THE INSERTION OF ECHO SOUNDINGS ON CHARTS

by Captain A. VIGLIERI, Director of I.H.B.

The question of methods to be followed in the insertion of echo soundings on charts was considered for the first time by the Supplementary International Hydrographic Conference held in 1929; it was again discussed at the Third International Hydrographic Conference held in 1932 and as a result the following successive resolutions were adopted:

(1) METHOD OF INSERTION OF ECHO-SOUNDINGS ON CHARTS

a) *The soundings obtained by echo should be plotted on charts after having been corrected as much as possible ;*

b) *They should not be distinguished from other soundings marked on the chart.*

See « Report of the Proceedings of the 1929 *Conference » page* 244.

(2) ADOPTION OF A STANDARD VELOCITY FOR THE PROPAGATION OF SOUND IN SEA WATER

The Conference did not adopt a standard velocity for propagation of sound through sea water.

See « Report of the Proceedings of the 1929 *Conference » page* 244.

(3) ECHO-SOUNDINGS ON CHARTS

Echo-distances of less than 1,000 *metres will be transformed as well as possible into depths and then be inserted on charts in the same type of figures as that used for wire soundings.*

See « Reports of the Proceedings of the 1932 *Conference » page* 412.

(4) STANDARDIZATION OF THE METHOD FOR CALCULATING THE DEPTH INDICATED BY THE TIME-INTERVAL IN ECHO-SOUNDING

The scales of the echo-sounding appliances should permit either rough echo-distances or echo-intervals to be read. The signification of the scale shall be indicated on the apparatus itself (for a scale of length, the velocity on which it is based; for a scale of echo-intervals, the unit of time involved).

See « Report of the Proceedings of the 1932 *Conference » page* 412.

Long discussions were held during these Conferences because of the expression of different opinions regarding the desirability of differentiating on charts between echo and wire soundings and the corrections to be made; these discussions were necessitated by the fact that echo sounding machines were as yet not greatly developed and were accordingly employed only to a very limited extent. With the increase in the use of echo-sounding machines, the chief advantages of the system were brought to the fore, i.e., much greater facility and speed of measurements of depths in navigation and hydrographic surveying than those obtained by hand sounding or any other type of wire sounding. Even greater advantage could be gained if errors in the measurements could be conveniently corrected.

However, a gradual clarification of opinion occurred following the introduction in sounding machines of ultra-sonic frequencies (resulting from the study of piezo-electric and magnetostrictive phenomena) enabling the machines

to be highly directional, and of recorders which, by determining the bottom contours, make it possible to correct the rough depth figures with greater accuracy (possibility of eliminating also slope error and cross-over effect).

The tendency of most Hydrographic Offices has therefore been to make no distinction on charts between wire and echo soundings having first corrected the latter as required.

The most important matter that still remained to be settled was the acceptance of a uniform system of correction. The importance of such uniformity is easy to appreciate if it is remembered that :

— Frequently on marine charts, and nearly always on oceanographic charts, it is necessary to insert soundings that have been obtained by different operators using machines adjusted to sound velocities which may differ;

— As the echo soundings shown on charts may have been determined by the use of machines adjusted to sound velocities which differ from those of shipboard instruments, uniformity is necessary if hydrographers, navigators and oceanographers are to be able to use charts to their best advantage.

The Fifth International Hydrographic Conference held in 1947 therefore adopted the following resolution in order to obtain uniformity when soundings are corrected :

(5) VELOCITY OF SOUND IN SEA WATER

The Conference resolved that for the purpose of obtaining uniformity in the correction prior to charting of sonic soundings, in off-shore areas where the use of the bar check calibration is not feasible, the British Hydrographic Department's publication H.D.-282, « Tables of the Velocity of Sound in Pure and Sea Water for use in Echo-Sounding and Sound Ranging », should be provisionally adopted.

See « Reports of the Proceedings of the 1947 *Conference » page* 230.

To remove any possible doubts that might still exist in regard to the interpretation of relevant resolutions (some of which were already obsolete), the Directing Committee sent out Circular-Letter No. 8-H of 9th March, 1951, in which a short resume of the subject was given and States Members were asked to reply to the following questions :

I. What standard velocity of sound is incorporated in sounding machines used by your Office ?

II. Are bar check calibration tests included in survey specifications and how are they specified ?

III. What type of corrections do you make to sonic soundings prior to plotting on charts depths of

0 — 100 metres
100 — 200 —
200 — 500 —
500 — 1000 —
above 1000 metres.

