of tacheometric survey, however, the high precision obtained from such an instrument rarely justifies the additional weight and the extra organisation required in the field. Observations to a horizontal staff are always much more accurate but it is much easier for the staffman to hold a staff vertically by hand than it is to set up a bar horizontally and to direct it so that it is at right angles to the line of sight. For this reason it is the self reducing tacheometer for use with a vertical staff that has become really popular in recent years and, without doubt, this type of instrument has done more to remove everyday drudgery from a normal survey task than any other piece of equipment.

It is unnecessary to embark on the rather lengthy description of classical stadia line tacheometry (the expression "old-fashioned" is a valid one) but it is easy to appreciate how much easier this work has been made by the development of a modern self-reducing tacheometer. In an instrument such as the Wild RDS the stadia lines have been replaced by flat curves, which are etched on a plate mounted in the diagram housing on the right hand standard of the tacheometer, which is actually a modified version of the T16 theodolite. These curves are designed to take into account the tacheometric formulae - i.e. the staff intercept multiplied by 100 $\cos^2 B$ and 100 $\cos B . \sin B$ for the reduced horizontal distance and the vertical interval, respectively. When sighting a vertical staff the telescope field of view shows the image of the staff, which is projected to the diagram curve plate, from which a combined image is projected through a system of prisms and lenses onto the reticule plate, which itself has only a vertical "cross-hair". The angle at which the telescope is inclined, B, dictates the portion of the diagram curve that is viewed and the spacing is such that the appropriate corrections are always made so that the intercepts give the required, reduced values.

The observer actually sees three curves. The lowest of these is almost straight and is referred to as the Base or Zero Curve. The top curve is also very flat and is known as the Distance Reading Curve. Irrespective of the angle of slope the intercept cut by these two curves represents one-hundredth the reduced horizontal distance. Between these curves the Height Reading Curve is seen and against it there is a simple factor. There are actually several of these height curves, each with its own factor and, as the telescope is tilted progressively steeper, it will be seen that one curve will "run off" and that another will take its place. The function of these curves is similar to that of the distance curve. If the intercept cut by the base curve and the height curve is multiplied by 100 and again by the simple factor that appears on the curve, the result gives the vertical interval between the instrument axis and the point on the staff read by the zero curve. As the factors are $\pm$ 0.1, 0.2, ½ and 1, respectively, it will be realised that this involves virtually no calculation at all and that the field work and office work are already reduced considerably by such a system.

This is not the end of the story, however. As the same result is obtained irrespective of the telescope's angle of slope it is logical that a further saving can be made by setting the base curve to a convenient staff reading - with a foot staff, 5 feet would probably be a suitable value. In this way the two intercept subtractions are simplified and the "height of target" portion of the final calculation is also made easier. Unlike the alternative methods described for stadia hair tacheometry, only one pointing to the staff is needed, however, and after setting the base curve to a suitable value all that is required in the field is to read the distance and height curves and to book the values, together with height curve factor. The subsequent office work is almost nil. It is reduced even further by the final refinement that makes tacheometry almost foolproof. By setting the base curve to a value such as 5 feet, the subtraction is simplified but, to eliminate all subtractions completely, a setting to zero would be required. This would normally be impossible and, in fact, undesirable. It is rarely possible to see to the bottom of a vertical staff and the influence of the rapidly changing refractive layers close to the ground would cause serious inaccuracies in the results. A special staff, however, overcomes this problem by having its zero mark three feet above the bottom of the staff and, in addition, it has an extendable leg which enables the main staff to be raised until the zero mark is the same height above ground level as the instrument is above the ground. At each instrument station the observer calls out the height of instrument to the staffman (or staffmen, if additional speed is required) who merely "jacks up" the staff until the correct height is reached. This is done in a matter of seconds. The extension leg slides along a notched guide rail and is clamped in position at the required value.

