icot

ICOT/IR/5

A PROGRESS REPORT ON TESTS OF THE FISCHER AND PORTER TIDE GAUGE CONDUCTED AT BIRKENHEAD

BY

G W LENNON

1966

institute of coastal oceanography and tides

NATURAL ENVIRONMENT RESEARCH COUNCIL

A PROGRESS REPORT ON TESTS OF THE FISCHER AND PORTER TIDE GAUGE CONDUCTED AT BIRKENHEAD

BY

G. W. LENNON

1966

This Report was prepared before the Tidal Institute became the Institute of Coastal Oceanography and Tides.

A description of the instrument and a preliminary report upon the tests conducted at Birkenhead were presented to the Advisory Committee on Oceanographic and Meteorological Research in T.I. Internal Report No. 4. At this time, it was stated that the gauge possessed a potential accuracy considerably in excess of that experienced with conventional tide gauges, but that at least one major defect was apparent in the instrument in its original form, and again that certain administrative problems were likely to arise with an instrument which produces a digital record at discrete intervals of time. The main criticism was levelled at the arrangement of the float tape and counterweight system which allows an accumulation of silt on the driving pulleys and also introduces a slight non-linearity in the response of the instrument to changes in water level.

In the interval immediately following the presentation of this paper, the silt problem became serious in that build-up on the float pulley frequently caused the float tape to disengage from the sprocket drive and to slip at intervals through a 0·2 ft. change in datum. On September 23rd, 1965, the problem was discussed fully at the Fischer and Porter factory on the occasion of a visit to Workington made by Messrs. Noble and Lennon. Alternative counterpoise systems were suggested and in particular the attention of the manufacturers was drawn to the tensator device, a constant tension band spring, as a possibility in this respect. On April 15th, 1966, a tensator system designed by the manufacturers was fitted to the gauge under test and this arrangement is illustrated in figure 1. The tensator is an 'S'-shaped band spring which can deliver a torque to a shaft, in this case the shaft upon which the take-up pulley for the float tape is mounted. The magnitude of the torque is almost entirely dependent upon the tendency to flex of that part of the band spring which lies between the two curls. Since the length of this part of the spring remains constant, it follows that the torque also remains constant within reasonable limits. The diagram shows that the applied torque is utilised to pack the unused part of the float tape so that it no longer needs to descend into the well-water and at the same time, a tension is applied to the float tape.

In Internal Report No. 4 some of the problems associated with digital recording were mentioned. In particular the need to have complete confidence in the paper-punching mechanism was stressed since failure may not be as obvious as with an analogue record; furthermore, partial failure, or the tendency to punch badly formed holes in the paper tape, or even depressions rather than holes may result from wear. Again the monitoring of water levels which are perturbed by a complete spectrum of surface waves from short waves through seiches into the tidal frequencies involves careful consideration of the dangers of aliasing, and suggests a more adequate knowledge of the response functions of tide gauge stilling wells than has previously existed. It is unlikely that a sampling interval as long as 15 minutes can be tolerated if aliasing is to be avoided. In the light of these considerations a test was conducted in which the sampling interval was reduced by a factor of 30 to 30 seconds, the object being to test the ability of the instrument to meet a severe aliasing problem and at the same time to induce wear on the punching mechanism so as to examine its reliability under strain. An external timer was constructed for the purpose designed to trigger the punch at 30 second intervals and at the same time a digital counter was incorporated in the circuit so as to count the number of occasions on which the punch mechanism completed a punching cycle. By the latter means it was possible to check that the total contents of a long record matched the time interval which it was supposed to represent without manual and tedious inspection of the actual record. An illustration of the instrument complete with the external timer and counter is appended in figure 2.

The instrument with tensator system and using a 30 second sampling interval was put into operation on April 20th, 1966. On June 2nd, after a period of run-in, a Van de Casteele test was performed, in order to check upon the performance of the new counterpoise system. Meanwhile a close scrutiny was made of the punching quality particularly in the case of the registration punches which operate for every recorded item and also in the case of the junior punches for the first and second decimals of a foot which operate for half all recorded items. From this inspection it appeared that in all cases holes were punched cleanly and efficiently but on August 1st, 153 days after the commencement of this rigorous test, the punch in the junior position for the first decimal of a foot failed completely and inspection at this time showed the punch in the junior position for the unit feet to be bent and nearing a point of failure. The experience acquired with this instrument since January 1965 shows that this failure occurred after usage equivalent to 13 years at the normal sampling interval of 15 minutes or 4⅓ years at a 5 minute sampling interval. In view of the fact that the punches complete with die can be replaced quickly and with a minimum of inconvenience, this situation is considered to be quite satisfactory.