IV. Do you correct sonic soundings for temperature, pressure and salinity by other figures than those of Tables H.D.-282 ?

V. Does your Office differentiate between soundings that are to be plotted on a bathymetric chart and those plotted on a navigational chart ?

VI. State methods used by your Office that are not clarified by replies to the above questions.

Furthermore, the Directing Committee again brought to the attention of the Sixth International Hydrographic Conference held in 1952 the question of the insertion of echo soundings on charts.

Out of the discussions which took place at that Conference, the following points of view resulted and were generally accepted :

1. Depths obtained by echo-sounding should be plotted on charts after having been reduced to actual depth.

2. In order that such results may be obtained, and in the interest of oceanographers as well as navigators, echo-soundings plotted on charts should be amended by means of appropriate corrections, with due regard to the degree of approximation that is obtainable from instrument readings and according to chart scale. It is pointed out in this regard that other observations carried out by hydrographers for scientific purposes are always corrected for instrumental error, and insofar as possible, according to the medium.

3. Under present conditions, in any case, correction methods employed by the various Offices must be made known in order that the data supplied may always be correctly used.

With the acceptance of the principles of paragraphs 1, 2 and 3, the disadvantages arising from the different velocities of sound adjustments of echo sounding machines would be to a large extent eliminated.

It should, however, be noted that even if all manufacturers were to adopt the same velocity of sound, *hydrographers* would still be under the obligation of making corrections, within the limits of approximation required, based on the difference between the speed for which their machines are adjusted and the velocity of sound obtaining at the time and place of each sounding (See above Resolution (5) of 1947).

From the point of view of the practical application of the echo-sounding machine by *navigators*, consideration should be given to the fact that :

— a very accurate knowledge of the bottom is only, in practice, required in shallow waters where errors arising from faulty sound velocities (within the limits of velocity generally adopted by constructors) are fairly small and are close to the safety margin usually accepted;

— the use of soundings for maritime purposes in which considerable depths are met with can in general only give a very approximate position depending on the characteristics of the bottom and on the density of soundings shown on the charts.

For this reason, navigators are not accustomed to take into consideration the actual velocity of sound; but if, with the development of navigation, they were prepared to consider differences in sound velocity (as, for example, by means of Tables H.D.-282), they would then be able to operate independently of the velocity of sound on which their instrument is based. In this connection, mention should be made of a device sometimes adopted in modern machines, which incorporate several instrumental speeds and thereby compel the navigator, if for no other reason, to make a choice amongst them.

Because of this situation, the Conference decided to support the view that it is essential to know the methods used by the various Hydrographic Services in the correction of echo soundings, and, with this end in view, it approved the following resolution :

(6) ECHO-SOUNDINGS ON CHARTS

Details of the correctional methods used should be promulgated suitably in the country's own publications and through the I.H.B.

See « Reports of the Proceedings of the 1952 Conference », page 287.

It can be considered that with this resolution this subject has now entered its final phase.

As the desirability of publishing reports on this question in the « International Hydrographic Review » was also brought out in the course of the discussions held during the Conference of 1952, the results of the enquiry undertaken by the Bureau through Circular-Letter No. 8-H of 9th March, 1951 (results that have, for the most part, already been transmitted to the States Members in Circular-Letters Nos. 14-H of 9th August, 1951, 22-H of 26th October, 1951, and 9-H of 14th April, 1953) are set out below.

The Bureau has received replies to the above-mentioned letters from the following countries : Argentina, Canada, Chile, Denmark, France, Germany Great Britain, Indonesia, Italy, Japan, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Thailand, Turkey, the Union of South Africa, the U.S.A. (H.O and C.G.S.), Uruguay and Yugoslavia.

Answers are lacking from Australia, Brazil, China, Cuba, Egypt, Greece, Monaco and Poland.