Everything is now simplified to the extreme and observations are made under the best possible conditions for vertical staff work, as the lowest measuring ray is to a point on the staff that is about 5 feet above the ground. The sequence, after levelling up the instrument and adjusting the staff height, is to set the base curve to the staff zero mark and to read the distance and height curves and the height factor. This is followed by no subtractions at all! As the base curve is on 0.0 the other readings are directly equivalent to the intercepts. The vertical interval (obtained as height curve reading x 100 x factor) is already the required height difference between instrument and target stations, as the height of instrument has already been equaled to the height of target. Not only is the field work reduced to a minimum but the subsequent office work also disappears almost completely.

This principle has been incorporated in the latest version of what many people misguidedly consider to be an out-dated instrument that should be relegated to the status of a museum-piece - namely the plane table alidade. Memories of almost back-breaking days spent bending over a plane table, cutting in control points and items of detail may be rather painful to the surveyor of only a few years back but most, if not all, of the unpleasantness associated with planetabling has now been eliminated.

With a diagram similarto the RDS's, the RK1 self-reducing alidade enables the observer to measure reduced horizontal distance and the vertical interval in the minimum of time and with virtually no calculations. If the same type of staff with extendable leg is used, the height of staff target can be made equal to the instrument height, thus giving direct height differences between station and target ground levels. The observation is made through a powerful telescope, with the added advantage of a rotatable eyepiece inclined at 45^{o} to the line of sight - a major feature in easing the physical discomfort of this type of survey. The mental strain is reduced by the simplicity of reading and the lack of computations. After sighting the target staff, and this is also made easier by means of a slow motion swivel-action knob for the fine-pointing, the readings are made in the same way as with the self-reducing tacheometer and the parallel plotting arm is shifted sideways so that it passes through the plotted position of the instrument station. This arm holds a plotting scale which is then slid in its groove until the value of the measured distance is against the station point. The fine pricker at the distance zero mark is then depressed - giving a sharply defined, unique position for the point of detail to which the observation has been made. This dispenses with the former requirement of drawing a line to the point in question and then fixing it either by cutting it in with one or two more rays from other parts of the board or by scaling off the distance, if it was known, using a boxwood scale and a pair of dividers (which eventually reduced the paper surface to a series of large and often irregularly-shaped holes). To be able to mark each point with a single, fine hole, using one of the interchangeable plotting scales, improves both the speed and accuracy of the work. After fixing the position, the elevation can be written alongside it - the sighting, the measurements and the plotting being done more or less at the same time, with the plan building up as the field work progresses. When the target point is inaccessible or beyond the range for normal staff observation the alidade can be used for classical plane-tabling, with the great advantage of having a powerfully magnified image, plus a vertical circle that can be read in the telescope's field of view. In the Face Right position there are no self-reducing curves but, instead, ordinary fixed interval stadia circles, with a 200 multiplication constant, allowing readings to be made to a vertical staff far beyond the normal limit.

With the availability of such self reducing alidades, plane tabling has taken on a new lease of life and is finding increasing popularity in large scale work, such as road reconnaissance surveys and the revision or completion of plans. Maps produced by aerial survey methods, using photogrammetric plotting machines, always need a field completion survey to fill in the gaps that cannot be "seen" in the stereo models. By taking a paper print from the machine plot, pinning it or taping it to the plane table board and by setting up over one of the many points already plotted, using other plotted detail for orientation, the gaps can be filled in on the spot, with excellent opportunities for the checking of other features. As an educational means the plane table is ideal, as the student can do his work by more or less any of the normal survey methods and can see the results of his efforts building-up graphically on the board. Using a modern alidade he has even greater possibilities of doing good work, thereby making it easier for him to understand the principles of survey techniques.

Considerable time and space has been devoted to a discussion on the old and new methods used for the optical measurement of distances and, of course, there are other devices that have already appeared on the market for use over relatively short "tacheometric" distances. These include the "code theodolite" type of instrument designed to give an automatic readout which the observer does not have to book down in the field.

