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WAR DEPARTMENT

TECHNICAL MANUAL

SOUND LOCATORS
M1A1 TO M1A8, INCLUSIVE

April 15, 1941

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TECHNICAL MANUAL No. 9–1661

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SOUND LOCATORS, M1A1 TO M1A8, INCLUSIVE

Prepared under direction of the Chief of Ordnance

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SECTION I

GENERAL

1. **Purpose.**—This manual is published primarily for the information and guidance of ordnance maintenance personnel.

2. **Scope.**—This manual supplements the technical manuals which are prepared for the using arm. It contains descriptive matter and illustrations sufficient to provide a general working knowledge of the equipment, and in addition contains information of use in the maintenance and repair thereof by ordnance personnel.

3. **References.**—Appendix II lists the technical manuals and Standard Nomenclature List for the equipment described herein.

4. **Principles of operation.**—*a. Definition.*—A sound locator is an instrument for determining the angular position (that is, the azimuth and elevation) of an aerial target by the sound it emits.

b. Binaural sense.—(1) This instrument takes advantage of a faculty, possessed by all human beings with normal hearing, of being able to determine, with considerable accuracy, the direction of a source of sound. The human auditory system is a binaural one (that is, it involves the use of two ears) and is, in effect, a two-station position finding system, consisting of a base line (ordinarily horizontal), approximately 6 inches long, with listening devices, the ears, at both extremities. The ability of the individual to determine directions acoustically by means of this system is called the *binaural sense.*

(2) The specific effect which renders this ability possible is called the *binaural phase effect.* This effect depends on the fact that, unless the listener is facing the source, each sound wave will arrive at one ear a fraction of a second before it arrives at the other. The resulting sensations, transmitted to the brain, are analyzed, with the result that the sound seems to emanate from the right or left as the case may be; if the listener then turns his head a corresponding amount, the sound waves then arrive at both ears simultaneously and thus seem to come from the front.

(3) Confusion should be avoided at this point with another effect known as the *binaural intensity effect.* This effect, which indicates a source of sound to be on the side of greatest *intensity*, also exists, but is not believed to be particularly effective in the making of accurate directional determinations.

(4) A person with normal hearing is able, without mechanical aid, to turn so as to face, within 10° of azimuth, the true direction of a source of sound. By the use of a longer base line with sound-collecting means at the extremities, this accuracy may be greatly improved. Sep-

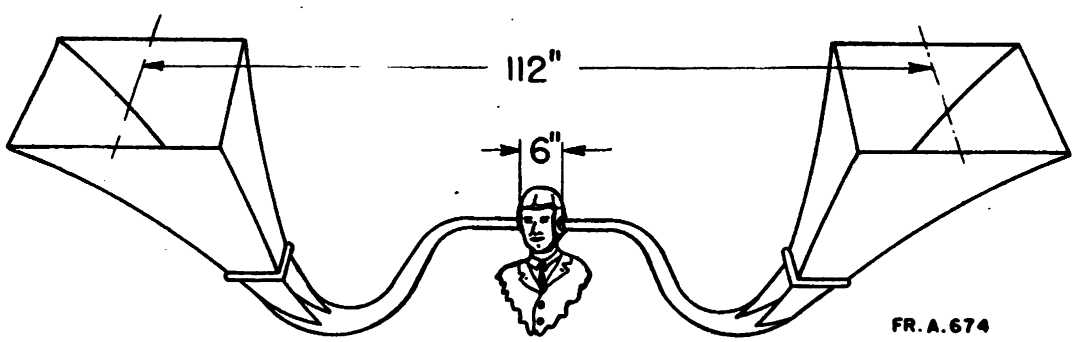
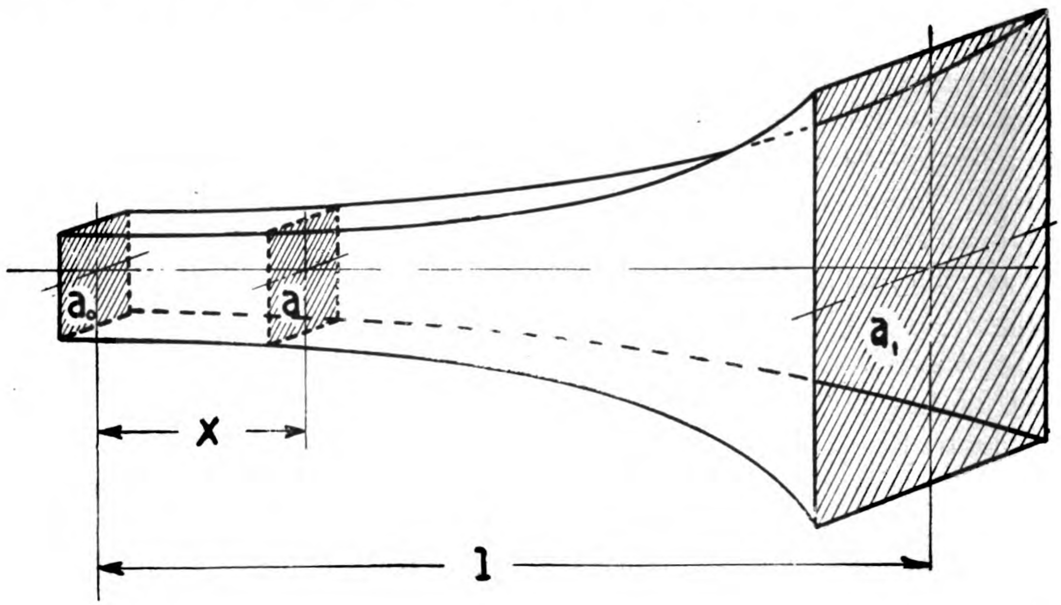


FIGURE 1.—Sound location—binaural principle.

arate systems with vertical and horizontal base lines make possible the determination of the elevation and the azimuth of the source, respectively, simultaneously with equal facility. These sound locators utilize base lines 112 inches long and the determinations, when the source is stationary, are accurate to within ¼°.

c. Horns.—The sound-collecting means used in these sound locators are horns. These horns present a greater effective area than the ear to the sound wave and therefore provide a certain amount of amplification, extending the hearing range two or three times. They also have in themselves certain directional properties, giving an increase in volume as the direction of sound is approached. The losses due to internal reflection are minimized by approaching closely the ideal, or "exponential" shape, that is, the area of cross section varies exponentially along its length, in accordance with the relation shown in figure 2. The design constants of these horns are determined by



$$a = a_0 e^{mx}$$
$$a_1 = a_0 e^{ml}$$

a_0 = AREA AT THROAT.
a = AREA AT DISTANCE X FROM THROAT.
a_1 = AREA AT MOUTH.
l = LENGTH OF HORN.
e = 2.718··· (NAPERIAN BASE.)
m = DESIGN CONSTANT

FR.A.671

FIGURE 2.—Exponential horn.

mechanical considerations and by the frequencies at which efficient operation is desired. It is essential that extreme care be taken in manufacture to insure that both horns of each pair are matched, that is, have the same acoustical properties.

d. Frequency range.—(1) The sound of an airplane in flight consists, like any other musical sound, of periodic variations in air pressure. The sound is not a pure tone, such as is produced by a tuning fork, but, like most sounds normally encountered, consists of vibrations of a basic frequency, or *fundamental*, plus vibrations of higher frequencies which are integral multiples of the fundamental frequency and are called *harmonics*. It is the presence of these harmonics in varying intensities which determine the *quality* of a sound and enables a listener to distinguish between two separate sound sources of the same fundamental frequency and loudness.

(2) The *frequency* of a sound, sometimes referred to as its *pitch*, is normally expressed in *cycles* (that is, number of complete vibrations) per second. For brevity, the phrase "per second" is sometimes omitted; when a frequency is expressed simply as "cycles", it is to be assumed that the number of cycles specified occurs in one second.

(3) Since different parts of the airplane emit sounds of different frequencies, the composition of the sound, as heard by the listener, is rather complex. The relative amplitudes over a wide range of frequencies for one type of airplane are shown graphically in figure 3.

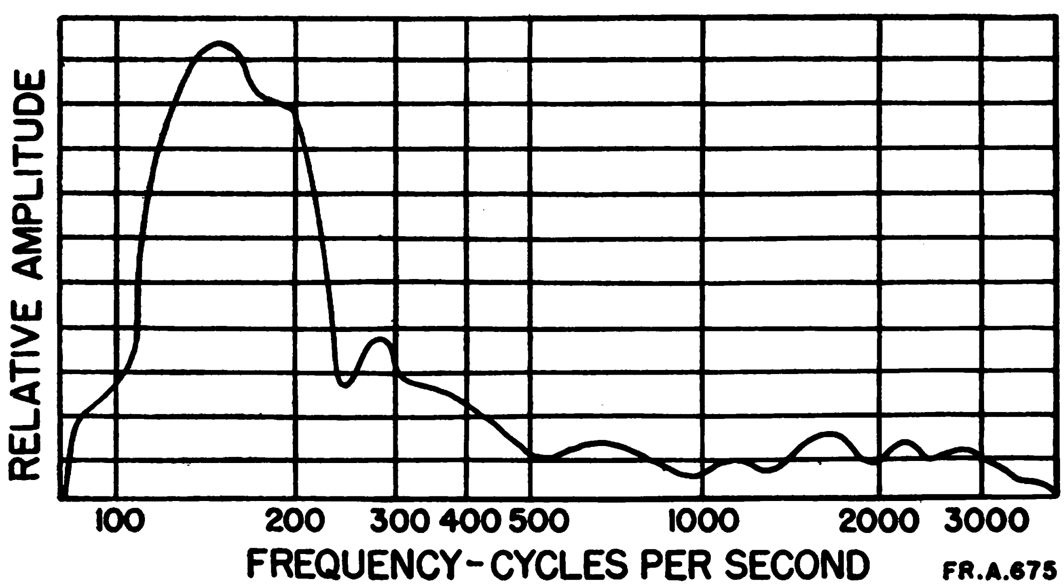


FIGURE 3.—Frequency distribution of sound of airplane in flight. (Single 9-cylinder radial engine with 2-blade propeller.)

(4) By far the greater portion of the sound of all types of airplanes occurs at the lower frequencies and originates from the engine exhaust and propeller noise. The fundamental frequencies for these sounds for several different types of engines and propellers are listed below.

Source	Speed	Frequency
	R. p. m.	*Cycles per second*
7-cylinder radial engine	1, 800	105
9-cylinder radial engine	1, 800	135
7-cylinder radial engine	2, 100	122. 5
9-cylinder radial engine	2, 100	157. 5
2-blade propeller	1, 800	60
3-blade propeller	1, 800	90
2-blade propeller	2, 100	70
2-blade geared propeller	1, 400	47
3-blade geared propeller	1, 400	70

(5) The horns on these sound locators are designed primarily to collect and amplify sounds of all frequencies from 40 to 300 cycles per second. They are also very effective, up to several thousand cycles per second, in permitting successful identification by skilled listeners of the nature of the source, by means of the quality of the sound. Frequencies above 1,300 cycles per second are useful for identification purposes only, as the binaural phase effect is believed to cease for most listeners above that value.

e. Sound lag time.—(1) The velocity of sound in air is very close to 1,100 feet per second. It is therefore evident that the sound emitted at any instant by a distant airplane in flight does not reach the listener until an appreciable period thereafter has elapsed, during which time the airplane will have traveled a considerable distance on its course. This period is known as the *sound lag time* and is denoted by the symbol t_s.

(2) The former position of the airplane from which the sound *seems* to the listener to emanate at any instant is called the *apparent position.* The azimuth and elevation of this position are denoted by the symbols A' and ϵ', respectively.

(3) The position *actually* occupied by the airplane at that instant is known as the *present position.* The azimuth and elevation of this position are denoted by the symbols A_0 and ϵ'_0 respectively.

(4) The acoustic corrector is provided to compute the sound lag time (t_s) and to apply the corresponding corrections to the azimuth and elevation of the apparent position (A' and ϵ') so that the values of these quantities for the present position are obtained. The computations performed by the acoustic corrector are in the nature of approximations and are based on the following assumptions:

(*a*) That the azimuth (A′) and elevation (ϵ') of the apparent position indicated by the sound locator are correct.

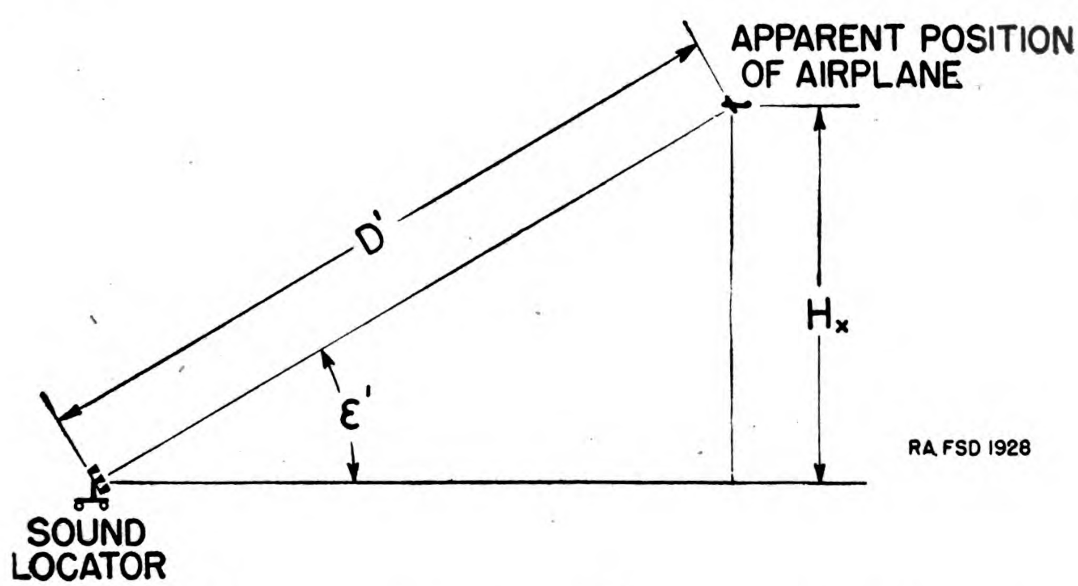
(*b*) That the altitude (H_x) of the apparent position of the target may be *estimated* by personnel with sufficient accuracy.

(*c*) That sound travels from the apparent position of the airplane to the listener along a straight-line path and at a constant velocity of 1,100 feet per second.

(*d*) That the average angular rates of travel of the airplane about vertical and horizontal axes at the sound locator (that is, rate of azimuth change (denoted by Σ'_a) and rate of elevation change (denoted by Σ'_e)) are the same during the sound lag time (t_s) as during a predicting period of predetermined duration while the apparent position is being approached.

(5) The general principles of the acoustic correctors involve performance of the following operations:

(*a*) To determine the sound lag time (t_s). This is the time taken for the sound to travel from the apparent position of the target to the listener and depends directly on the straight-line distance between them and inversely on the velocity of sound. The relation is as shown in figure 4.



$$D' = \frac{H_x}{\sin \epsilon'} \qquad t_s = \frac{D'}{\text{VELOCITY OF SOUND}} = \frac{H_x}{1100 \sin \epsilon'}$$

FIGURE 4.—Determination of sound lag time (t_s).

(*b*) To periodically compute the lateral and vertical angular velocities (that is, rate of change of azimuth and of elevation, Σ'_a and Σ'_e, respectively) of the target by observing the azimuth and elevation changes over a predetermined predicting interval.

(*c*) To multiply these rates by the sound lag time (t_s) and thus obtain the *lateral sound lag correction angle* (denoted by δ_x) and the *vertical sound lag correction angle* (denoted by σ_x), respectively, through which the target has traveled during that interval.

(*d*) To add to the corrections thus determined (δ_x and σ_x), any desired *arbitrary corrections* (denoted by dA and $d\epsilon$), the sums being termed the *total lateral correction angle* (denoted by δ), and the *total vertical correction angle* (denoted by σ), respectively.

(*e*) To add the total corrections so obtained (δ and σ) to the apparent azimuth (A′) and apparent elevation (ϵ'), resulting in an indication of the present azimuth (A_o and present elevation (ϵ_o).

(*f*) To provide means for continuously transmitting the values for the latter quantities electrically to the searchlight control station.

f. Miscellaneous errors.—Outside of errors arising from purely mechanical, physiological, and personal causes, there are numerous uncorrected inaccuracies in the computations of the sound locators, all arising from failure of the assumptions made to completely fit the actual conditions. These inconsistencies are briefly reviewed as follows:

(1) It was assumed that the altitude (H_x) of the airplane could be estimated accurately by personnel. Experienced listeners are able to make this estimation with remarkable precision, basing their estimate on the quality and loudness of the sound and taking into consideration weather conditions, time of day, temperature, winds, etc. However, even skilled listeners may be in error as much as 300 yards, and the effect is to increase or decrease the computed value of the sound lag time (t_s) and hence the sound lag correction angles (lateral (δ_x) and vertical (σ_x)) in the same proportion that the error bears to the altitude.

(2) The sound wave was assumed to travel at the uniform velocity of 1,100 feet per second. Actually this velocity is correct only for still air at a temperature of 45.5° F. The velocity of sound increases about 1.1 foot per second for each 1° F. increase in temperature. There may also be a change in velocity due to humidity (moisture content) of over 1 percent. As the velocity of sound is used in computation of the sound lag time (t_s), that quantity and the corrections based thereon (δ_x and σ_x) are proportionately affected.

(3) Temperature of the air varies through wide limits, not only seasonably, but throughout the day. This affects the velocity of sound, as described in (2) above.

(*a*) If the temperature were uniform, the only effect would be to introduce a proportionate error in the corrections for sound lag time (δ_x and σ_x).

(*b*) However, the temperature is seldom constant; the layer near the ground may be either cooler or warmer than the layer above, and, as higher altitudes are approached, a continuous decrease in temperature occurs. When a sound wave passes from one stratum where its velocity has one value to another stratum wherein its velocity is different, a change in direction occurs which is known as *refraction*. This effect is analogous to the comparatively well-known refraction effect experienced by a ray of light when passing from one medium to another—air to glass, for example. Since the velocity change is mainly due to difference in temperature, the effect is known as *temperature refraction*.

(*c*) Ordinarily, the air temperature does not change at sharply defined strata, but varies gradually over a considerable distance. Thus, abrupt changes in the direction of the sound wave do not ordinarily occur, but the path does become curved. In either event, the result is that the binaural indication of the direction of the refracted wave does not indicate the correct direction of the apparent position of the sound source, the error being mainly, but not entirely, in elevation. Ordinarily, the effect is to impart a slight upward curvature to the path of the sound wave resulting in an indication of apparent position which is lower than the correct apparent position (position at which the sound was emitted), and hence necessitating a positive correction in elevation.

(4) Wind (atmospheric motion) also exerts two effects on the accuracy of sound location.

(*a*) A uniform motion of the atmosphere, with speed and direction constant everywhere between source and sound locator, has the net result of causing the sound locator to indicate an apparent position which is displaced from the correct apparent position (position at which the sound was emitted) by a distance equal to the product of the wind velocity and sound lag time, in the direction *toward* which the wind is blowing. This error is known as *wind drift*.

(*b*) When the motion of the air is nonuniform, a refraction effect occurs similar to that which occurs for nonuniform temperatures. This effect is exerted on the apparent elevation (ϵ'), primarily, with little effect on azimuth. This error is known as *wind refraction*.

(5) The assumption that the average angular rates of travel of the target remain the same during the sound lag time as they do during the predicting interval is not compatible with the more likely assumption used in modern antiaircraft directors, that is, straight-line flight

at constant speed and altitude. Errors arising from this cause are known as *angular travel errors.*

(6) The searchlights and their control stations are ordinarily located at some distance from the sound locators. Small angular differences therefore result between the azimuth and elevations of the true position of the target as viewed from the sound locator and as viewed from the searchlight. This condition is known as *parallax.*

g. Introduction of corrections for miscellaneous errors.—(1) It is possible to compute the values of the corrections for the errors arising from the various acoustic properties of the atmosphere. However, in order to determine these quantities with sufficient accuracy, more information is required about the continuously varying atmospheric temperature and motion, at all the levels between the source and the sound locator, than it is ordinarily practicable to determine. Parallax and angular travel errors are capable of mechanical correction, but provision for such corrections would require computing mechanisms as complicated as those found in antiaircraft directors.

(2) The error involved in the determination of altitude by estimation, however, is not capable of correction. In view of the fact that this error is comparatively large, and of the difficulties involved in introducing the other corrections for the reasons just stated, no provisions are included in this matériel for computing corrections for any of these miscellaneous errors.

(3) Formulas for correcting these errors, where circumstances warrant and sufficient data are available, are included in Section VI. Such corrections may be introduced as arbitrary corrections (dA and $d\epsilon$) when computed.

(4) Another method of determining corrections which may be employed is analogous to the trial shot method used in artillery fire. This procedure consists in the observation of comparative positions of a visible target, as determined by the sound locator and by visible position finding means.

(5) Modern searchlights have a beam which covers a circular field of about 1¼°, and use is made of "searching" to cover the expected circular field of error of about 5°.

(6) It is therefore only necessary that the sound locator determine locations with an accuracy of within 2.5°, an accuracy which can usually be met by well trained, experienced personnel, without the introduction of any computed corrections for miscellaneous errors.

5. General description.—*a.* The sound locator, complete, consists of the following major components:

Sound locator (horns and horn mount).
Acoustic corrector.
Trailer.

b. Several different models of sound locators, trailers, and acoustic correctors have been issued to date. The particular models of sound locators, trailers, and correctors which make up the complete sound locators in service are tabulated below. Some models are arranged for angular indications in degrees, while others indicate in mils; the angular unit employed is specified in the table.

Sound locator, complete	M1A1	M1A2	M1A3	M1A4	M1A5	M1A6	M1A7	M1A8
Sound locator (horns and horn mount)	M1A1	M1A2	M1A3	M1A4	M1A5	M1A6	M1A7	M1A8
Trailer	M2	M2A1	M2A2	M2A3	M2A2	M2A3	M3	M2A4
Corrector	M1	M1	M1	M1	M1A1	M1A1	M2	M2
Angular unit	degree	degree	degree	degree	mil	mil	mil	mil

c. A separate section of this manual is devoted to each of the components of the sound locator.

d. Figures 5 to 12, inclusive, are photographs showing the appearance and general arrangement of the complete sound locators. Figures 13 to 16, inclusive, are typical assembled views.

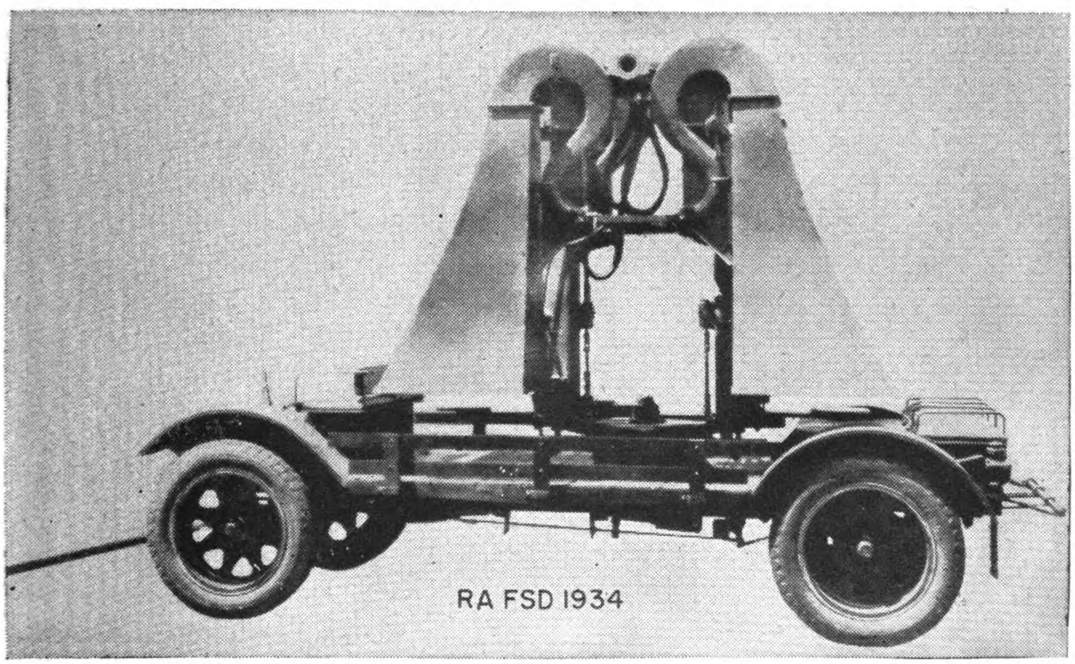


FIGURE 5.—Sound locator, M1A1, complete in traveling position.

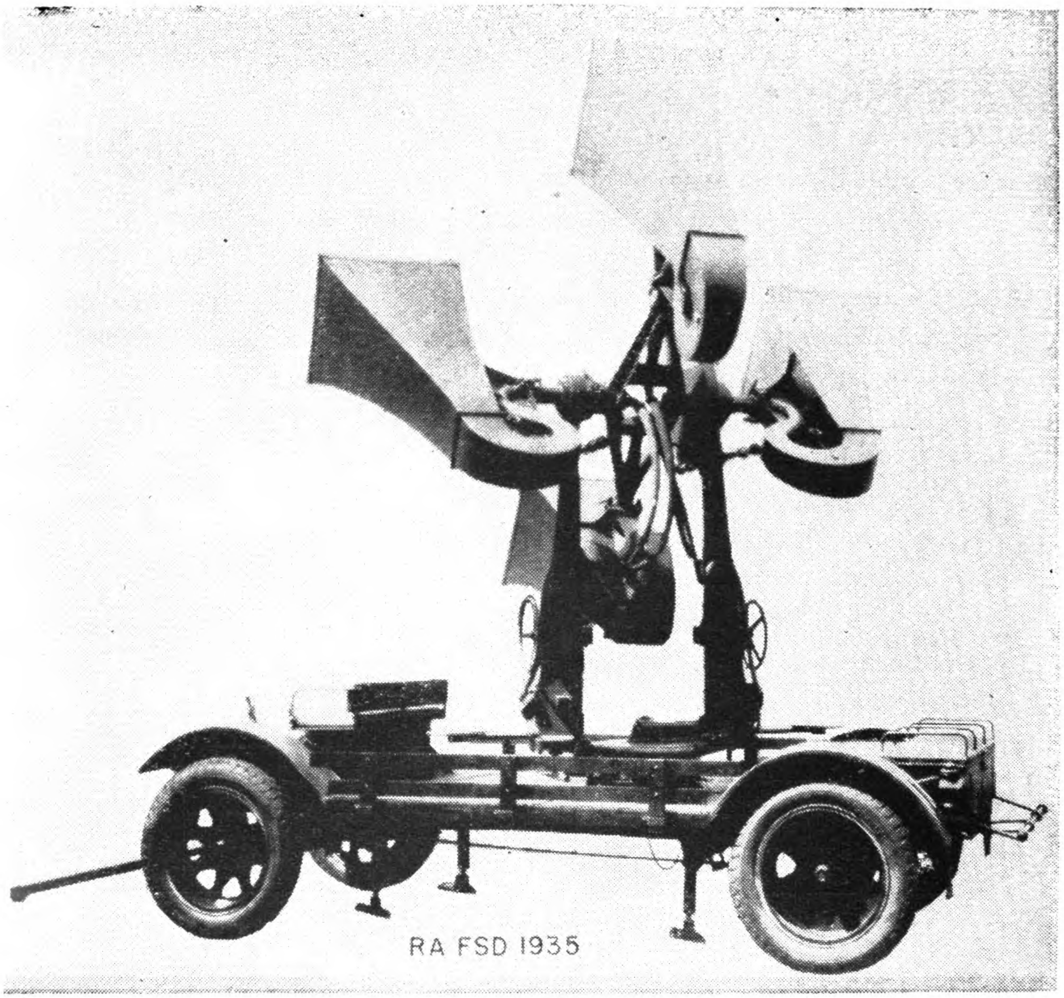


FIGURE 6.—Sound locator, M1A1, complete in operating position.

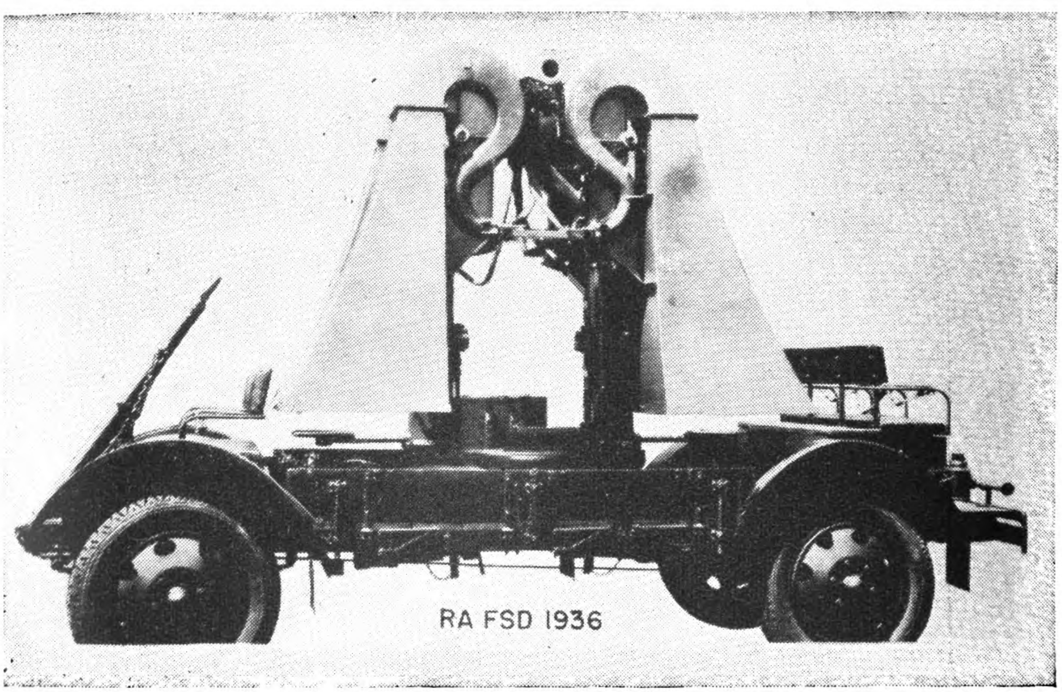


FIGURE 7.—Sound locator, M1A6, complete in traveling position—side view.

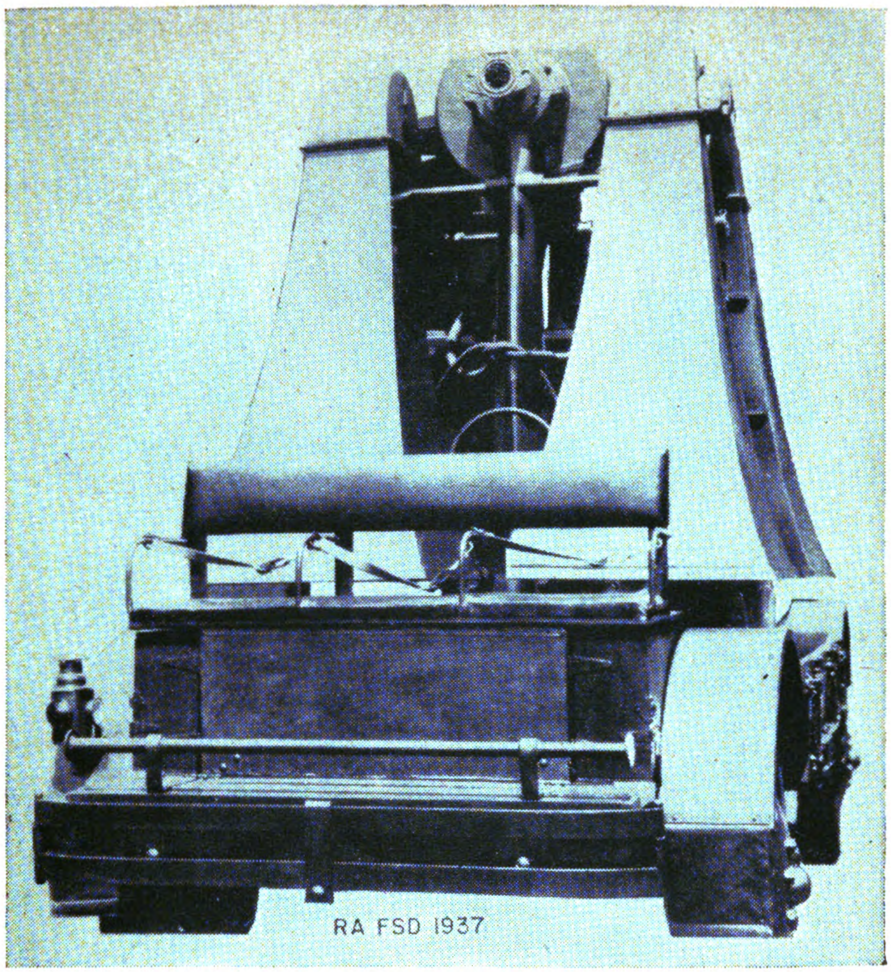


FIGURE 8.—Sound locator, M1A6, complete in traveling position—rear view.

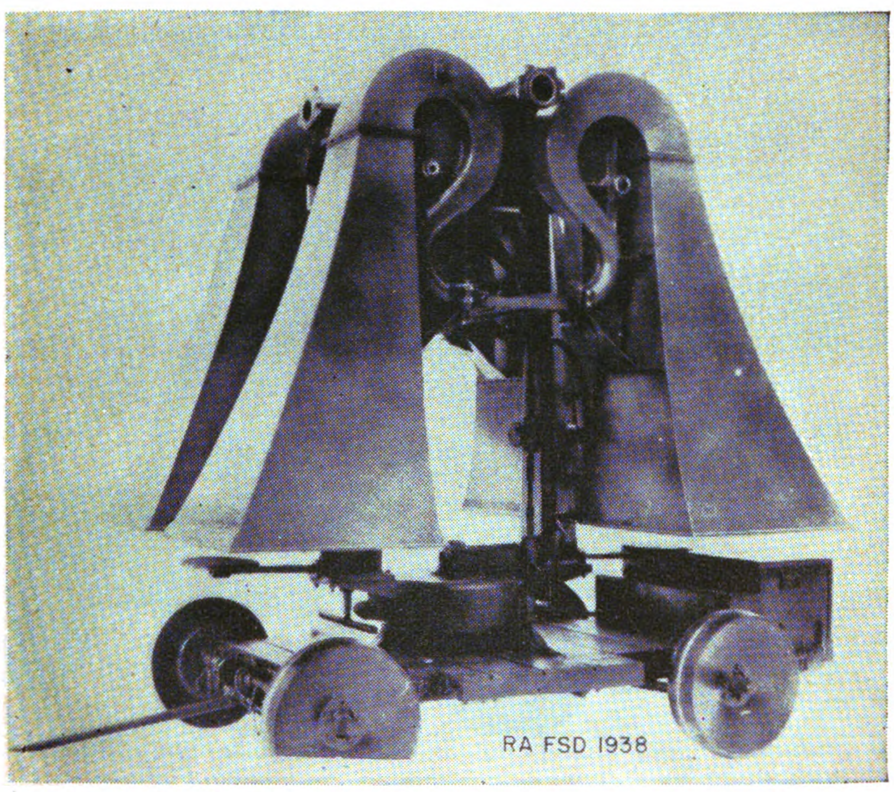


FIGURE 9.—Sound locator, M1A7, complete in traveling position.