Country	Velocity of Sound Used (1500 m. = 820 fathoms 1463 m. = 800 fathoms)	1) Bar Check Used 2) What substitute method used	Corrections Applied at following depths : 0 - 100 m. 100 - 200 m. 200 - 500 m. 500 - 1000 m. above 1000 m.	1) Tables H.D.-282 Used 2) Other Values Used for Temperature, Pressure and Salinity
1 **Argentina**	1463 m./s.	1) Yes. 2) Also ordinary sounding machine checks. Checks and adjustements made at 30, 60 and 90 ft. (about 10, 20 and 30 m.).	1) Oscillator immersion corrections made in all cases. 2) Tidal corrections made except in cases of great depth and when tide is small.	1) No. 2) No.
2 **British Commonwealth** a) Great Britain	1500 m./s. (small variations according to local conditions).	1) Yes (up to about 12 m. in small boats only). 2) —	— *From* 0-100 *fathoms.* Corrections for instrumental speed to bring it up to figure observed by bar check. — *Above* 100 *fathoms.* Speeds adjusted for 1500 m.; corrections with Tables H.D.-282.	1) Yes. 2) No.
b) New-Zealand	—	—	—	—
3 **Canada**	1500 m./s.	1) Yes (by fathoms up to 10 fathoms). 2) Above 10 fathoms, by « Lucas » check, whether in boats or vessels.	— *From* 0-914.4 *m.* (i.e. from 0-500 fathoms) 1) Tidal corrections. 2) Corrections for calibration error. — No corrections above 914.4 m. unless large calibration errors are encountered.	1) No. 2) No.

4 **Chile**	1463 m./s. 1500 m./s.	1) No. 2) Hand sounding check.	— *From* 0-100 *m.* 1) Corrections for reduction to chart datum. 2) Corrections for oscillator immersion. — *At* 100 *m. and above.* Correction for immersion of oscillator.	1) ? 2) No.
5 **Denmark**	1500 m./s.	1) No. 2) Hand sounding check.	— Corrections with Tables H.D.-282. — *From* 0-200 *m.* 1) Correction for oscillator immersion. 2) Tidal correction. — *Above* 200 *m.* Corrections with Tables H.D.-282 only.	1) Yes. 2) No.
6 **France**	1463.2 m./s.	1) Yes (up to 30 m.). 2) Also wire sounding check up to 200 m.	— *From* 0-300 *m.* Corrections based on direct check. — *Above* 300 *m.* Corrections sometimes made with Tables H.D.-282 ; apparatus generally adjusted to average speed of sound.	1) Yes. 2) No.
7 **Germany**	1500 m./s.	1) No. 2) Hand sounding check.	— Corrections with Tables H.D.-282. — In the North and Baltic Seas, use made of Dietrich tables which take into account seasonal variations.	1) Yes. 2) Dietrich tables for North and Baltic Seas.

8 **Indonesia**	1500 m./s. (small variations according to local conditions).	1) Yes (up to 30 m.). 2) Tables H.D.-282 and « Lucas » check used above the range of bar checks.	— Corrections for bar checks. — Tidal and oscillator immersion corrections made within the range of bar checks.	1) Yes. 2) No.
9 **Italy**	1500 m./s. 1463 m./s.	1) Yes (up to 30 m.). 2) —	— Tidal corrections up to 20 m. — *From* 0-30 *m.* Bar corrections. — *From* 30-50 *m.* Magnaghi or Lucas sounding machines or measurements for temperature, salinity and pressure. — *From* 50-200 *m.* Measurement for temperature, salinity and pressure. — *Above* 200 *m.* Corrections with Tables H.D.-282.	1) Yes. 2) No.
10 **Japan**	1500 m./s.	1) Not yet. 2) —	1) Corrections for variations in speed of motor. 2) Corrections for temperature, salinity and pressure. 3) Tidal corrections up to 100 m.	1) No. 2) Susumu Kuwahara Speed Tables of Japanese Hydr. Serv. ; Hydr. Manual 1944 (P. 5615).

11 **Netherlands**	1500 m./s.	1) No. 2) —	— *From* 0-100 m. 1) Shallow depth corrections depending on the depth. 2) Reduction to chart datum. 3) Corrections for immersion of oscillator. 4) Corrections for temperature, salinity and pressure. *From* 100-200 *m.* Corrections 2), 3) and 4). — *From* 200-500 *m.* Corrections 3) and 4). — *From* 500-1000 *m.* Corrections 3) and 4). — *Above* 1000 *m.* Correction 4).	1) No. 2) Hydrographische T a f e l s 1950 adapted to Tables H. D.-282 for Indonesia and the region of Equatorial Africa.
12 **Norway**	1480 m./s.	1) No. 2) —	— Direct check of all soundings. (The surveys are made in coastal waters and the checking methods used are not specified).	1) No. 2) No.
13 **Portugal**	1500 m./s. 1463 m./s.	1) Yes. 2) « Lucas » check in great depths.	— None other than checks already mentioned.	1) Yes. 2) No.