The idea behind this is to photograph the circles and their positions when pointing to the targets of a special type of subtense bar. As yet these instruments are difficult to justify as their cost, plus very expensive ancillary equipment, is too high and the organisational procedure too elaborate to be considered by the normal individual or even a large department. As the circles are not numbered in a conventional manner but are symbolised (to give the "code") the photographs, after developing and printing, have to be fed into a special reader for de-coding and the results, in punched tape or card form, must then be processed through an electronic computer for the bearing and distance (and possibly the height difference) to be calculated. The overall expense of the equipment and manpower involved is naturally very high and, as already stated, is beyond the limits of the average surveyor or organisation. Additional criticism of this type of equipment is that the surveyor cannot "talk back" to his ingeneous code theodolite and is unable to lay off an angle or distance with it, as there is no way of giving reciprocal instructions. The Breithaupt digital theodolite uses a pick-off device but this is used for horizontal circle readings only, as it would require a second rather bulky cylinder for the vertical readings.

The various descriptions and comments that have been given cover most aspects of the ways in which conventional survey instruments have changed face in recent years. It would be quite wrong, however, to conclude without mentioning other recent developments which have certainly given a new look to survey instrumentation and methods, but which are independent items in their own right. All surveyors are familiar with the electronic distance measuring devices of the Tellurometer and Geodimeter varieties - the former a micro-wave instrument and the latter an electro-optical one. Although the two types of systems differ to the extent that, in one, a radio micro-wave is transmitted and in the other a light wave, there is similarity in the measuring principles in that both use reflectors (either active or passive) to return the modulated wave from the "remote" to the "master" stations and that the distance is obtained by reference to the travelling speed of the wave and the actual time elapsing between the transmission and return of the signal. This time interval is measured in different ways by the various makes of equipment but invariably involves the measurement of phase shift. In the case of the Distomat, a built-in computer converts the interval into a fully digitalised distance which is displayed in a read-out window, without any partial results to be booked and combined. Experiments are now being made using lasers as a means of providing accurate distance measurements, but as yet, the art has not been mastered sufficiently for consideration as a practical survey method. The "Tellurometer and Geodimeter" types of equipment however, have long been accepted as survey tools and the many different makes on the market have already contributed a great service to the engineer and the surveyor. Without doubt these instruments will continue to be improved, but they are already at the worthwhile limit of their practical accuracy, as it is impossible to measure the atmospheric conditions with anything like the same precision as the basic distance, with the result that an inadequate correction for refraction is made.

Another new device is the gyro attachment, which is mounted on a special holding bridge which, in turn, is fixed to the standards of an ordinary theodolite. This light-weight attachment has a small gyro motor, which is suspended from a thin, wire band and which runs at 22,000 r.p.m. The combined action of gravity and the horizontal component of the earth's rotation pulls the gyro out of its initial random spinning plane in space and creates a reaction which results in the gyro's spin axis taking up an oscillating position in the meridian plane. By means of cleverly devised observing methods it is possible to find the middle of these oscillation movements and, thereby, to establish the direction of True North. As the gyro is not affected by magnetic anomalies it is possible to use the attachment more or less anywhere (except close to the Poles) and at any time of the day or night. In 20 minutes of working time an orientation is obtained to the True North, with a m.s.e. within $\pm$ 30 seconds of arc. This development has great possibilities, especially for use underground in the mining industry.

In conclusion, a brief mention of future trends would not be out of place. Amazing improvements are already being made in other fields where the latest electronic and laser devices are making reading and operational conditions easier and more accurate. Exactly how these ideas and developments will be applied to our conventional survey equipment or to the design of entirely new instruments is difficult to forecast. The time will come, no doubt, when all surveying will be of a fully-automatic push button , digitalised read out form and the operator will become more of an electronic technician than anything else. For the time being, it is possible to reflect on the fact that modern design has already made great progress in changing the face of survey instruments and that these changes have all been of great benefit to the surveying and engineering professions. At the same time it is comforting to know that whatever further advances are made and however "automatic" we may become, it is difficult to visualise a peg or other marker being positioned in any other way than by the field man himself, who will continue (we hope) to set up his own equipment himself.