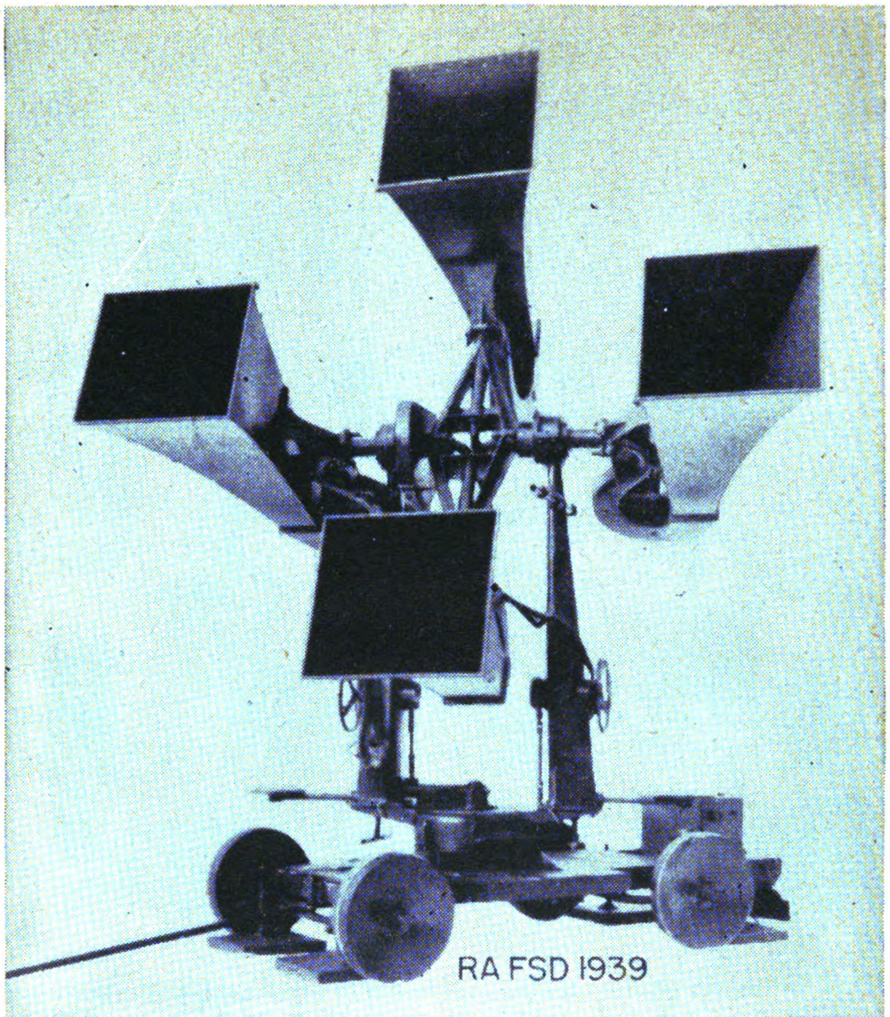


FIGURE 10.—Sound locator, M1A7, complete in operating position.

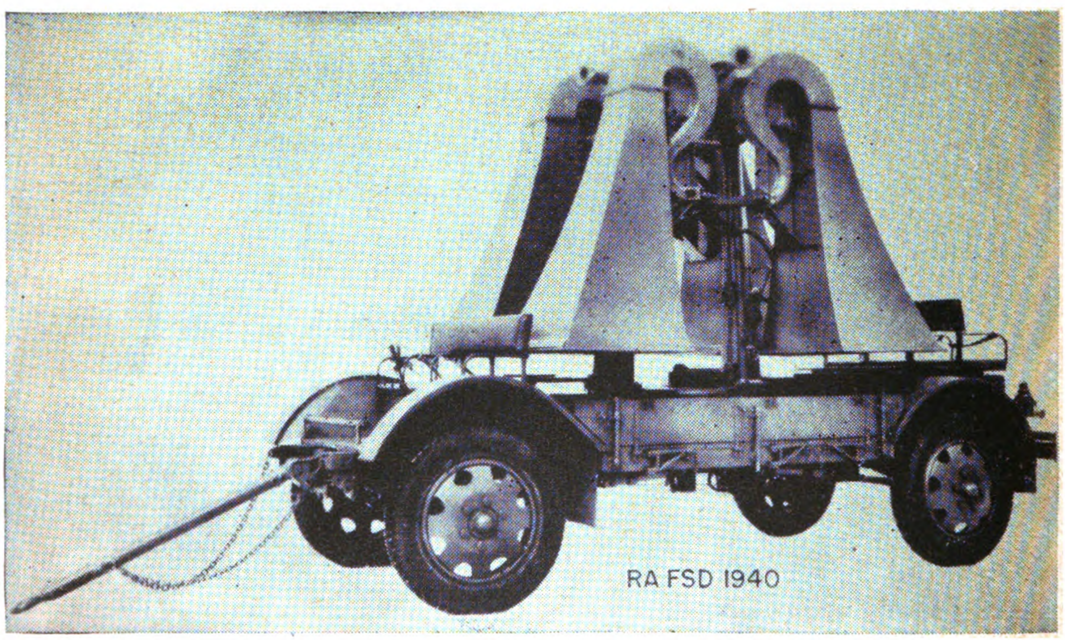


FIGURE 11.—Sound locator, M1A8, complete in traveling position.

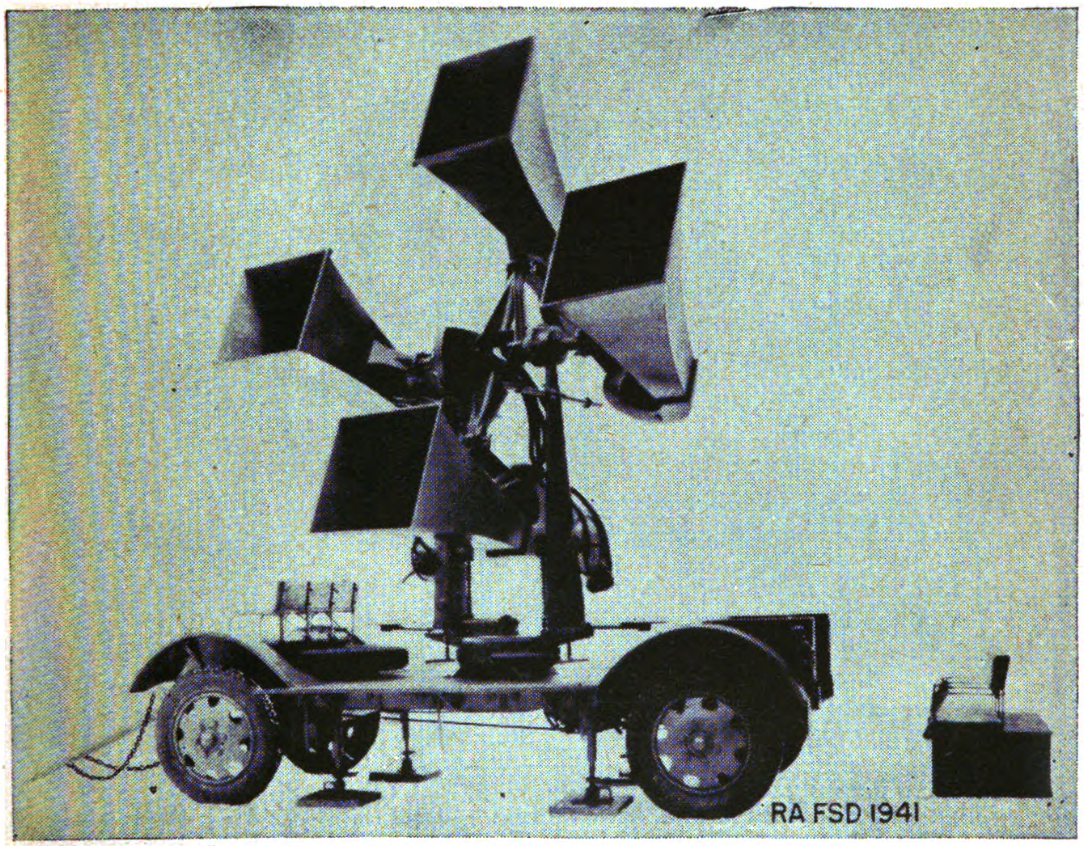


FIGURE 12.—Sound locator, M1A8, complete in operating position.

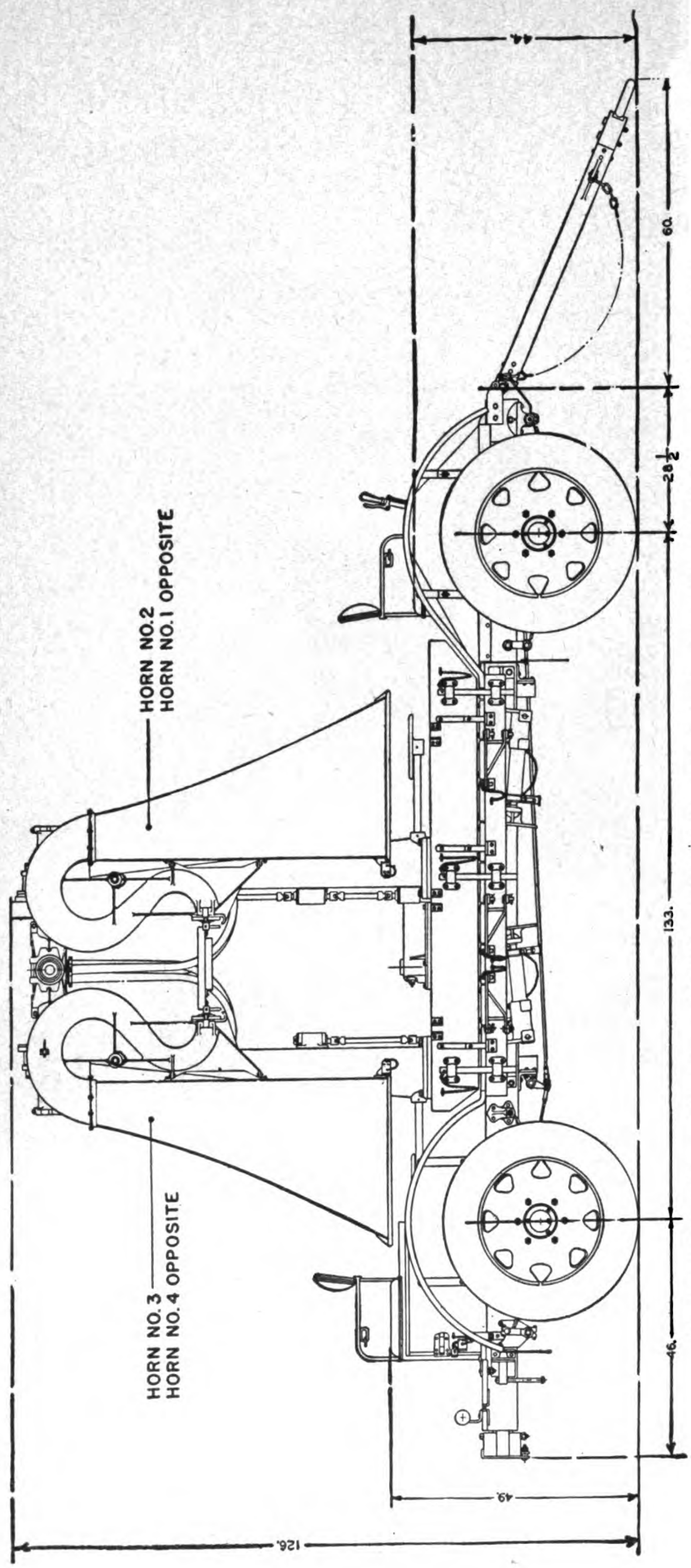


FIGURE 13.—Sound locators, M1A4 and M1A6, complete in traveling position—assembled view. FR.A. 747

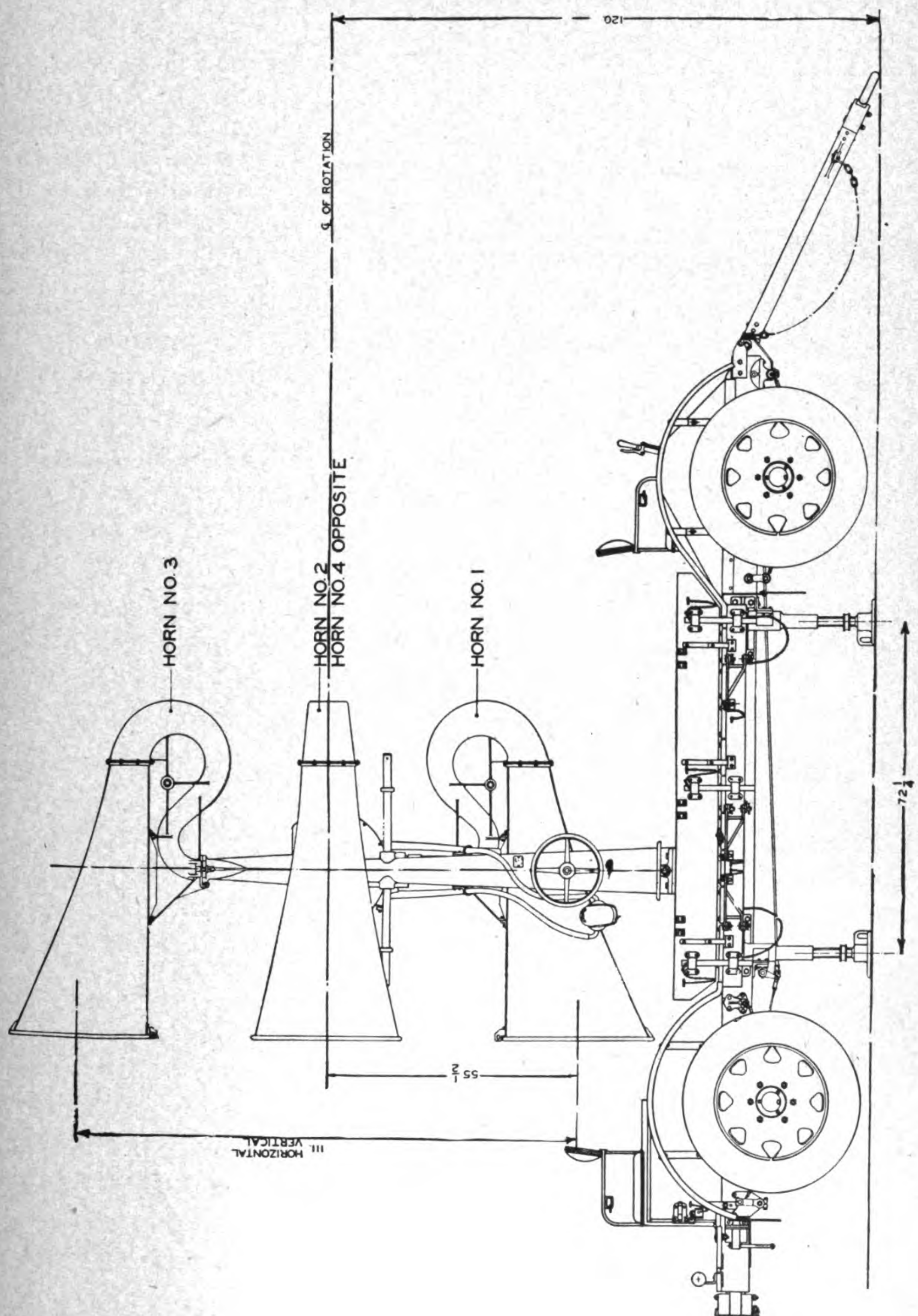


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FIGURE 14.—Sound locators, M1A4 and M1A6, complete in operating position—assembled view.

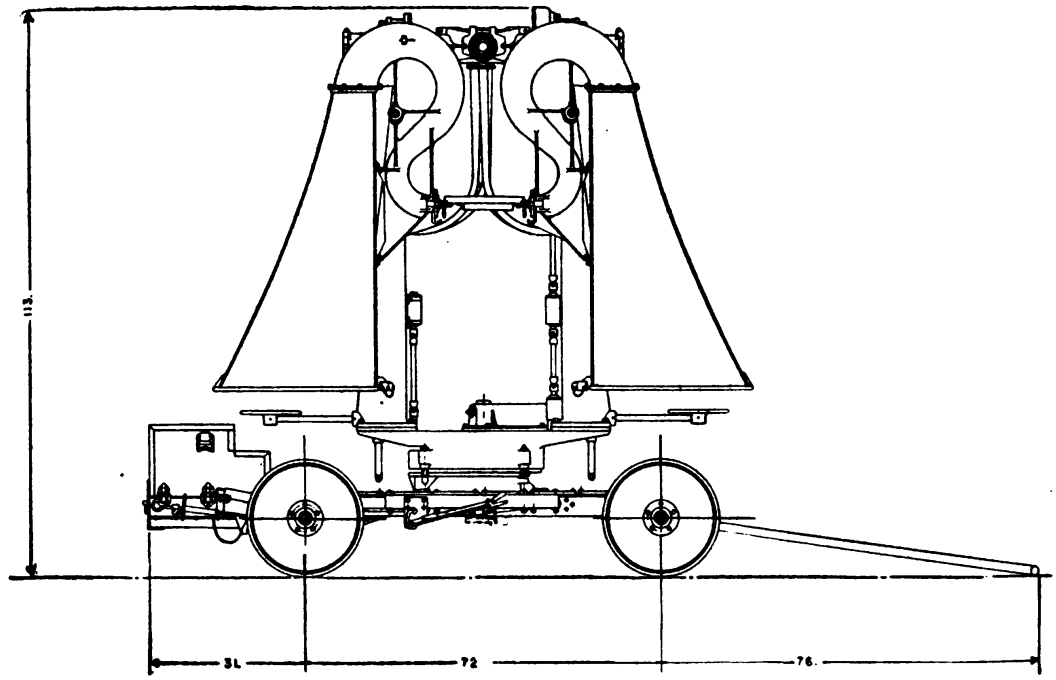

FIGURE 15.—Sound locator, M1A7, complete in traveling position—assembled view.

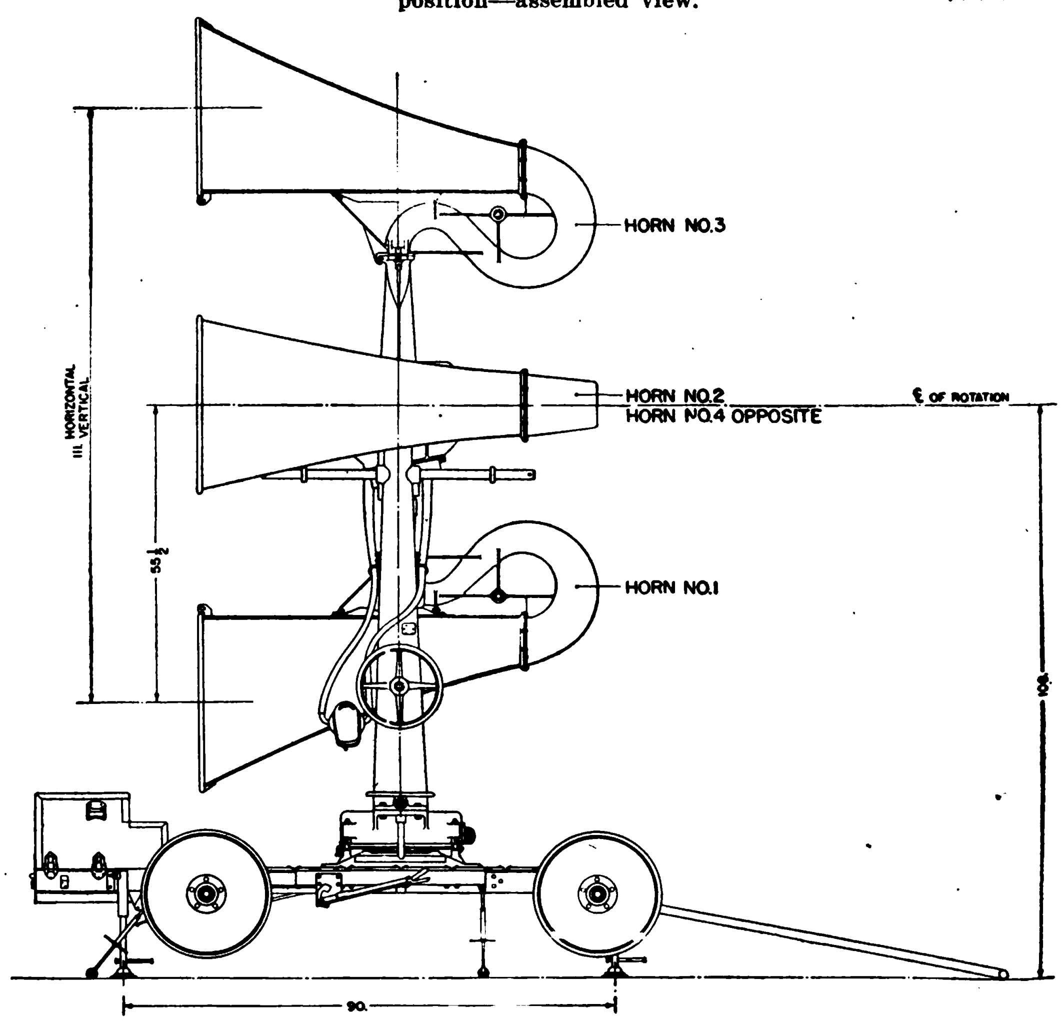

FIGURE 16.—Sound locator, M1A7, complete in operating position—assembled view.

SECTION II

SOUND LOCATORS (HORNS AND HORN MOUNTS)

6. General.—*a.* The sound locator (horns and horn mount to be distinguished from the sound locator, complete, which includes a trailer and an acoustic corrector) is designed to collect and amplify the sound emitted by an aerial target, to determine, by means of the binaural sense of the observers, the direction from which the sound waves are traveling and to provide indications of the azimuth and elevation of that direction.

b. Each unit consists essentially of four horns, binaurally matched in pairs, so mounted that they may be directed simultaneously in azimuth and in elevation by the listeners, two of whom are required.

c. The limits of operation are as follows:

Azimuth	no limits.
Elevation	−10° to +100° or −180 mils to +1,780 mils.

d. Weights and dimensions are as follows:

Weight, total	1,815 pounds
Weight, one horn	120 pounds
Overall height above platform, in traveling position	95 inches

7. Description of horn mount.—*a.* The horn mounts are essentially alike in all the sound locators of the M1 series, differing only in that the azimuth and elevation scales of sound locators, M1A1 to M1A4, are graduated in degrees, while the scales of the latter models, M1A5 to M1A8, are graduated in mils. The arrangement of the horn mount is shown in figures 17 to 23, inclusive.

b. The base (D25546, sec. J–J, fig. 22) of the horn mount is arranged to be bolted directly to the frame of the trailer and supports the upper or revolving part of the mount by means of a rigid vertical spindle (B129102). The traversing worm wheel (C44337, sec. K–K, fig. 22) and the azimuth scale (C56720, degree, or C44542, mil, are fastened to the base (D25546).

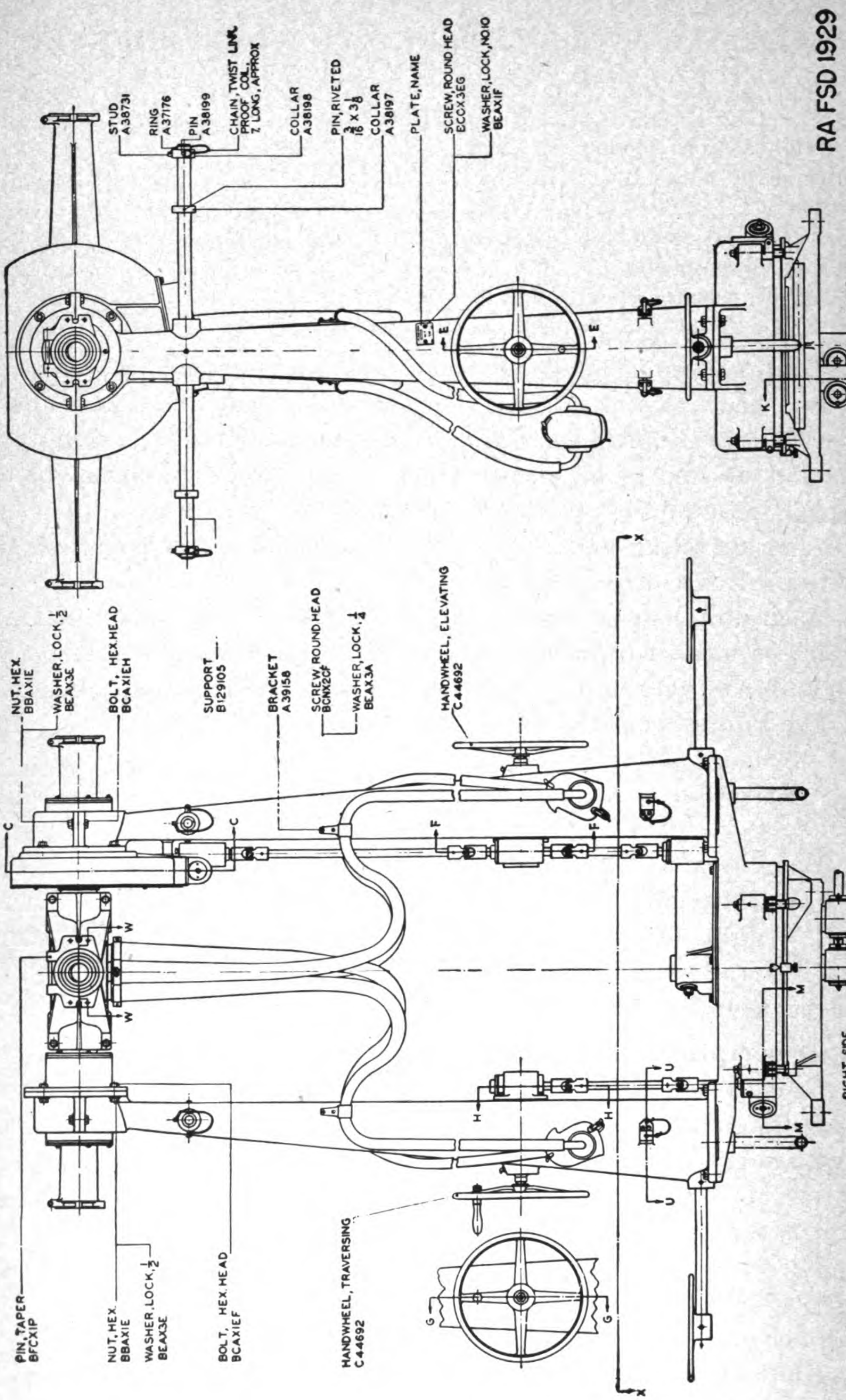

FIGURE 17.—Sound locators, M1A1 to M1A8—rear and right elevation. (Secs. E–E and F–F are shown on fig. 21.)

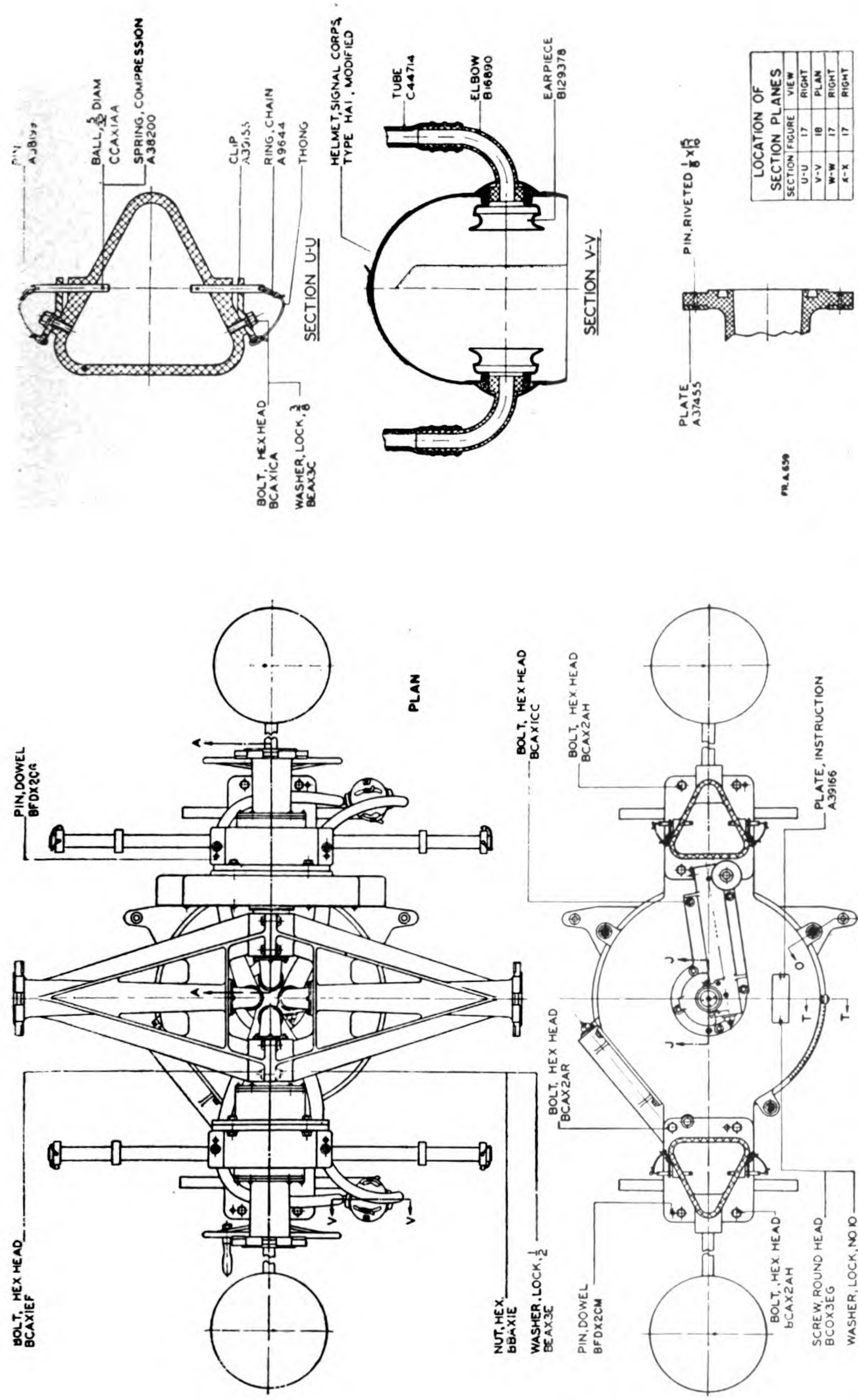

FIGURE 18.—Sound locators, M1A1 to M1A8—plan and sectioned views. (See fig. 17 for section planes U–U, W–W, and X–X; fig. 18 for V–V.)

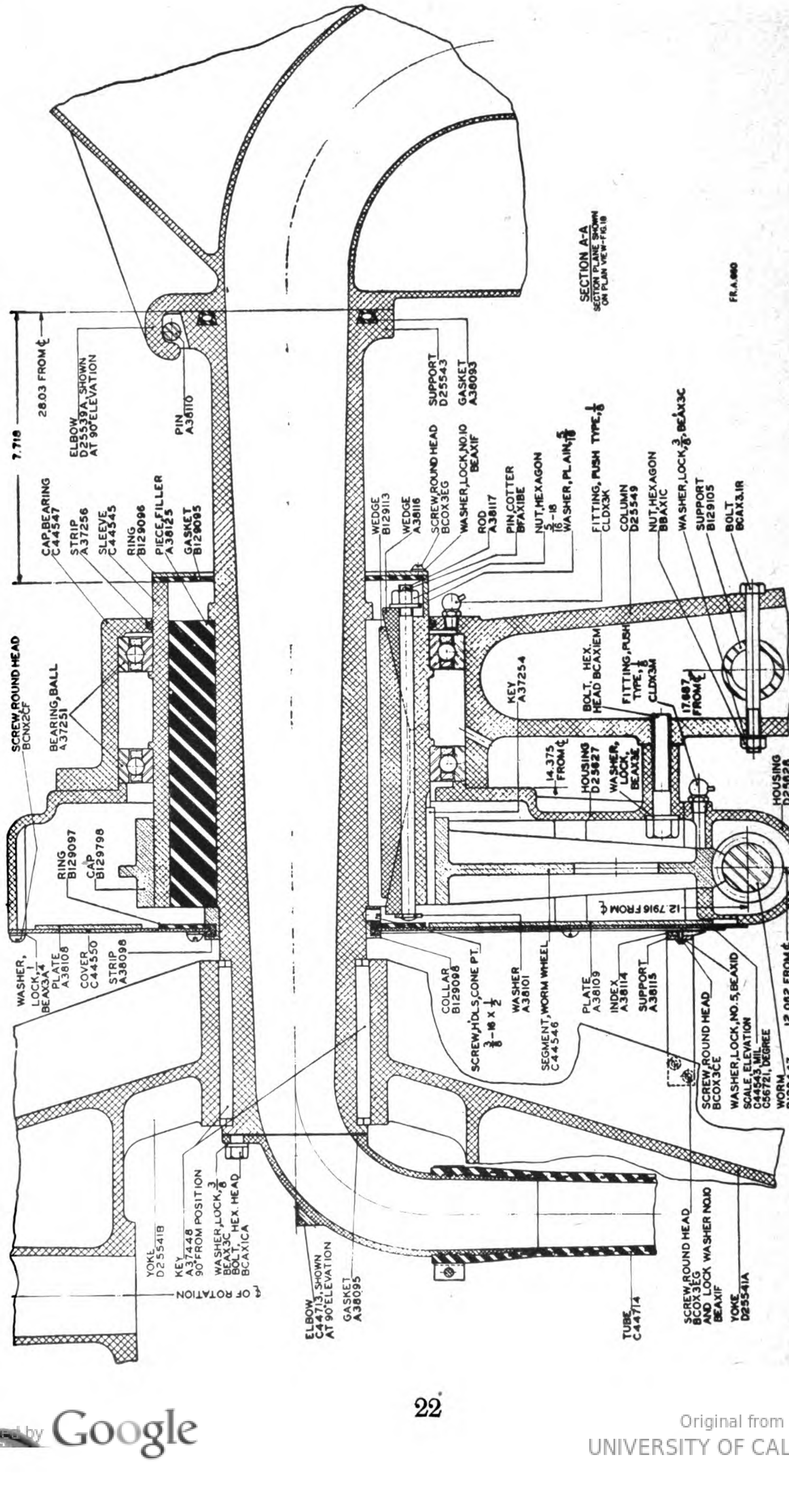

FIGURE 19.—Sound locators, M1A1 to M1A8—sectioned views. (Sec. A–A is shown on fig. 18.)