14 **Spain**	1464 m./s.	1) No. 2) —	— *From* 0-100 *m.* 1) Tidal corrections. 2) Oscillator immersion corrections. — *From* 100-200 *m.* Immersion correction. — *Above* 200 *m.* Correction for temperature, salinity and pressure.	1) Yes. 2) No.
15 **Sweden**	1500 m./s. 1450 m./s.	1) Yes. 2) Also wire sounding check.	— *From* 0-200 *m.* Bar and wire sounding check. — *Above* 200 *m.* Corrections for wire sounding check.	1) No. 2) No.
16 **Thailand**	1500 m./s.	1) No. 2) Wire sounding check.	— Ultra-sonic sounding machines generally not used.	1) No. 2) No.
17 **Turkey**	1500 m./s.	1) No. 2) Wire sounding check.	— Does not at present undertake soundings in the open sea. Intends to follow Bureau's advice.	1) No. 2) No.
18 Union of South Africa	1600 m./s.	1) No (but intends to apply it). 2) Wire sounding check.	— Corrections for « Lucas » check (Surveys restricted to 100 fathoms).	1) No. 2) No.

19 **United States of America**				
a) C. & G.S.	1500 m./s. 1463 m./s.	1) Yes (for all depths sounded by small boats). 2) —	— Corrections for temperature, salinity and pressure at all depths.	1) Yes. 2) No.
b) H.O.	1463 m./s.	1) Yes (at depths of 30, 60 and 90 feet). 2) —	— *From* 0-200 *feet.* Corrections based on bar check. — *Above* 200 *feet.* No corrections made.	1) No. 2) No.
20 **Uruguay**	1500 m./s.	1) No (In experimental stage). 2) Hand sounding check for small depths; hand sounding, « Lucas » or « Thompson » checks for greater depths up to 200 m.	— *From* 0-100 *m.* 1) Correction for immersion of oscillator and for instrumental errors due to check. 2) Tidal corrections. — *From* 100-200 *m.* Corrections for immersion of oscillator and for instrumental errors.	1) No. 2) No.
21 **Yugoslavia**	1500 m./s.	1) No. 2) Single wire check.	— *From* 0-200 *m.* 1) Oscillator immersion correction. 2) Tidal correction. — *Above* 200 *m.* No soundings made.	1) No. 1) No.

A study of the tables outlined above leads to the following observations:

1. *The basic velocities* of sound used in present echo sounding machines lie between 800 and 820 fathoms (1463 and 1500 metres).

(The Hydrographic Office of the Union of South Africa in an exception: it has indicated that it uses a velocity of sound of 1600 m./s.)

2. *Bar checks* are used by eleven States and are also contemplated by other countries. With the use of bar checks, sounding machines are generally checked for accuracy to at least a depth of 90 feet (30 metres). Bar checks are made several times in the day's work, according to local variations of water temperature and salinity. Wire sounding checks are used by those States that do not use the bar check.

3. The Bureau's request for information regarding corrections applied to different depth measurements has been interpreted in various ways. Some countries have replied by enumerating all the corrections made, whether in connection with instrumental adjustment or the reduction of depths to chart datum or the difference in sound velocity; others, on the other hand, have confined themselves to certain types of corrections. Consequently, complete data have not yet been obtained from the enquiry on this matter.

However, the replies which have been received show a diversity of points of view in so far as some Hydrographic Offices correct all measurements at whatever depth they happen to be taken (with the exception, of course, of errors which are negligible in proportion to the depth measured). Others, on the contrary, only correct soundings for small and medium depths, each of these offices adopting a different upper limit beyond which the correction is not made.

4. The use of Tables H.D.-282 is widespread: some States use similar tables; other countries do not use any table and do not make any corrections for salinity, pressure and temperature beyond small depths.