Let us therefore, accept all that the designers have in store for us and content ourselves with the satisfying knowledge that, as always in the past, the intention is not to replace the instrument man but merely to assist him.

Reprinted from June,1969 issue of
North Point, Volume 6,Number 2.-

- EVENTS AND PERSONALITIES -

From Bert Robertson we hear that the Dept. of Lands & Forests have been busy this season increasing the density of control monuments in Cape Breton County.

While down in the Valley the Geodetic Survey of Canada have been increasing the 1st order control.

A troop of military surveyors from 13 Field Survey Squadron of 42 Survey Engineer Regiment, Royal Engineers, have been carrying out survey tasks in Nova Scotia in cooperation with the Surveys and Mapping Branch of the Department of Energy, Mines and Resources during the spring and summer of 1969.

Tasks allotted to the Troop included (1) the provision of mapping control for eight 1:25,000 photo maps in Annapolis County, (2) observing a trilateration net in an area between Halifax, Greenwood and Liverpool and (3) increasing the density of vertical control in the latter area by spirit levelling.

Our Secretary-Treasurer, Ed Rice, has been transferred to the Port Hawkesbury office of Maritime Tel & Tel for a few months.

We also hear that Peter Dodge has married and that he and his bride have left for the United States.

Down on the Southwestern shore Bob Sarty is having built "the finest 37' sloop on the Eastern seaboard", so says Elliott Whitby, her designer.

Our best wishes go out to Donald Eldridge, for many years associated with the George Eddy Company, who has recently been appointed Managing Director of the Forest Products Association and has moved their office to Truro.

Our President, Roy A. Dunbrack, after spending more than ten years with the City of Halifax as Chief Surveyor, has joined the firm of W. E. Servant Surveying Limited.

Ivan P. MacDonald has left the Legal Surveys Division of the Federal Surveys and Mapping Branch to return to Nova Scotia as Surveyor-in-Charge of the Province's Department of Lands & Forests Co-ordinated Survey Section.

Fred Roberts has recently been appointed to the post of Supervisor of the Surveying & Drafting Section of the City of Halifax.

Fred Newberry has recently been appointed Chief Surveyor for the City of Halifax.

Barry Hebb and Wm. Thompson have recently joined the Survey Section of the City of Halifax.

Murray Banks has joined the Engineering Dept. of the City of Dartmouth as surveyor after spending five years with the Iron Ore Co. of Canada in Shefferville, Que.

Clark Beattie, a 1969 graduate of U. N. B., has joined the Dept. of Lands & Forests as survey engineer.

Garnet Clarke has left Atlantic Survey Ltd. to join the Dept. of Lands & Forests and is engaged with the field operations of the Provincial Control Surveys.

Victor Comeau has joined the Dept. of Lands & Forests and is working out of the St. Peters office as district surveyor.

Brian Cameron, a 1968 graduate of the Nova Scotia Land Survey Institute, has been admitted to the Association of N. S. Land Surveyors after serving as Surveyor-in-training with the Dept. of Lands & Forests surveyors.

Grant Bowman is another recent graduate who has completed articles with the Dept. of Lands & Forests surveyors.

Marcelin Chiasson has returned to the Assessment Dept. at Port Hood after a year's leave of absence which he spent as a surveyor-in-training with Walter Servant. Marcelin successfully completed his examinations and has been admitted to the Association of Nova Scotia Land Surveyors.

Russell Atkinson, after serving a year as surveyor-in-training with J. D. McKenzie and Walter Servant, has returned to Canadian-British Engineering Consultants Ltd. and since has been accepted as a member of the Association

A D V A N C E   N O T I C E ! !

April 14th to 18th, 1970

at the

Hotel Nova Scotian - Halifax, N. S.