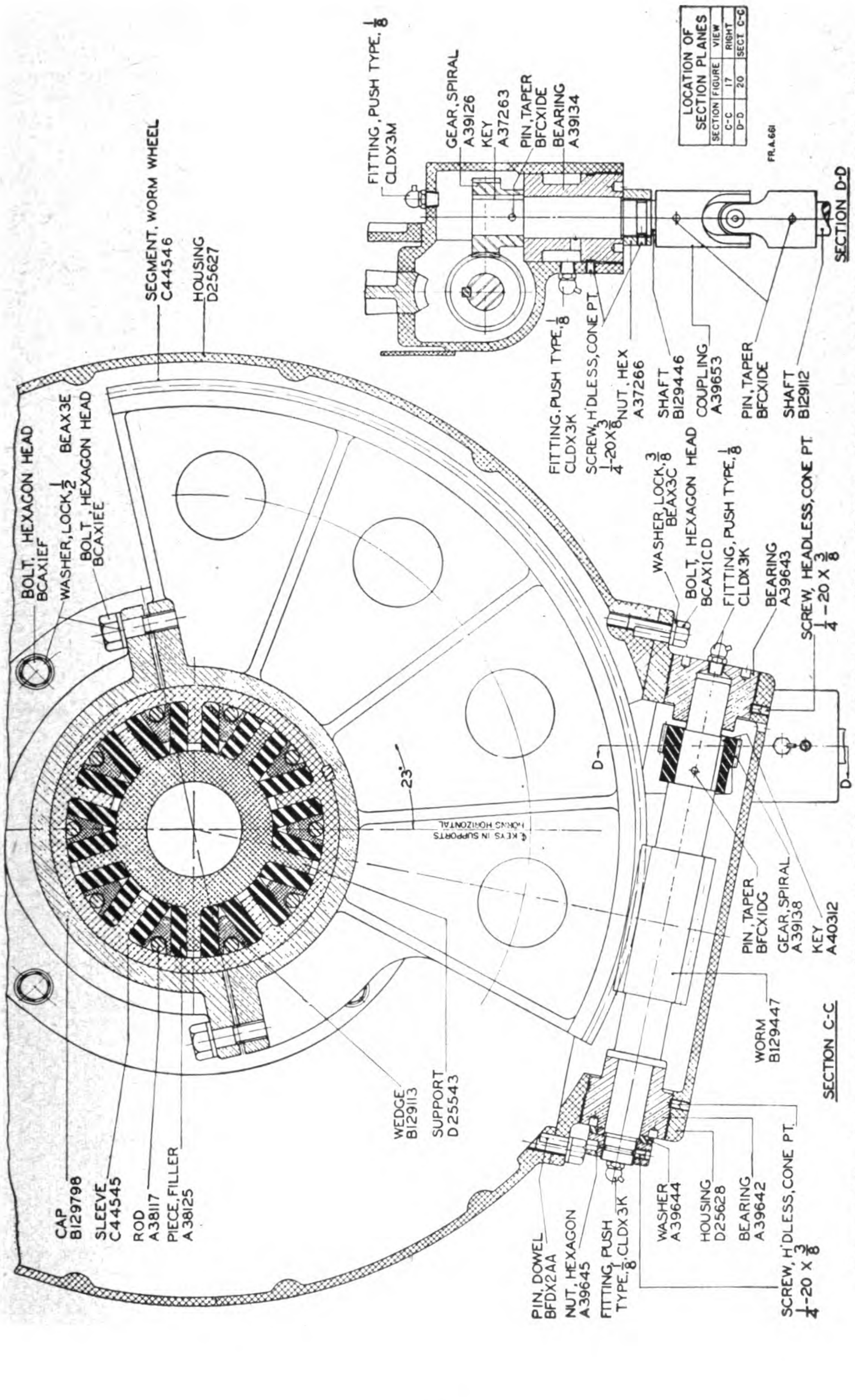

FIGURE 20.—Sound locators, M1A1 to M1A8—sectioned views. (Sec. C–C is shown on fig. 17; sec. D–D on fig. 20.)

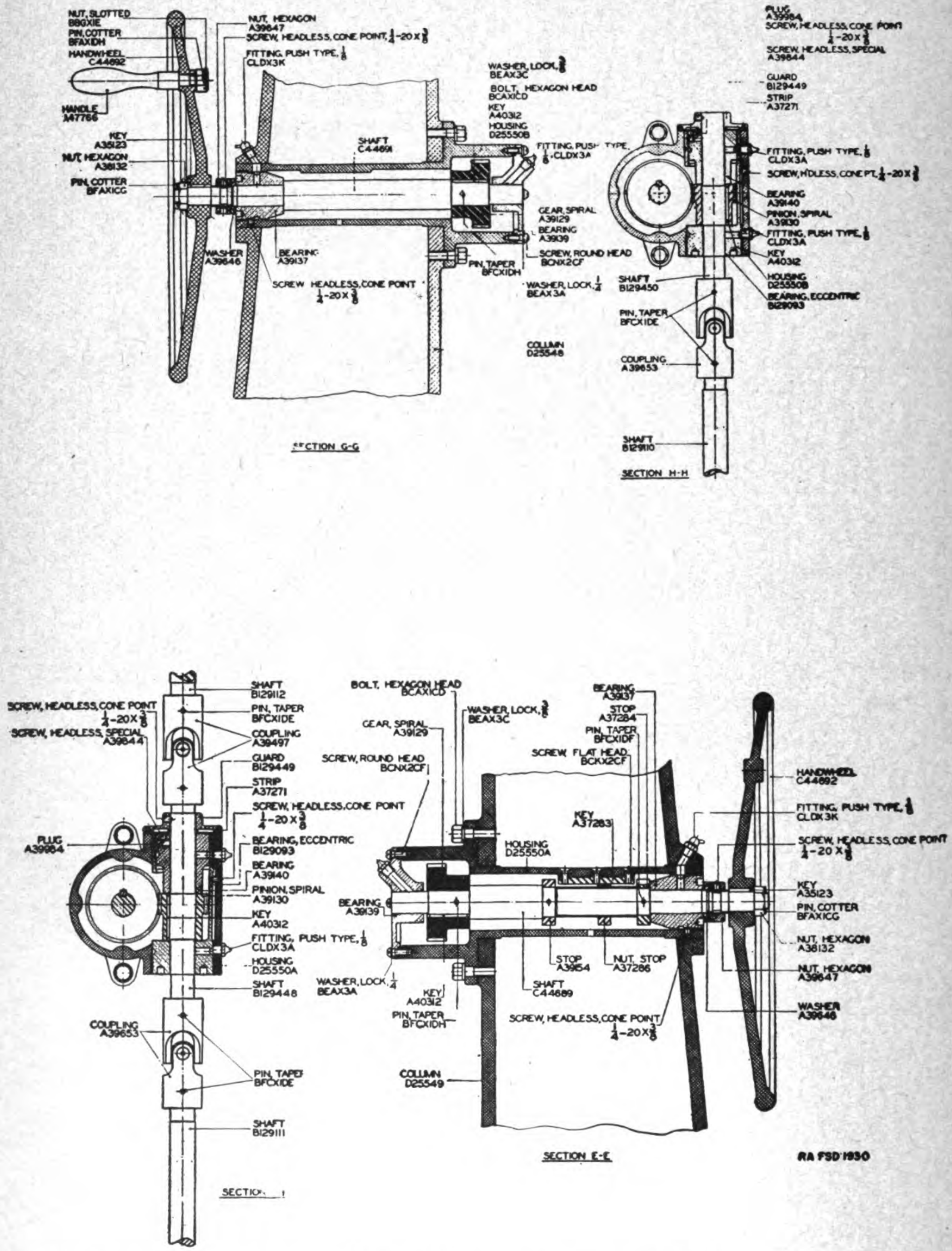

FIGURE 21.—Sound locators, M1A1 to M1A8—sectioned views. (See fig. 17 for section planes E–E, F–F, G–G, and H–H.)

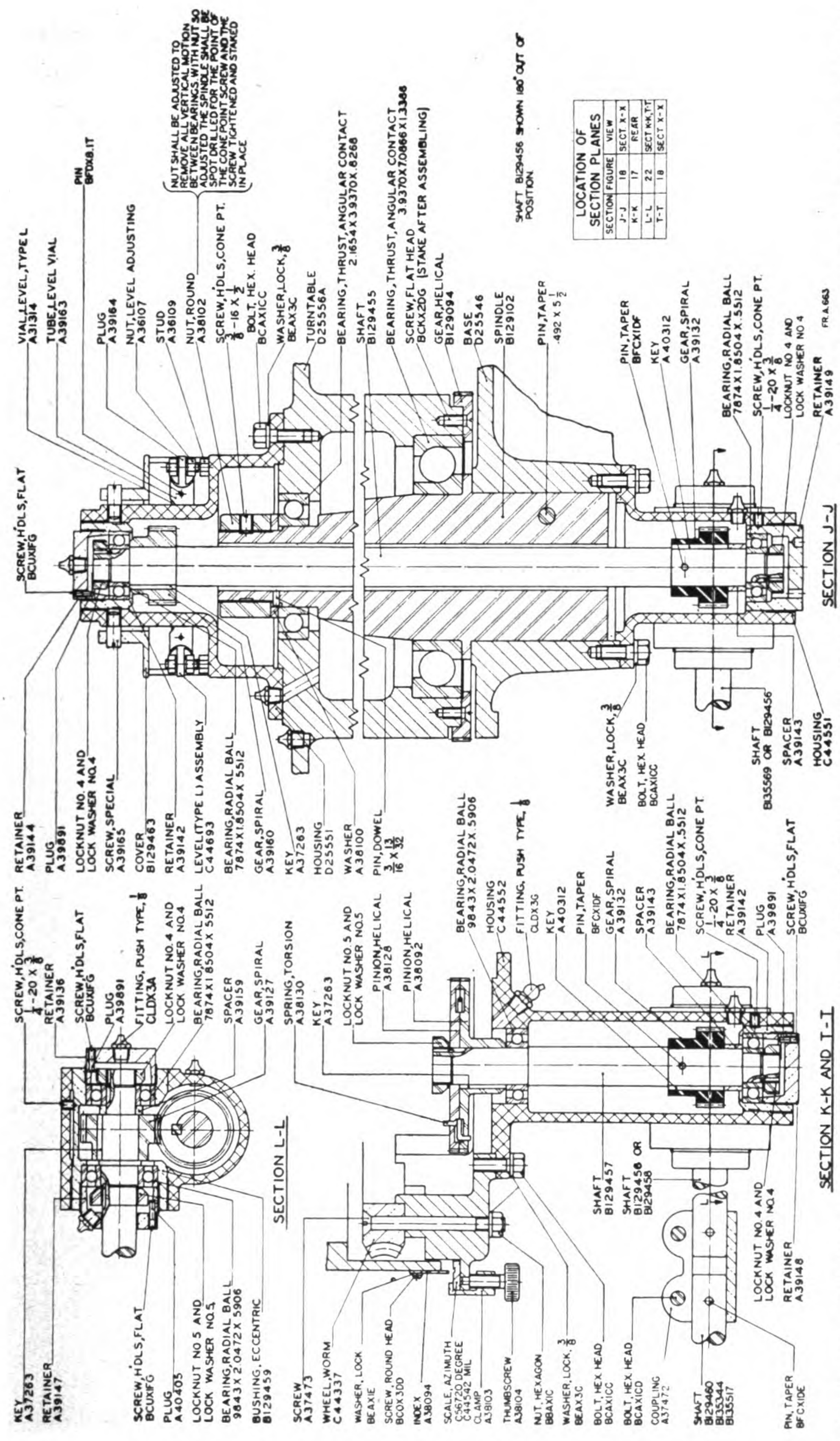

FIGURE 22.—Sound locators, M1A1 to M1A8—sectioned views. (See fig. 18 for section planes J–J and T–T; fig. 17 for K–K; fig. 22 for L–L.)

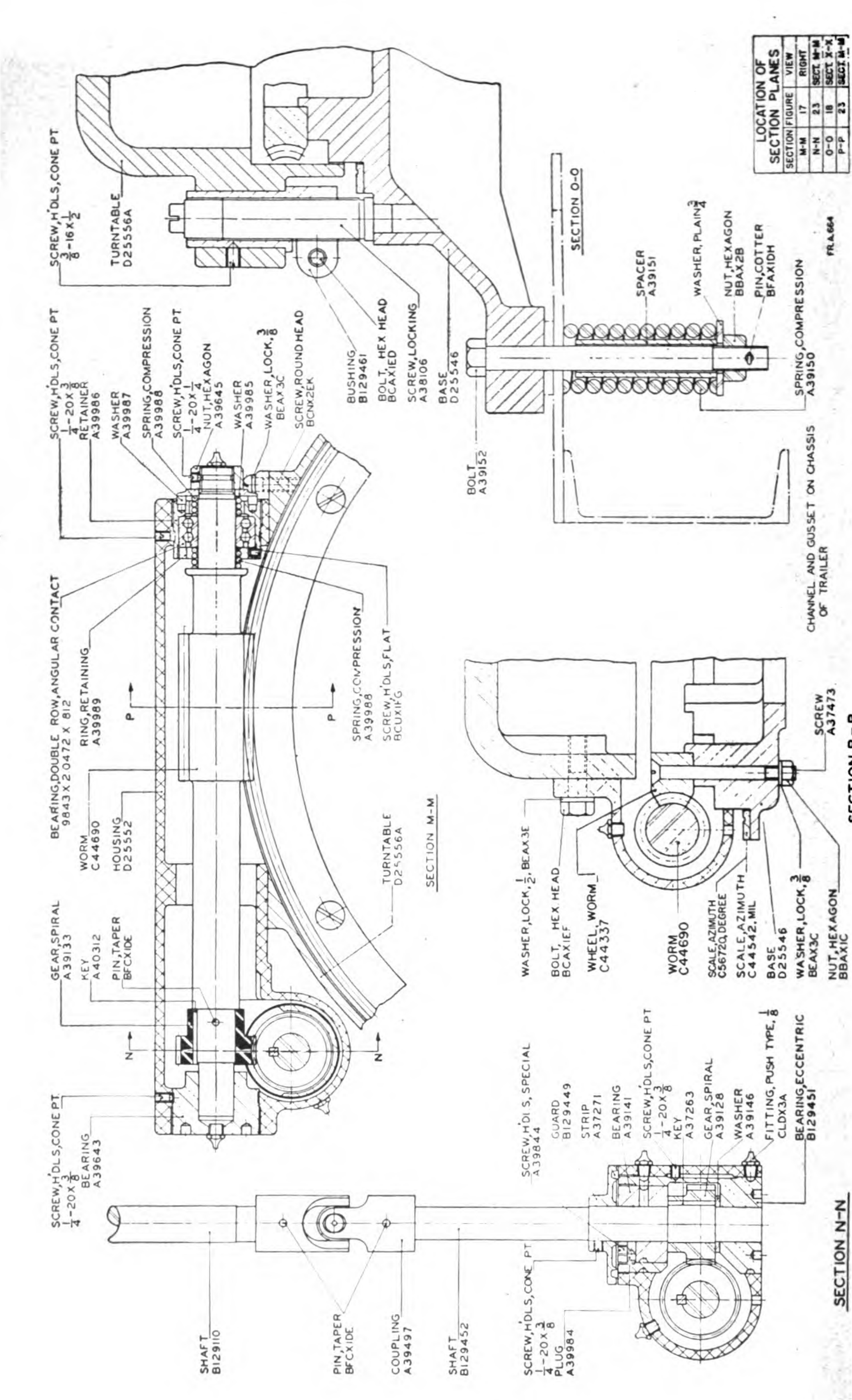

FIGURE 23.—Sound locators, M1A1 to M1A8—sectioned views. (See fig. 23 for section planes N–N and P–P; fig. 17 for M–M; fig. 18 for O–O.)

c. The turntable (D25556A, sec. J–J, fig. 22), supporting the two vertical columns, is positioned in rotation about the vertical spindle (B129102) by means of the worm (C44960) engaging the traversing worm wheel (C44337, sec. P–P, fig. 23) in the base. The azimuth gearing (see figs. 21 and 23) is driven by the traversing handwheel (C44692), rotation of which causes motion of the entire upper portion of the mount in azimuth. This gear train is extended through shafting for connection to the acoustic corrector, located on the front or rear of the trailer. The turntable is provided with locking screws (A38106, sec. O–O, fig. 23) to prevent movement and strain while traveling.

d. A horn journal support (D25543, fig. 19) is held in a bearing at the top of each of the two vertical columns. The two horn journal supports are rigidly connected by the yokes (D25541A and D25541B). This entire assembly may be revolved about a horizontal axis by means of a worm wheel segment (C44546) which engages a worm (B129447) operated by the elevating handwheel (C44692). This gear train, like the traversing gear train, is extended through shafting for connection to the acoustic corrector. A scale (C44543 or C56721) is provided, indicating in mils or degrees, respectively, the elevation of the horns.

e. The entire horn support is contructed in such a manner as to rigidly support the horns and to cause them to revolve simultaneously. The horn support bearings are rubber-insulated to damp out vibrations from the gearing in the columns. The construction of these bearings is shown in figures 19 and 20. The filler pieces (A38125) are of rubber and the wedges (B129113) are aluminum alloy castings.

f. The vertical columns are provided with additional supports (B129105, fig. 17) upon which the horns are mounted when in the traveling position. Removable pins (A38199) are used to secure the horns to the traveling supports. Similar pins, together with clips (A39155, sec. U–U, fig. 18), secure the horns against the columns, when in the traveling position.

g. The vertical columns also support two seats for the operators, one in front of each handwheel.

h. The azimuth and elevation drives are provided with eccentric bushings so that the spiral gear and pinion units may be properly adjusted. These bushings are arranged as shown in figures 21 (sec. H–H), 22 (sec. L–L), and 23 (sec. N–N).

i. The azimuth drive is provided with a backlash gear (sec. K–K, fig. 22), the pinion (A38092) being keyed to shaft (B129457) and the pinion (A38128), meshing with the same gear, being offset approximately 13 teeth in a clockwise direction against the torsion spring (A38130).

j. The elevation drive for the acoustic corrector is brought out concentrically with the vertical axis of the horn mount through shaft (B129455, sec. J–J, fig. 22). For any fixed elevation setting, this shaft will not remain stationary when the horn mount is traversed, but will be rotated with same. The motion of this drive is therefore modified by having an azimuth component subtracted therefrom. Provision to restore this component, in order that rotation proportional to apparent elevation (ϵ') independent of azimuth (A′) can be obtained, is not included in the horn mount. A differential gear is provided in each acoustic corrector for this purpose.

8. Description of horns.—*a.* The horns of sound locators, M1A1 to M1A6, are identical in construction, and those pertaining to the later models, M1A7 and M1A8, differ from these only in that the edges of the horns are curled to eliminate the whistling caused by the wind on the straight edges of the earlier models.

b. The four horns of a sound locator are identical as to acoustic properties and differ only in the arrangement of the clips used in holding them against the columns when in the traveling position, and in that the lower elevation (No. 1) horn alone is provided with open sights.

c. Each horn has a specific numerical designation in accordance with its proper position as follows:

No. 1—Lower elevation horn.
No. 2—Left-hand (facing target) azimuth horn.
No. 3—Upper elevation horn.
No. 4—Right-hand (facing target) azimuth horn.

Horns and corresponding supports are marked with the above identifying numbers.

d. The horns are of the exponential type (see par. 4*c*). The design constants in the equations given in figure 2 are as follows:

a_0—.39 square inch.
a_1—1,018 square inches.
l—204 inches.
m—.0385.

e. These horns are constructed with one of the four surfaces of the forward portion flat. This accentuates their directional characteristics, and also provides a locating surface for alinement at assembly.

f. Extreme care is taken at manufacture to insure that both horns of each pair have identical acoustical properties, that is, they are binaurally matched.

g. The effective length of the horn, 204 inches, includes a 60-inch sheet aluminum front section, a 64-inch cast aluminum section formed by the large curved elbow of the horn and the parts through the horn supports (fig. 19), and the 80-inch rubber tube (C44714) which terminates in the listener's helmet. This rubber tube has a tapering cross section for a distance of approximately 50 inches which is reinforced with flat metal wire to prevent collapsing or distortion; the remaining length consists of approximately 30 inches of small diameter flexible rubber tubing.

h. The listener's helmet (sec. V–V, fig. 18) consists of a leather hood with earpieces constructed to enter into the ends of the sections of flexible rubber tubing. The portion of each earpiece (B129378) adjacent to the listener's head is fitted with a molded rubber cushion to cover the ear.

i. When in operating position, each of the four horns is fastened to a yoke or horn support by means of a double hook and is clamped in place by two swinging eyebolts which are pivoted about pins in the horn elbow and are provided with clamping nuts having 4-inch pivoted handles. The support or yoke is slotted to receive these eyebolts and contains a gasket to provide a seal at this point.

j. When in the traveling position, the horns are supported by passing the holes in the webs of the elbows over the horizontal supports (B129105) extending from the columns. A removable retaining collar (A38198) held in place by a removable pin (A38199) is provided for each horn. A horn brace is clamped between the horns to give additional rigidity. The horns are attached to this brace when in the traveling position in the same manner that they are attached to the yokes or supports of the sound locator when in the operating position.

k. Two open sights are provided on the lower elevation (No. 1) horn.

9. Operation.—*a.* To place the horns in the operating position, proceed as follows:

(1) Remove the horn brace from the horns.

(2) Release the clip (A39155, sec. U–U, fig. 18) from the forward position of the horn by removing the pin (A38199).

(3) Remove the horn from the horizontal support (B129105) by withdrawing the pin (A38199) and sliding off the collar (A38198).

Restore the collar and pin to original position to prevent loss of same.

(4) Place the horn on the horn support or yoke with the same identifying number, in a position corresponding to 90° or 1,600 mils (that is, target directly overhead) elevation, first utilizing the double hook integral with the elbow of the horn, then clamping same securely by means of the clamping nuts provided.

(5) Unlock the turntable (D25556A, sec. O–O, fig. 23) by loosening the three locking screws (A38106), first releasing the bolts (BCAX1ED).

(6) Level the instrument by means of the jacks provided on the trailer (see operating instructions for the particular trailer in use). Two levels (C44693, sec. J–J, fig. 22) are provided on the turntable (D25556A) for this purpose.

(7) With the aid of the open sights attached to the lower elevation (No. 1) horn, orient the sound locator horns with respect to the searchlight and the acoustic corrector. This may be performed by sighting on a datum point of known azimuth, and setting the azimuth scales to read accordingly, or, if such a point is not available, by sighting on a distant point (preferably an astronomical body) with both sound locator and searchlight, and setting the scales so that both agree.

(*a*) The azimuth scale (C56720 or C44542, sec. K–K, fig. 22) is read opposite the index (A38094) and is readily loosened and tightened for orientation purposes by the thumbscrew (A38104).

(*b*) The elevation scale (C56721 or C44543, sec. A–A, fig. 19) is read opposite the index (A38114). This scale should require no adjustment for orientation purposes if the instrument is properly leveled.

(*c*) The azimuth scale of the acoustic corrector will require orientation in a similar manner. The elevation scale of the acoustic corrector will require orientation only if the drive from the sound locator has been disconnected. It is essential that these settings be properly made. Full instructions for orientation of the acoustic correctors are included in paragraphs 18*a* and 25*a*.

b. To operate the sound locator, each listener seats himself at his control wheel, adjusts his helmet, and is ready for action. The horns are then placed in the general direction from which sound is expected, or a systematic search is made for possible airplanes. As soon as a sound is picked up, both operators "center" on the sound so that it appears to come from directly in front or directly in the rear of the listener's head (the direction depends upon the particular listener).

When both have done this, the locator will be pointed at the apparent sound source. In tracking a moving sound source, both operators will follow the sound as nearly as they can, thus keeping the locator continually pointed at the apparent sound source.

c. To place the horns in the traveling position, proceed as follows:

(1) Lock the turntable to the base, by means of the locking screws provided, in such a position that the horn supports (B129105) are perpendicular to the longitudinal axis of the trailer.

(2) Elevate the horns to 90° or 1,600 mils (that is, target directly overhead), unclamp the two hand-operated clamping nuts, lift each horn upward to clear the double hook, and remove. Remove the collars (A38198) from the horn supports (B129105), then slide the holes in the horn elbows on the horn supports and secure the collars in place by the pins (A38199) provided. Place the horns in the following locations with reference to the trailer:

Horns Nos. 1 and 3—front left or rear right.
Horns Nos. 2 and 4—front right or rear left.

(3) Fasten the lower parts of the horns to the columns by means of the clips (A39155) and pins (A38199) provided, and attach each corner of the horn locking frame to the flange at the small end of each horn by means of the clamping nuts thereon, making a compact and rigid unit of the entire assembly.

10. Disassembly and assembly.—*a.* Removal and replacement of externally accessible small parts not affecting the alinement or accuracy of the matériel is permitted when performed by competent personnel thoroughly familiar therewith. The assembled and sectioned views and other illustrations show the location of the various parts and the means by which they are held in place. These figures should be carefully studied before attempting any assembling or disassembling operation.

b. Transfer of the horns from the traveling to the operating position and vice versa is to be performed by the using arms as a normal operating procedure (par. 9). The horns are binaurally matched and must only be operated in their designated positions. Horns are not to be interchanged from one instrument to another.

c. For removal of connections to the acoustic corrector, see paragraphs 17 and 24.

11. Tests and adjustments.—*a.* Adjustments incident to orientation of the sound locator are to be performed by the using arms as a part of normal operating procedure (par. 9).

b. Excessive tightness, looseness, or lost motion in the spiral gears of the traversing and elevating drives may be removed by properly adjusting the eccentric bushing provided for this purpose (par. 7*h*), the procedure being to determine the housing in which the trouble exists by disconnecting the various couplings, then adjusting the proper bearing with the spanner wrench provided, first loosening the set screw.

c. The rubber-insulated bearings of the horn mounts (figs. 19 and 20) can be adjusted to compensate for shrinkage or wear of the insulating material and to insure a firm fit. This adjustment is accomplished by removing the screws (BCOX3EG), the ring (B129096), and the gasket under it; tightening the nut on the rod (A38117) until the desired fit is obtained; then replacing the gasket, ring, and screws.

d. The adjustment of the horns and levels and the indications on the elevation scale may be checked as follows:

(1) Carefully level the sound locator trailer.

(2) Position the mouths of the horns in a vertical plane by means of a plumb line suspended from the upper edge of the top horn.

(3) In this position the index (A38114) should indicate zero on the elevation scale.

(4) Traverse the sound locator mount 90°, 180°, and 270° from the initial position, and check the vertical plane by means of the plumb line at each of these positions. If the vertical plane does not check at each position, the levels are out of adjustment and must be reset.

(5) To reset the levels proceed as follows:

(*a*) Unlock the turntable (D25556A, sec. 0–0, fig. 23) by loosening the three locking screws (A38106), first releasing the bolts (BCAX1ED), and level the instrument by means of the jacks provided.

(*b*) Turn the instrument 180° and note the position of the bubble in the level tube (A39163). By means of the two adjusting nuts (A36107) on the stud, raise or lower (whichever may be necessary) the level tube until the bubble moves to a point which is halfway between the true level indication on the level tube and the position of the bubble before the adjusting nuts were adjusted; then tighten both adjusting nuts firmly. The instrument is now again leveled by means of the jacks provided as previously described and turned 180°. The bubble should remain in the central position of the level tube at both positions of the instrument; if not, the preceding procedure must be repeated.

(*c*) The procedure to be followed for resetting the other level tube located at right angles to the first one (sec. J-J, fig. 22) is similar to that given in (*b*) above. When checking and resetting one level tube, the other level tube should also be checked and reset.

(6) Place a gunner's quadrant on the upper flat surface of the lower horn and mark the base positions of the quadrant on the horn surface. Adjust the quadrant until the bubble is in the center and note the quadrant angle reading, which is the zero-elevation reference.

(7) Check the elevation scale indications at various points throughout the operating range by comparing these indications with actual measured horn elevations. Horn elevations are readily measured with the gunner's quadrant, the zero-elevation reference being subtracted algebraically from the quadrant angle reading in each case. In case the actual horn elevations as determined by means of the gunner's quadrant do not check with the elevation scale indications, an adjustment must be made. This is accomplished by loosening the screws which hold the index (A38114, fig. 19) and moving the index the desired amount. There is a small amount of clearance between the screws and the holes in the index to permit this. In case the holes in the index are not large enough to permit enough lateral movement of the index, they may be elongated.

(8) Stops should function at −180 (−10°) and +1,780 mils (+100°). If they do not function at these values, the adjustment is made as follows:

(*a*) The taper pins (BFCX1DF) from the upper and lower limit stops (sec. E-E, fig. 21) are removed. The elevation handwheel is turned until −180 mils is indicated on the scale. The lower limit stop is turned on the shaft (C44689) so as to function at this point.

(*b*) Drill a hole, using the hole in the stop as a guide, in the shaft when the stop is in this position. Insert the taper pin thus securing the stop to the shaft.

(*c*) Turn the elevation handwheel until +1,780 mils is indicated on the scale. The upper limit stop is turned on the shaft (C44689) so as to function at this point.

(*d*) Drill a hole through the shaft, using the hole in the stop as a guide, when the stop is in this position. Insert the taper pin thus securing the stop to the shaft.

12. Care and preservation.—*a*. The horns should ordinarily be placed in the traveling position when the locator is not in use. However, should it be necessary that the locator be left assembled after use, the horns should be depressed as far as possible in order to prevent rain from entering them. The horns have a smooth interior finish to facilitate the passage of sound, and if water is permitted to stand in the elbows this finish will soon be destroyed.

b. The elevation handwheel drive is provided with stops limiting the motion of the horns in elevation. These stops should not be forced, as their functioning indicates that a limit of travel has been reached.

c. Care should be exercised in locking the turntable to insure that the locking screws (A38106) enter the holes in the base (D25546, see O–O, fig. 23) properly and tightened until the collars on the screws rest on the seats in the base. No attempt should be made to turn the traversing handwheel while the mount is in the locked position, as the strain may result in serious damage. The setting of the elevating handwheel to 90° or 1,600 mils elevation should not be disturbed when traveling.

d. The horn mount is equipped with push type fittings and should be lubricated prior to each day's operation, using lubricating oil, Navy symbol 3065 or 1065 (SAE 30) for operation in temperatures above 32° F., and Navy symbol 3050 or 1047 (SAE 20) for temperatures between 0° F. and 32° F. For temperatures below 0° F., Navy symbol 1042 (SAE 10W) should be used. An oil gun is provided for this purpose. These fittings are located as follows:

	Number of fittings
Traversing handwheel shaft housing	4
Elevating handwheel shaft housing	4
Traversing worm housing	6
Elevating worm housing	9
Elevating worm wheel segment housing	4
Horn journal (left)	1
Horn journal (right)	1
Turntable	1
Shaft housings (below platform)	7

13. Data.—The name plate is located on the upright column near the elevating handwheel. The model number thereon applies to both the sound locator, complete, and the sound locator (horns and horn mount), as both model numbers are the same.

Section III

ACOUSTIC CORRECTORS, M1 AND M1A1

Paragraph

14. General.—*a.* The acoustic correctors, M1 and M1A1 (figs. 24, 25, and 26) are instruments for computing the true angular position of an aerial target, based upon the data pertaining to the apparent position thereof as determined by a sound locator.

b. The acoustic corrector, M1, differs from the acoustic corrector, M1A1, only in that the angular scales in the former are graduated in degrees while in the latter they are graduated in mils.

c. These instruments function in accordance with the principles and assumptions enumerated in paragraph 4*e*. The corrections for the angular travel of the target during the sound lag time are made intermittently and applied continuously. Provision is made also for the application of arbitrary corrections for effects not provided for in

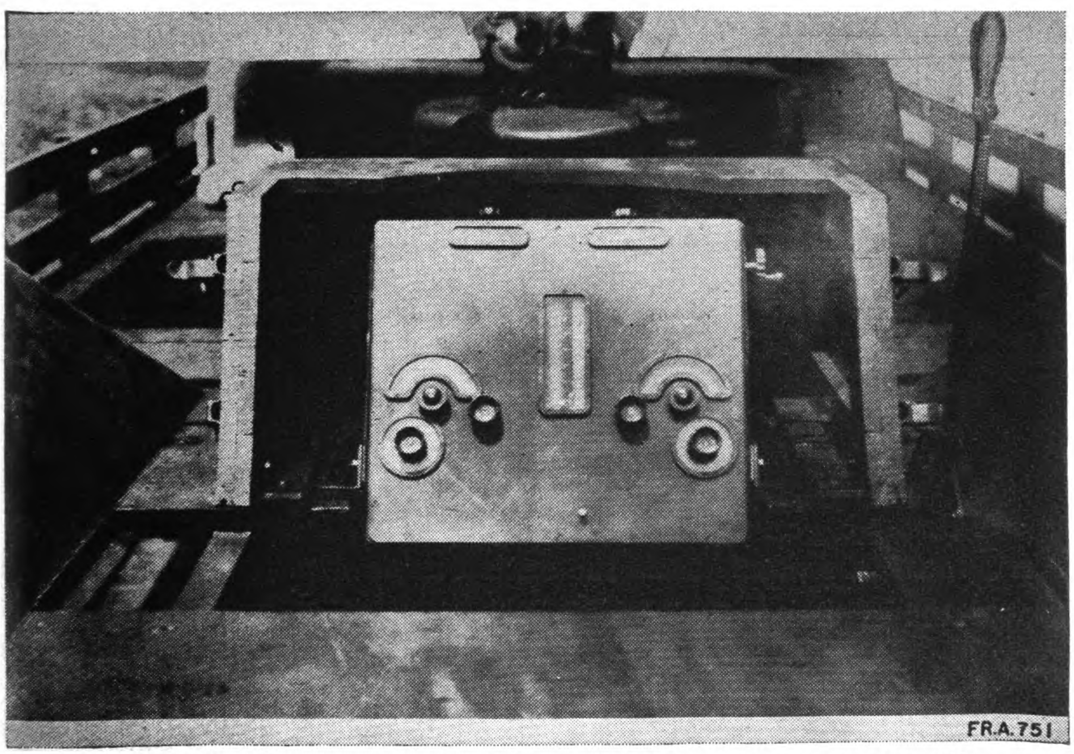

FIGURE 24.—Acoustic corrector, M1 mounted on sound locator trailer, M2.

the computing mechanism. The present azimuth and elevation of the target, thus computed by the corrector, are transmitted automatically and continuously to the searchlight comparator.

d. The functioning of this instrument may be best understood by referring to the schematic diagram (fig. 27).

