

VARIABLE COURSE CLOCK

MARK 2 MODEL 0
and
MARK 2 MODEL 1



RESTRICTED

NAVY DEPARTMENT
WASHINGTON D. C.

RESTRICTED

FOREWORD

IMPORTANT

It is the opinion of authorities on both anti-submarine and submarine warfare that the sinuous courses steered by means of the Variable Course Clock cams offers far greater protection from submarine or air torpedo attack than any straight line zig-zag courses available in any Navy or commercial publications. The distance made good is also greater than that made good by use of most zig-zag plans. At no time during steering by the Course Clock is the vessel proceeding on a straight course, thereby making it extremely difficult, and even impossible, to accurately predict the vessel's position in order to compute a torpedo firing bearing.

In convoy, the sinuous courses produced by the use of the variable course cams has extreme advantage over the straight line zig-zag courses obtained by the use of the adjustable time interval disc in conjunction with a predetermined zig-zag plan for the following reason: Since all Course Clocks on all ships in the convoy are synchronized, all movable pointers will be moving in the same direction at all times. Regardless of whether any one vessel has temporarily ceased steering by the movable pointer in order to correct for drift and the effects of seaway, upon assuming correct position in the convoy and resuming steering by the movable pointer the vessel is bound to be steered in the direction all other vessels are steering for the movable pointer direction has not failed to remain synchronized with the pointer direction of all other Variable Course Clocks in the convoy. This fact eliminates any possibility of a left turn being made when a right turn should have been made as a result of manual error that can occur when using a zig-zag plan.

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INSTRUCTIONS

VARIABLE COURSE CLOCK

The Variable Course Clock is a self-contained auxiliary instrument to be mounted on an ARMA MARK 6, a SPERRY MARK 15, or a SPERRY MARK 24 repeater. Its purpose is to enable the helmsman to steer a predetermined constantly curving track along a base course as a means of protection from submarine or air torpedo attack.

The clock is equipped with the following accessories:

Four variable course cams for steering continual curved tracks.
These cams are numbered No. 20, 21, 22, and 23. Each cam is complete with a full complement of signal pins.

One adjustable time interval disc for conventional zig-zag courses.

Twenty-five signal pins for the time interval disc and for spares.

Two cam curve charts for each variable course cam.

One clock-winding key.

Three No. 1 bezel-ring spacers for use with SPERRY MARK 15 repeater.

Three No. 2 bezel-ring spacers for use with SPERRY MARK 24 repeater.

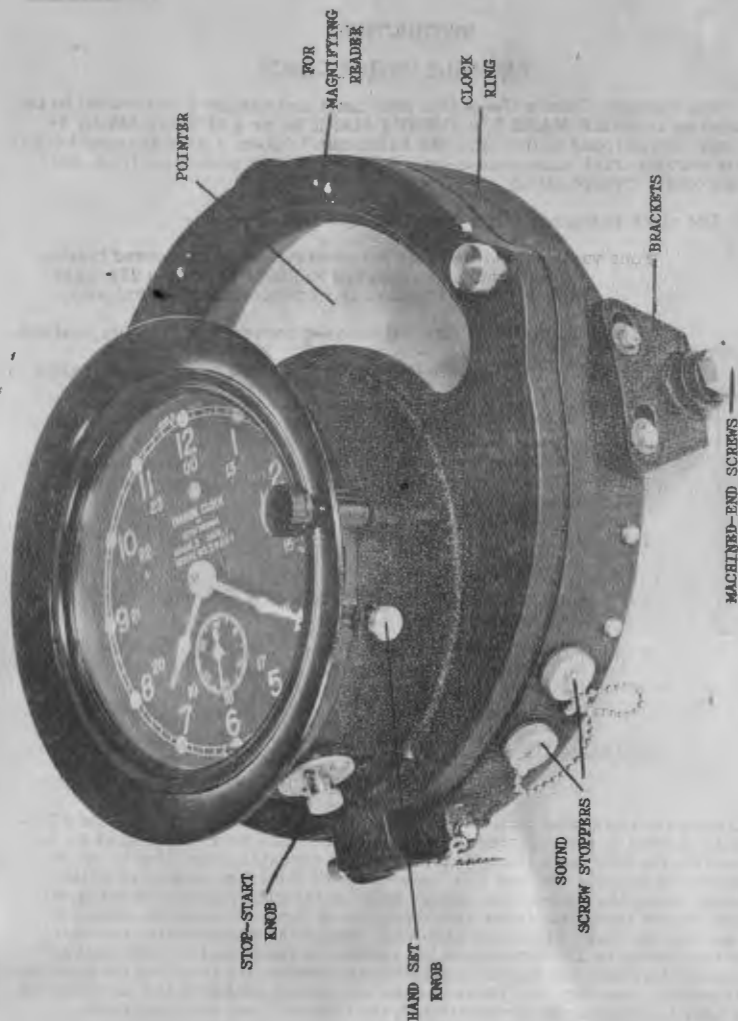
Two clamp-plates for use with ARMA MARK 6 and SPERRY MARK 24 repeaters.

Eight spare filister head screws and eight spacer-washers in cotton bag. (For accessories see Fig. 4).