63rd ANNUAL MEETING of the
CANADIAN INSTITUTE OF SURVEYING

* *

NOTE THE DATE! This will be only the second time in over Sixty years that the Annual Meeting of the Institute has been held outside of Ottawa. It will be a wonderful opportunity to see, hear and meet the leaders in our profession. For eighteen months, the 1970 Convention Committee, under J. E. R. March as Chairman, has been working hard, if quietly, and now has ready a tentative program that promises to be one of the best ever. The Papers Committee, under Dr. Gottfried Konecny of U.N.B. has assembled a comprehensive and interesting assortment of qualified authorities who will speak on a wide range of subjects under the general program theme, "Integrated Surveying and Mapping". There will be five main sessions, dealing with (1) Control surveys, (2) Mapping, (3) Technical sessions, (4) Legal surveys, and (5) Hydrographic surveys.

There will be a Newfoundland Day, a New Brunswick Day and a Nova Scotia Day, with a daily Chairman from each province in charge for that day.

Judging from the enthusiasm and interest that is already being expressed in various parts of the country and in New England, it could be a wise move to make an advance registration. We are expecting approximately 1000 delegates, with sixty rooms already booked by the New Englanders.

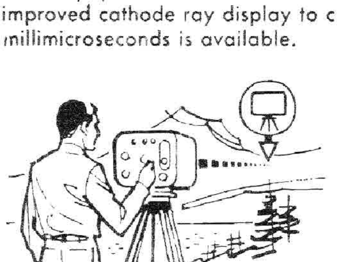
Watch for the tentative programme in the next issue of the Nova Scotia Surveyor.

the NEW MRA3

MICRO-DISTANCER

an all new completely transistorized compact microwave system for precise distance measurement—with built-in battery and direct readout in centimetres

The new MRA3 Micro-Distancer is the latest development of Dr. T. L. Wadley, and the laboratories which created the original "Tellurometer". The MRA3 is complete in one package — no extra power supplies, batteries or other excess equipment to carry around. The MRA3 provides improved accuracy (within 2 centimetres at short distance), either phase resolver (digital) display or an improved cathode ray display to customer's choice; also readout either directly in centimetres or in millimicroseconds is available.



FEATURES:

- Accuracy 2 centimetres: 3 parts per million.
- Measures 100 metres or less to over 60 kilometres day or night.
- Weighs only 34 lbs. with built-in rechargeable nickle-cadmium battery.
- Only 3 main operating controls.
- Plug-in circuit cards and modular construction throughout.
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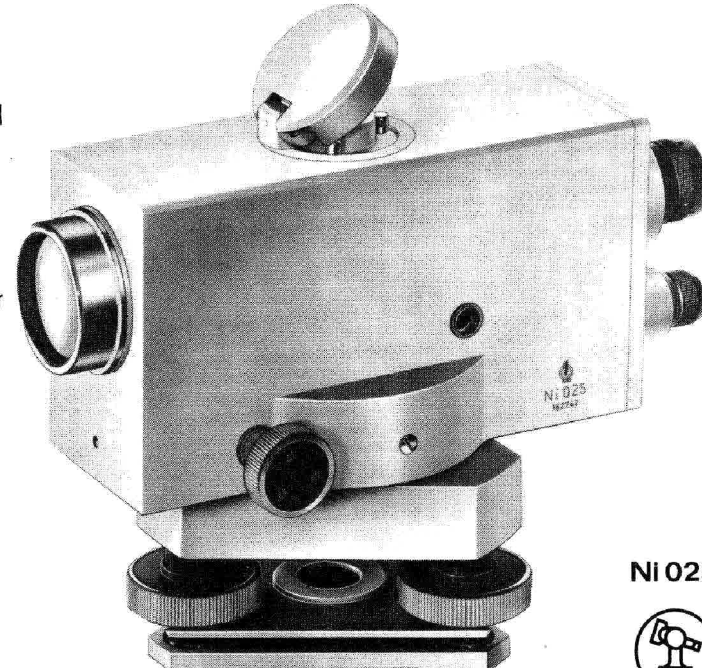

Ni 025

OUTSTANDING FEATURES:

- High speed operation; increase in measuring speed up to 50%
- Excellent optic gives very long sides
- Very light weight
- Shock resistant compensator on supported wires
- Metal container
- If necessary, very easy to adjust in the field
- Ideal for second order leveling
- Service guaranteed by trained mechanics

TECHNICAL DATA

Mean square error per mile of double run leveling ±1/10'

Sensitivity of the compensator 0.5''

Magnification (specify when ordering) 22X or 25X

Shortest focus distance 5 ft.