The optimum process for translation of records into computer-type paper tape or cards and/or numerical listings has not yet been selected. Use has been made of the services offered by the Water Resources Board in providing a translation into 5-hole tape, and a 6 weeks' record from the gauge was despatched for this purpose. This represented a great bulk of material in fact 121,000 items of data. Unfortunately this task proved too much for the translation service and the machinery failed when only half the task had been completed. Experience in handling massive data sets causes anxiety concerning their use and storage on paper tape which is particularly susceptible to damage. Messrs. Fischer and Porter offer translation facilities into other media, including cards, and it is planned to investigate data handling and processing by this means.

Experience must still be gained in the handling of digital records at small sampling intervals. Recent work on the response functions of tide gauge wells combined with the availability of the records from this test gauge makes it possible to investigate such problems in considerable detail and this work is now being planned.

Reports of specific tests on the Instrument.

I Clock mechanism

The clock supplied with the gauge has been superseded in recent tests by the external timer described above. In the nine months prior to the introduction of the small sampling interval, however, careful tests were made :-

On the basis of bi-weekly checks, the clock error, after intervals of 3 or 4 days, was found to be as follows :-

1 minute slow	on	7%	of	all	occasions
correct	"	57%	"	"	"
1 minute fast	"	28%	"	"	"
2 minutes "	"	7%	"	"	"
3 minutes "	"	1%	"	"	"

The greatest error was therefore 3 minutes. No adjustment to the regulator was made and the performance of this clock was found to be quite satisfactory. On the basis of this experience the same clock has been used on other instruments at the Tidal Institute.

II Van de Casteele Tests

Three such tests have now been conducted :-

The first on January 19th, 1965 immediately after installation.
The second on November 9th/10th, 1965, and
A third on June 2nd, 1966, a few weeks after the reinstallation of the revised form of the instrument complete with tensator counterpoise.

The results of these tests are shown in figure 3.

The first test was discussed in Internal Report No. 4 and it was suggested that the non-linearity in the response of the gauge, was due partly to the original counterpoise system and partly to the kinks in the float tape noticed upon delivery. This error amounted to 0·04 ft. at low water compared with high water in a 30 foot range.