INSTALLATION ON ARMA MARK 6 OR SPERRY MARK 24

STEERING REPEATER

1. Secure the two clamp plates to the repeater case, one each at 90° and 270° with respect to the repeater lubber line. This may be accomplished by removing the nuts from the bolts that hold the repeater bezel ring to the repeater case at the 90° and 270° positions, fit the clamp-plates over the bolts, using the appropriate spaced holes in the clamp-plates (see Fig. 4), and secure the plates to the repeater case at these positions by means of the nuts that were originally removed. Should the clamp-plates not seat properly due to insufficient seating surface on the repeater case, sets of spacer-washers and longer repeater bezel screws are provided for this contingency. (See Fig. 4). These screws and spacer-washers are furnished in a small cotton bag as accessories in the Course Clock carrying case.
2. Mount the Course Clock on the repeater. For proper mounting on a SPERRY MK 24 it is necessary to secure the three radial spacers, marked No. 2, to the inside of the Course Clock ring by means of the screws and locating holes provided in the Course Clock ring. (When mounting the Course Clock on an ARMA MK 6 repeater, radial spacers are not necessary since the diameter of the repeater bezel suits the diameter of the Course Clock ring.) Remove the machined-end screws from the clock ring brackets. (These



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FIGURE 1

screws are for use with the SPERRY MK 15 repeater.) Loosen the screws clamping the side brackets to the Course Clock ring, and after snugly seating the Course Clock on the repeater, fasten the brackets to the clamp-plates on the repeater bezel by means of the screws provided.

3. Stop the clock with second hand at "60" by turning "STOP-START" knob, located on side of clock case between "5" and "6" on clock dial. Set minute hand at "12" by means of hand-set knob, located on side of clock case at "4" on clock dial. (See Fig. 1).
4. Install the desired variable course cam by backing off the two knurled head thumb screws on cam shaft on back of clock and place cam on shaft at the same time holding cam follower roller away from cam, and turn until cam sets down on locating pin. Tighten clamp thumb screws. The follower roller when released, should now rest at exactly the "0" point marked on the cam and the pointer should point exactly in line with "6" and "12" on the clock dial. (See Fig. 2).
5. Close the clock down on the clock ring and secure by means of the two clamp thumb screws provided. **IMPORTANT:** Adjust the clock ring on the repeater until the pointer is exactly over the repeater lubber line when the cam roller is at the cam zero position. Provision is made for the radial adjustment of the Course Clock by means of elongated slots for the screws that secure the brackets to the clock ring. (When installing the Course Clock on a SPERRY MK 24 or an ARMA MK 6 repeater additional radial movement is provided by the elongated slots for the screws securing the brackets to the clamp-plates.)
6. When the pointer has been adjusted exactly over the repeater lubber-line and the clock ring is snugly fitted down on the repeater, tighten the clock ring bracket screws and the screws clamping the clamp-plates to the brackets.
7. Wind fully both clock spring barrels.
8. Set the clock on the correct time and start the clock by turning the "STOP-START" knob.

The Course Clock is now ready for use.

INSTALLATION ON SPERRY MK 15 REPEATER

1. Mount the Course Clock on the repeater. For proper mounting on a SPERRY MK 15 repeater it is necessary to secure the three radial spacers, marked No. 1, to the inside of the Course Clock ring by means of the screws and locating holes provided in the Course Clock ring. (See Fig. 3). Loosen the screws securing the clock ring brackets to the clock ring and enter the machined-end screws of the clock ring brackets in the repeater case holes located at 90° and 270° with respect to the repeater lubber-line.
2. Proceed with installation in accordance with sub-paragraphs 3, 4 and 5 above.
3. When the pointer has been adjusted exactly over the repeater lubber-line, and the clock ring is snugly fitted down on the repeater, tighten the clock ring bracket screws and tighten the machined-end screws entered in the holes in the repeater case.
4. Wind fully both clock spring barrels.
5. Set the clock on the correct time and start the clock by turning the "STOP-START" knob.

The Course Clock is now ready for use.

FIGURE 1

REPEATER LUBBER LINE MAGNIFYING READER

The SPERRY MK 15 repeater is equipped with a magnifying reader attached to the repeater bezel by means of thumb screws. This reader, when removed in order to mount the Course Clock, may be attached to the Course Clock bezel ring by means of the thumb screws and threaded holes provided in the clock bezel ring for this purpose. (See Fig. 1). The magnifying reader will serve the same purpose as heretofore and will be turned on its mount away from the steersman's line of vision while steering by means of the moving pointer.

REPEATER COURSE INDICATING DEVICE

Some models of the SPERRY MK 15 repeater contain a course indicating pointer with a resetting knob that protrudes through the center of the repeater glass. This knob will prevent mounting of the Variable Course Clock unless it is removed. It is recommended that SPERRY service personnel be required to remove the hand setting device and replace the repeater glass.

THE CLOCK

The clock consists of an eight-day double spring barreled movement and is geared to rotate the cam spindle once in one hour. Each clock, before issue, has been adjusted to keep accurate time within a very small + or - deviation. The cam spindle with its cam locating pin has been accurately oriented in order that the cam follower roller rests on the zero mark on each cam with the minute hand of the clock at exactly twelve on the clock dial.

WARNING: NEVER TURN THE CAM BY HAND AGAINST THE CLOCK MOVEMENT. Always turn the cam by means of the hand setting knob provided on the side of the clock case.

VARIABLE COURSE CAMS

Variable course cams are numbered beginning with "CAM No. 20" (CAM No. 20A with the audible signal pins) and continuing "CAM No. 21", "CAM No. 22", and "CAM No. 23", all cams having audible signal pins. The first digit, (2), represents the MARK number of the cam, the second digit, "0", "1", "2" or "3" represents the MODIFICATION number of the cam. As the modification number of the cam increases, the corresponding cam has been designed to produce a more sinuous track calculated for use in more dangerous waters. The serial number of the particular cam appears under the cam number and this number only serves to keep account of each cam for security reasons. All cams marked "CAM No. 20" (without signal pins) and "CAM No. 20A" (with signal pins) are identical. All cams marked "CAM No. 21" are identical and so on regardless of the serial number.

All cams are for use on Seth Thomas Course Clocks MARK 2 MOD 0 serial numbers beginning with 20,001 and Seth Thomas Course Clocks MARK 2 MOD 1 serial numbers beginning with 20,501.