WEIGHTS

Instrument with container	7.5 lb.
Tripod rigid	12.5 lb.
Tripod telescopic	11.0 lb.

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PROGRAMMA 101
self-contained desk-top computer

olivetti underwood

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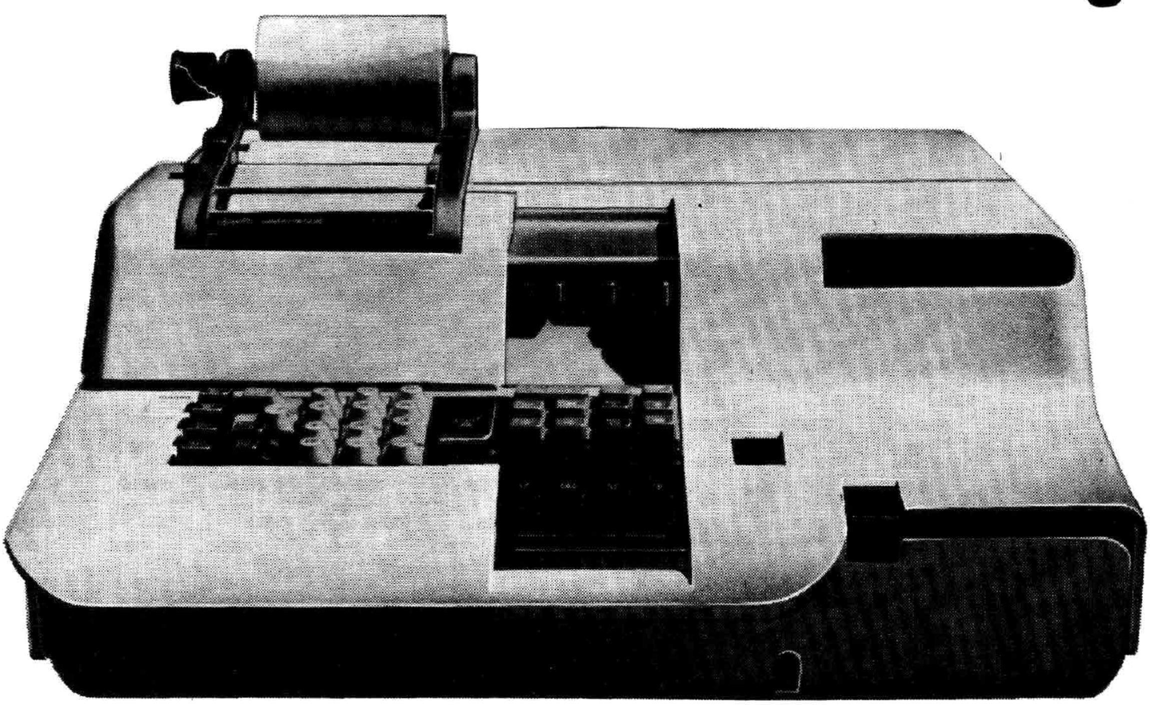


The Programma 101 is not simply an electric calculator. It is a true computer and can solve complex repetitive problems automatically—and almost instantly. It stores, computes, makes logical decisions and prints. Programs are stored on magnetic cards about the size of punched cards. Only variables need be entered—the 101 does the rest. In seconds it can work out problems ranging from circuit design to curve fitting, numerical integration and interpolation. Call or write your Olivetti Underwood representative for the full story on this self-contained, desk-top computer.