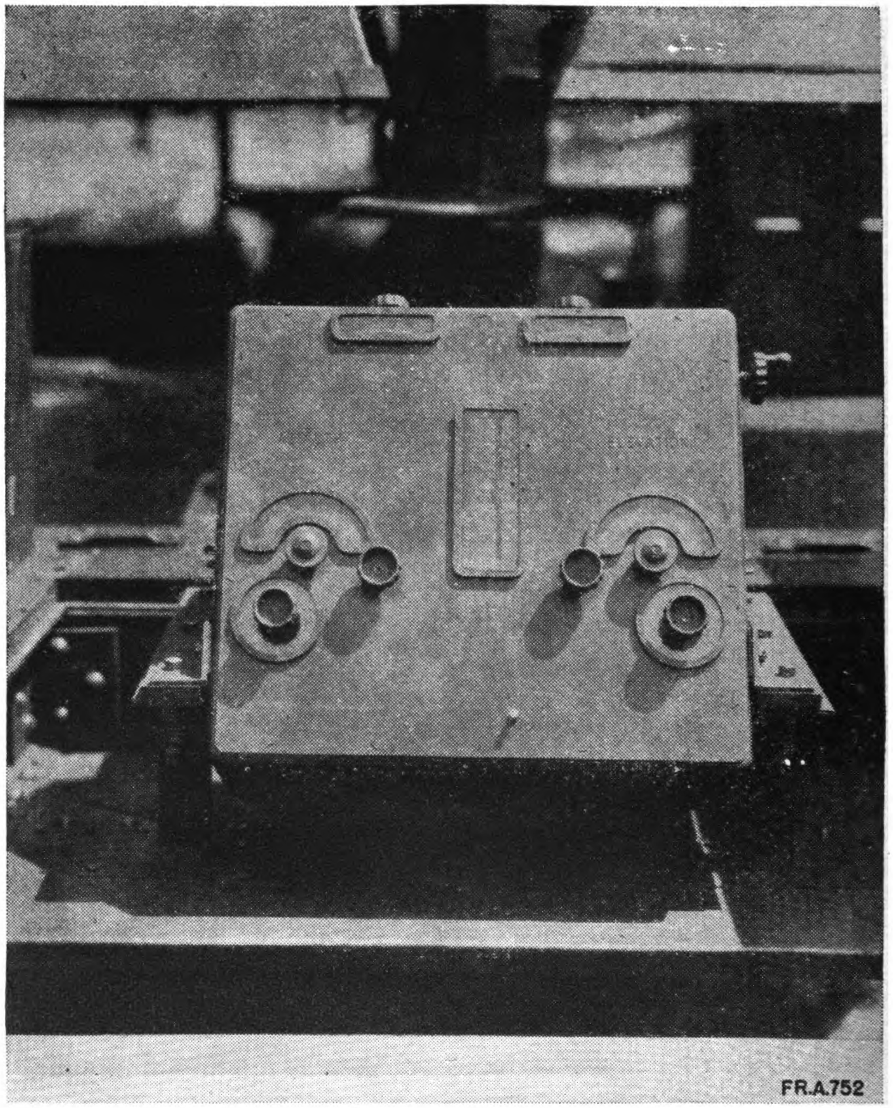

FIGURE 25.—Acoustic corrector, M1A1 mounted on sound locator trailer, M2A3.

(1) The settings of apparent azimuth (A′) and elevation (ϵ') are made through gearing direct from the sound locator. The altitude (H_x) must be estimated and the setting made with the knob provided for the purpose. A stop watch, not furnished with the instrument, is required for making the necessary settings to introduce the sound lag time (t_s).

(2) Since the elevation drive from the sound locator is brought out concentrically with the vertical axis of the horn mount, it is evi-

dent that for any constant apparent elevation (ϵ') setting, this shaft, instead of remaining stationary when the horn mount is traversed, will be rotated thereby (par. 7*j*). The differential gear in the acoustic corrector, driven by this shaft and also by the azimuth drive, functions to restore the azimuth component removed by this superimposed rotation and hence to provide indications of apparent elevation (ϵ') which are independent of apparent azimuth (A′).

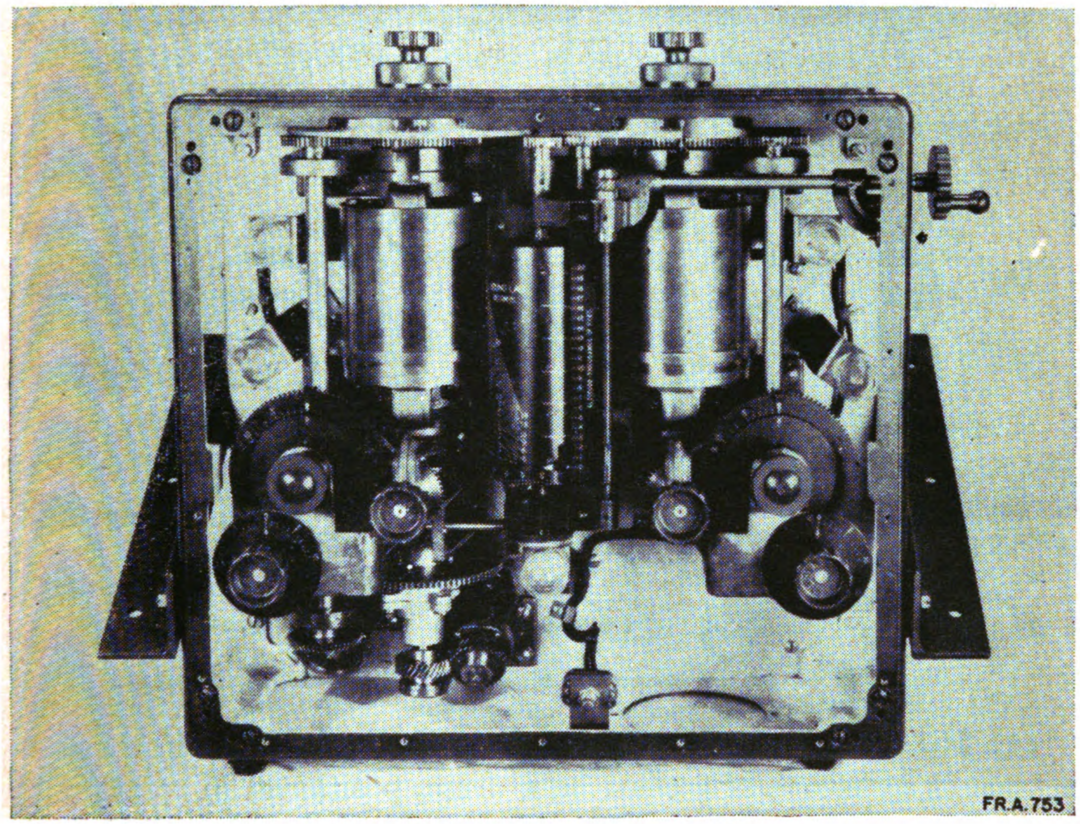

FIGURE 26.—Acoustic corrector, M1—front cover plate removed.

(3) The apparent azimuth (A′) and the apparent elevation (ϵ') motions are geared directly to the rotors of the azimuth and elevation synchronous transmitters, respectively. The frames of these transmitters are geared to mechanisms subsequently described so as to be offset an angle equal to the total lateral or vertical correction angle (δ or σ), respectively. The net angular displacement between rotor and frame is thus the *sum* of the apparent azimuth or elevation (A′ or ϵ') plus the total lateral or vertical correction (δ or σ), that is, the present azimuth or elevation (A_o or ϵ_o), which angles are transmitted to the searchlight comparator. These angles are also indicated on the scales of the acoustic corrector, each scale being arranged to rotate with the rotor of the synchronous transmitter, and being read opposite an index which rotates with the field thereof.

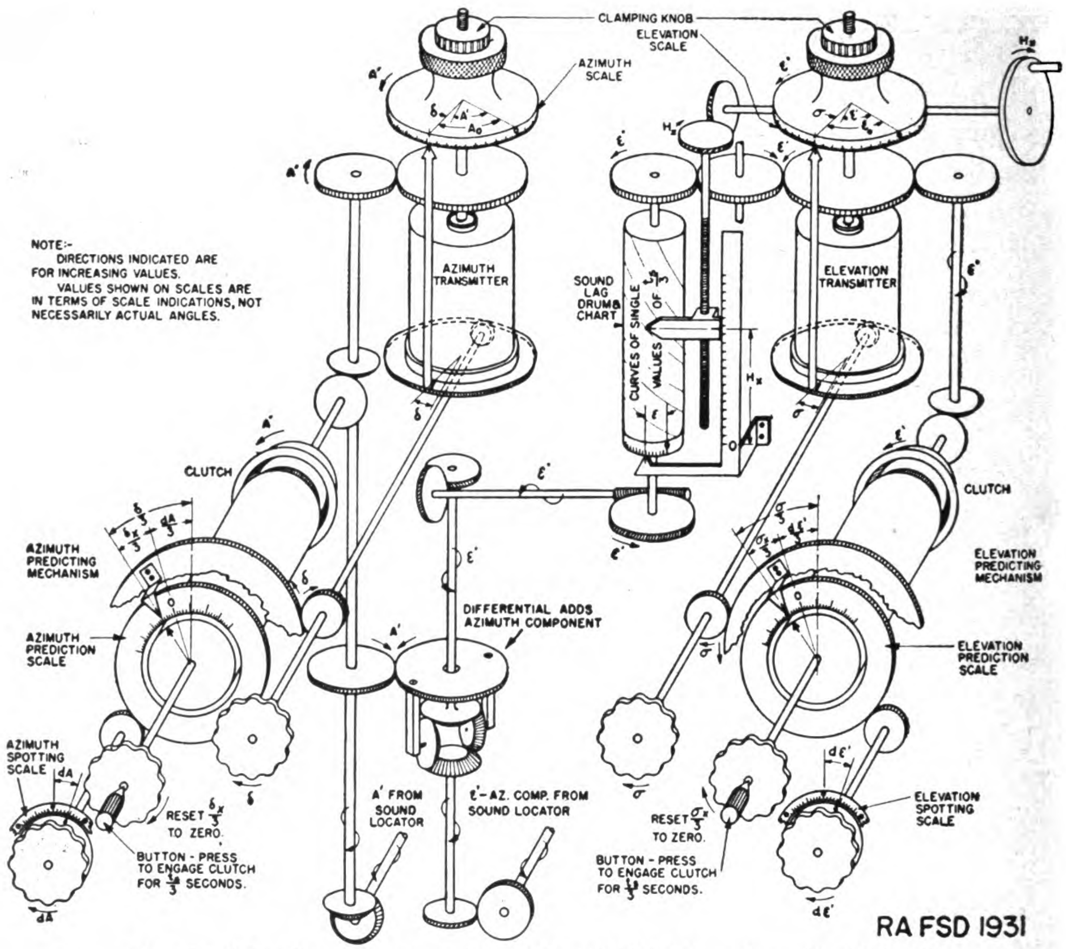

FIGURE 27.—Acoustic correctors, M1 and M1A1—schematic diagram.

(4) The determination of sound lag time (t_s) is made in these instruments by means of a chart on a drum, positioned in rotation by gearing in accordance with apparent elevation (ϵ') and read opposite a pointer which is positioned vertically in accordance with altitude (H_x). This chart carries a number of curves each corresponding to a single value of sound lag time (t_s). Each curve is marked to indicate the corresponding time with the factor one-third introduced for reasons subsequently explained. Thus the curve labelled "10 seconds" actually corresponds to a sound lag time (t_s) of 30 seconds. Values of sound lag time for this chart were computed from the formula given in figure 4.

(5) The corrections (δ_x and σ_x) for the travel of the target during the sound lag time are computed, using the angular speed during a predetermined predicting period as the basis for the computation. In these instruments, the predicting period is not of fixed duration, but is taken proportional to the sound lag time, thus avoiding the use of complicated multiplying devices. The factor of proportionality has,

for practical reasons, been taken as one-third, and, as explained in (4) above, the curves of the sound lag chart have been labeled accordingly.

(6) In operation, the clutches are engaged by the operator by pressing the associated buttons for a period equal to one-third the sound lag time $\left(\frac{t_s}{3}\right)$ as indicated on the chart and measured by means of a time interval recorder. During this period, the index marks on the clutches will rotate through angles corresponding to one-third the sound lag corrections $\left(\frac{\delta_x}{3} \text{ and } \frac{\sigma_x}{3}\right)$ from their original positions.

(7) Each clutch is arranged so that its index mark may be set to the correct initial position by means of the knob concentric with the button. This correct initial position is indicated by the zero (0) graduation on the prediction scale. This scale is arranged to be offset in accordance with the arbitrary correction (dA or $d\epsilon$) desired. The arbitrary correction is indicated on the spotting scale and is made by the knob concentric therewith. The prediction scale is so graduated that the indications thereon, both of the sound lag correction and of the arbitrary correction, are for one-third the actual value of these quantities. The spotting scale reads the actual value of the arbitrary correction.

(8) The total displacement of the index mark on the clutch from its central position is thus one-third the sum of the sound lag correction and the arbitrary correction, which is one-third the total correction $\left(\frac{\delta_x + dA}{3} = \frac{\delta}{3} \text{ or } \frac{\sigma_x + d\epsilon}{3} = \frac{\sigma}{3}\right)$. The operator then causes the pointer to aline with the above index mark by means of the knob provided, displacing it from its central position through the same angle $\left(\frac{\delta}{3} \text{ or } \frac{\sigma}{3}\right)$. By means of gearing, the frame of the associated transmitter (par. 14*d*(3)) is rotated simultaneously, the gear ratio being such that an angular rotation exactly equal to the total correction (δ or σ) is experienced. A correction so made continues to be applied until a new setting of the pointer is employed. The index mark on the clutch is at once reset by the operator to its zero position and the prediction procedure repeated periodically to determine the new setting.

(9) The azimuth and elevation scales are adjustable for orientation purposes, clamping knobs being provided. Adjustment of the elevation scale in this manner does not, however, affect the elevation (ϵ') setting of the sound lag drum.

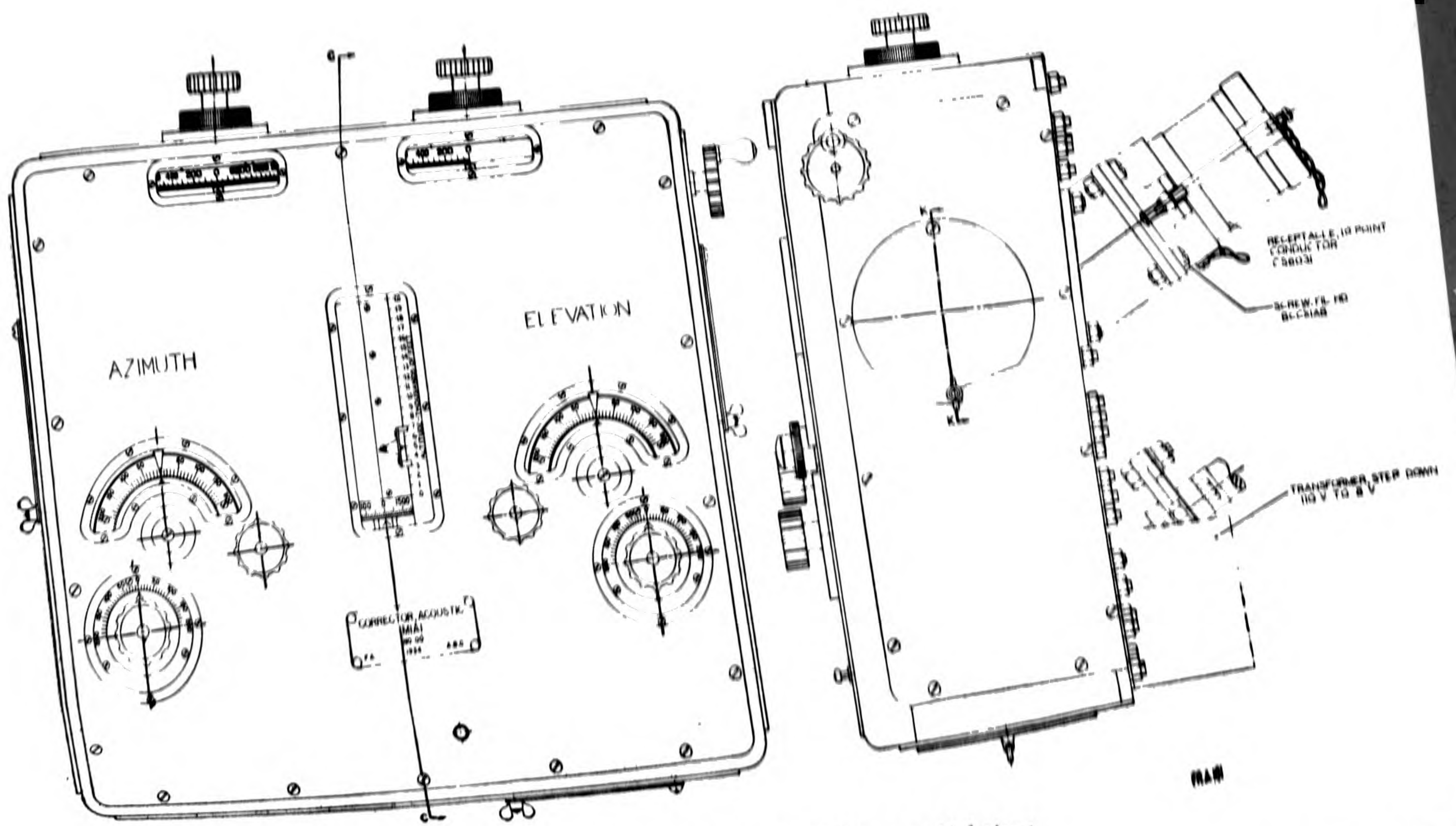

FIGURE 28.—Acoustic corrector, M1A1—assembled views.

e. The limits of operation are as follows:

Element of data	Acoustic corrector, M1	Acoustic corrector, M1A1
Altitude (H_x)	0 to 20,000 feet	0 to 20,000 feet.
Apparent azimuth (A′)	No limits	No limits.
Apparent elevation (ϵ')	0° to 90°	0 mils to 1,600 mils.
Sound lag correction in azimuth (δ_x).	−30° to +30°	−600 mils to +600 mils.
Sound lag correction in elevation (σ_x).	−30° to +30°	−600 mils to +600 mils.
Arbitrary corrections in azimuth (dA).	−10° to +10°	−200 mils to +200 mils.
Arbitrary corrections in elevation ($d\epsilon$).	−10° to +10°	−200 mils to +200 mils.

f. The power required for this instrument is approximately 160 watts from a supply of 110-volt, 60-cycle a. c. This does not include the power for the two repeaters in the searchlight comparator connected to the transmitter in the acoustic corrector.

15. Description.—*a. General.*—The acoustic correctors, M1 and M1A1, are enclosed in aluminum rain and dustproof cases and are mounted at an angle of approximately 30° from the vertical, for ease of operation, on the front or the rear of the sound locator trailers. The description which follows and the accompanying figures 28 to 34, inclusive, apply strictly to the acoustic corrector, M1A1. However, the M1 instrument differs only in a very few parts having to do with settings and indications, which are in degrees instead of mils on that instrument.

b. Azimuth and elevation drives.—(1) The main azimuth and elevation shafts from the sound locator horn mount connect with the corresponding shafts (A38192 and A38193, sec. A–A, fig. 30 and sec. F–F, fig. 33), respectively, in the rear of the acoustic corrector.

(2) Connection is by flexible couplings, each composed of two yokes (A38194) bolted to a flexible brass disk (A38195) or to a flexible disk of packing material (A40653). These couplings, including the taper pins (BCFX1BD) therein, are part of the acoustic corrector, not of the horn mount.

(3) The elevation drive in the acoustic corrector is first geared to a differential, shown on section E–E, figure 33, the function of which is to restore to the apparent elevation (ϵ') the component of azimuth

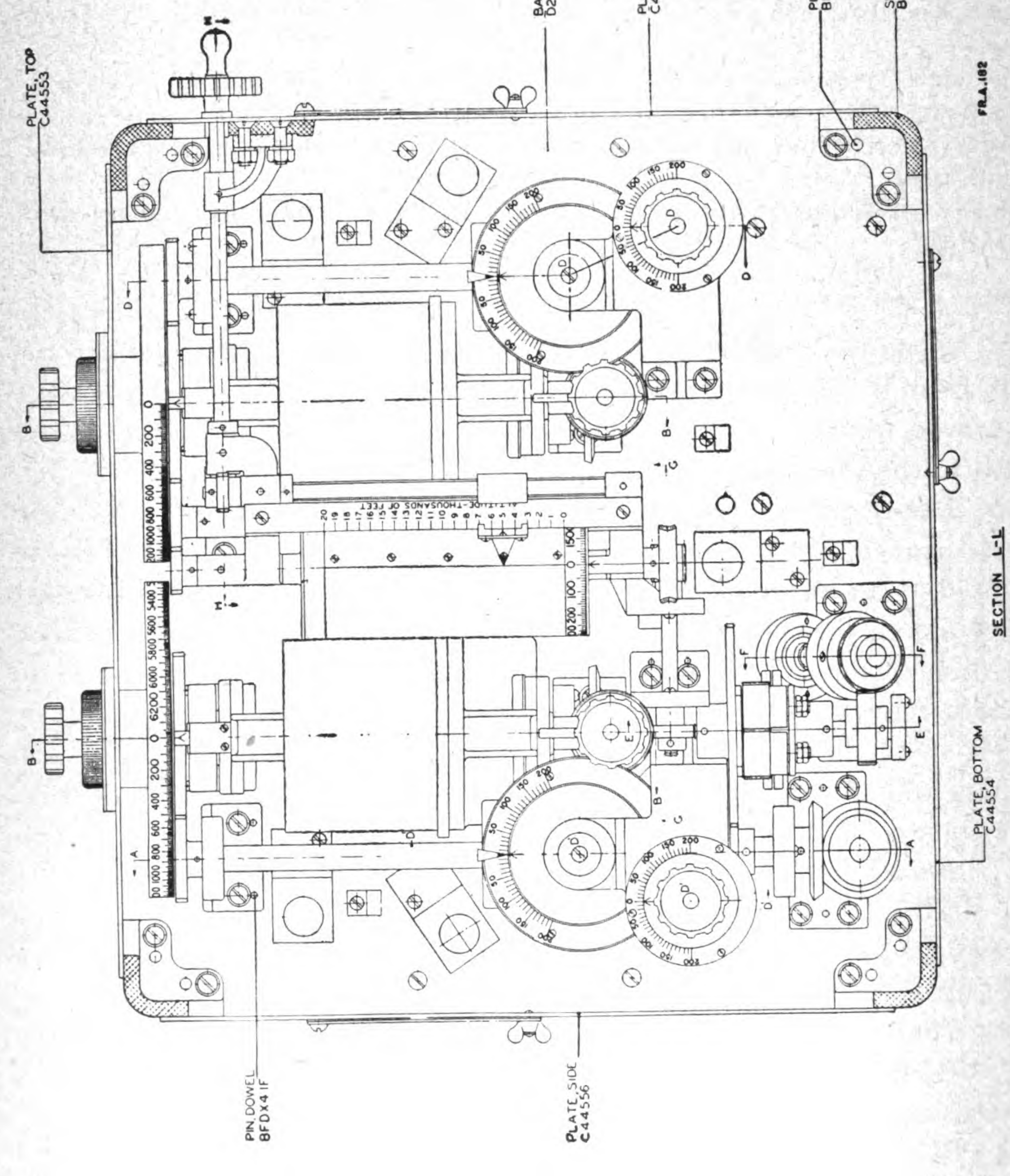

FIGURE 29.—Acoustic corrector, M1A1—interior view.

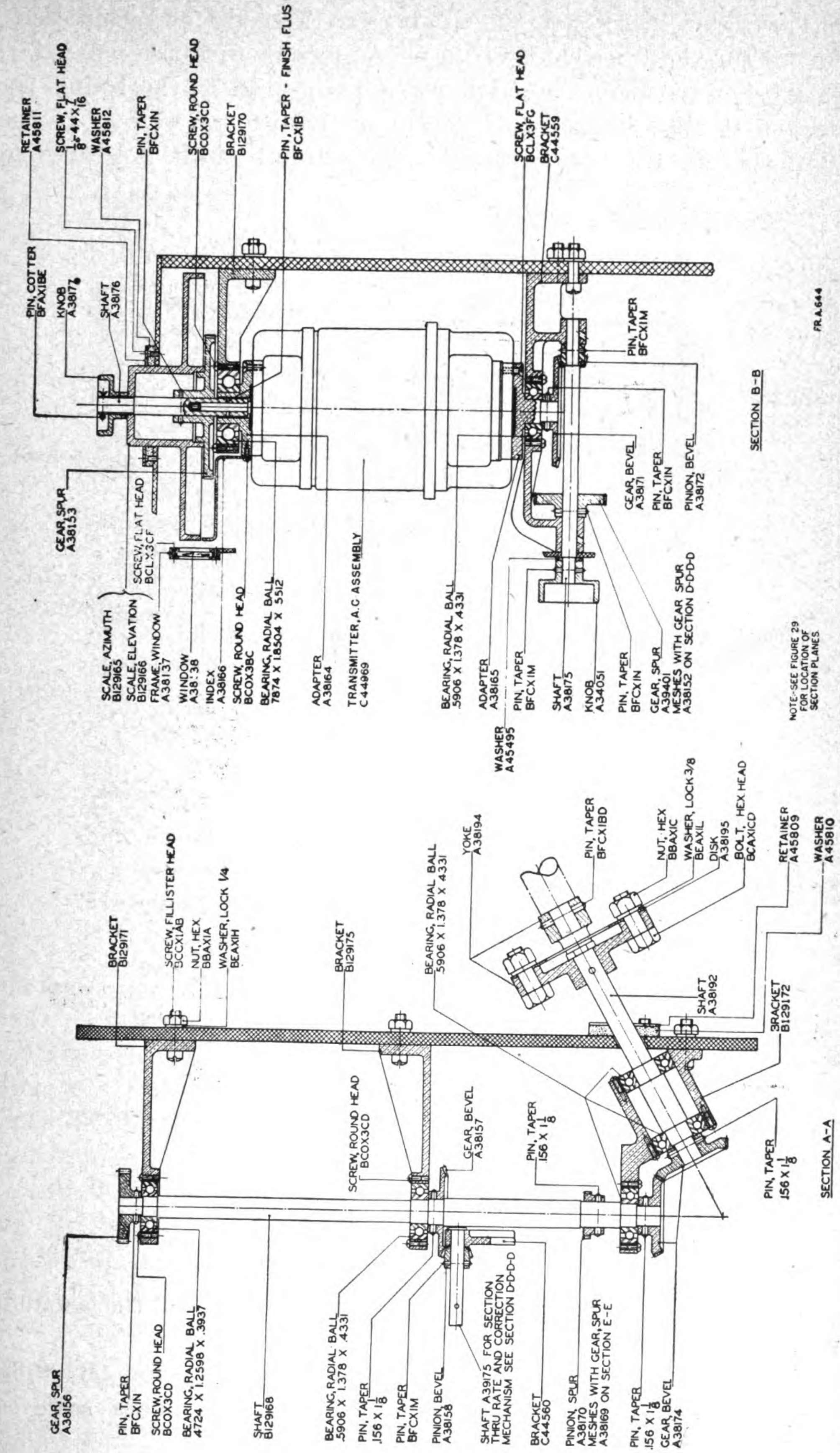

FIGURE 30.—Acoustic corrector, M1A1—sectioned views.

which has been subtracted due to the fact that the elevation shaft passes out through the center of the sound locator turntable (par. 7*j*).

(4) The output from this differential is geared to the sound lag drum and to the elevation predicting mechanism as well as to the rotor of the elevation transmitter. The azimuth shaft is geared to

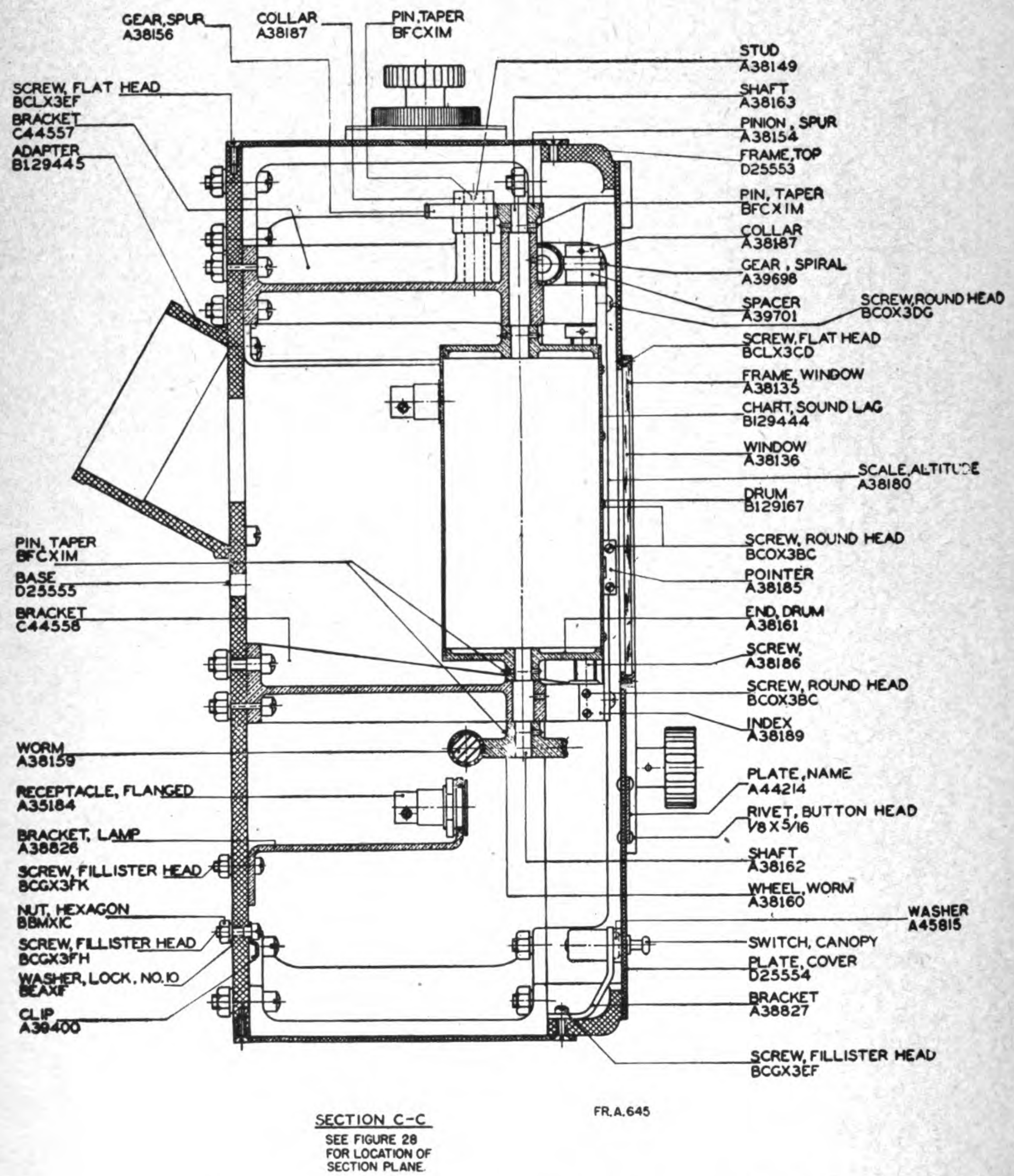

FIGURE 31.—Acoustic corrector, M1A1—sectioned view.

the azimuth predicting mechanism and to the rotor of the azimuth transmitter.

c. Sound lag drum and chart.—(1) The sound lag drum (B129167, fig. 31, also seen in the center of figs. 28 and 29) has a scale on

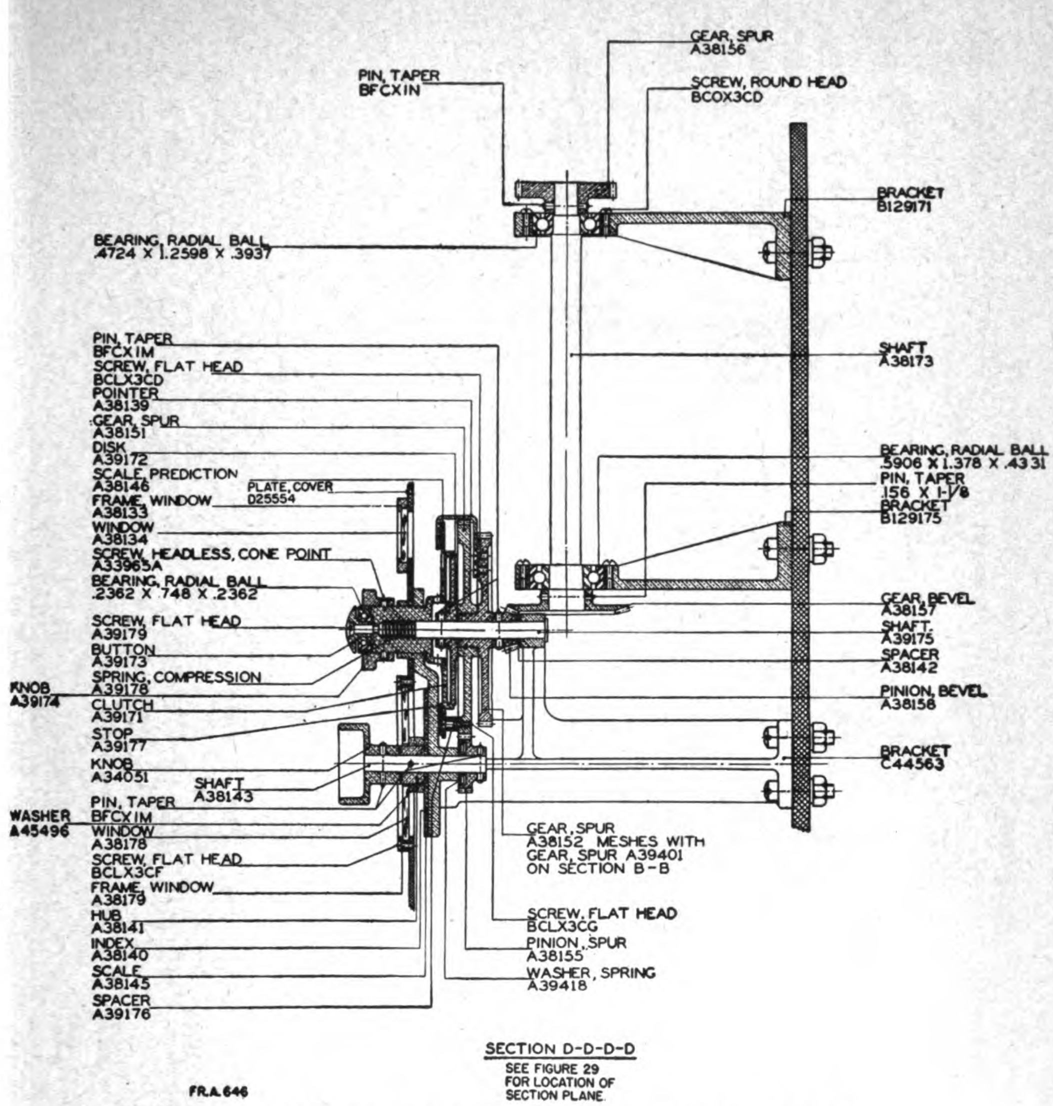

FIGURE 32.—Acoustic corrector, M1A1—sectioned view.

its lower periphery, indicating in mils the apparent elevation (ϵ') of the target as indicated by the sound locator horns, and bears a chart (B129444) showing curves of constant sound lag time (t_s), the distance from the base representing altitude (H_x). The numerical value of time designated for each curve on the chart is one-third of the true sound lag time (t_s) given by the equation developed in figure 4.