TIME INTERVAL ATTACHMENT

In the event the use of a conventional zig-zag course is chosen, the adjustable time interval disc is furnished for this purpose. This disc is attached to the cam shaft in the same manner as the variable course cams. (See Fig. 3). Starting at the zero point on the time interval disc, screw-pin stops, (provided in a block attached to the inside of the carrying case), may be positioned for any sequence of intervals in steps of one (1) minute. As each interval passes, the stop pins trip a rocker arm which strikes a bell, thus providing an audible signal indicating the next change in course is due. The clock ring is provided with two screw plug stoppers which may be removed if a louder bell signal is desired. (See Fig. 3).

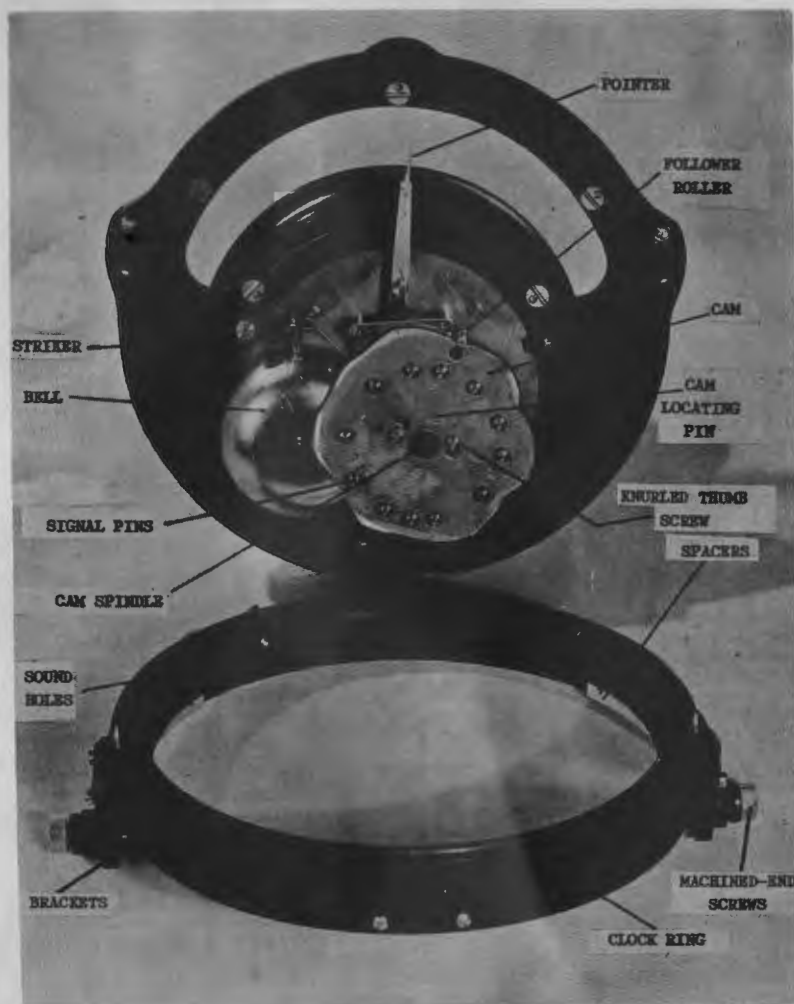


FIGURE 2

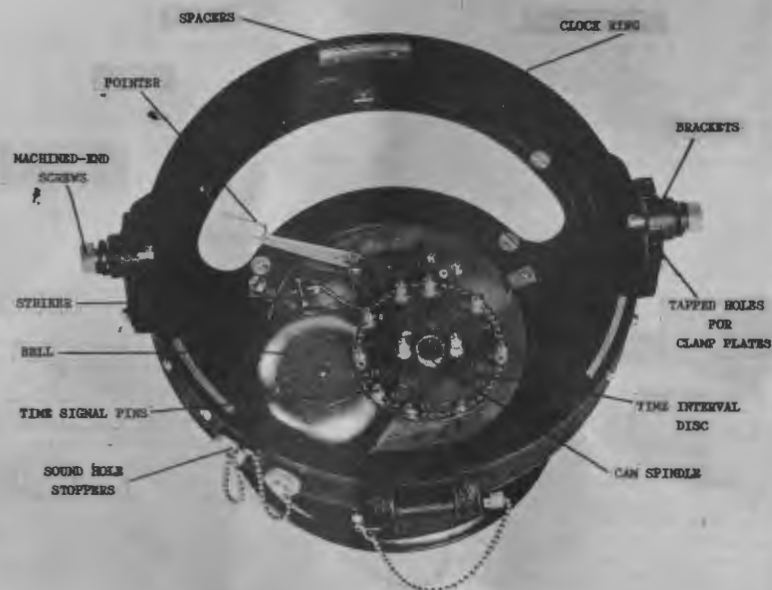


FIGURE 3

OPERATION

In operation the helmsman should disregard the repeater lubber line and steer by the moving clock pointer, swinging the ship so that the designated base course appears on the repeater card directly below the pointer at all times.

The variable course cams have been manufactured and adjusted in conjunction with dead reckoning equipment so that, excluding the effects of drift, windage, and manual error occurring during steering, the vessel will return to base course after each complete cycle of the cam. The helmsman should follow his course by the moving lubber-line (pointer) as closely as possible in order to reduce the manual error to a minimum. An upper finger on the pointer is provided to reduce parallax error. To warn the steersman of a change of pointer travel direction, in order that he may be prepared to check the swing of the ship in preparation for a reversal of direction of the helm, each variable course cam is provided with removable screw-pins so located in the cam that as the cam rotates the pins cause a striker to be tripped that strikes a bell thus providing an audible signal. (Should local conditions be such that difficulty is experienced in hearing the warning bell, two screw stoppers are provided in the clock bezel that may be removed to allow greater emission of sound volume from the bell.) These signal pins are placed so that the warning signal occurs 30 ± 15 seconds before each reversal of direction of the moving pointer.