AD **6805B**

AGA Geodimeter® Model 6A

AGA

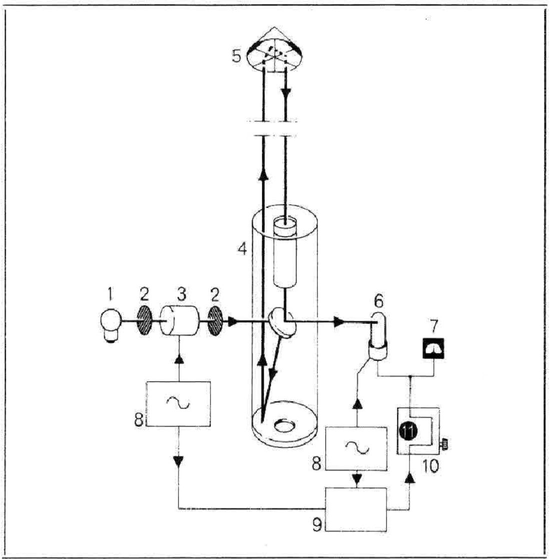
Publication 571/053

The Geodimeter Model 6 brochure with the following alterations becomes applicable also for the Model 6A

The Model 6A, with its simplified measuring procedures and increased accuracy, has been developed from the Model 6. The changes will be explained in this sheet.

New electronic system

In the brochure for the Model 6, under the heading, "Operating Principle in Brief" (with the accompanying diagram), a description is given of how the phase difference between the projected and received pulses is determined by varying the delay-line setting. The model 6A is equipped with a resolver for this phase determination. The setting of the resolver is linear in relation to the distance to be measured which means that a calibration table is not needed when calculating the distance.



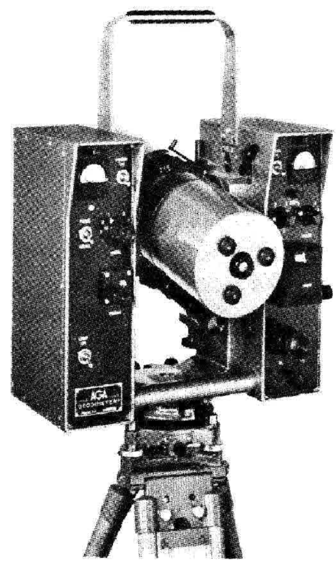
1 Lamp
2 Polaroid filters
3 Kerr cell
4 Coaxial optics
5 Reflector
6 Photocell
7 Null indicator
8 Crystal-controlled generator
9 Mixer
10 Resolver
11 Digital read-out

Four modulation frequencies

Since the Model 6 only utilizes three frequencies it is necessary to know the distance to be measured to within ±1 kilometer in order to compute the distance. However this is not necessary with the Model 6A since four frequencies result in a direct determination of all distances within the instrument range.

Increased accuracy

The new method of phase determination and improved crystal ovens have increased the accuracy of the Model 6A. The possibilities for utilizing special methods for measuring with even greater accuracy remain the same as for the Model 6.



Technical data for the Model 6A

The range depends upon the type of lamp, the visibility conditions and the size of the reflector. The data presented below are relevant under normal conditions.

Range: up to	Daylight	Darkness
With standard lamp	5 km (3 miles)	15 km (9 miles)
With mercury lamp	10 km (6 miles)	25 km (15 miles)

Accuracy (MSE): 6 mm + 1 mm/km (0.02 ft + 1 ppm)

Measuring time: 5—10 minutes per distance

Elevation: —55° to +90°

Weight:		kg	lb
	Instrument	16	35
	Tripod	7	15
	Mercury lamp kit with generator	20	44
	Reflector (1 prism)	0.5	1.1
	Reflector (3 prisms)	1.1	2.5

Power consumption: Standard lamp: 30 W/12 V from battery or generator
Mercury lamp: 300 W/12 and 50 V from generator
Modulation system: Bjerhammar