5. No differentiation is made between nautical and bathymetric charts.

6. As a general rule, only the methods mentioned in the preceding paragraphs are used.

COMMENTS

An examination of the replies and of the summarizing tables leads to the observation that even if there are certain appreciable differences in the methods of correction used by the different Offices, there is, at the same time, a considerable uniformity in the sense that all the States, following the intent of above resolutions (1), (2), (3), (4), (5) and taking into consideration special hydrographic conditions, correct their echo soundings at least up to a certain depth with the aim of getting as close as possible to the actual values.

For such corrections, it will be noted that, from the hydrographic point of view, satisfactory results can be obtained by different methods. The use of the bar, for example, gives the direct value of the correction required; however, the same result can be obtained through the measurement of physical constants by means of computation. This measurement, in turn, can be realized by different methods because sufficiently close values of sound velocity can be obtained when approximations to within 1/10th degree centigrade of temperature and to within the first decimal figure of the salinity value expressed in thousandths

are available. These approximate values can be easily arrived at with any type of instrument designed for the measurement of such elements.

At any rate, as the International Hydrographic Conference of 1952 decided to add the above Resolution (6) stipulating that detailed information should be supplied through the *special publications of every office* regarding the methods used for corrections of echo-soundings, this question could be carried further if the different States Members would consider the possibility of eventually moving towards standardization, always bearing in mind the following factors:

1. A list of all the corrections that can be applied to echo soundings of depths measured is set out below :

Group 1 - Instrumental Corrections

These consist of adjustments that have to be made to the apparatus and to its checking during operations according to the constructor's specifications.

Group 2 - Corrections affected by the position of the apparatus on board ship

(a) *Corrections of error caused by the immersion of the oscillator.*

This error is almost constant as it varies only according to the conditions of immersion of the ship.

Measurements of less than 10 fathoms (18 metres) should be known to within a quarter of a foot (i.e., less than 10 centimetres), and consequently the depth of immersion must be measurable to the same degree. Depths of more than 10 fathoms should be known to within at least 0.5 % of the depth. For measurements of great depth where the error may be a quite small fraction of the depth, it is sufficient to know the mean value of immersion.

b) *Corrections of error for separation effect (depending on the distance between the oscillator and the receiver in the hull).*

To diminish as much as possible the error for separation effect, the oscillator is placed as close as possible to the receiver when the instrument is fitted to the ship.

The formula used to correct errors in soundings caused by this condition is the following :

$$E = d + \sqrt{(D - d)^2 - \frac{S^2}{4}}$$

where E = sounding corrected for separation effect, but not for oscillator immersion,

D = depth recorded on apparatus,

d = mean immersion of the apparatus,

S = horizontal distance between centres of oscillator and receiver.

The extent of error increases in proportion as the value of S increases and it diminishes as the measured depth increases. In practice, this error is only appreciable in very shallow water. When the depth of water is five times the S distance, the real depth is 99.5 % of the recorded depth ; consequently, when

the ratio of depth to the S distance is greater than 5 to 1, this error becomes negligible. It can, therefore, be assumed that

$$E = d + \frac{Vt}{2}$$

where V = velocity of sound, and

t = time taken for sound to travel from oscillator to receiver.

Group 3 - Correction of errors produced by local conditions prevailing at time measurements are taken.

(a) *Tidal corrections* (reduced to sounding datum)

According to a resolution adopted by the Sixth International Hydrographic Conference in 1952 this correction should be applied to soundings up to 200 metres (or 100 fathoms).

(*See « Report of the Proceedings of the 1952 Conference », p. 287*)

Within these limits, it will be applied in relation to the special rules laid down by the different Hydrographic Offices regarding the degree of approximation of figures to be shown on the charts.

(b) *Correction of error produced by difference between real velocity of sound and instrumental velocity of sound.*

The error caused by the difference between the actual velocity of sound and that of the instrument used is obviously in proportion to the depth encountered, and for that reason must be carefully considered : in the case of great depths, because it is a large error, and in the case of shallow depths, because a greater degree of accuracy is required. (For example, for a speed difference of 40 metres, the error of a depth of 10 metres is 25 cm., which is an amount that cannot be ignored.)

In addition to the errors of which a list has been given above, a slope error may be encountered when the seabed presents particular characteristics : thus, when the bottom under the vessel is sloping, the minimum depth recorded by the echo-sounding machine is not that shown by the reflection of the sound against the point vertically below the ship, but against some point on the slope situated at a lesser distance from the transmitter.