It is realized that steering by the movable lubber-line (pointer) and to disregard the fixed lubber-line, is a departure from usual procedure and somewhat difficult even for a steersman of some years experience, and more difficult for a steersman of comparatively little experience. Only perseverance, practice and a realization of the considerable increased safety for the ship, as a result of the use of this device, will bring about the accuracy of steering desired. When steering normally, that is by the fixed lubber-line, the steersman often alternately watches the bow of the vessel and the course by the repeater with reference to the fixed lubber-line. When so steering, the steersman turns the wheel to bring the fixed lubber line onto the base course and the bow responds logically to the turn of the steering wheel. Steering by the movable lubber-line involves a different procedure. As the movable pointer falls off to the left, the steersman turns the wheel to the right in order to keep the base course on the movable pointer, and as the pointer moves to the right the steersman turns the wheel to the left in order to keep the base course on the pointer. In other words, instead of bringing the ship (the fixed lubber-line) around to the base course as the steersman does when steering conventionally, he now must, when steering by the movable pointer, keep the base course on the pointer by bringing the ship around to the right as the pointer turns to the left and vice versa. Until the steersman has become thoroughly accustomed to this new method of steering, any attempt on his part to occasionally watch the bow of the vessel will produce a detrimental psychological effect that should be avoided. It is recommended that when steering by the movable pointer the steersman be instructed to concentrate his undivided attention upon the pointer only, and not consider it as moving. By this means it is possible to easily and accurately steer the sinuous courses obtained by use of the cams.

It is not recommended that the fixed lubber-line be obscured during operation of the variable course cams because it is intended that it be possible to resume steering by the fixed lubber-line at a given signal. If steering by the fixed lubber-line is resumed on any even hour, the vessel should then be reasonably on its base course providing steering by the movable pointer has been accurate, speed has remained constant, and drift and windage have not materially effected the vessel's course. Should steering by the fixed lubber-line be resumed during the cycle of the variable course cam, notation of the time and reference to the applicable cam chart (see DETERMINATION OF SHIP'S POSITION) will indicate whether the vessel is to left or right of base track and approximately how far. Resort to normal methods of navigation will serve to bring the vessel back onto base course.

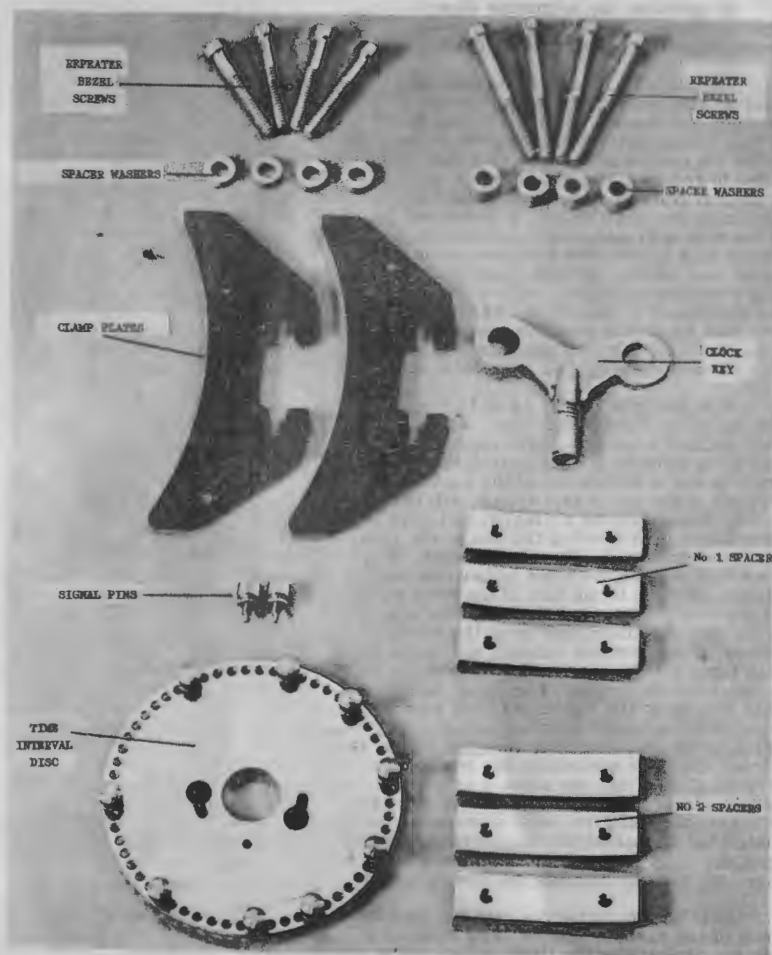


FIGURE 4

IMPORTANT RECOMMENDATION

It is recommended that use of the variable course cams be started on the hour for that the "0" may be checked to verify that the pointer coincides with the lubber-line of the repeater when the clock is on the exact hour. This is especially important should the Variable Course Clock be used in convoy.

DETERMINATION OF SHIP'S POSITION

To determine relative ship's position with respect to base track at any time during the period the variable course is being followed proceed as follows:

- (1) Determine the average ship's speed to the nearest knot during operation of the cam. (NOTE: During this period, any change in ship's speed or average speed will effect the ship's actual curved track, and the chart curve will not conform. The following method of determining distance made good, or distance off base track, will therefore no longer apply.)
- (2) Note time on Course Clock.
- (3) Opposite corresponding time on chart, step off with dividers, (a) distance made good along base track and, (b) distance to left or right off base track.
- (4) Interpret distances with dividers on chart scale corresponding to the ship's average speed.

For a detailed description of the above operation see "EXAMPLE OF THE USE OF THE CHART."