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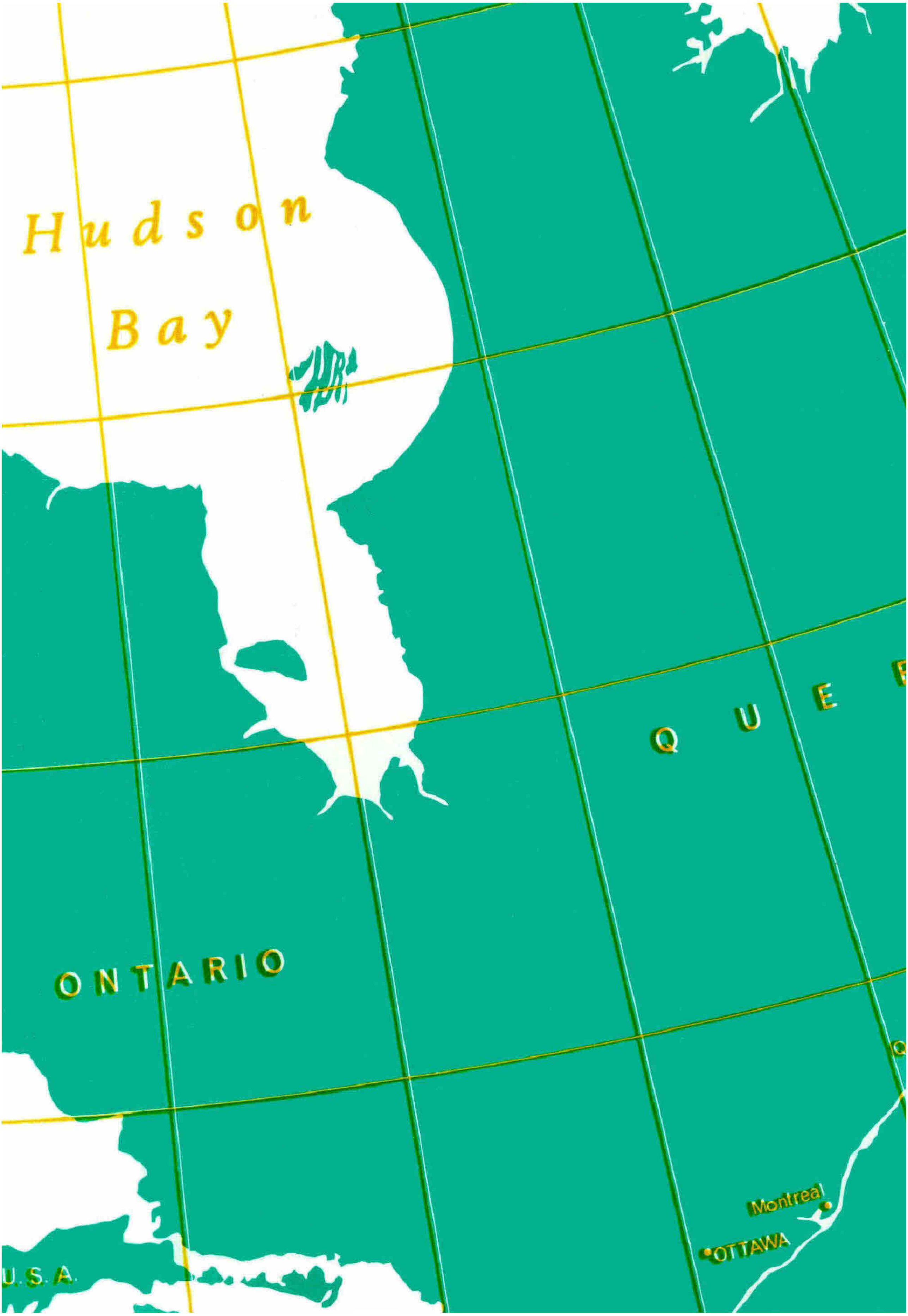
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