Slope errors constitute an extremely complex problem because of the great variety of bottom outlines that may be encountered in practice.

These errors can be caused by :

(a) the slope of the bottom with respect to the horizontal ;

(b) the depth of the water ;

(c) the shape of the bottom ;

(d) the reflecting characteristics of the bottom;

(e) the dimensions of the sound cone transmitted, when the transmitter is directive ;

(f) the frequence of sound transmitted ;

(g) the intensity of the transmitted signal ;

(h) the sensitivity of adjustment of the instrument.

Articles relating to slope error and the possible systems for its correction have appeared in various publications (Adams - Hydrographic Manual, U.S. Coast & Geodetic Survey; Shalowitz - Slope Corrections for Echo Soundings, U.S. Coast and Geodetic Survey, S.P. No. 165-1930, etc.) and also in the « International Hydrographic Review » (Volume V, No. 1, May, 1928, p. 167, H. Maurer ; Volume VII, No. 1, May, 1930, p. 82, A.L. Shalowitz ; Volume VII, No. 2, November, 1930, p. 50, P. de Vanssay ; Volume X, No. 1, May, 1933, p. 38, J.D. Nares ; Volume X, No. 2, November, 1933, p. 154, J.H. Hayes ; Volume XXIX, No. 1, May, 1952, p. 126, F. Schüler).

From the important studies mentioned above, it follows that, theoretically, slope errors should also be corrected, but for other reasons (particularly the fact that nautical charts based on hydrographic surveys are compiled for the use of navigators) it is not possible to lay down set rules for the application of corrections to such errors. Because of this, the different Hydrographic Offices publish special rules governing the application or non-application of this correction according to the different cases encountered and the purpose for which the charts are compiled.

II. In order to decide which corrections should be applied according to the depth measured, it would seem advisable to define limits which might be generally adopted. These limits might be well described as follows :

— for shallow waters: from about 0 to 30 metres;

— for medium depths: from about 30 to 200 metres;

— for great depths: from 200 metres upwards (*).

For shallow waters: All the corrections of Groups 1, 2 and 3 should be applied. For corrections in regard to sound velocity, it would be advisable for the bar check to be generally used.

For medium depths: The corrections of Group 1, the correction (a) of Group 2 and the correction of Group 3 should be applied.

The correction for the velocity of sound could be carried out by extrapolating the bar check; or by the direct measurement of temperature, pressure and salinity; or by extrapolating Tables H.D.-282; or by wire-sounding checks.

For great depths (*) : The corrections of Group 1, the correction (a) of Group 2 and the correction (b) of Group 3 should be applied.

Corrections for velocity of sound can be obtained by Tables H.D.-282 or by the direct measurement of temperature, pressure and salinity.

With the aim of eventually perfecting the important publication H.D.-282, which, according to above quoted Resolution (5) of 1947, should be universally used, all those States that are in a position to take accurate measurements of temperature, pressure and salinity should make known the possible differences that they encounter as compared with the Tables.

(*) According to Resolution (3) of 1932, the upper limit for great depths to be corrected should be 1,000 metres. It might perhaps be considered again whether it is advisable to apply the necessary corrections also to depths greater than 1,000 metres, in which case the correction (b) of Group 3 should at least be applied.

In every case, the frequency of checks for velocity of sound will depend, of course, on conditions prevailing at the place where the survey is being undertaken and on the extent of depths measured.

The above considerations could be used by States Members as a starting point for reaching agreement on the establishing of standard tables in which, according to whether small, medium or great depths are being dealt with, the corrections applied and the methods used could be set out.

The tables could then be inserted by the different States in their nautical documents.

Note. — The Resolutions mentioned in this paper can also be found in the « Repertory of Technical Resolutions », 1953 edition, under the following numbers :

(2) — Part B, Charts, No. 131 § I

(3) — Part B, Charts, No. 130 § I

(5) — Part B, Charts, No. 131 § II

(6) — Part B, Charts, No. 130 § II

(7) — Part B, Charts, No. 134

Resolution **(1)** of 1929 is no longer in the Repertory, since it has been superseded by Resolution **(3)** of 1932.

Resolution **(4)** of 1932 is no longer in the Repertory, as it is obsolete.