CAM CURVE CHARTS

Two duplicate charts are furnished with each cam showing the cam track with respect to the straight track or base course. Each chart shows the sinuous track divided into time intervals of one (1) minute, and scales, in miles and tenths of a mile, are provided for constant speeds of six (6) to thirty (30) knots in increments of one (1) knot. From these charts the ship's relative position with respect to the base track or base course may be determined. The distance made good, during the period of time the vessel has been steered by the clock pointer, may also be determined. (See DETERMINATION OF SHIP'S POSITION.)

In order to provide a clear understanding of the proper use of the cam charts, an explanation of the theory upon which construction of the charts is based, together with a description of the method employed in their making, follows.

Assume that two vessels, one travelling at a constant speed of thirty knots and the other at six knots, commence steering by identical cams, both starting with the clocks on the hour and therefore the cams on zero. Provided both vessels sustain constant speed and both steer accurately by the cam, both vessels will steer exactly the same sinuous course with the exception that the thirty knot vessel's distance made good and distance off base track will be five times that of the six knot vessel at any given time during the cycle of the cams. This fact forms the basis for construction of the charts issued with each cam.

To obtain an accurate master chart of the sinuous course produced by use of the cam, the following method is employed in the Laboratory. The Variable Course Clock is mounted on a gyro compass repeater and the particular master cam is installed on the clock. The movement of the repeater card is accurately controlled by means of a manually operated synchro transmitter so that a predetermined base course is always indicated by the lubber line which is the moving pointer of the Course Clock. A Dead Reckoning Tracer Equipment,

supplied with a constant speed input, is connected to the same synchro transmitter and is used to plot the sinuous track produced by following the Course Clock pointer exactly as the steersman of a vessel will do. Each master cam is rotated through one cycle by the Course Clock which covers a period of exactly one hour. If necessary, the periphery of the master cam is adjusted in order that the sinuous track produced will return to base track after each cycle. From this master cam, all production cams for issue are produced.

The curve chart for a particular cam, two copies of which are furnished with each cam, is explained as follows: The line representing the base track or base course (straight solid line beginning at "0" or "START") on the chart is extended to a point past the sinuous course finish (marked "CAM COURSE FINISH") to a point marked "BASE COURSE FINISH." This point represents the total distance of the vessel's sinuous track were it straightened out to a straight line. This means that the distance between the point marked "START" and the point marked "BASE COURSE FINISH" along the base track, is the same as the distance from the point marked "START," along the sinuous track, to the point marked "CAM COURSE FINISH." Theoretically this is true, discounting the manual error resulting from inaccurate steering by the pointer, windage and drift, and slippage due to turning. The error due to slippage should be minor if the smooth curves obtainable are followed as closely as possible through accurate steering by the pointer. The point marked "BASE COURSE FINISH" is the theoretical distance made good had the vessel travelled on a straight course for one hour. The point marked "CAM COURSE FINISH" is the distance made good in one hour as a result of steering by the cam for one cycle. The difference between these two points on the base track is the theoretical loss, in distance made good, as a result of steering by the particular cam. The sinuous track is subdivided into sixty equal parts thus providing a visual means of determining the location of the vessel, either to left or right of base track, at any time during the sixty minute cycle of the cam. By noting the time on the clock and projecting the applicable point on the sinuous track down or up, as the case may be, onto the base track, this distance from the base track is the distance the vessel is to left or right of base track at that particular time. This same point on the sinuous course when projected to the base track, will give the distance made good from the beginning of the last hour (the present cycle of the cam) to the particular time referenced. In order to interpret these distances in terms of miles, a series of distance scales are produced below the sinuous course chart and calibrated in miles and tenths of miles applicable to different speeds from six knots to thirty knots in increments of one knot.

EXAMPLE OF THE USE OF THE CHART

As an example of the use of the chart, assume a vessel has travelled for thirty-five minutes at a constant speed of fifteen knots and has steered accurately by the Course Clock pointer. By means of dividers, step off the distance on the chart applicable to the cam in use, between the point marked thirty-five minutes on the sinuous track and the point opposite on the base track. This represents the distance to left or right (determined from the chart by visual means) off base track after steering according to the Course Clock pointer for thirty-five minutes. Apply this distance with the dividers to the fifteen knot scale on the chart and read directly the distance in miles and tenths of a mile off base track. Similarly with dividers step off the distance from the same point on base track to the point marked "START" on the chart and read directly the distance made good along base course in miles and tenths on the fifteen knot distance scale below the sinuous course chart. This value is the distance made good only during that part of the present cycle of the cam at which time by the clock was taken. If the vessel has been proceeding by the cam for more than one hour, the distance made good for each consecutive cycle of the cam must be added in order to determine the total distance made good along base course from the time steering by the Course Clock pointer was assumed. The distance made good for one cam cycle by the vessel travelling at a constant speed of fifteen knots, is obtained by stepping off with dividers, as before, the distance along base track between the points marked "START" and "CAM

COURSE FINISH" and applying this distance with the dividers to the fifteen knot scale on the chart. Multiply the distance obtained in miles and tenths, by the number of consecutive hours the vessel has been steered by the Course Clock pointer and add this value to the distance made good during the elapsed period of the present cam cycle as previously determined. The total obtained is the distance made good since steering by the Clock pointer was assumed. It will be found that normally this will result in a dead reckoning position as accurate as that obtained using ship's speed R.P.M. curves and straight courses.

CONCLUSION

In conclusion it is emphasized that the charts have been developed under ideal laboratory conditions; therefore, too great a deviance from a constant speed, failure of the helmsman to closely follow the Course Clock pointer, and the effects of windage and drift, all combined, tend to detract from the accuracy of the distance values obtained by use of the charts. Experience in the use of the chart under varying seagoing conditions, and frequent checking against celestial observations, will in time give an indication as to the limits wherein tolerable accuracy may be assumed. Wherever practicable, the ship's actual track should be plotted by Dead Reckoning Tracer to check the results obtained from the cam charts.