(2) A pointer (A38185) operated by the knob (A38167, sec. H–H, fig. 33) on the right side of the case indicates on the altitude scale (A38180) the altitude (H_x) of the target as set on the instrument. The altitude scale (A38180) is graduated in thousands of feet with a maximum value of 20,000 feet. The pointer (A38185) also indicates, on the sound lag drum chart (B129444), the prediction period $\frac{(t_s)}{3}$ for use in determining the sound lag correction.

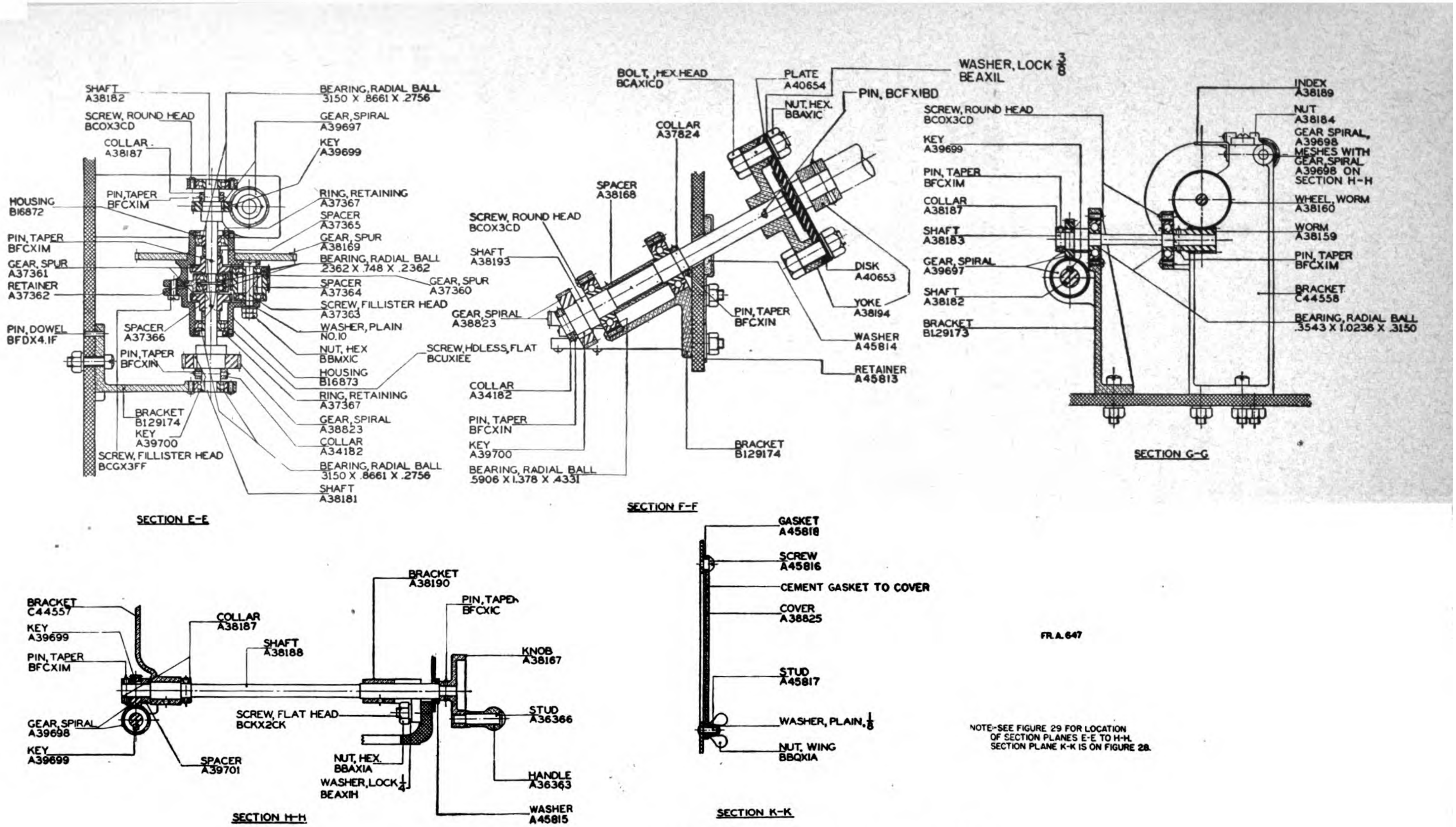

FIGURE 33.—Acoustic corrector, M1A1—sectioned views.

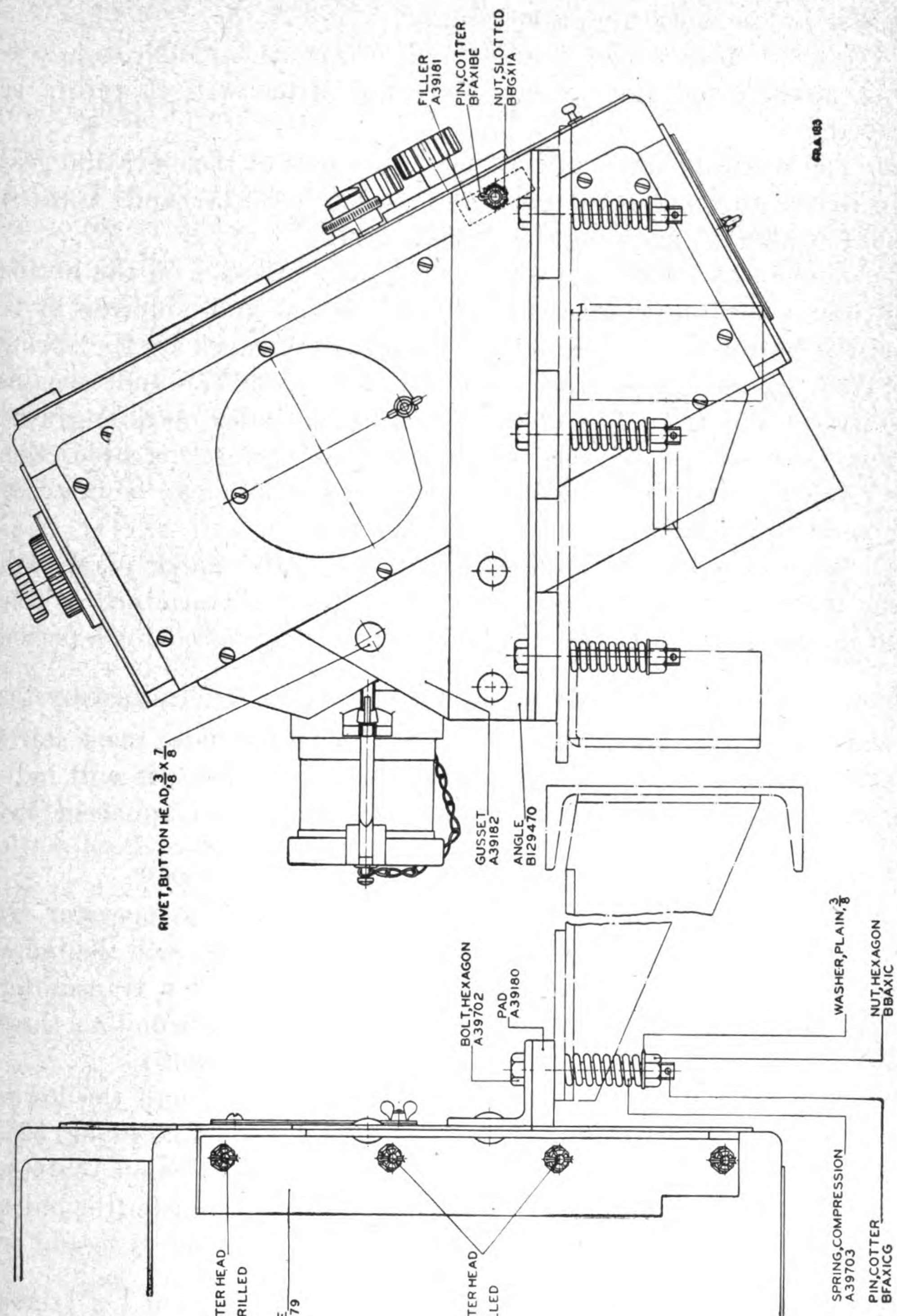

FIGURE 34.—Acoustic corrector, M1A1—mounting arrangement.

(3) Figure 31 and section G–G in figure 33 show how the drum (B129167) is driven through a worm (A38159) and worm wheel (A38160) by the elevation gear train.

d. The predicting mechanism.—(1) The azimuth and elevation predicting mechanisms are similar; only the latter will therefore be described.

(2) The vertical shaft (A38173, fig. 32), a part of the elevation gear train, drives through bevel gear and pinion (A38157 and A38158) the shaft (A39175) carrying the disk (A39172).

(3) The clutch (A39171), when engaged by pressure on the button (A39173), comes into contact with the above disk and is driven by it. When the button is not pressed, the clutch, disengaged by the spring (A39178), comes into contact with the stop (A39177) and remains stationary. The front face of the clutch has an index mark engraved thereon (best seen in fig. 29) which indicates against the prediction scale (A38146) and with which the pointer (A38139) may be matched as subsequently described.

(4) When the button (A39173) is pressed, the index mark will rotate, indicating the change in elevation (ϵ') as determined by the sound locator horns. In practice, the button is depressed for a period equal to one-third of the sound lag time $\left(\frac{t_s}{3}\right)$, as determined by the indication on the sound lag drum chart. Thus, if the index mark starts from its zero position on the prediction scale (A38146), it will indicate, after the button is released, the total change in apparent elevation (ϵ') in one-third the sound lag time $\left(\frac{t_s}{3}\right)$ on that scale.

(5) The outer pointer (A38139) is rotated by the operator by means of the knob at the left of the button to coincide with the index mark. This knob also rotates the field of the elevation transmitter (sec. B–B, fig. 30) simultaneously through an angle equal to three times the angle indicated on the prediction scale (A38146).

(6) Arbitrary corrections ($d\epsilon$) are introduced through the lower knob (A34051), spotting scale (A38145), and index (A38140, fig. 32). Rotation of this knob causes a rotation of the prediction scale (A38146). The zero of the latter scale determines the initial position for the index mark on the clutch, so that the effect of displacing same is to add or subtract a constant angle $\left(\frac{\delta\epsilon}{3}\right)$ to the sound lag correction $\left(\frac{\sigma_x}{3}\right)$ there introduced. Indications on the spotting scale (A38145) correspond to the *actual* value of the correction there introduced; indications on the prediction scale (A38146) correspond to *one-third* the actual value

of the corrections introduced, the scale calibrations and gear ratios being arranged accordingly.

(7) Thus, by matching the outer pointer and inner index mark, when the latter indicates the change in elevation in one-third the sound lag time $\left(\frac{\sigma_x}{3}\right)$ plus an arbitrary correction $\left(\frac{d\epsilon}{3}\right)$, the proper total correction (σ) is introduced to the transmitter.

(8) The elevation scale (B129166) and index (A38166) at the top of the corrector (sec. B–B, fig. 30) indicate the present elevation transmitted to the searchlight comparator. The scale is clamped to the rotor shaft by means of the knob (A38177) and the index is assembled to the transmitter frame. The scale may be rotated about the rotor shaft for orientation purposes by releasing the clamping knob (A38177), but changes of indication on the sound lag drum elevation (ϵ') scale cannot be made in this manner. Orientation of the azimuth scale (B129165) is not, of course, subject to the latter limitation.

(9) The prediction and arbitrary correction scales of the acoustic corrector, M1, are graduated in degrees; those of the acoustic corrector, M1A1, are graduated in mils. The scale graduations filled with white indicate positive (+) corrections to azimuth or elevation angles, and the graduations filled with red indicate negative (−) corrections. Clockwise corrections to azimuth, and upward corrections to elevation, are considered positive (+) in sign.

e. Mounting arrangement.—These instruments are provided with springs and rubber pads for mounting, to lessen the shock incident to transportation, and also to prevent the transmission of vibrations to the horns. The mounting arrangement is shown in figure 34.

f. Electrical components.—(1) Two a. c. synchronous transmitters (C44969) are provided for the continuous transmission of the present azimuth and elevation (A_0 and ϵ_0) to the searchlight comparator. These units require approximately 0.8 ampere from a 110-volt, 60-cycle, a. c. source and have a load power factor of about 30 percent. Variations in the a. c. supply voltage exceeding ±10 volts will affect the accuracy of the transmission of data. However, the voltage fluctuations in the a. c. power source normally used with these instruments, if properly adjusted, should not result in serious errors in transmitted data. These transmitters are the same as are used in the various data transmission systems. The elevation transmitter is ordinarily set on "electrical zero" for zero elevation. For a description of the transmitters and method of setting the elevation transmitter on the "electrical zero", see TM 9-1656. There is no "electrical zero" setting for the azimuth transmitters.

(2) The scales, indexes, and pointers of the instrument are illuminated by means of five electric lamps (Mazda No. 1130 type, bayonet base, double contact, 21 cp., 6–8 volt, 2.52 amp.). Three hand holes are provided, one on each side and one on the bottom of the case, to permit access to the lamps. These holes are provided with covers, held in place by wing nuts (sec. K–K, fig. 33).

(3) The lighting current is taken from the 110-volt circuit through a small 110-volt to 8-volt step-down transformer located in the rear of the corrector, as shown in figure 28. A canopy type switch, located on the lower face of the instrument, operates the lights.

(4) A 10-pole receptacle (C56031) for connecting the plug of the cable leading to the comparator is located on the back of the case. (See fig. 28.) As only 8 poles are needed, the remaining two are available as spares. This receptacle is provided with a cover, arranged to be held in place by bolts and wing nuts when the plug is not inserted.

(5) A 200-foot cable with 10-pole plug at both ends is included for connecting the above receptacle to the comparator. A reel and chest are provided for storing same when not in use.

(6) The wiring diagram is shown in figure 35.

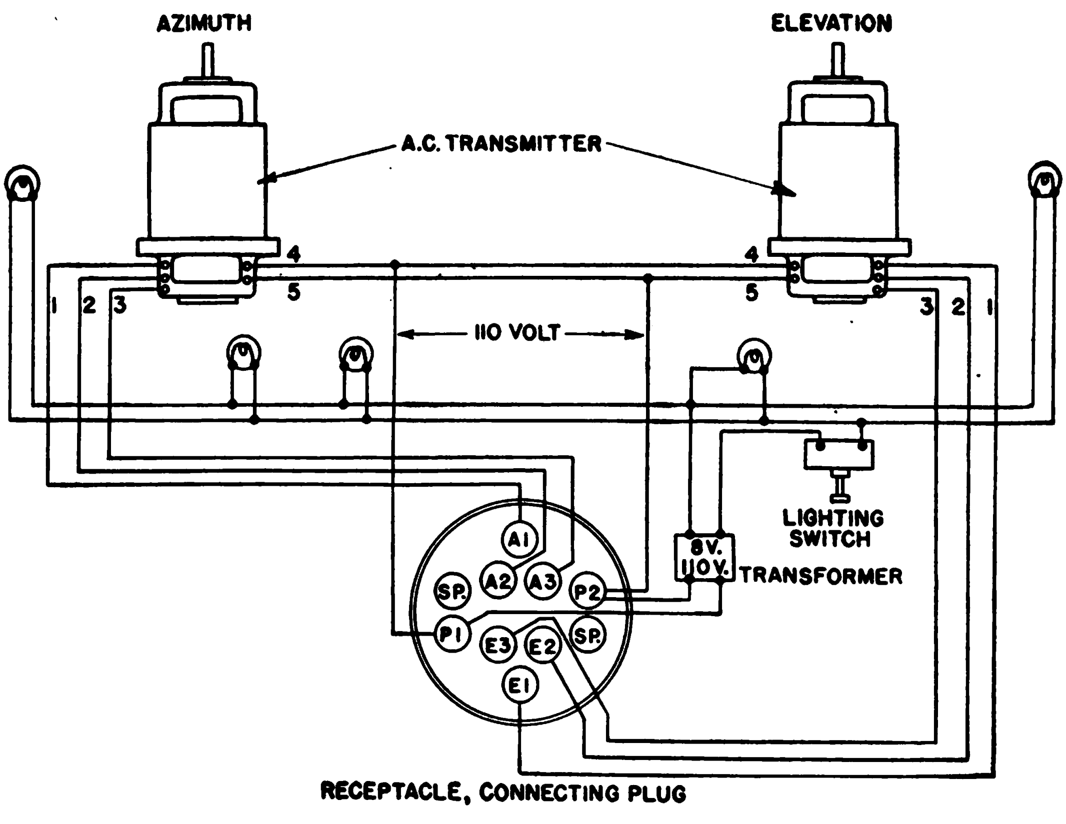

FIGURE 35.—Wiring diagram acoustic correctors, M1 and M1A1.

16. Operation.—*a. Preliminary preparation.*—(1) The operations herein described presume that the initial adjustments (par. 18*a*) have been correctly made.

(2) Plug the cable leading to the searchlight comparator into the 10-pole receptacle in the rear of the instrument. The receptacle cover is removed by loosening the wing nuts. The longer of the two plugs on the cable is for insertion in the acoustic corrector receptacle. It is not possible to transmit data to the comparator until this cable has been plugged into the receptacle and the a. c. supply line has been energized.

(3) After the sound locator is in the operating position (par. 9*a*) and the horns oriented with respect to the searchlight comparator, the azimuth scale of the acoustic corrector must be adjusted to the same orientation data. This scale is adjusted by releasing (unscrewing) the orienting clamping knob (A38177, fig. 30) located on the left-hand side of the top of the instrument. The index (A38140) must be set at zero on the azimuth spot correction scale, and the pointer (A38139) must be set at zero on the azimuth prediction scale when making this setting in order to place the index (A38166) at the position corresponding to zero correction ($\delta=0$), and hence indicate apparent azimuth (A'). After the scale has been unclamped, it may be adjusted to the desired position by means of the larger knob below the clamping knob and held in position, if necessary, during the reengagement of the clamping knob. After the scale has been properly oriented, the indications thereon should be checked at various positions of the sound locator horns throughout the operating range.

(4) A similar arrangement is provided for the elevation scale. Any attempt to adjust this scale, however, once it is properly set, will result in a discrepancy between the indications thereon and those on the base of the sound lag drum. This setting therefore should not be disturbed, but indications thereon should be checked at various positions of the sound locator horns. Should the indications fail to agree, the procedure outlined in paragraph 18*a* must be followed.

(5) Synchronization of the synchronous transmitters with their respective repeaters is accomplished by clutches at the searchlight comparator.

b. Sound lag corrections.—(1) The sound locator listeners attempt to pick up the target and, having done so, report "on target" and estimate the altitude (H_x) of same. During the "pick-up" period, one of the corrector operators turns on the light switch and sets the estimated altitude (H_x) of the target into the instrument by means of the knob on the right side of the case.

(2) Two operators are required, one for the azimuth, and the other for the elevation prediction mechanism. One of these operators is provided with a stop watch and is to note the time indicated on the sound lag drum chart. This is the prediction period for the next determination of sound lag corrections.

(3) Prior to making a determination, both operators set the index marks on the clutch faces opposite the zero graduations of their respective prediction scales by means of the knobs concentric with the buttons.

(4) The operator with the stop watch indicates the start of a prediction period by the command ***Ready———take.*** At the command ***Take*** he starts the stop watch, and both operators simultaneously apply a slight pressure with the thumb or fingers to the buttons, thus engaging the friction clutches and permitting the inner index marks to move with the sound locator horns. At the end of the prediction period, as indicated by the stop watch, he gives the command ***Ready———Halt*** or ***Set,*** and both operators release the pressure on the buttons.

(5) The operators then immediately match the outer pointers with the inner index marks by means of the knobs to the right and left, respectively, of the azimuth and elevation prediction scales.

(6) The inner index marks are then returned to their zero positions, and the foregoing procedure is repeated. The outer pointers, of course, should not be returned to zero, as a correction once inserted should remain until another is determined and introduced. Experience on the part of the operators will indicate to them when an erroneous prediction has been made, in which case the former one is left in the system until the proper correction is determined by a subsequent operation.

c. Arbitrary corrections.—(1) Arbitrary corrections in azimuth and elevation (dA and dϵ) are set into the corrector by means of the lower knobs and spotting scales.

(2) Corrections made on these scales should be introduced either prior to, or at the conclusion of, a prediction period. Corrections made during a prediction period will not be introduced until the completion of the next subsequent entire prediction period.

(3) Ordinarily, arbitrary corrections are best determined by estimation on the part of experienced operators.

(4) Under certain circumstances it may be considered advantageous to compute values for such corrections. Formulas for computing these values are given in paragraph 35. It is seldom advisable to attempt to compute such values, however, in view of the difficulty

of obtaining complete basic data and of the comparatively large errors usually resulting from the necessary determination of altitude (H_x) by estimation.

(5) Another method of determining these corrections which may in some cases be employed is analogous to the trial shot method used in artillery fire. The procedure is to have a friendly airplane make several trips through the defended zone, with running lights on. The position indicated by the sound locator is compared with that indicated by the searchlight, using the sights thereon, or, if revealing the location of the searchlight is not objectionable, by actually tracking the airplane with the beam. The corrections thus determined represent the cumulative effect of all acoustic and mechanical errors at the time. The values of the corrections required will be found to differ with different positions of the target and with time. Usually a single average value of each (dA and $d\epsilon$) should suffice.

d. Out of service.—(1) When the acoustic corrector is to be out of service for a considerable period, the electrical power should be removed from the system and the corrector covered with the canvas cover provided. It is not necessary to remove the plug from the receptacle, but the receptacle should be sealed, either by the plug or by the receptacle cover, both of which have swing bolts and wing nuts to insure a tight fit.

(2) When preparing to travel, the same procedure is to be followed except that the cable must be removed and placed on the reel and in the chest provided.

17. Disassembly and assembly.—*a.* The assembled and sectioned views and other illustrations show the location of the various parts and the means by which they are held in place. These figures should be carefully studied before attempting any assembling or disassembling operation.

b. The replacement of lamps can be accomplished through the hand holes provided, thus making it unnecessary to remove the case cover plates.

18. Tests and adjustments.—*a.* The initial settings of the acoustic corrector with the sound locator, once properly made, should require no change unless either or both the azimuth and elevation drives have been disconnected. Should this be the case, the orientation procedure is as follows:

(1) Level the horns in a manner as previously described, using the zero reading of the elevation scale of the sound locator as the reference point. The method of verifying the correctness of this point is described in paragraph 11*d*.

(2) Set the elevation scale on the lower periphery of the sound lag drum to read zero by rotating the elevation shaft (A38193, sec. F–F, fig. 33). Turning the azimuth shaft (A38192, sec. A–A, fig. 30) will also rotate the sound lag drum through the differential.

(3) With both of the above shafts (elevation shaft and azimuth shaft) in their proper positions, the associated couplings may be connected. Care is to be exercised that the azimuth and elevation couplings are not interchanged. If the gear meshes have not been broken, the taper pin holes in the yokes (A38194) and in the sound locator shafting should be in alinement, and the taper pins may be inserted and driven tight.

(4) If after correctly orienting the sound locator and acoustic corrector the taper pin holes in the yokes do not line up with the holes in the shafting, it will be necessary to break a gear mesh and slip a gear the number of teeth to bring the pin holes in alinement, or to drill and ream a new pin hole as the case requires. Should it be necessary to break the gear meshes at any time for inspection or servicing, it is essential that all parts be plainly marked so that they may be returned to their original positions.

b. The arbitrary lateral and vertical correction knobs and the estimated altitude knob are provided with stops to limit their motion. The limits of operation have been stated in the foregoing. The method of setting these stops for the acoustic correctors, M1 and M1A1, is similar to that employed for the acoustic corrector, M2. The procedure to be followed for these settings to the latter are explained in paragraph 25*c* and *d*.

19. Care and preservation.—*a*. The acoustic correctors, M1 and M1A1, though sufficiently rugged for normal operation, are not designed to withstand rough handling and abuse. Undue force must never be exerted on the handwheels or knobs, and they must never be rotated so that the pointers or indexes go off of their respective scales.

b. These acoustic correctors ordinarily require no maintenance in the field beyond being taken indoors every 6 months and having the cover plates removed for inspection and lubrication of moving parts. Lubricating oil, aircraft instrument and machine gun (U. S. A. Spec. 2-27), should be used for the lubricant.

c. Follow the instructions of paragraph 16*d* when removing the instrument from service or preparing to travel.

20. Data.—The name plate is located on the front of the instrument, as shown in figure 28.

SECTION IV

ACOUSTIC CORRECTOR, M2

21. General.—*a*. The acoustic corrector, M2 (figs. 36 to 40, inclusive) is an instrument for computing the true angular position of an aerial target, based upon the data pertaining to the apparent position thereof, as determined by a sound locator.

b. This instrument functions in accordance with the principles and assumptions enumerated in paragraph 4*e*. The corrections for the angular travel of the target during the sound lag time are computed at regular intervals of 10 seconds and are applied continuously. Provision is made, also, for the application of arbitrary corrections for effects not provided for in the computing mechanism. The present azimuth and elevation of the target, thus computed by the corrector, are transmitted automatically and continuously to the searchlight comparator.

c. The functioning of the instrument may be best understood by referring to the schematic diagram (fig. 41).

(1) The settings of apparent azimuth (A′) and elevation (ϵ') are made through gearing direct from the sound locator. The altitude (H_x) or the slant range (D′) must be estimated and the setting made on the appropriate scale by means of the knob provided for the purpose. Timing of the predicting period is accomplished by an internal constant speed motor, and no external timing device is required.

(2) Since the elevation drive from the sound locator is brought out concentrically with the vertical axis of the horn mount, it is evident that for any constant apparent elevation (ϵ') setting, this shaft, instead of remaining stationary when the horn mount is traversed, will be rotated thereby (par. 7*j*). The differential gear in the acoustic corrector, driven by this shaft and also by the azimuth drive, functions to restore the azimuth component removed by this superimposed rotation and hence to provide indications of apparent elevation (ϵ') which are independent of apparent azimuth (A′).

(3) The azimuth and elevation motions are geared directly to the rotors of the azimuth and elevation synchronous transmitters, respectively. The frames of these transmitters are geared to mechanisms subsequently described, so as to be offset an angle equal to the total lateral or vertical correction applied (δ or σ respectively). The net angular displacement between rotor and frame is thus the *sum* of the apparent azimuth or elevation (A′) or (ϵ') plus the total lateral or vertical correction (δ or σ), that is, the present azimuth or elevation (A_o or ϵ_0), which angles are transmitted to the searchlight comparator. These angles are also indicated on the dials of the acoustic corrector, each dial being arranged to rotate with the rotor of the synchronous transmitter and being read opposite the zero graduation on the associated correction scale which rotates with the field.

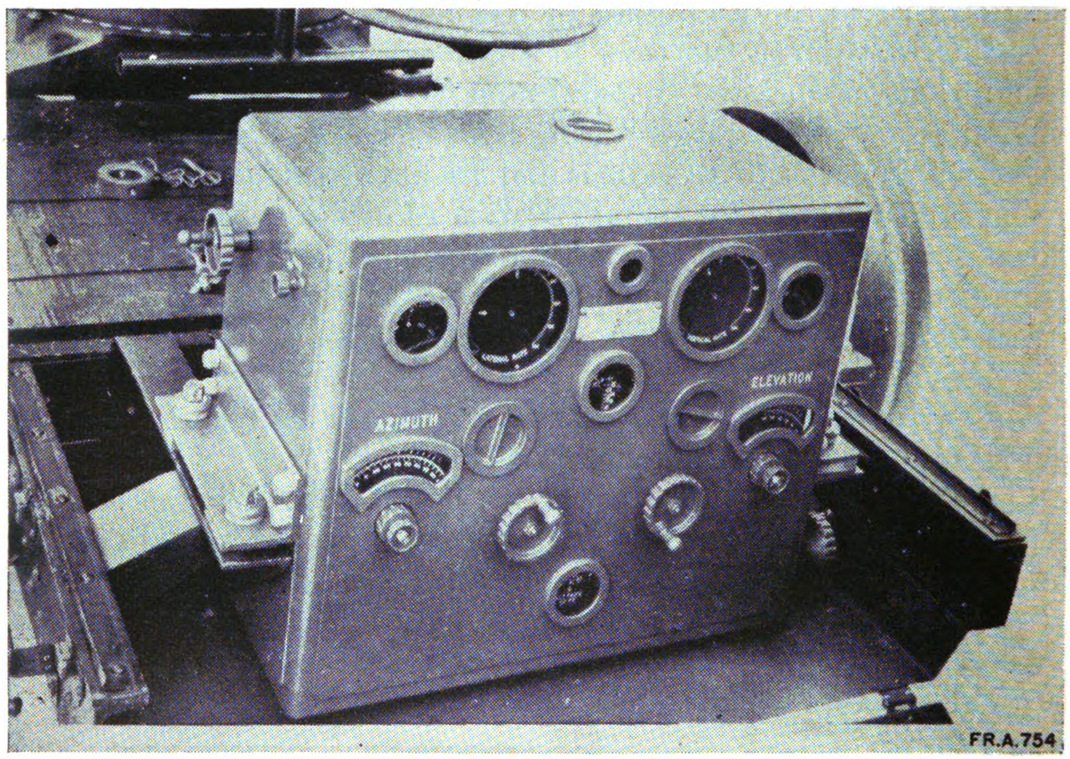

FIGURE 36.—Acoustic corrector, M2 mounted on sound locator trailer, M3.

(4) In these instruments, lateral and vertical rate indicators are employed to provide indications of the lateral and vertical angular velocities (Σ'_a and Σ'_e), respectively. The inner element of each indicator is a pointer, arranged by a system of friction drives and other devices, subsequently described, to be driven directly by the elevation (ϵ') or azimuth (A′) motion of the instrument during the predicting period, which is 6 seconds. At the conclusion of this

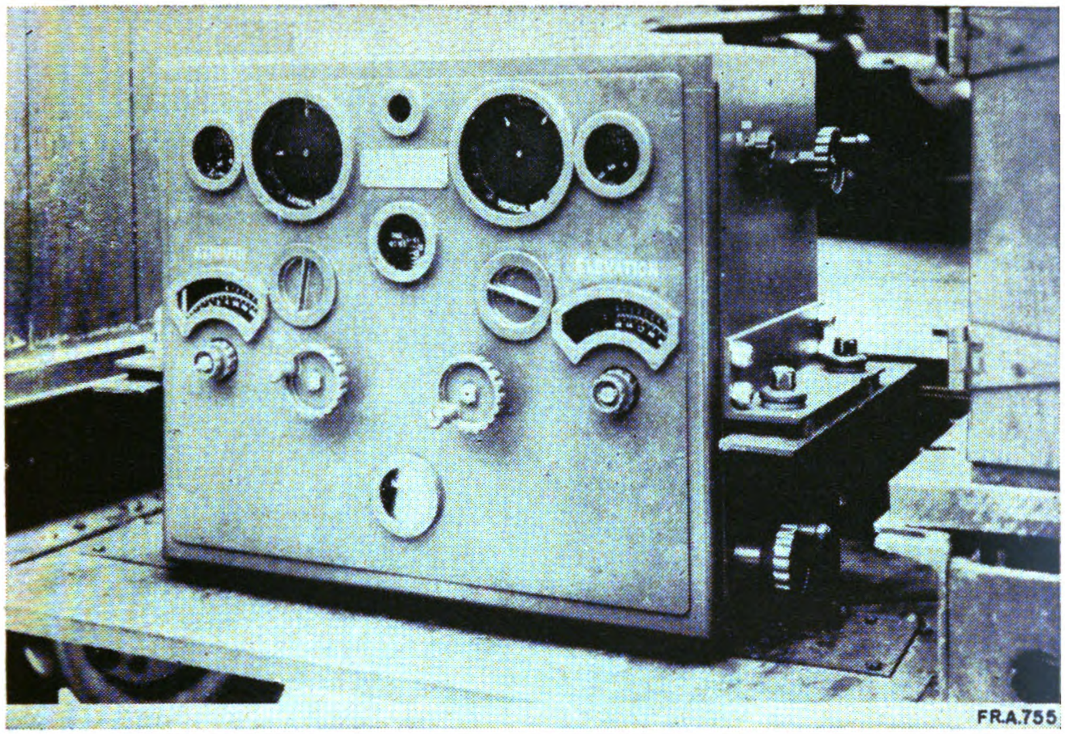

FIGURE 37.—Acoustic corrector, M2 mounted on sound locator trailer, M2A4.

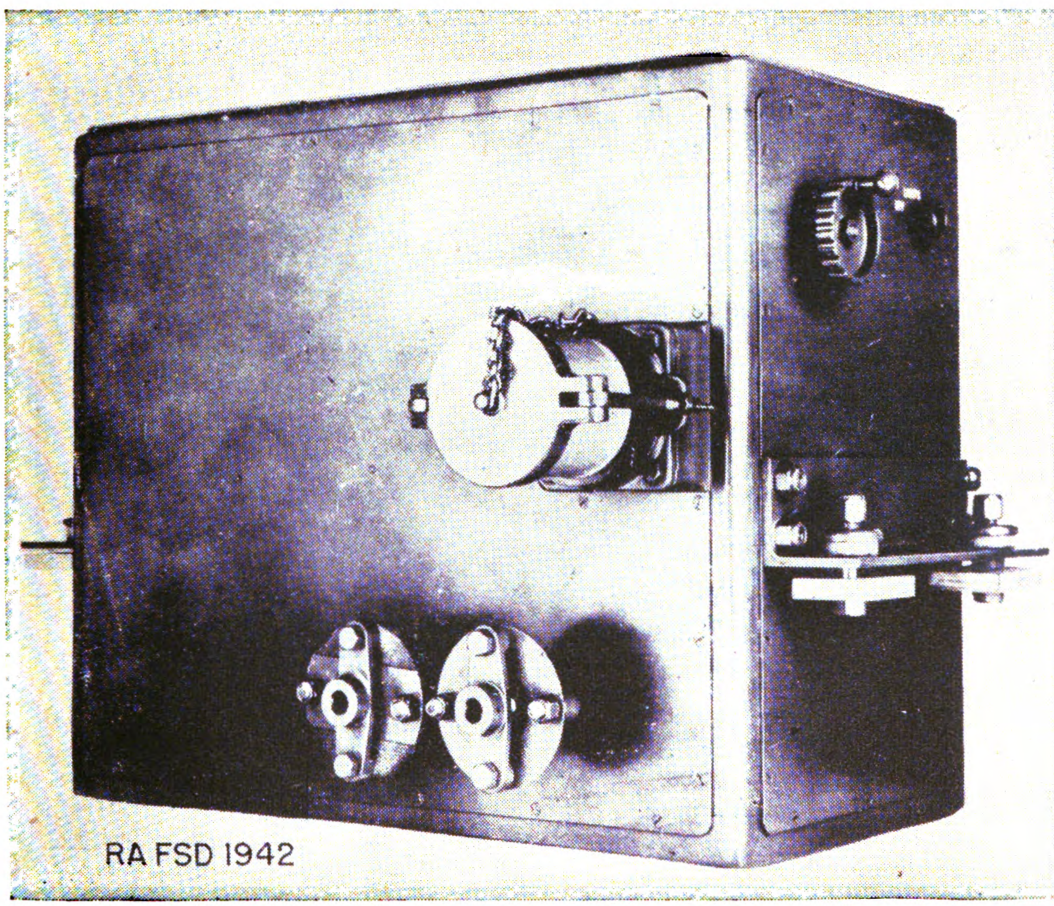

FIGURE 38.—Acoustic corrector, M2—rear view.