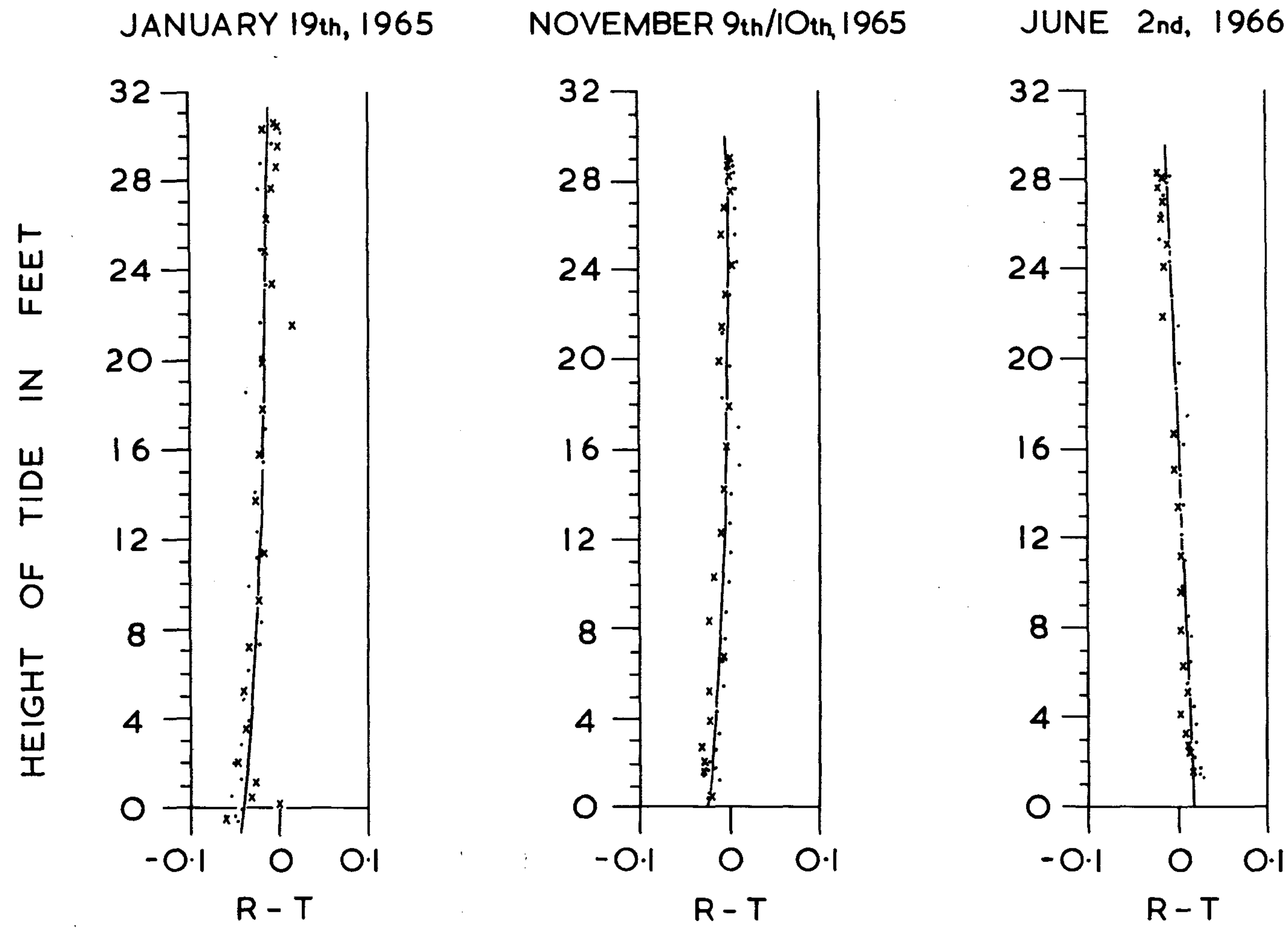
These remarks are confirmed by the results of the second test some ten months later. Here it is seen that the non-linearity is less marked and that the error has been reduced to 0•025 ft. presumably by the disappearance of tape kinks in use, leaving a residual error produced by the tape tensioning system. After the fitting of the tensator system, the third test shows a linear error in the tidal range of the order of 0•03 ft. but with an opposite sign to that experienced earlier. It is suggested that this feature is contributed by the design of the tensator system in that although the tensator itself may apply a constant torque to the take-up pulley shaft, this force is transmitted to the float tape through a varying radius on the pulley itself dependent upon the length of tape which this pulley contains at any one time. Also the weight of the varying length of tape which hangs down the well tube opposes the torque applied by the tensator. A report has been made to the manufacturers and amendments to the system are being considered. Nevertheless, the performance of the gauge in its present condition is superior to that of any conventional gauge which has been tested in this country by the routine program of the Ordnance Survey.

III Datum Stability

A particularly welcome feature of the instrument is its ability to retain a datum setting and in this it has considerable advantage over the conventional gauge beset with uncertainties of chart and pen settings. During the course of the tests the Fischer and Porter gauge was checked against precise well-soundings, usually twice each week, and the same soundings were used to check a Légé gauge installed in the same well. The gauge errors on each occasion are plotted for both instruments in figure 4. It can be seen that the Fischer and Porter gauge generally remained within 0•01 ft. of the correct level and this represents about the limit of accuracy in well-sounding so that its actual performance is probably slightly better. In contrast the conventional gauge shows erratic changes 1 order of magnitude greater in amplitude. This feature is an important consideration particularly in association with the use of gauges for mean sea level purposes.

In conclusion it is important to make reference to the interest and assistance given to this project by the manufacturers and in particular by Mr. G. Young, the Products Manager. Mr. Young is keen to produce an instrument which will meet the requirements of modern tidal practice and is at the present time, at our suggestion, investigating the possibility of producing an analogue output from the instrument which might meet routine local requirements without detracting from the accuracy of the digital record for the purposes of research.