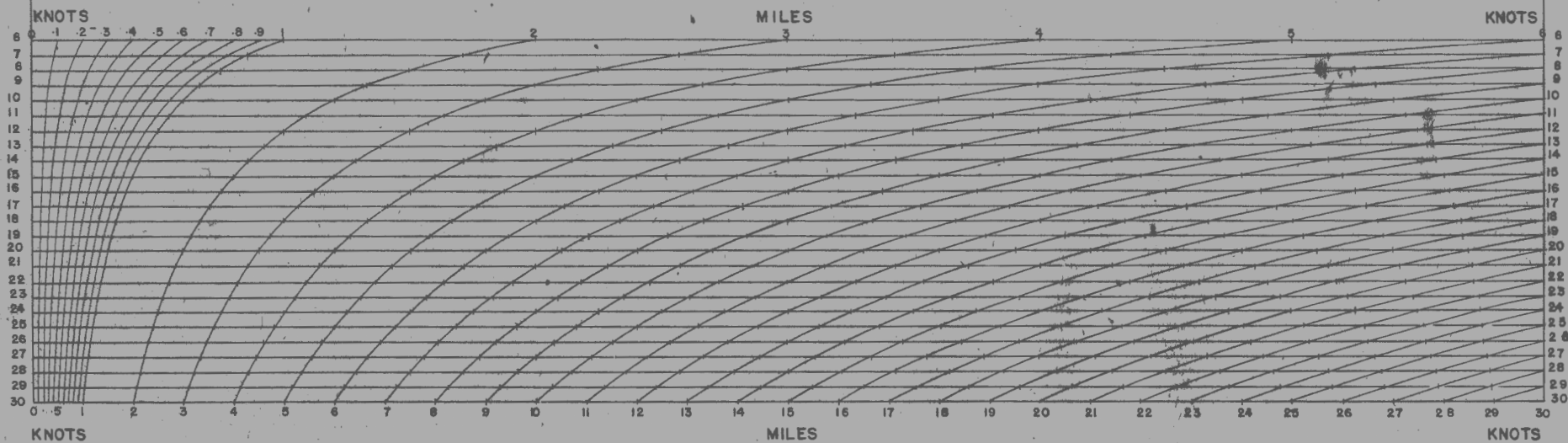
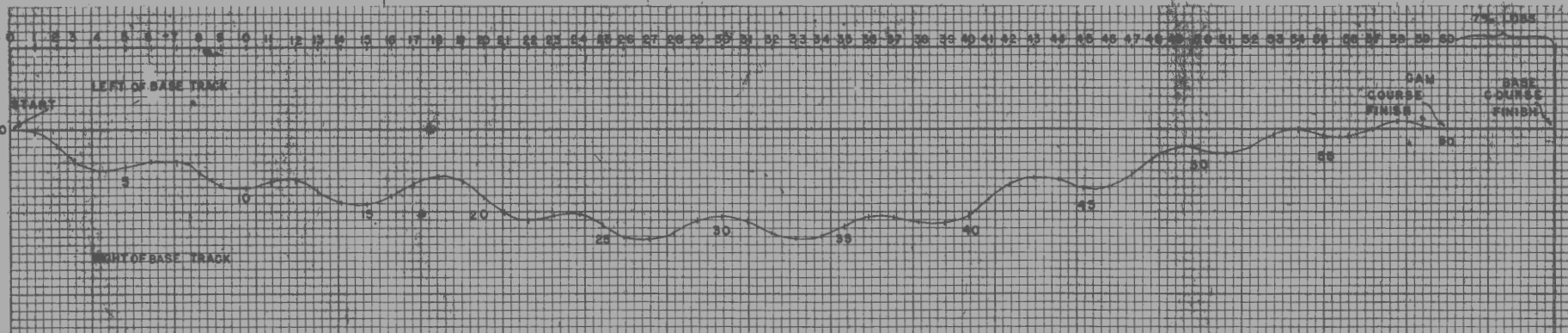
CONFIDENTIAL

CURVE CHART FOR CAM N° 23

FOR USE WITH VARIABLE COURSE CLOCKS

MK II MOD. 0 AND MK II MOD. 1

BUREAU OF SHIPS
NAVY DEPT. WASH. D.C.