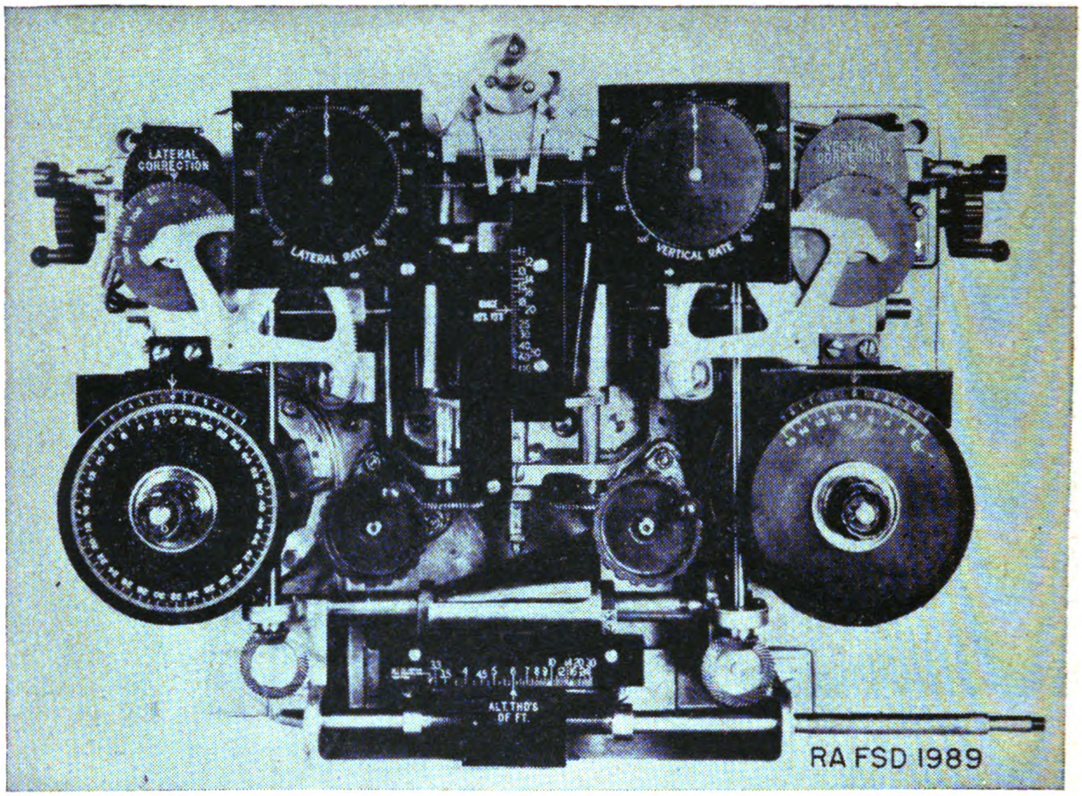

FIGURE 39.—Acoustic corrector, M2—interior view, front.

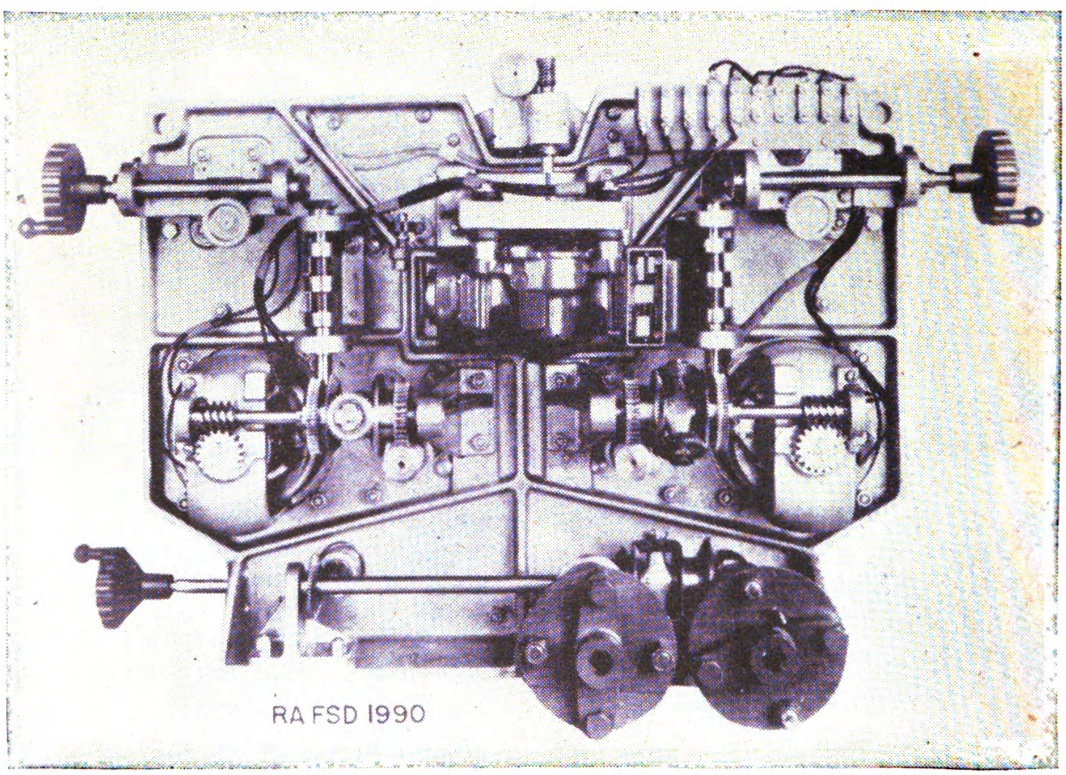

FIGURE 40.—Acoustic corrector, M2—interior view, rear.

period, the pointer indicates on the associated scale the actual angle (in mils) passed through by the target in that time, which, expressed in mils per second, is 6 times the average angular velocity ($6\Sigma'_a$ or $6\Sigma'_e$). The pointer remains locked in the above position for a period of slightly less than 4 seconds and is then restored to its original, or

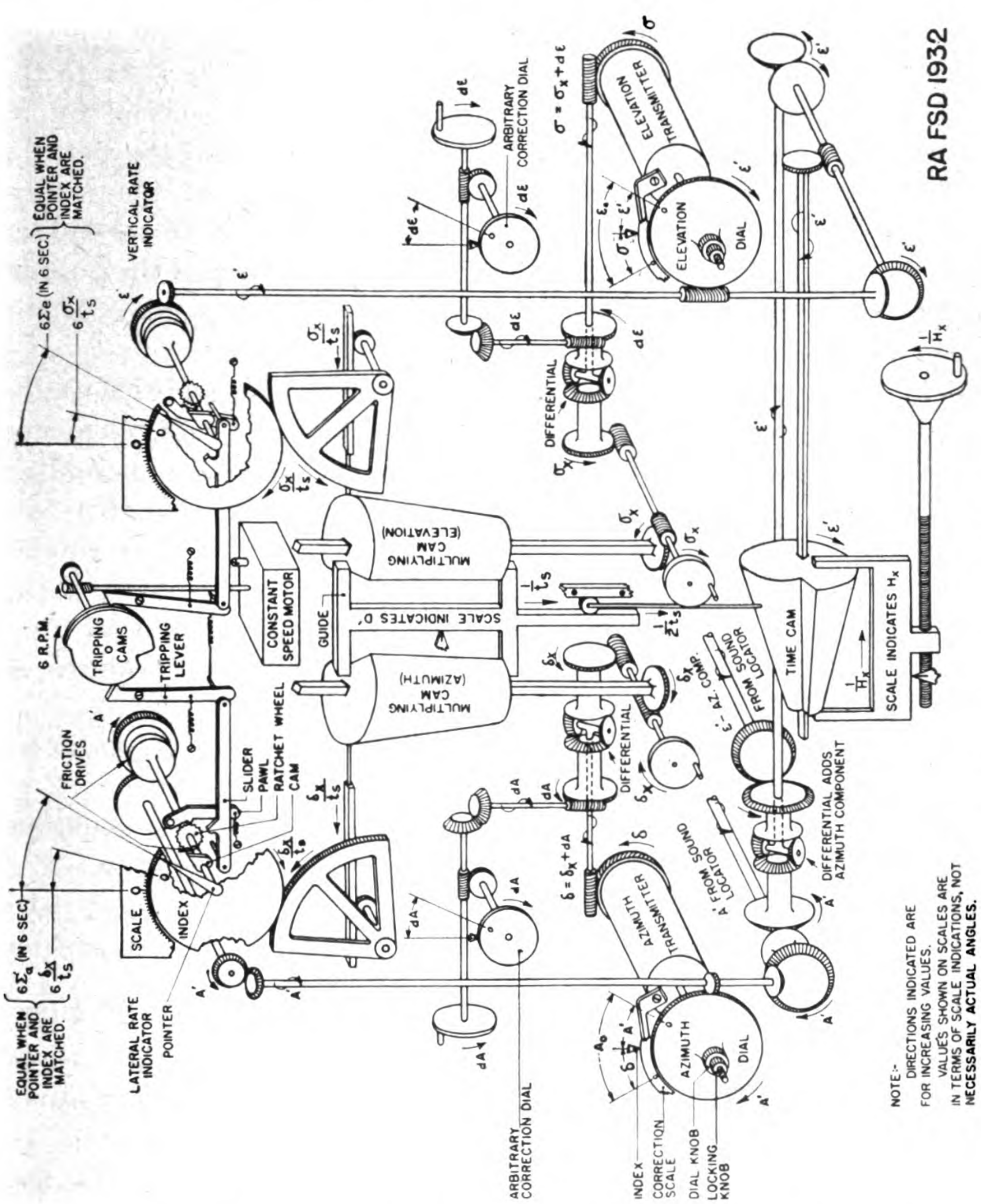

FIGURE 41.—Acoustic corrector, M2—schematic diagram.

zero, position in preparation for the next prediction, the entire cycle described requiring exactly 10 seconds for its completion.

(5) Timing of this procedure is accomplished by means of a constant speed electric motor which drives the tripping cams at a constant speed of 6 r. p. m. (1 rev. in 10 secs.). These cams actuate the sliders

of the lateral and the vertical rate indicators through separate tripping levers. The cams and levers are so designed that the events on both indicators have the same sequence but occur 5 seconds apart, not simultaneously. Each slider has three positions.

(*a*) In the outermost position (farthest from the center of the instrument), which is occupied for a fraction of a second prior to the beginning of a predicting period, a projection on the slider engages with the cam near the indicator pointer, causing it to be reset to the initial, or zero, position. Since the ratchet wheel is locked by its pawl, slippage occurs at the friction drive between it and the cam.

(*b*) In the innermost position (nearest the center of the instrument) which is occupied during the predicting period (6 secs.), the pawl is disengaged from the ratchet wheel, allowing it and the pointer to be driven by the azimuth or elevation motion, no slippage occurring at either of the friction drives.

(*c*) In midposition (intermediate between the two positions described in (*a*) and (*b*) above), which is assumed at the conclusion of a predicting period and occupied for nearly 4 seconds thereafter, the pawl is allowed to engage with the ratchet wheel, locking it, and causing the pointer to retain its indication. As long as the ratchet wheel is locked, slippage occurs at the friction drive between it and the driving gears. It is during this part of the operation that these data are utilized, the operator matching pointers and indexes as subsequently described.

(6) Sound lag time (t_s) is introduced by means of the 3-dimensional time cam.

(*a*) This cam is positioned in rotation by gearing from the apparent elevation (ϵ') drive of the instrument.

(*b*) It is also positioned longitudinally in accordance with the altitude (H_x) but, for mechanical reasons, such displacements are not proportional to that quality itself, but to the reciprocal thereof $\left(\frac{1}{H_x}\right)$. The altitude scale indicates the actual value of altitude (H_x) corresponding to the displacement, the graduations thereon necessarily being nonuniformly spaced. The time cam and altitude scale are both positioned by a yoke which is threaded to run along the lead screw driven by the altitude knob. As shown in figure 40, this knob is to be rotated counterclockwise for *increasing* values of $\frac{1}{H_x}$, that is, *decreasing* values of H_x.

(*c*) This cam is so shaped that the lift of the follower depends on the corresponding sound lag time (t_s). However, as with altitude, displacements of the follower are proportional, not to the sound lag time (t_s) itself, but to the reciprocal thereof $\left(\frac{1}{t_s}\right)$. The relation solved by this cam is thus the reciprocal of that given on figure 4, or $\frac{1}{t_s}=1{,}100 \sin \epsilon' \times \frac{1}{H_x}$.

(*d*) The follower of the time cam in turn displaces a guide which positions longitudinally the 3-dimensional multiplying cams subsequently described. Displacement of the guide is proportional to the reciprocal of the sound lag time $\left(\frac{1}{t_s}\right)$ and hence also to the reciprocal of the slant range $\left(\frac{1}{D'}\right)$. The range scale mounted on the guide indicates the actual value of slant range (D') corresponding to the displacement. Graduations on this scale, as on the altitude scale, are necessarily nonuniformly spaced. In any case where slant range (D') can be more accurately estimated or determined than altitude (H_x), it is to be set directly into the instrument using this scale.

(7) Each multiplying cam is so designed that the lift of the follower of each cam is proportional to the product of the longitudinal displacement, multiplied by the rotational displacement.

(*a*) The follower is geared to the index of the lateral or vertical rate indicator, the gear ratios being such that the scale indication thereon is 6 times the above product.

(*b*) These cams together receive longitudinal displacements proportional to the reciprocal of sound lag time $\left(\frac{1}{t_s}\right)$ and are arranged to be individually displaced in rotation, by means of knobs, in accordance with the sound lag correction (δ_x or σ_x) as actually applied. The indexes thus indicate angles equal to 6 times the products of these quantities $\left(6\frac{\delta_x}{t_s} \text{ or } 6\frac{\sigma_x}{t_s}\right)$.

(*c*) The pointers of the rate indicators have been shown in paragraph 21*c*(4) to indicate 6 times their respective angular velocities ($6\Sigma'_a$ or $6\Sigma'_e$). Thus, when the operator rotates the knobs so that the indexes become matched with these pointers, the following conditions will be met:

$$6\frac{\delta_x}{t_s}=6\Sigma'_a \qquad 6\frac{\sigma_x}{t_s}=6\Sigma'_e$$

or or

$$\delta_x=\Sigma'_a\times t_s \qquad \sigma_x=\Sigma'_e\times t_s$$

These are the correct values for these quantities under the assumptions of paragraph 4*e*(5)(*c*).

(8) Arbitrary corrections (dA or $d\epsilon$), set on the corresponding dials by means of the knobs provided, are added to the sound lag corrections (δ_x or σ_x) thus determined, through differential gears. The resulting value of total correction ($\delta = dA + \delta_x$ or $\sigma = d\epsilon + \sigma_x$) is transmitted to the frame of the corresponding synchronous transmitter, rotating it through that angle, thus introducing the corrections (par. 21*c*(3)) to the data furnished the searchlight comparator.

(9) The azimuth and elevation dials are adjustable for orientation purposes, clamping knobs being provided. Adjustment of the elevation dial in this manner does not, however, affect the elevation (ϵ') setting of the time cam.

d. The limits of operation are as follows:

Slant range of target (D′)	1,100 to 11,000 yards.
Altitude of target (H_x)	3,300 to 30,000 feet.
Angular velocity of target—	
Azimuth (Σ'_a)	−83 to +83 mils per second.
Elevation (Σ'_e)	−83 to +83 mils per second.
Arbitrary corrections—	
Azimuth (dA)	−200 mils to +200 mils.
Elevation ($d\epsilon$)	−200 mils to +200 mils.
Sound lag corrections—	
Azimuth (δ_x)	−250 mils to +250 mils.
Elevation (σ_x)	−250 mils to +250 mils.
Predicting period	6 seconds.
Frequency of predictions—	
Azimuth	6 per minute.
Elevation	6 per minute.

e. The power required for this instrument is approximately 160 watts from a supply of 110-volt, 60-cycle a. c. This does not include the power for the two repeaters in the searchlight comparator connected to the transmitters in the acoustic corrector.

22. Description.—*a. General.*—The acoustic corrector, M2, is inclosed in an aluminum rain and dustproof case and is mounted vertically on the rear of the sound locator trailer. Figures 42 to 50, inclusive, show the mechanical details of these instruments and should be referred to frequently in connection with the description which follows.

b. Azimuth and elevation drives.—(1) The main azimuth and elevation shafts from the sound locator horn mount connect with the

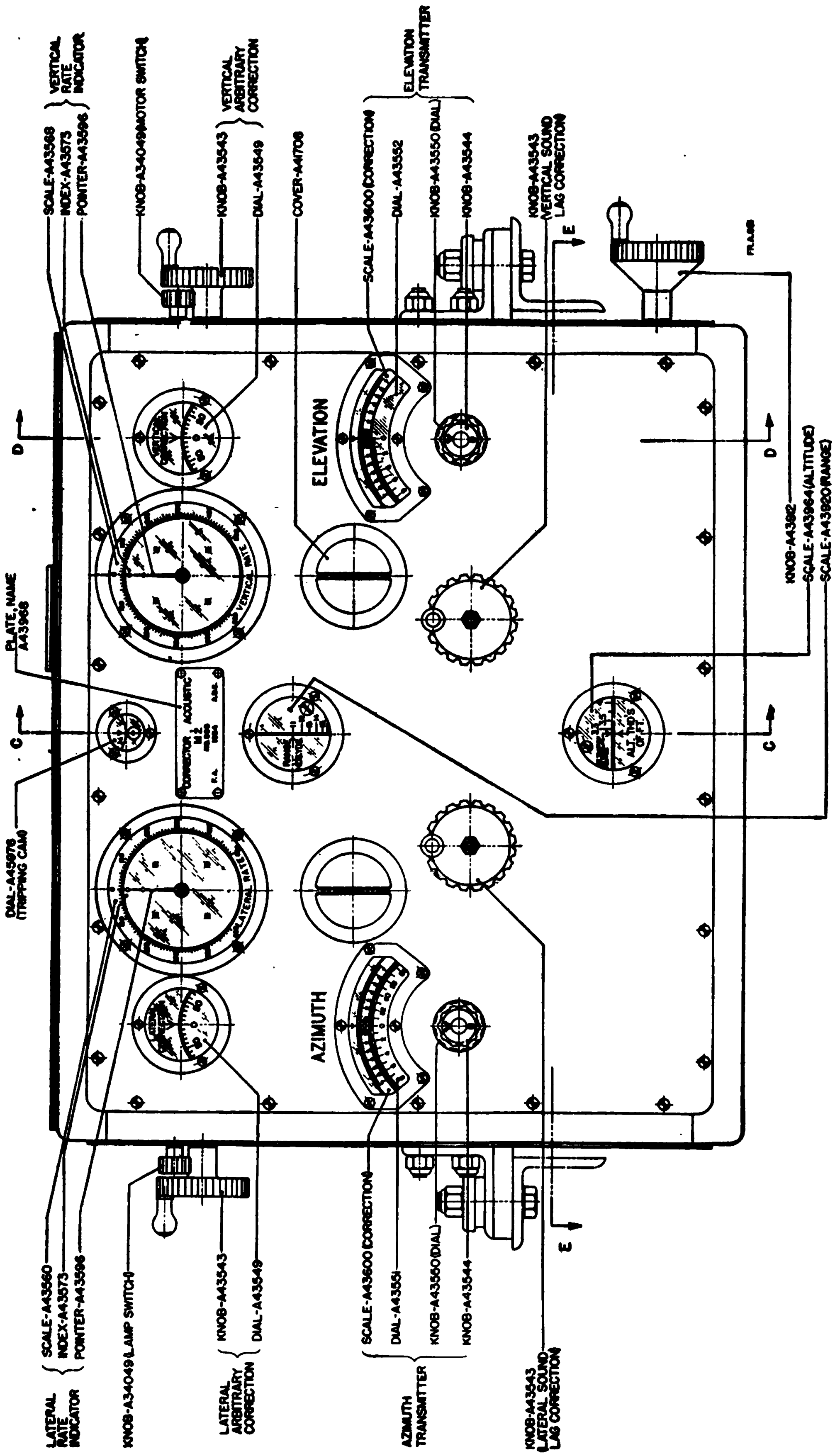

FIGURE 42.—Acoustic corrector, M2—front view showing location of controls.

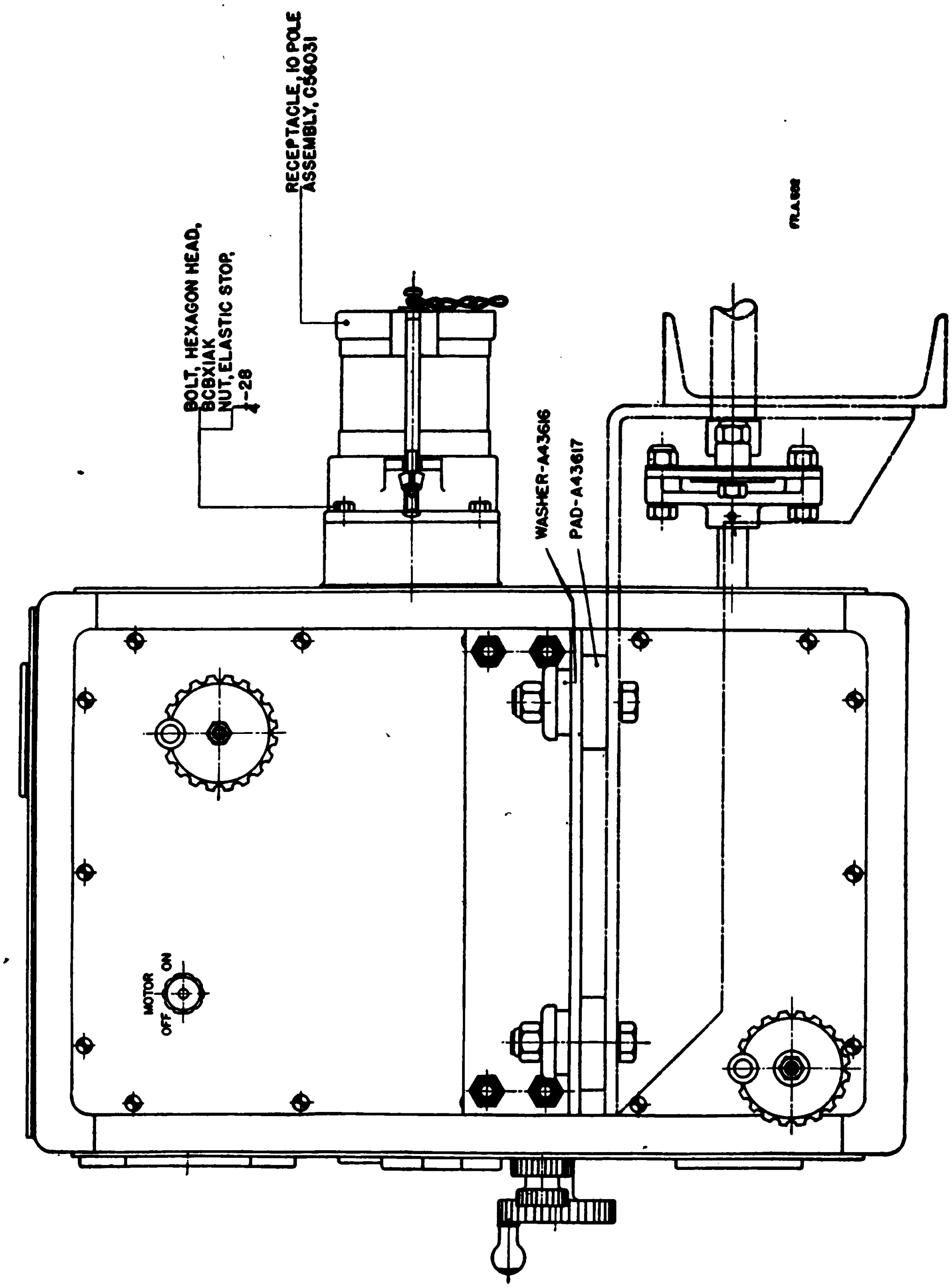

FIGURE 48.—Acoustic corrector, M2—side view.

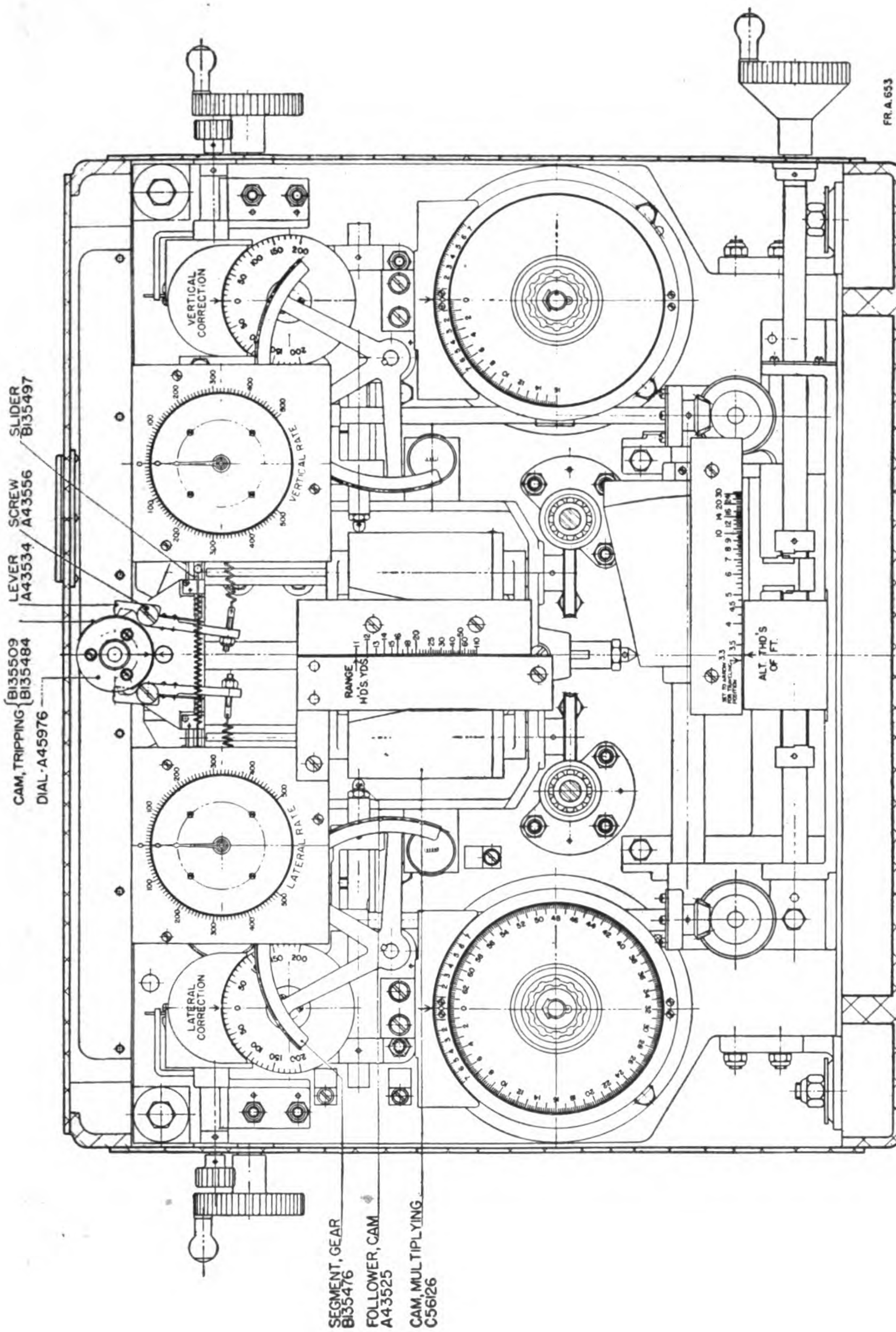

FIGURE 44.—Acoustic corrector, M2—interior view—front.

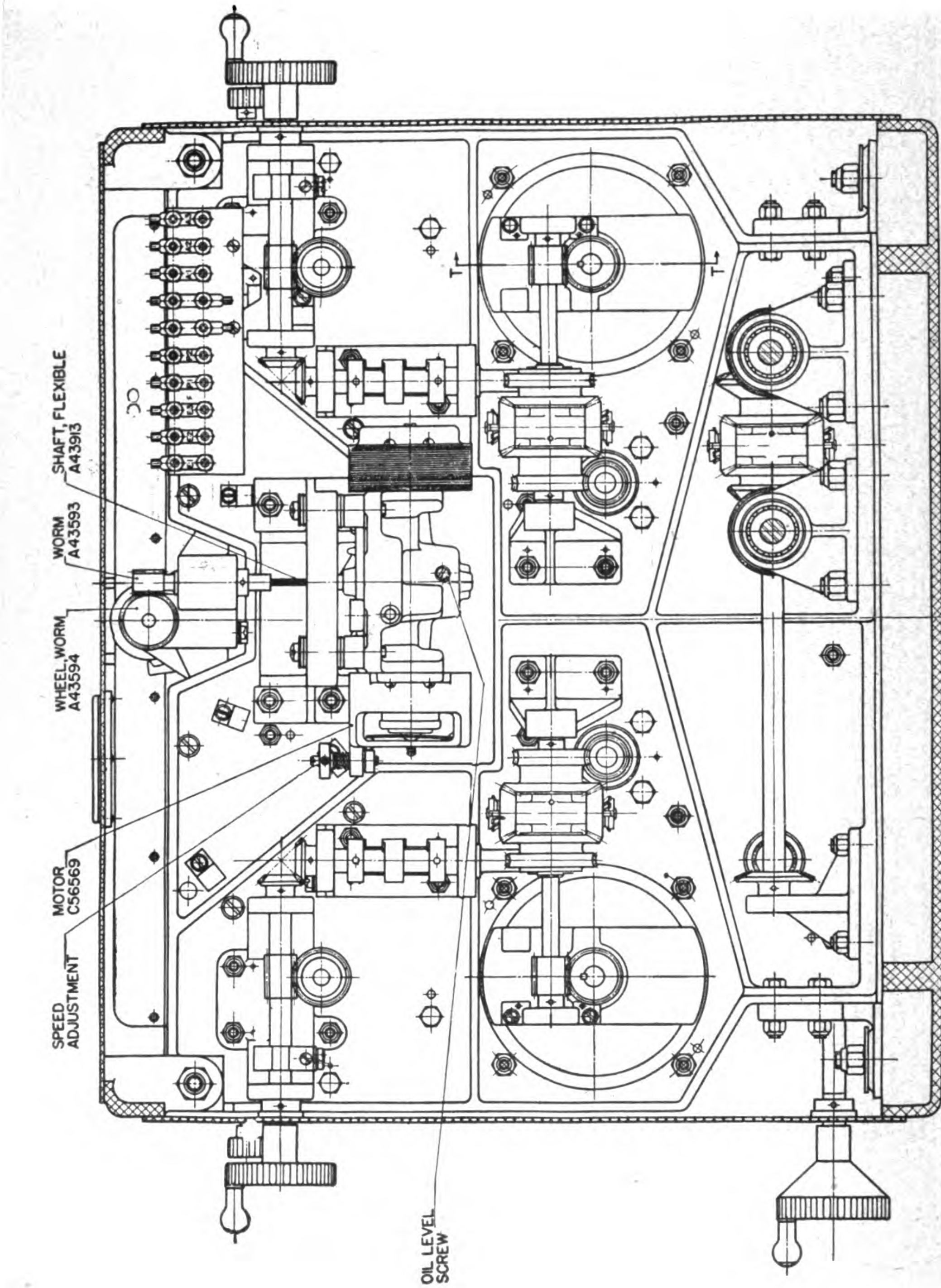

FIGURE 45.—Acoustic corrector, M2—interior view—rear.

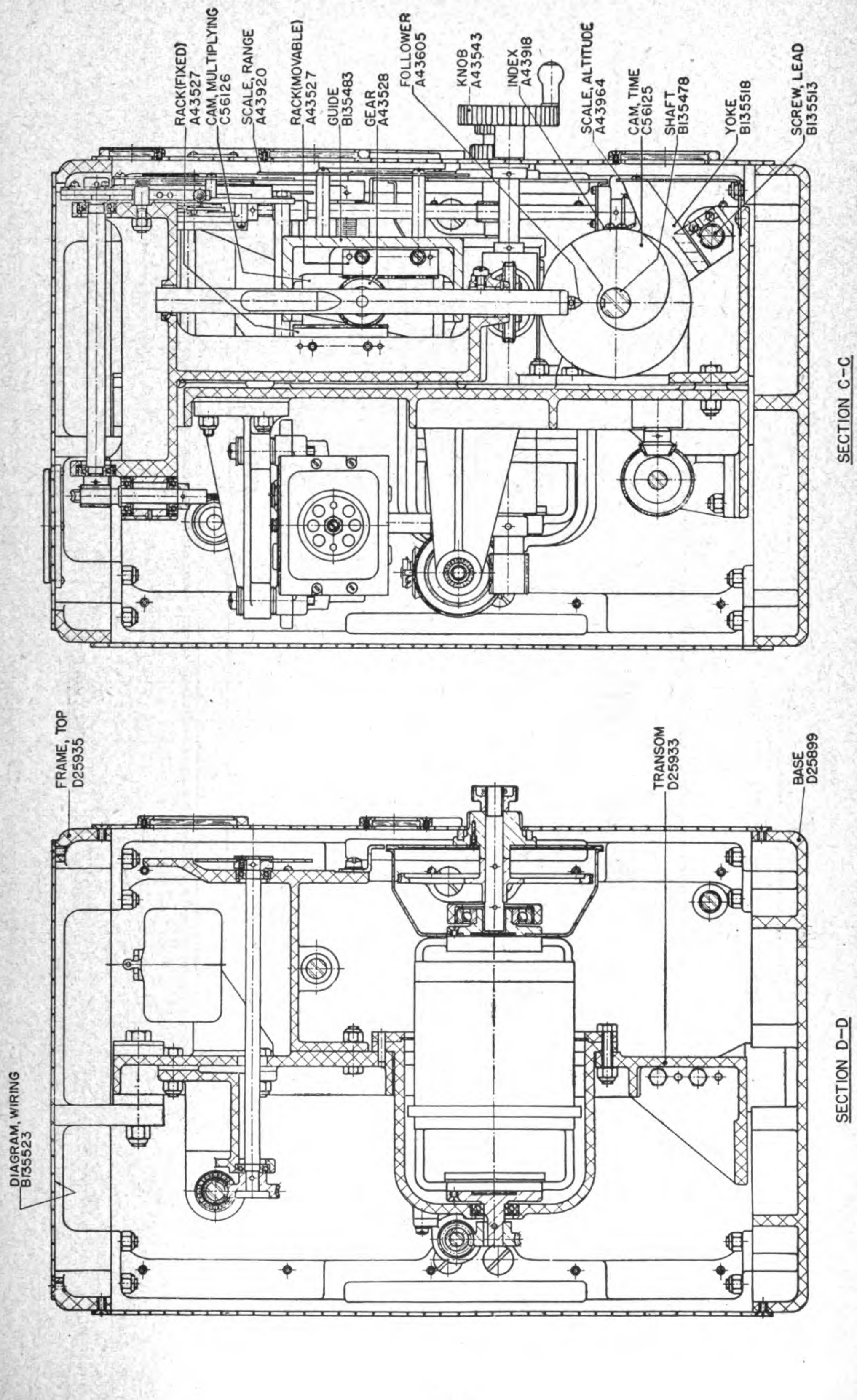

FIGURE 46.—Acoustic corrector, M2—sectioned views. (See fig. 42 for section planes D–D and C–C.)