FISCHER AND PORTER VdC TESTS

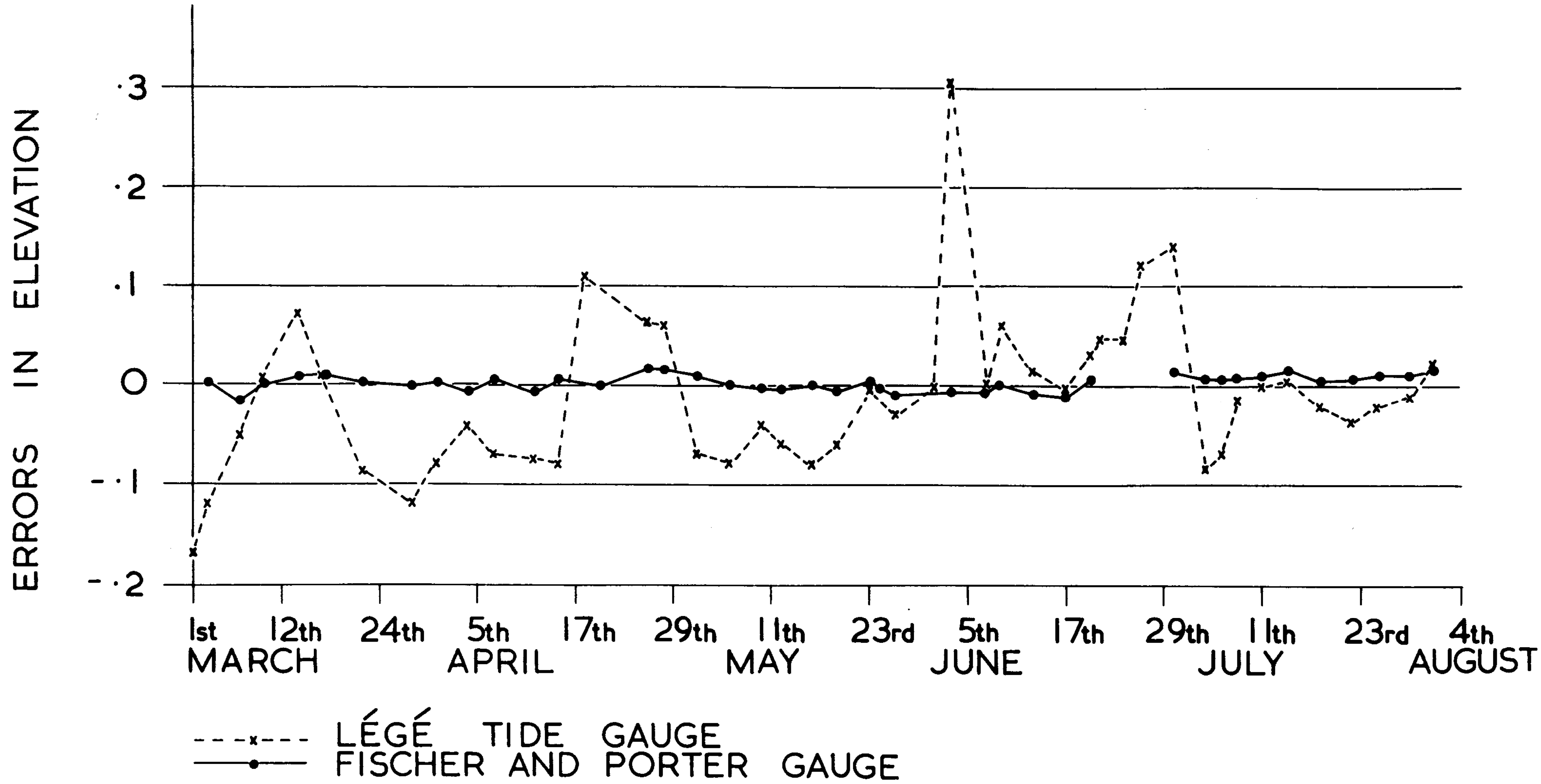


R - T = TIDE GAUGE RECORDING MINUS WATER HEIGHT FROM SOUNDING

× RISING TIDE
· FALLING TIDE

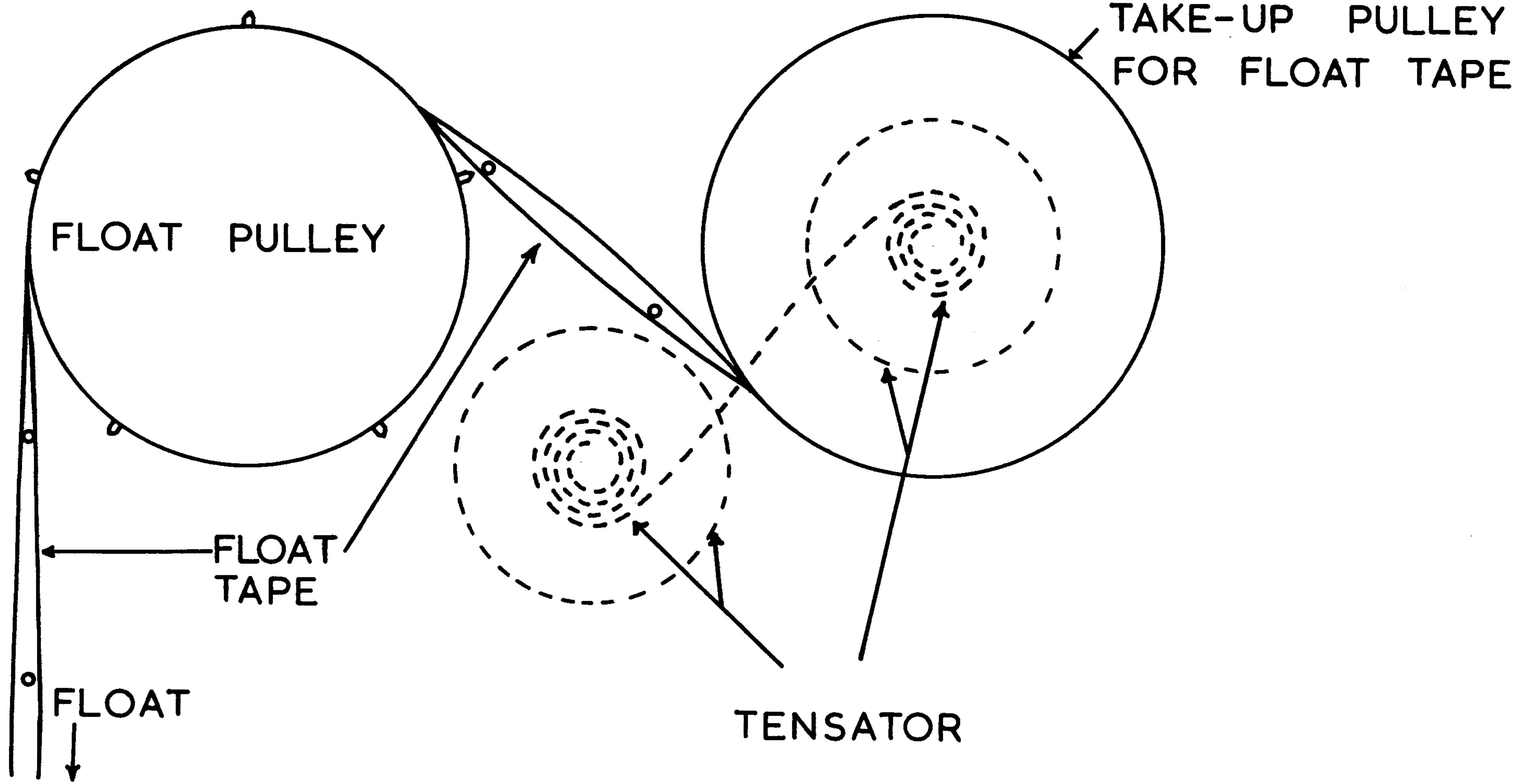
663115

DATUM STABILITY — COMPARISON WITH CONVENTIONAL GAUGE



ERRORS IN ELEVATION ARE BASED UPON PERIODIC WELL-SOUNDINGS.

TENSATOR SYSTEM



COMPONENTS SHOWN IN PECKED LINES ARE IN DIFFERENT PLANE FROM OTHER COMPONENTS

063115