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DO NOT FOLD

CURVE CHART FOR

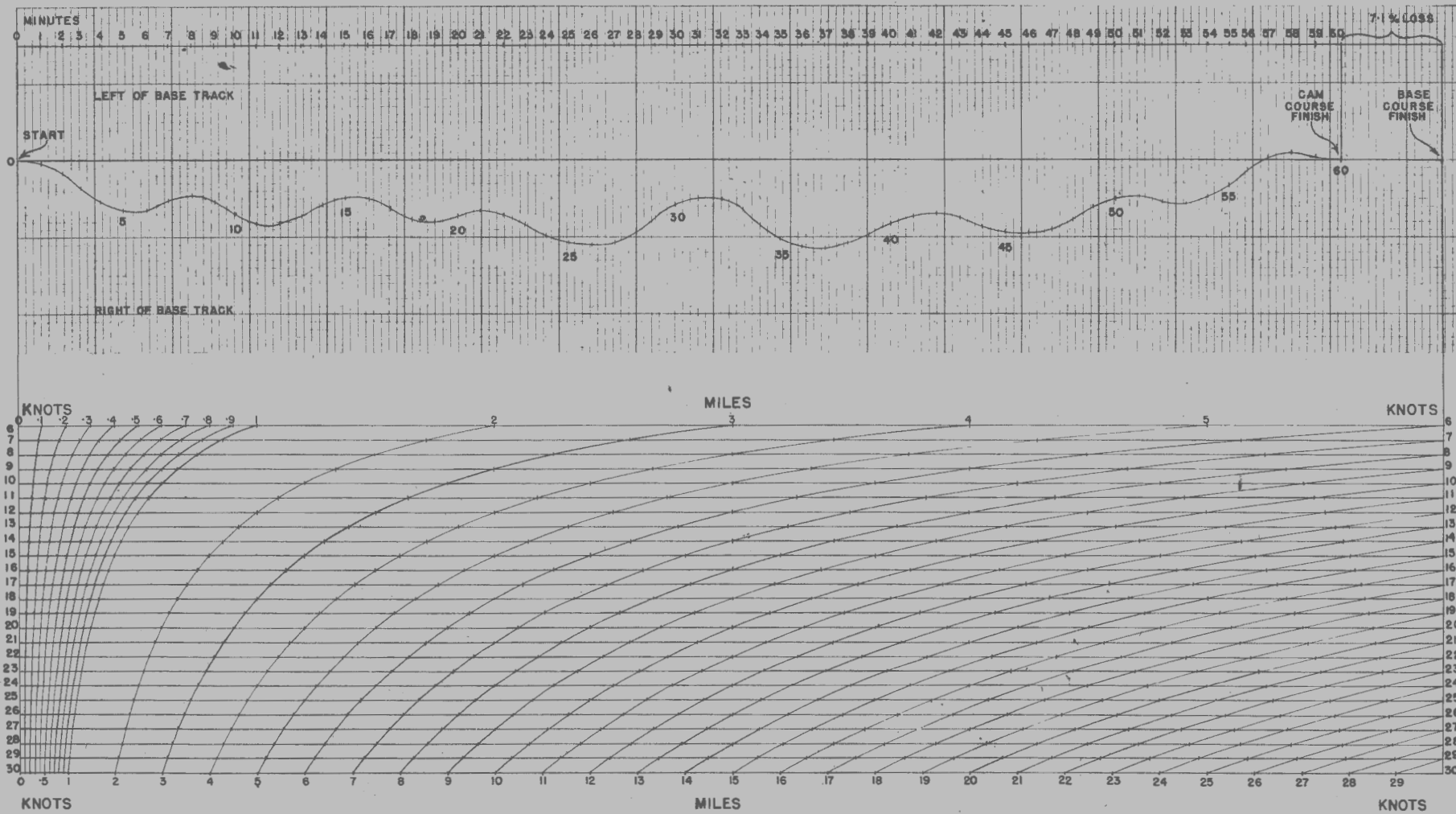
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CAM N°22

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NAVY DEPT. WASH. D.C.

FOR USE WITH VARIABLE COURSE CLOCKS

MK II MOD. O AND MK II MOD. I



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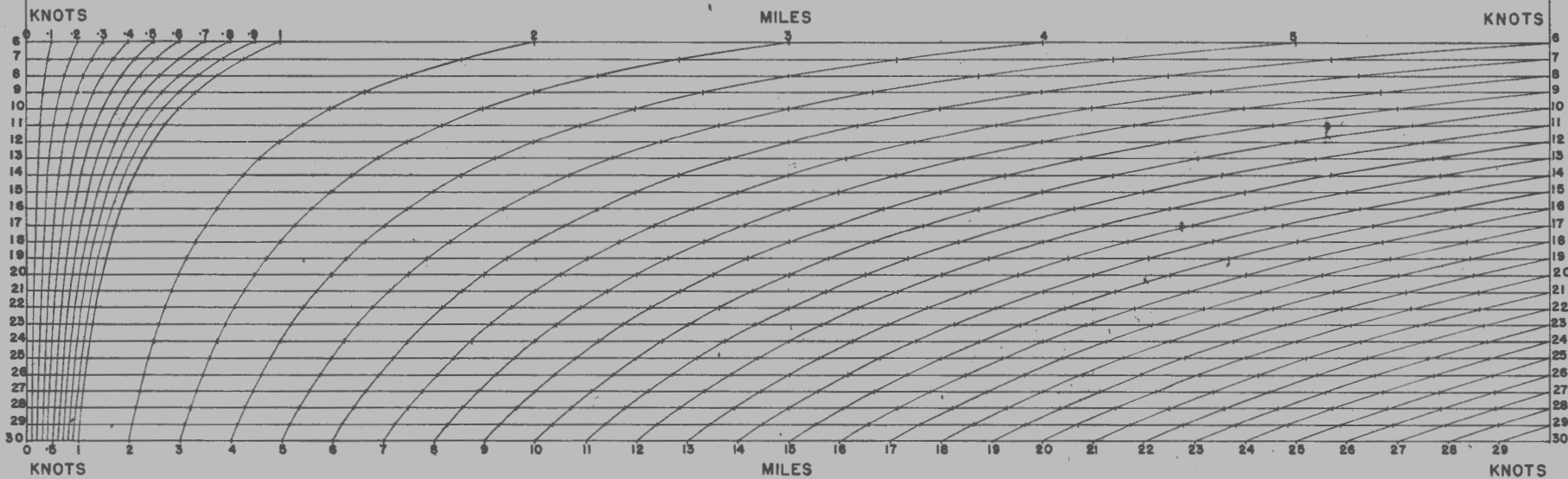
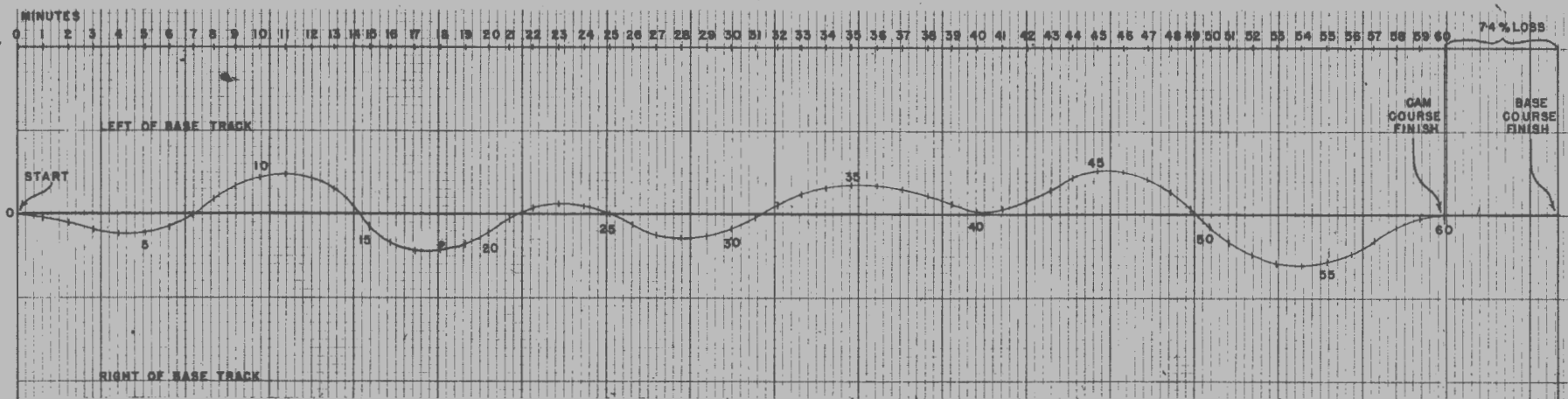
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CURVE CHART
FOR
CAM N° 21