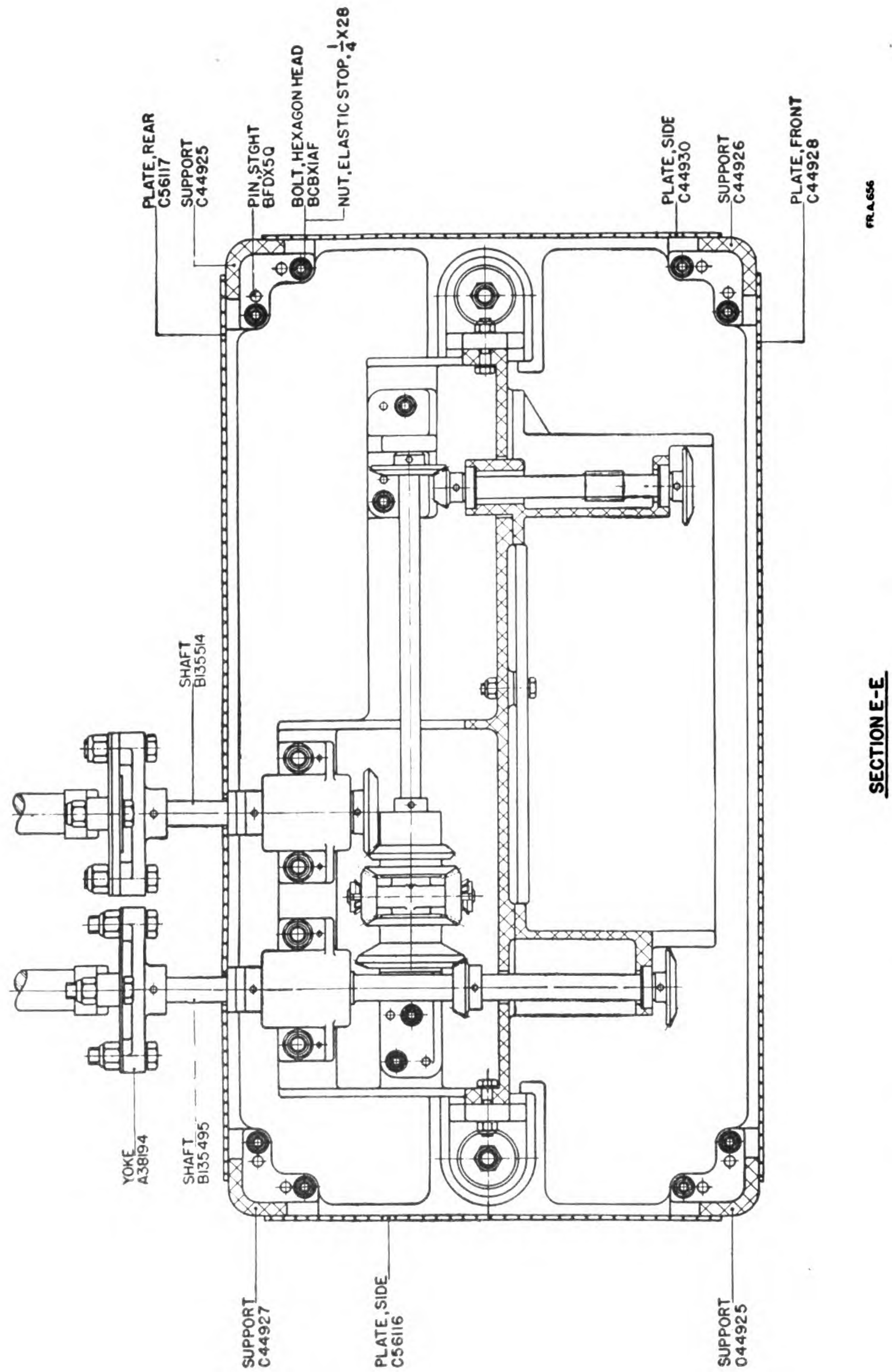

FIGURE 47.—Acoustic corrector, M2—sectioned view. (See fig. 42 for location of section plane.)

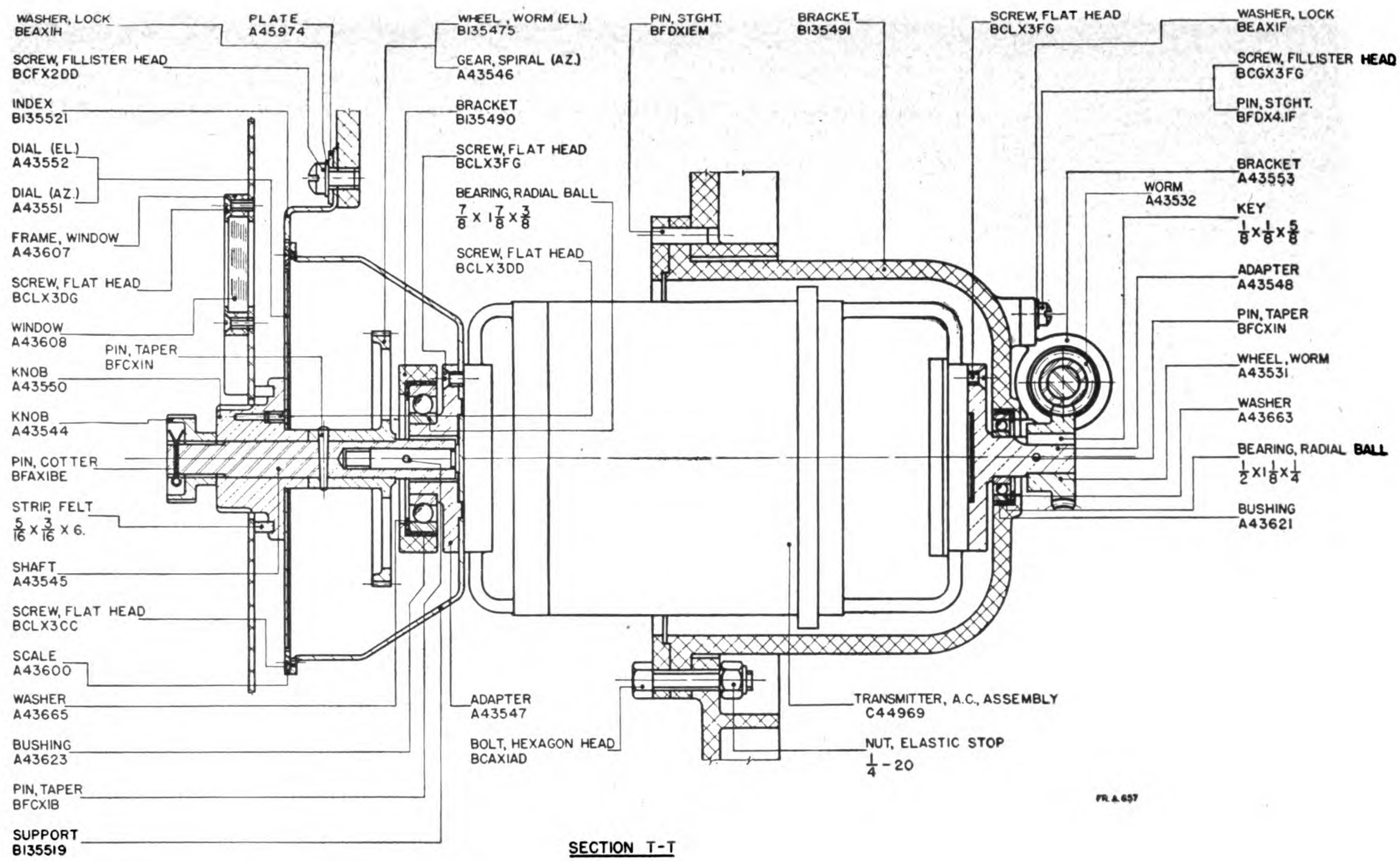

FIGURE 48.—Acoustic corrector, M2—sectioned view. (See fig. 45 for location of section plane.)

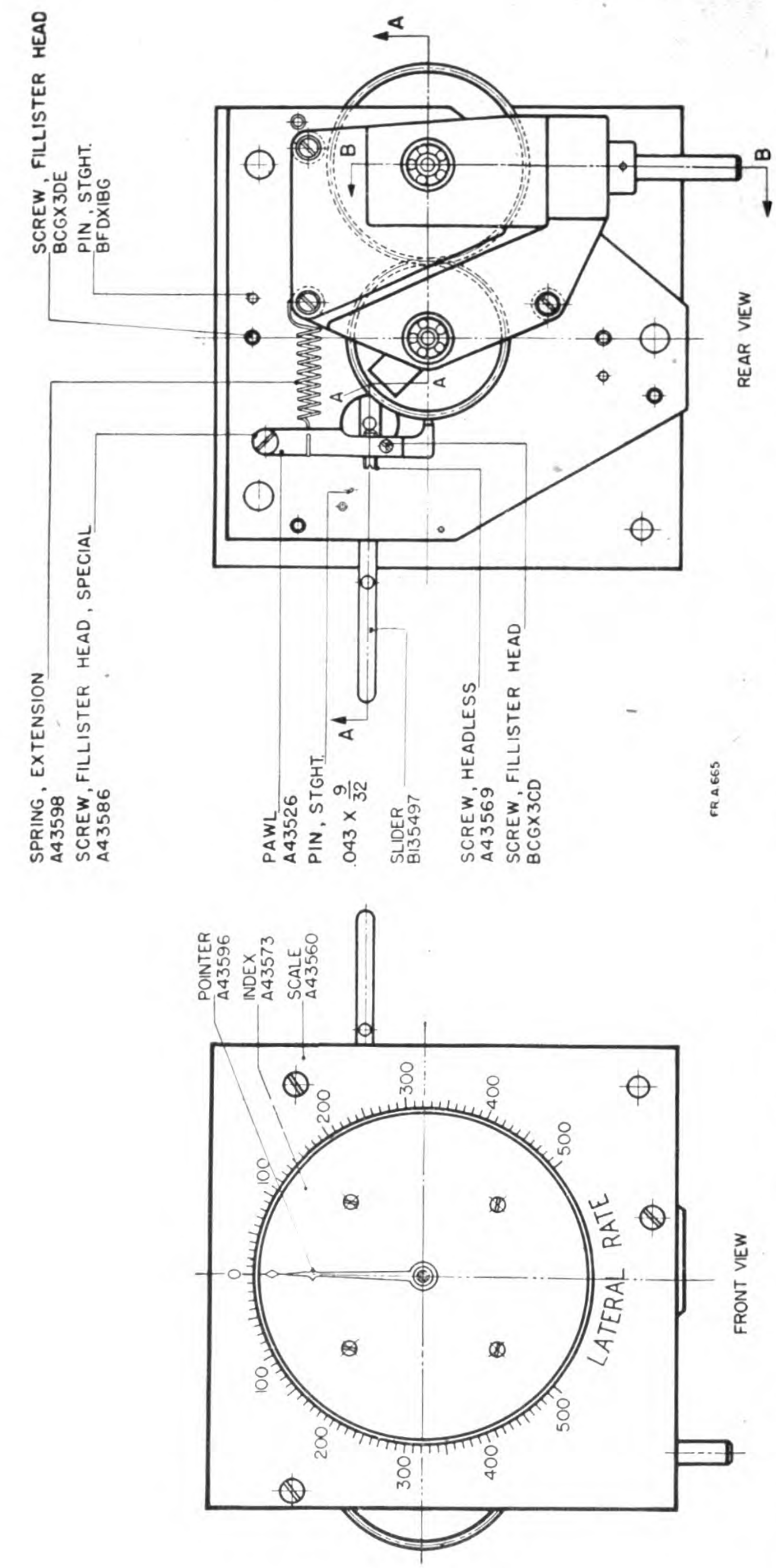

Figure 49.—Acoustic corrector, M2 and lateral rate indicator, D25932—assembled views. (See fig. 50 for location of section planes.)

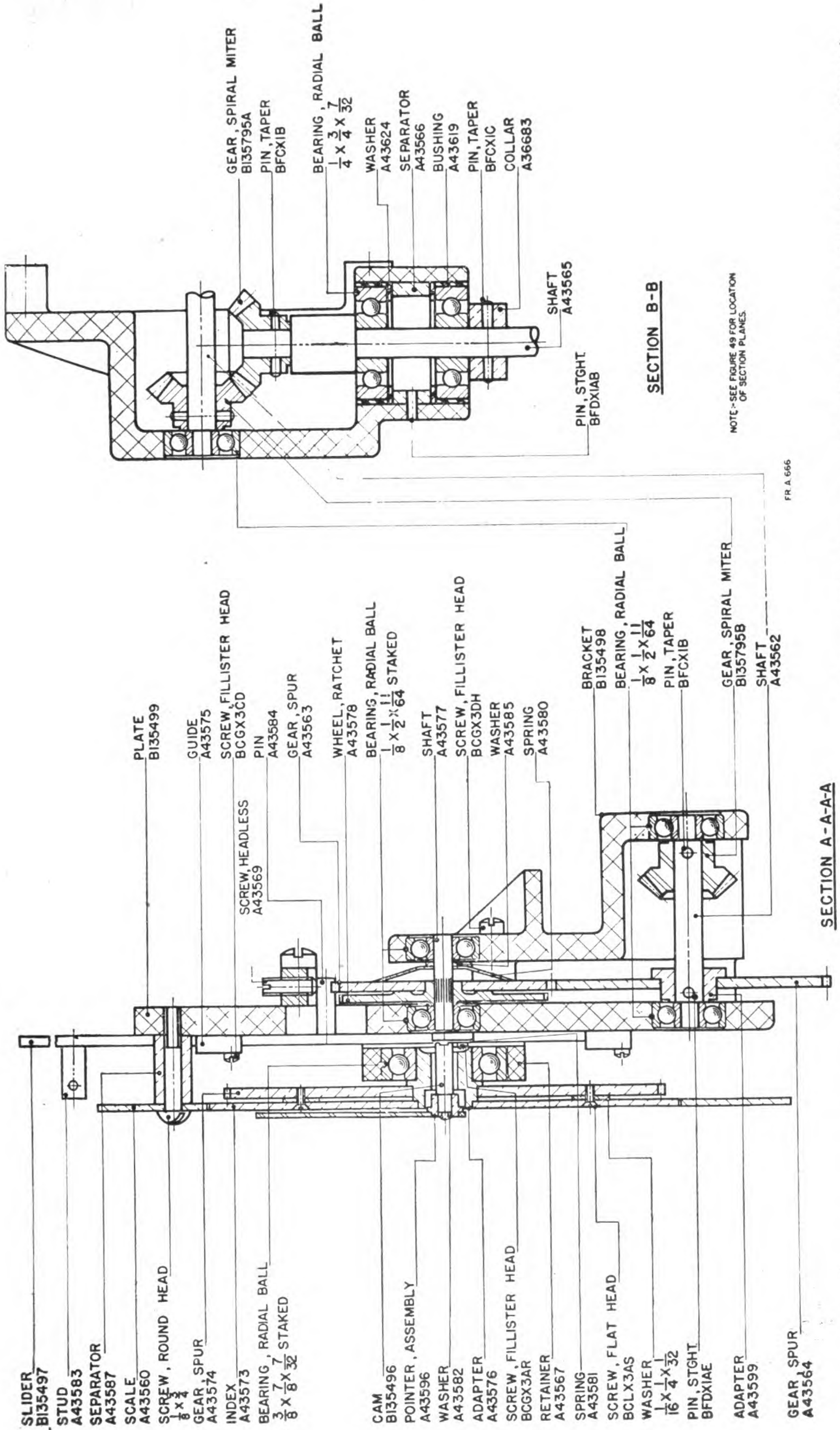

FIGURE 50.—Acoustic corrector, M2 and lateral rate indicator, D25932—sectioned views. (See fig. 49 for location of section planes.)

corresponding shafts (B135495 and B135514, fig. 47), respectively, in the rear of the acoustic corrector.

(2) Connection is by flexible couplings, each composed of two yokes (A38194) bolted to a flexible disk of brass or packing material. These couplings, including the taper pins therein, are part of the acoustic corrector, not of the horn mount.

(3) The elevation drive in the acoustic corrector is first geared to a differential, shown in figure 47, the function of which is to restore to the apparent elevation (ϵ') the component of azimuth (A'), which has been subtracted due to the fact that the elevation shaft passes out through the center of the sound locator turntable (par. 7*j*).

(4) The output from this differential is geared to the shaft of the time cam and to the vertical rate indicator, as well as to the rotor of the elevation transmitter. The azimuth shaft is geared to the lateral rate indicator and to the rotor of the azimuth transmitter.

c. Time cam.—(1) The time cam (C56125, sec. C–C, fig. 46) is driven in rotation in accordance with elevation (ϵ') by the shaft (B135478). This shaft has a long keyway permitting the cam to be moved longitudinally without effect on the rotation. An index (A43918) is provided on the yoke (B135518) for orientation of the time cam. An index line engraved on the cam should match the index (A43918) when the sound locator horns are set at 1,600 mils elevation.

(2) The time cam is positioned longitudinally (laterally) by means of the yoke (B135518) which is threaded on the lead screw (B135513) and carries the altitude scale (A43964). This scale is graduated in thousands of feet, from 3.3 (3,300 ft.) to 30 (30,000 ft.).

(3) The time cam is designed so that the follower (A43605) receives a vertical displacement proportional to the reciprocal of the sound lag time $\left(\frac{1}{t_s}\right)$ corresponding to the altitude and elevation settings of the cam. This motion is transmitted, by means of the gear (A43528) and the fixed and movable racks (A43527), to the guide (B135483), which experiences a displacement twice that of the follower (A43605). The range scale (A43920) is attached to the guide and indicates the value of slant range (D') corresponding to the sound lag time (t_s). The range scale is graduated in hundreds of yards from 11 (1,100 yards) to 110 (11,000 yards).

d. Multiplying cams.—(1) The three dimensional multiplying cams (C56126) are both positioned longitudinally (vertically), at the same time, by the guide (B135483), described in *c* above.

(2) Each cam is rotated individually by a worm wheel and worm, driven by a knob (A43543) on the front of the instrument. The shafts on which the cams are assembled have long keyways to permit longitudinal motion without effect on rotation.

(3) Both multiplying cams are alike, and each is so designed that the lift of the follower (A43525, fig. 44) is proportional to the product of the rotational and longitudinal displacements of the cam.

(4) The rotational motion of the cam is geared to the mechanism which applies the sound lag correction (δ_x or σ_x) by rotating the frame of the associated transmitter, and is thus proportional to that quantity as actually applied. The longitudinal motion has already been shown to be proportional to the reciprocal of the sound lag time $\left(\frac{1}{t_s}\right)$.

(5) The lift of the follower (A43525, fig. 44) is therefore proportional to the product of these two quantities $\left(\frac{\delta_x}{t_s} \text{ or } \frac{\sigma_x}{t_s}\right)$ and this motion is transmitted through the segment (B135476) to the lateral or vertical rate indicator, as the case may be.

e. Rate indicator.—Both rate indicators function similarly, although differing as to the relative location of parts and the arrangement of gearing; only the lateral rate indicator (D25932) is therefore described in this manual. This indicator is shown in figures 49 and 50.

(1) The vertical shaft (A43565) drives, through miter gears (B135795A and B135795B), the horizontal shaft (A43562) carrying the spur gear (A43564), which meshes with the mating gear (A43563). The latter gear rotates on the hub integral with the ratchet wheel (A43578), the faces of these two wheels being forced into contact by the spring (A43580), forming a friction drive.

(2) The pointer (A43596) is mounted securely on the hub integral with the cam (B135496). The shaft (A43577) on which the ratchet wheel is mounted passes through the hole in the hub of the cam and is held in place by the washer (A43582). This shaft drives the pointer and cam by means of the spring (A43581), providing a second friction drive in the indicator.

(3) The pawl (A43526) is drawn into engagement with the ratchet wheel (A43578) by the spring (A43598).

(4) The slider (B135497, fig. 44) has three positions, as determined by the tripping mechanism described in *g* below.

(*a*) In the outermost (extreme left for lateral indicator) position, a projection on the slider engages with the cam (B135496) rotating same and causing the pointer (A43596) to indicate zero. This position is assumed just before the start of a predicting period. Slippage occurs between the cam (B135496) and the shaft (A43577).

(*b*) In the innermost (extreme right for lateral indicator) position, the pin (A43584) in the slider engages with the screw (A43569) in the pawl (A43526) causing the latter to be disengaged from the ratchet wheel (A43578). This is the position assumed during the predicting period. There is then no slippage at either of the friction drives, and the pointer (A43596) is driven directly from the azimuth drive of the instrument, the gear ratios and scale graduations being such that the pointer indicates, at the end of the predicting period, the actual angle (in mils) passed through during that period. The period is 6 seconds in length, and this indication is therefore 6 times the average angular velocity ($6\Sigma'_a$) attained therein, expressed in mils per second.

(*c*) In midposition (intermediate between the two positions just described), which is assumed at the conclusion of the predicting period and occupied for nearly 4 seconds thereafter, the pin (A43584) recedes and allows the pawl (A43526) to drop into engagement with the ratchet wheel (A43578) causing the pointed (A43596) to retain its indication until reset to zero by the next operation. During the entire time that the pawl is thus engaged, slippage occurs at the friction drive between the ratchet wheel (A43578) and the gear (A43563).

(5) The index (A43573) is driven by the segment (B135476, par. 22*d*(5)), the gear ratio being such that the indication on the scale (A43560) is equal to 6 times the lateral sound lag correction divided by the sound lag time $\left(6\frac{\delta_x}{t_s}\right)$.

(6) When the operator applies a lateral sound lag correction (δ_x) by means of the knob (A43543) on the front of the instrument, of such value as to bring the index (A43573) into coincidence with the pointer (A43596), the indicators of the two are equal:

$$6\frac{\delta_x}{t_s}=6\Sigma'_a$$

or

$$\delta_x=\Sigma'_a\times t_s$$

The sound lag correction (δ_x), so applied, thus has the correct value in accordance with the assumptions of paragraph 4*e*(5)(*c*).

(7) In a similar manner, the proper vertical sound lag correction (σ_x) is applied by means of the vertical rate indicator.

(8) The lateral and vertical rate scales are provided with white graduations to the right of the zero point and red indications to the left. Indications on the white portion indicate positive (clockwise or up) corrections; indications on the red portion indicate negative corrections.

f. Arbitrary corrections.—Arbitrary corrections (dA and dϵ) are applied by the two knobs (A43543, fig. 42) on opposite sides of the instrument, and are transmitted to the differentials by the shafts and gears shown in figure 45. The differentials add these corrections to the sound lag corrections (δ_x and σ_x), the outputs of the differentials being geared to rotate the frames of the respective transmitters through angles equal to the sum of these two quantities, that is, the total lateral and vertical corrections (δ and σ). The value of the arbitrary correction so applied is indicated on the corresponding dial (A43549, fig. 42), one of which is geared to each arbitrary correction motion. Indications on the white portion of this dial correspond to positive (clockwise or up) corrections, while indications on the red portion correspond to negative corrections. These dials are marked "Lateral Correction" and "Vertical Correction", and it must be understood that arbitrary corrections only are indicated thereon.

g. Tripping mechanism.—The tripping mechanism functions to position the sliders (B135497) of the rate indicators. It consists essentially of two concentric tripping cams driven at constant speed by an electric motor and arranged with springs and levers to operate the sliders at the proper time.

(1) The constant-speed electric motor (C56569) shown in figure 45 is essentially a commercial motor, originally designed for rotation of a phonograph turntable. This motor is described in paragraph 22*k*(3).

(2) Through a flexible shaft (A43913), worm (A43593), and worm wheel (A43594), the motor drives the tripping cams (B135484 and B135509), behind the dial (A45976, fig. 44), which engage the two tripping levers (A43534), each pivoted on a screw (A43556) and engaging the slider (B135497) of the corresponding rate indicator.

(3) Each tripping cam makes one revolution in 10 seconds (6 r. p. m.). The periphery of each tripping cam is composed of segments of two concentric cylindrical arcs, one of greater radius than the other, and a small depressed portion. The segment of greater radius, which is of such size that it is effective for the predicting period of 6 seconds, causes each slider in turn to assume its extreme inward position (toward center of instrument), allowing the pointer of the rate indicator to move without restraint during that period. At the

conclusion of the predicting period, the arc of lesser radius becomes effective, causing the slider (B135497) to assume its intermediate position, thus locking the pointer of the rate indicator until the remainder of the revolution of the cam is nearly completed. The depressed portion then becomes effective, causing the slider to assume its extreme outward (away from center of instrument) position, thus resetting the pointer to its initial or "zero" position.

(4) A dial (A45976, fig. 42) is assembled on the front of the tripping cams to provide a means for observing the rotation of same and for checking the speed thereof, when necessary.

(5) Since the levers (A43534) engage the cams at points 180° apart thereon, events will occur alternately on the two rate indicators, 5 seconds apart. This gives the operator ample opportunity to match the pointer and index on each rate indicator in turn.

h. Determination of present target position.—Since the mechanisms for determining the azimuth (A_o) and elevation (ϵ_o) of the target are similar, the case of the elevation unit alone will be described.

(1) The rotor shaft of the elevation transmitter (fig. 48) is geared to the elevation motion of the instrument (par. 22*b*(4)) through a differential gear. The angle of rotation of the transmitter rotor is indicated opposite fixed index (B135521) by the dial (A43552), which is clamped to the rotor shaft by means of a locking knob (A43544). One revolution of the elevation dial corresponds to 6,400 mils; however, only one-fourth of the dial is used, being graduated from 0 to 1,600 mils, in 20 mil divisions.

(2) The frame of the elevation transmitter (C44969) is rotated by means of a worm (A43532) and worm wheel (A43531) through an angle equal to the sum of the sound lag correction and the arbitrary correction ($\sigma_x + d\epsilon = \sigma$), as introduced through the appropriate handwheels and added by means of the differential, as described in paragraph 22*f*.

(3) The angle of rotation of the transmitter frame is also indicated opposite the fixed index (B135521) by the annular scale (A43600) which is concentric with the elevation dial (A43552). This scale, which indicates the total vertical correction (σ), is graduated 0 to ± 700 mils in 20-mil divisions. The graduations of this scale are color-coded white and red for increasing (up) and decreasing (down) corrections, respectively.

(4) The relative angle of rotation of the rotor and field of the transmitter may be read on dial (A43552) opposite the zero graduation of the scale (A43600) and corresponds to the apparent elevation (ϵ') as indicated by the sound locator, plus the angular corrections due

to the sound lag and arbitrary corrections (σ_x and $d\epsilon$). Thus the present elevation (ϵ_o) is transmitted to the repeater of the searchlight comparator.

(5) One revolution of the azimuth dial (A43551) also corresponds to 6,400 mils; however, this dial is graduated around the entire circumference, from 0 to 6,400 mils, in 20-mil divisions. The concentric annular scale, indicating the total lateral correction (δ), is identical with the total vertical correction scale (A43600) previously described. Corrections to the right are considered positive (white); corrections to the left are considered negative (red).

(6) Azimuth and elevation dials (A43551 and A43552) are clamped to the rotor shaft by means of the locking knobs (A43544). The dials may, however, be released for orienting by loosening the locking knobs. The dial knobs (A43550) serve as hubs for the dials and provide means for turning same for orienting purposes.

i. Elastic stop nuts.—(1) Elastic stop nuts (fig. 51) are used in these instruments instead of the nut and lock washer arrangement employed in older designs.

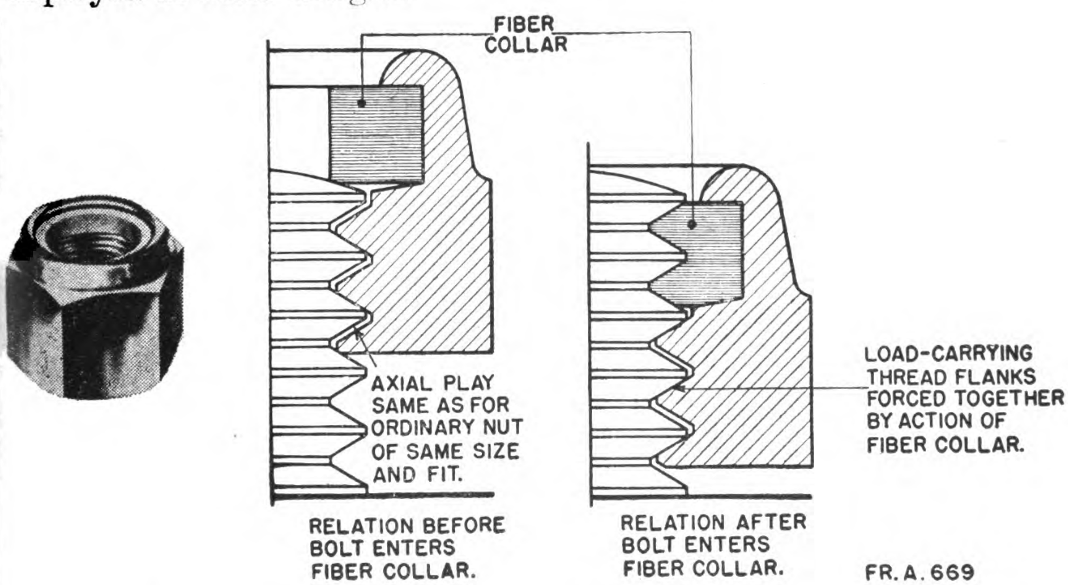

FIGURE 51.—Elastic stop nut.

(2) The elastic stop nut is a standard nut with the height increased to incorporate a fiber collar. The collar is smaller in diameter than the bolt and is not threaded. When the bolt reaches this fiber collar, the nut is forced upward until the thread flanks are in contact, the pressure then being distributed on the *same* side of the threads that will carry the load when the nut is drawn home. The play in the threads, which is believed to be the main reason why a nut backs off under vibration, is thus taken up. Additional braking effect is derived from the friction of the collar on the bolt threads.

(3) The bolt threads are impressed, not cut, in the fiber collar and the nut may therefore be used repeatedly. If, after repeated applications, the fiber has lost some of its braking effect, this may be restored by hammer blows applied to the top of the nut.

j. Provision for mounting.—Rubber cushion mountings are provided to lessen the shock incident to transportation and also to prevent the transmission of vibrations to the horns. The arrangement of this mounting is indicated in figures 42 and 43. The pad (A43617) and the washer (A43616) are made of rubber.

k. The electrical components.—(1) Two a. c. synchronous transmitters (C44969) are provided for the continuous transmission of the present azimuth and elevation (A_o and ϵ_o) to the searchlight comparator. These units require approximately 0.8 ampere from a 110-volt, 60-cycle, a. c. source and have a load power factor of about 30 percent. Variations in the a. c. supply voltage exceeding ± 10 volts will affect the accuracy of the transmission of data. However, the voltage fluctuations in the a. c. power source normally used with these instruments, if properly adjusted, should not result in serious errors in transmitted data, even if the amount of variation mentioned above is exceeded. These transmitters are the same as are used in the various data transmission systems and are completely decribed in TM 9-1656. The elevation transmitter is ordinarily set on "electrical zero" (see TM 9-1656) for zero elevation. There is no "electrical zero" setting for the azimuth transmitter.

(2) The scales, dials, indexes, and pointers of the instrument are illuminated by means of two 10-watt, 125-volt, electric lamps (double contact, automotive type base, filament C7A). A fixed resistor is placed in series with the lighting circuit to reduce the amount of illumination. In case the amount of light is not considered sufficient, the fixed resistor can be shunted without injuring the lamps, thus increasing the amount of light. Two handholes are provided, one below each rate indicator, to permit access to the lamps. These holes are provided with covers (A41708) which screw in place.

(3) The constant-speed electric motor (C56569, fig. 45) is essentially a commercial motor, originally designed for rotation of a phonograph turntable, and slightly modified for use in these instruments. This motor is the General Industries Company's "Green Flyer" electric motor, type 2DG4, rated at 44 watts, 78 r. p. m., on 110-volt, 60-cycle a. c. It is provided with a centrifugal governor which may be adjusted by means of the adjusting screw (shown at the extreme left of the motor in figure 45) to provide the proper speed of the tripping cam, 6 r. p. m., as indicated by the number of

revolutions per minute of the dial (A45976, fig. 42). The variation in the speed of this motor may be expected not to exceed 2.5 percent with power supply variations as follows:

Voltage—110 volts ±20 volts.
Frequency—60 cycles ±10 cycles.

(4) Two single-pole switches are provided for the motor and lights, respectively. These switches are operated by knobs (A34049), one of which is on each side of the instrument (fig. 42). The motor is controlled by the right-hand switch and the lights are controlled by the left-hand switch. They incorporate thermal-overload type circuit breakers and will automatically break the circuit when the load exceeds 1.4 amperes. These switches are the Westinghouse Electric and Manufacturing Company's "Sentinel Breaker", type H.

(5) A 10-pole receptacle (C56031) for connecting the plug of the cable leading to the comparator is located on the back of the case (fig. 43). As only 8 poles are needed, the remaining two are available as spares. This receptacle is provided with a cover arranged to be held in place by bolts and wing nuts when the plug is not inserted.

(6) A 200-foot cable with 10-pole plug at both ends is included for connecting the above receptacle to the comparator. A reel and chest are provided for storing same when not in use.

(7) The wiring diagram is shown in figure 52.