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FOR USE WITH VARIABLE COURSE CLOCKS
MK II MOD. 0 AND MK. II MOD. I



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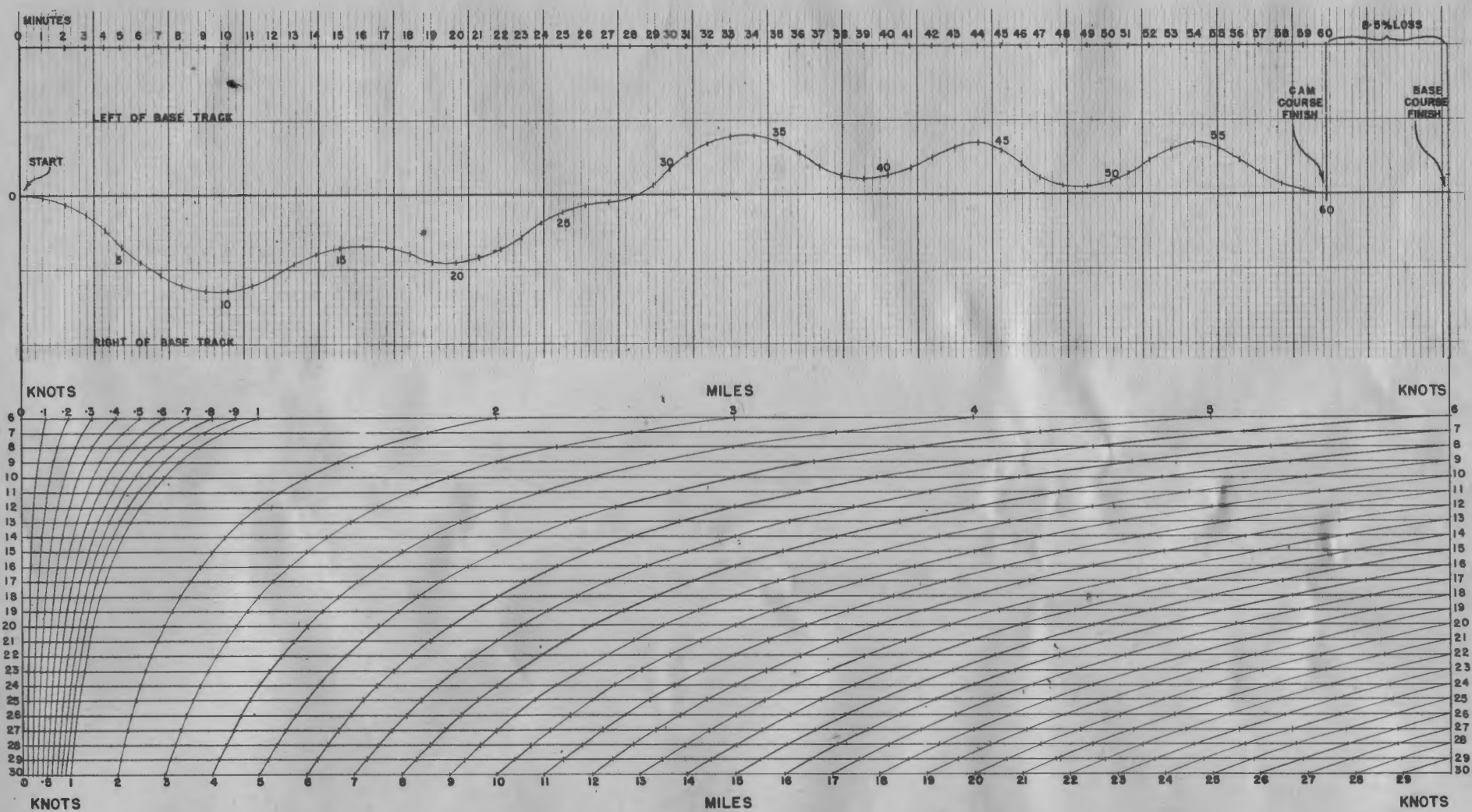
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CURVE CHART
FOR
CAM N°20

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FOR USE WITH VARIABLE COURSE CLOCKS
MK II MOD. 0 AND MK. II MOD. I



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