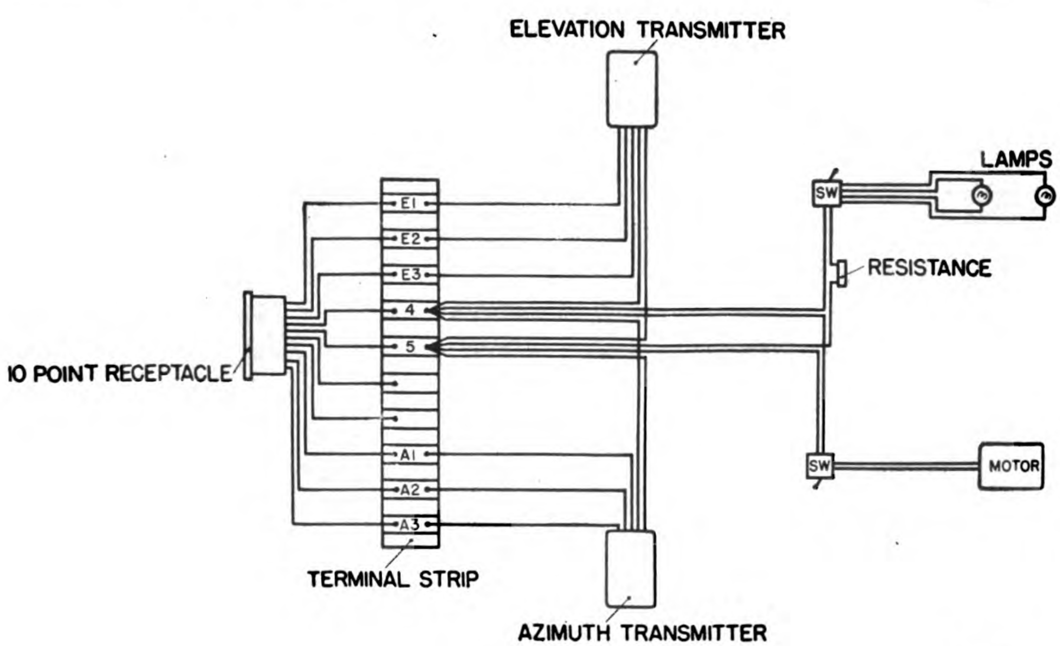

FIGURE 52.—Acoustic corrector, M2—wiring diagram.

23. Operation.—*a. Preliminary preparation.*—(1) The operations herein described presume that the initial adjustments (par. 25*a*) have been correctly made.

(2) For location of the various knobs, dials, scales, indexes, and pointers, see figure 42.

(3) Plug the cable leading to the searchlight comparator into the 10-pole receptacle in the rear of the instrument. The receptacle cover is removed by loosening the wing nuts. The longer of the two plugs on the cable is for insertion in the acoustic corrector receptacle. It is not possible to transmit data to the comparator until this cable has been plugged into the receptacle and the a. c. supply line has been energized.

(4) After the sound locator is in the operating position (par. 9*a*), and the horns oriented with respect to the searchlight comparator, the azimuth dial (A43551) of the acoustic corrector must be adjusted to the same orientation data. This dial is adjusted by releasing (unscrewing) the orienting locking knob (A43544) located on the left-hand side of the front of the instrument concentric with the dial. In order for apparent azimuth (A′) to be indicated thereon, the lateral correction scale (A43600) must be set to indicate zero correction ($\delta=0$) against the index above it, either the lateral sound lag correction knob, or the lateral arbitrary correction knob, or both, being utilized to make this setting. After the dial has been unclamped, it may be adjusted to the desired position by means of the larger knob (A43550) below the locking knob and held in that position, if necessary, during the reengagement of the locking knob. After the dial has been properly oriented, the indications thereon should be checked at various positions of the sound locator horns throughout the operating range.

(5) A similar arrangement is provided for the elevation dial (A43552). Any attempt to adjust this dial, however, once it is properly set, will result in a discrepancy between the indications thereon and the angular position of the time cam. This setting, therefore, should not be disturbed, but indications thereon should be checked at various positions of the sound locator horns. Should the indications fail to agree, the procedure outlined in paragraph 25*a* must be followed.

(6) Synchronization of the synchronous transmitters with their respective repeaters is accomplished by clutches at the searchlight comparator.

(7) Turn the motor switch knob (A34049) on the right-hand side of the instrument to the "On" position. Allow the motor to run

for at least 10 minutes, then check the speed of the tripping cam over a 1-minute to 5-minute period with a stop watch. The speed of the motor should be such as to rotate the tripping cam dial (A45976) (seen through the small window located between the two rate indicators) once every 10 seconds (6 r. p. m.).

(8) Adjust the motor speed, if necessary. The motor speed adjustment can be reached by unscrewing the cover located on the top of the case. A screw driver is required for changing the setting of the motor speed adjusting screw, which is located several inches below the top cover plate. (See fig. 45.) The adjustment from minimum to maximum motor speed requires less than one-half turn of this screw, and it is therefore necessary to turn the adjusting screw through only a few degrees to change the speed of the motor the requisite amount. This operation is to be performed only by competent personnel thoroughly familiar with the instrument.

b. Sound lag corrections.—(1) The sound locator listeners attempt to pick up the target and, having done so, report "on target" and estimate the altitude (H_x) or slant range (D') of same.

(2) Only one operator is required for the acoustic corrector, M2.

(3) During the "pick-up" period, the operator, by means of the knob (A43912) on the lower right-hand side of the instrument, sets the estimated value of the altitude (H_x) on the altitude scale (A43964) or of the slant range (D') on the range scale (A43920) and, if illumination is required, turns the light switch (A34049) on the left-hand side of the instrument to the "On" position.

(4) Arbitrary corrections in azimuth and elevation (dA and $d\epsilon$) are set into the corrector by means of the knobs (A43543) located on both sides of the instrument, the values being indicated on the dials (A43549).

(*a*) These dials are marked "Lateral Correction" and "Vertical Correction", respectively, but it must be understood that only the arbitrary corrections are indicated thereon.

(*b*) Ordinarily, arbitrary corrections are best determined by estimation on the part of experienced operators.

(*c*) Under certain circumstances it may be considered advantageous to compute values for such corrections. Formulas for computing same are given in section VI. It is seldom advisable to attempt to compute such values, however, in view of the difficulty of obtaining complete basic data and of the comparatively large errors usually resulting from the necessary determination of altitude (H_x) or slant range (D') by estimation.

501764°—43——6

(*d*) Another method of determining these corrections, which may in some cases be employed, is analogous to the trial shot method used in artillery fire. The procedure is to have a friendly airplane make several trips through the defended zone, with running lights on. The position indicated by the sound locator is compared with that indicated by the searchlight, using the sights thereon, or, if revealing the location of the searchlight is not objectionable, by actually tracking the airplane with the beam. The corrections thus determined represent the cumulative effect of all acoustic and mechanical errors at the time. The values of the corrections required will be found to differ with different positions of the target and with time. Usually a single average value of each (dA and dϵ) should suffice.

(5) As the sound locator proceeds to track the target, the operator of the acoustic corrector alternately matches the indexes (A43573) with the pointers (A43596) of the lateral and vertical rate indicators by rotating the corresponding knobs (A43543) located on the front of the instrument. The matching of indexes and pointers must be done within the 4-second period when the pointers are at rest.

c. Out of service.—(1) When the acoustic corrector is to be out of service for a considerable period, the altitude scale (A43964) should be set at the arrow indicating "Traveling Position." This separates the cam follower from the time cam when the sound locator horns are at 1,600 mils elevation, thus preventing injury to the cam surface due to vibration incident to travel. The electrical power should also be removed from the system and the corrector covered with the canvas cover provided. It is not necessary to remove the plug from the receptacle, but the receptacle should be sealed, either by the plug or by the receptacle cover, both of which have swing bolts and wing nuts to insure a tight fit.

(2) When preparing to travel, the same procedure is to be followed except that the cable must be removed and placed on the reel and in the chest provided.

d. Reclosing circuit breakers.—The switches in the constant-speed motor and the lighting circuits include thermal-overload type circuit breakers set for 1.4 amperes. If the current in either of these circuits is in excess of this amount, the breaker will trip and the switch knob will return to an intermediate position. To reclose the circuit after the breaker has tripped, the switch knob must first be turned to the extreme "Off" position and then to "On." If the breaker trips a second time shortly after reclosing the circuit, it is very probable that there is a short circuit in the instrument which must be cleared before further use.

24. Disassembly and assembly.—*a*. The assembled and sectioned views and other illustrations show the location of the various parts and the means by which they are held in place. These figures should be carefully studied before attempting any assembling or disassembling operations.

b. The replacement of lamps and adjustment of the speed of the constant-speed motor can be accomplished through the openings provided, thus making it unnecessary to remove the covers of the instrument.

c. The removal and replacement of lamps and other parts of the instrument is to be performed only by competent personnel thoroughly familiar therewith.

25. Tests and adjustments.—*a*. The initial orientation settings of the acoustic corrector with the sound locator, once properly made, should require no change unless either or both the azimuth and elevation drives have been disconnected. Should this be the case, the orientation procedure is as follows:

(1) Elevate the horns to 1,600 mils elevation, using the reading of the elevation scale of the sound locator as the reference. The method of verifying the correctness of the zero point on this scale is described in paragraph 11*d*.

(2) Rotate the time cam in the acoustic corrector until the index line thereon marked "90°" coincides with the index (A43918, fig. 46) on the cam yoke. Certain of the low serial numbered acoustic correctors, M2, have the index line on the time cam marked "0" in place of "90°"; this line is, however, the correct 1,600 mil position for the sound locator and acoustic corrector. Rotation of the time cam is accomplished by turning the elevation shaft (B135514, fig. 47). Turning the azimuth shaft (B135495) will also rotate the time cam through the differential.

(3) With both of the above shafts in their proper positions, the couplings may be connected. If the gear meshes have not been broken, the taper pin holes in the yokes (A38194) and in the sound locator shafting should be in alinement and the taper pins may be inserted and driven tight.

(4) If, after orienting the sound locator and acoustic corrector, the taper pin holes in the yokes do not line up with the holes in the shafting, it will be necessary to break a gear mesh and slip a gear the number of teeth to bring the pin holes in alinement or to drill and ream a new pin hole, as the case requires. Should any of the gear meshes be broken at any time for inspection or servicing, it is essential

that all parts are plainly marked so that they may be returned to their original positions.

(5) Set the elevation dial (A43552) to indicate 1,600 mils elevation. This dial is set in the same manner that the azimuth dial (A43551) is set for orientation purposes, as described in paragraph 23*a*(4), and the vertical correction scale (A43600) must likewise be set at zero.

(6) Verify the indications on the elevation dial (A43552) at several positions of the sound locator horns throughout the operating range.

(7) The foregoing elevation settings, when properly made, should require no change thereafter. The corresponding azimuth setting requires a change each time the instrument is oriented as described in paragraph 23*a*.

b. The motor speed should be adjusted to rotate the time cam (C56125, sec. C–C, fig. 46) every 10 seconds. The speed of this cam should be checked over a 1- to 5-minute period with a stop watch. This check should be made after the motor (C56569, fig. 45) has been running for at least 10 minutes. The motor speed is adjusted by turning the speed adjustment screw. (See fig. 45.) The adjustment from minimum to maximum speed requires less than one-half turn of this screw. For accurate speed adjustment, it is obvious that this screw should be turned only a few degrees at a time.

c. The arbitrary lateral and vertical correction knobs (A43543) located on the right and left sides of figure 42, respectively, are provided with stops to limit their travel in either the positive or negative direction.

(1) Since the setting of the stops is similar for both sets of stops, only the procedure for setting the vertical correction stops will be explained.

(2) These stops are located on the right side of figure 45. The upper limit stop should function at +200 mils indication. If it does not function at this point, remove the taper pin from the stop and turn the knob until +200 mils is indicated on the dial (fig. 42). Move the upper limit stop until it engages with the stop nut on the worm shaft. Drill a hole through the worm shaft using the hole in the stop as a guide when the stop nut is at the +200 mil indication; then insert the taper pin, thus securing the stop to the worm shaft.

(3) The lower limit stop should function at −200 mils indication. If it does not function at this point, remove the taper pin from the lower limit stop, and turn the vertical correction knob until −200 mils is indicated on the associated dial. (See fig. 42.) Move the stop until it engages with the stop nut. With the stop in this position, drill a hole through the worm shaft using the hole in the stop

as a guide; then insert the taper pin, thus securing the stop to the shaft.

d. The estimated altitude stops (fig. 44) should function when the index is at the "Traveling Position" and at the 30,000 feet indication on the scale. If they do not function at those points, they may be set as follows:

(1) Remove the taper pin from the stop, located to the left and a little below the estimated altitude scale (fig. 44), and turn the estimated altitude knob until the index is opposite the "Traveling Position" indication. Turn the stop on the lead screw shaft until it engages with stop portion of the yoke; then drill a hole in the lead screw shaft using the hole in the stop as a guide. Insert the taper pin, thus securing the stop on the lead screw shaft.

(2) Remove the taper pin from the upper limit stop, located below the altitude scale in figure 44, and turn the estimated altitude knob until the index is opposite the 30,000 feet indication. Move the stop on the lead screw until it engages with the stop portion of the yoke. Drill a hole, using the hole in the stop as a guide, through the lead screw shaft. Insert the taper pin, thus securing the stop to the lead screw shaft.

26. Care and preservation.—*a.* The acoustic corrector, M2, requires little skill and training on the part of the operator. However, it is a computing instrument employing delicate mechanisms and is not designed to withstand unnecessary rough handling and abuse.

b. All drives are provided with mechanical stops to indicate limits of motion, and unless undue pressure is exerted against these stops, it is not possible to damage the instrument through improper operation. Undue force must, therefore, never be exerted on any of the knobs.

c. This acoustic corrector ordinarily requires no maintenance in the field beyond being taken indoors every 6 months and having the cover plates removed for inspection and lubrication of moving parts. Lubricating oil, aircraft instrument and machine gun (U. S. A. Spec. 2–27), should be used as the lubricant. The cams of this instrument are lubricated by applying a light coat of Royco 6A grease. This coating prevents or retards oxidation of the cam surfaces, and also reduces the friction of the cam pins. The reduction gears in the constant-speed motor are also lubricated with Royco 6A grease. Spraying or using an excessive amount of oil on the computing mechanism may do considerable harm. Where practicable, soft rubber mountings are used to reduce the transmission of mechanical vibration and noise, and any oil on these mountings will destroy the rubber. Oil will also damage the wiring and other electrical components. A light coat of lubricating oil on the bearings and the polished metal parts is all that is required. The constant-speed motor is provided with an oil-level screw for checking the oil level when oil is added. See figure 45.

d. Follow the instructions in paragraph 23*c* when removing the instrument from service or preparing to travel.

27. **Data.**—The name plate is located on the front of the instrument, as shown in figure 42.

Section V

SOUND LOCATOR TRAILERS

28. **General.**—*a.* The characteristics of the various trailers and their sound locators which they include are shown below:

Trailer	M2	M2A1	M2A2	M2A3	M2A4	M3
Used on sound locator—complete.	M1A1	M1A2	M1A3 M1A5	M1A4 M1A6	M1A8	M1A7
Weight—pounds	4, 000	4, 500	4, 223	4, 500	4, 500	1, 130
Wheel base—inches	133	135	135	133	133	72
Tread, front—inches	62	66	66	66	66	56
Tread, rear—inches	69	66	66	66	66	56
Type of tire	(1)	(1)	(1)	(1)	(1)	(2)
Height of platform from ground—inches.	30	31	31	31	31	17
Over-all length excluding drawbar—inches.	200	206	203	210	210	107
Over-all width—inches	77	80 5/8	80 5/8	80 5/8	80 5/8	64
Turning radius—feet	23 1/4	23 1/4	23 1/4	23	23	--------
Brakes—method of operation.	Manual	Manual	Manual	Manual	(3)	Manual

[1] Pneumatic.
[2] Steel-rimmed wheels.
[3] Manual and vacuum power.

b. Sound locator trailers, M2 to M2A4, inclusive, are intended for towing by the searchlight truck. Sound locator trailer, M3, is intended only for towing by hand for short distances over prepared or cleared runways; it is not to be towed by power.

c. These trailers are all 4-wheeled vehicles, with rear wheel brakes and with front axles linked to the drawbar for steering. Insofar as has been practicable, standard automotive construction has been followed, and many standard commercial automobile or truck parts are included in these trailers. All trailers have manually operated brakes; the trailer, M2A4, has vacuum power brakes in addition. The trailer, M3, has steel-rimmed wheels. All others have pneumatic tires. The pneumatic tires have the following size markings: 7.00–24 Ex. Ply—10 Ply 36×6 HD. This tire replaces the old size having the following size markings: 10 Ply 36×6 HD.

29. Sound locator trailer, M2.—*a. Description.*—(1) *General.*—The sound locator trailer, M2 (figs. 53 to 57, incl., also figs. 5 and 6), is a mobile unit arranged for towing by the searchlight truck. It is equipped with standard automobile wheels fitted with pneumatic tires, and with rear wheel brakes operated by means of a brake lever in the front end of the trailer. A taillight is provided for night driving.

(2) *Arrangement.*—(*a*) Seats for six men are located in the front and rear ends of the trailer. The front seat, which is removable, houses the acoustic corrector, while the rear seat has under it a chest containing a spare wheel and tire and a drawer for tools and accessories. The acoustic corrector is made available for operation by releasing the side trunk bolts and eyebolts, permitting the front seat and cover to be removed. The first two floor boards and the foot rest may also be removed for greater ease in operating the instrument. The chest under the rear seat is closed with trunk bolts and padlock.

(*b*) The platform of the body is provided with side rails held in place by means of stakes, thus making this space available for soldiers' packs and other equipment. These side rails are removable when in the operating position.

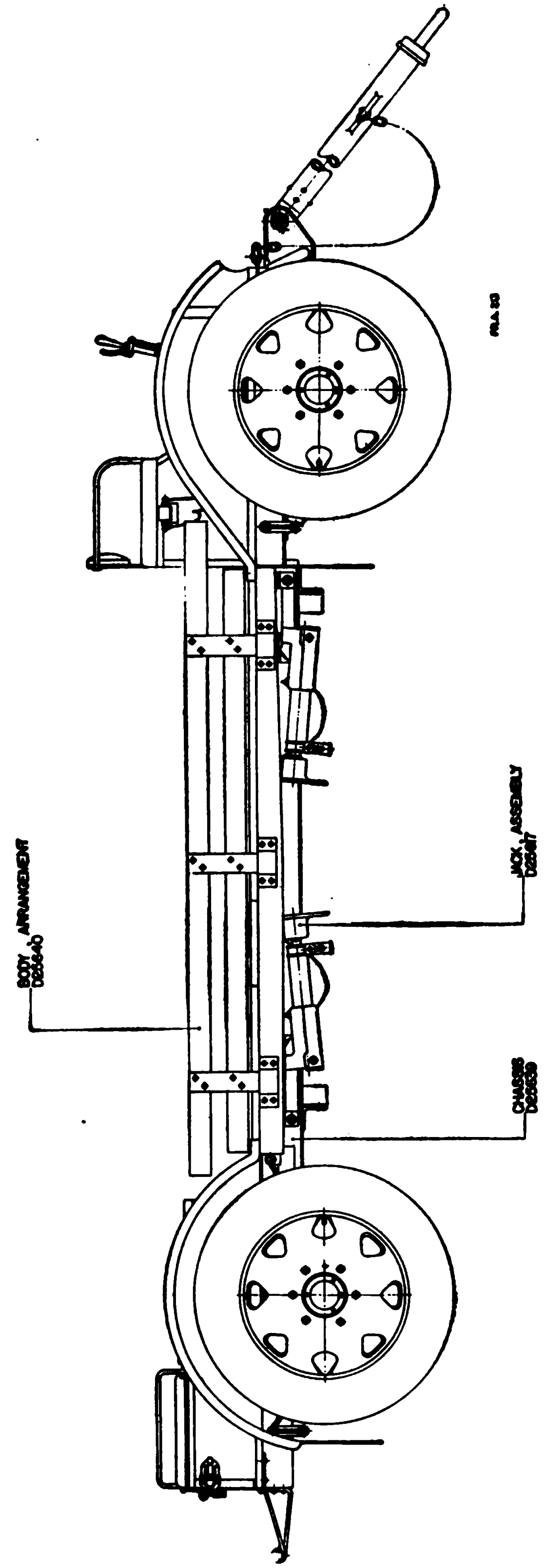

FIGURE 53.—Sound locator trailer, M2—right elevation.

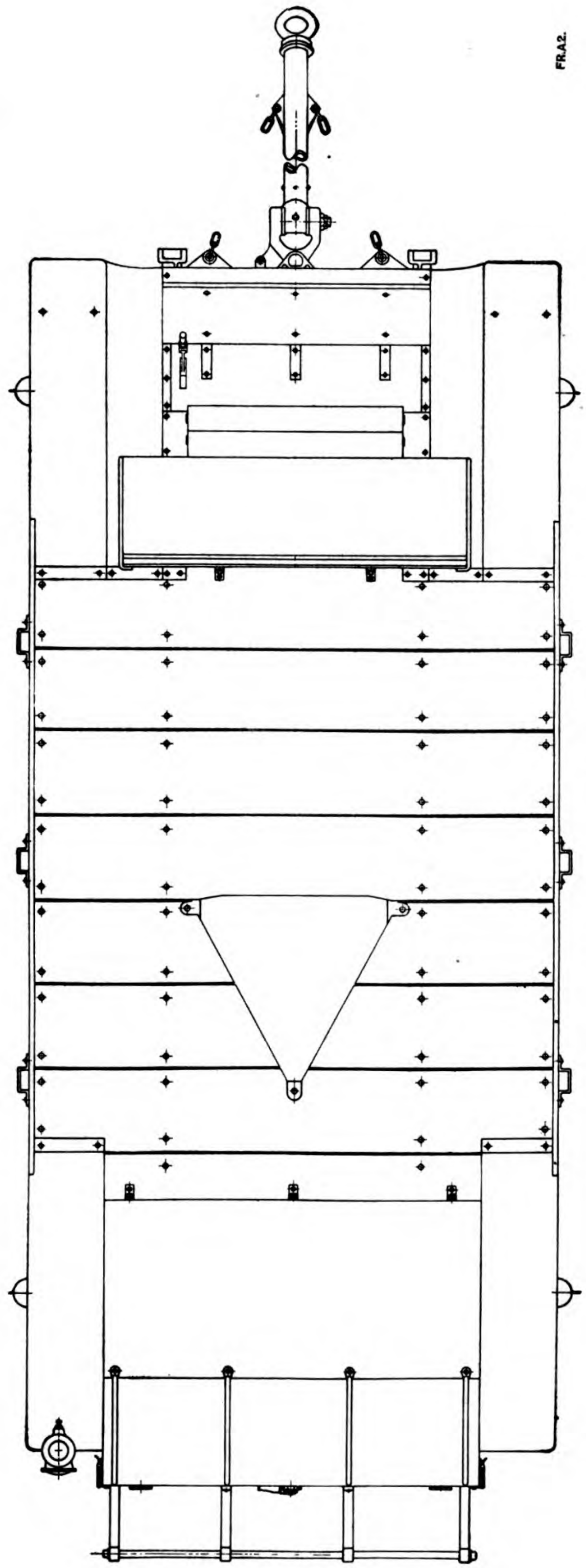

FIGURE 54.—Sound locator trailer, M2—plan.

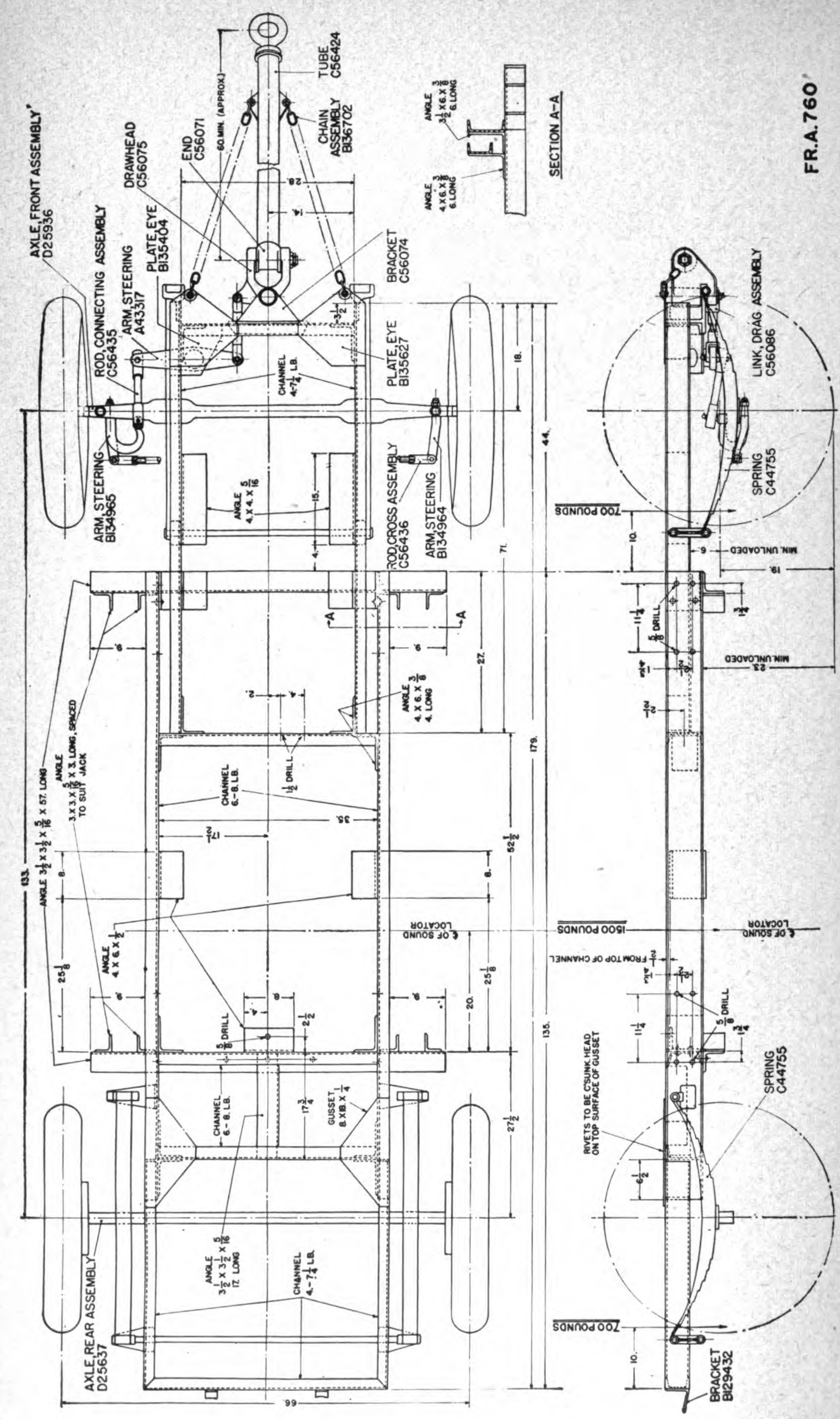

FIGURE 55.—Sound locator trailer, M2—chassis.

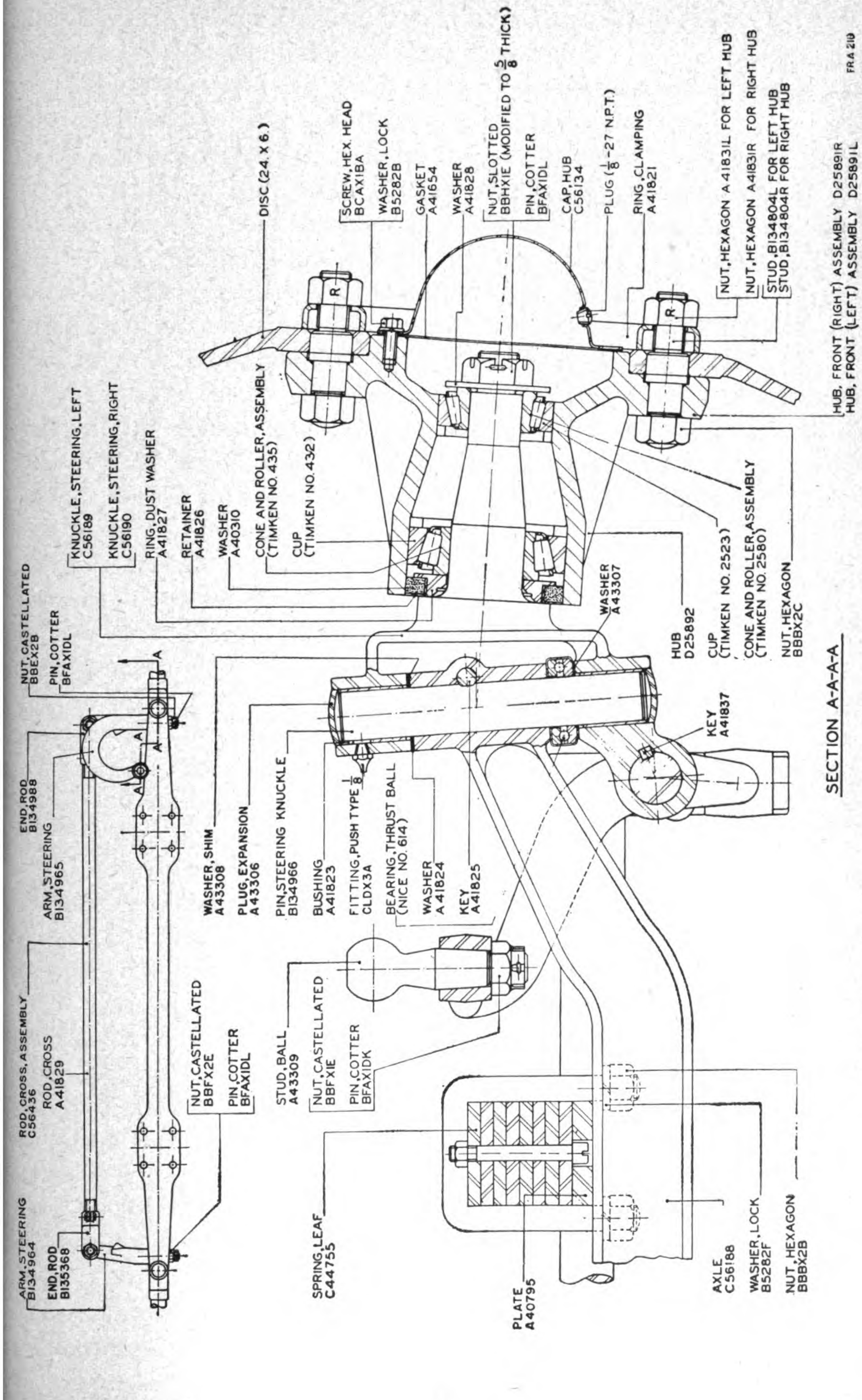

FIGURE 56.—Sound locator trailer, M2—front axle—assembled and sectioned views.

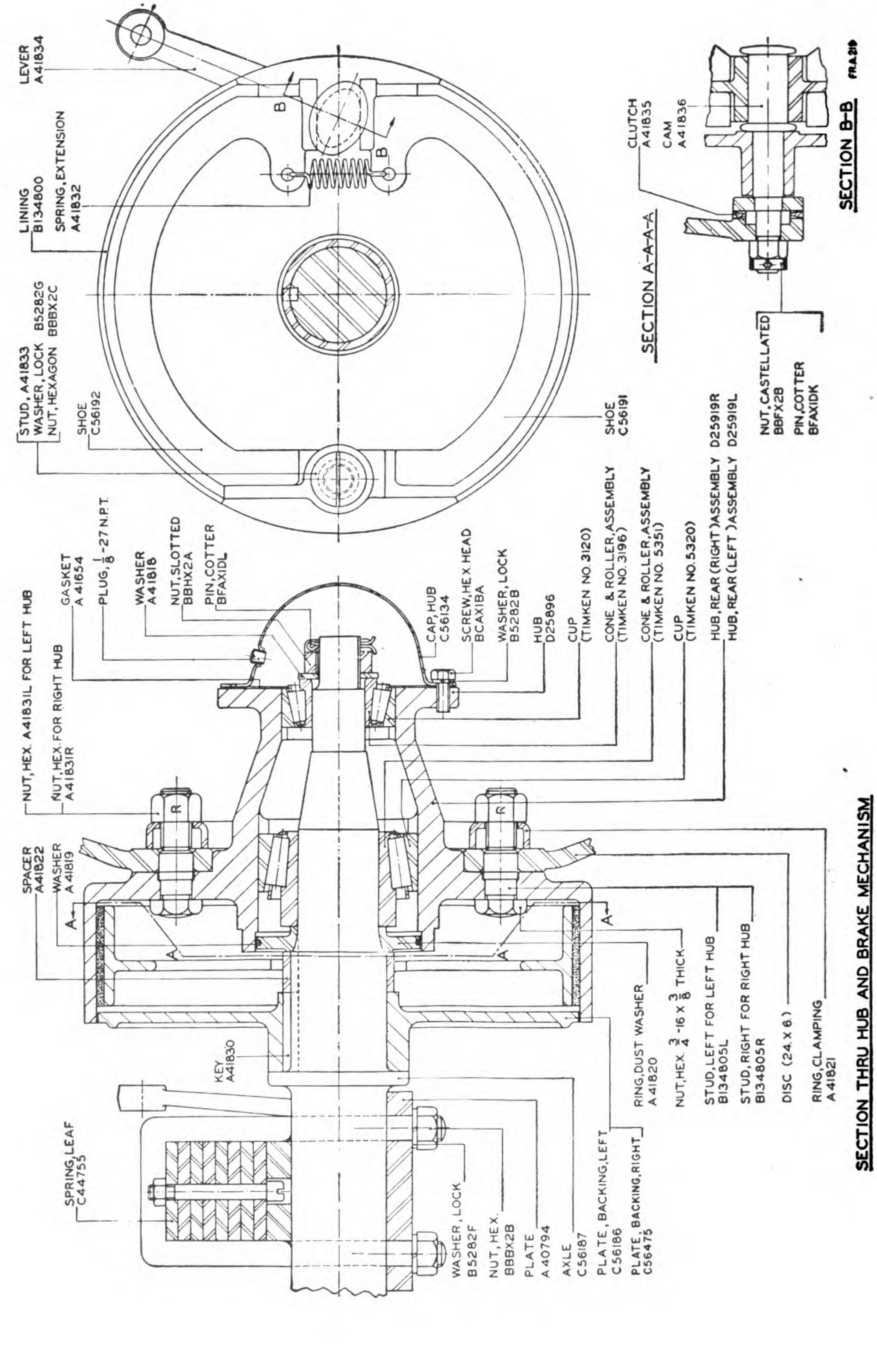

FIGURE 57.—Sound locator trailer, M2—rear axle—sectioned views.

(*c*) The trailer is equipped with four jacks (D25617) attached to the frame, which are used in leveling the sound locator turntable. These jacks are provided with pins with which they are held in place when in use as well as when in the traveling position.

b. Operation.—(1) To place the sound locator trailer in the operating position, proceed as follows:

(*a*) After disconnecting from the searchlight truck, jack up the trailer and level the sound locator turntable by means of the four jacks suspended from the frame. The jacks must be held rigidly in position by means of the retaining pins provided. The two levels on the turntable are used in leveling the instrument.

(*b*) The side rails may be removed, if desired. The sound locator, however, may be operated without removing these side rails.

(*c*) Uncover the acoustic corrector. This is done by removing the eyebolts and releasing the side trunk bolts, permitting the front seat and cover to be removed. Also remove the first two floor boards and the foot rest. This permits the corrector operators to sit on the front floor board while in action.

(2) To place the sound locator trailer in the traveling position, the jacks are lowered and slung into position against the trailer frame, and the side rails, front seat box, and foot rest are replaced. The drawbar is then connected to the searchlight truck.

c. Care and adjustments.—(1) *Wheel bearings.*—If there is excessive play in a wheel bearing, jack up the wheel, remove the hub cap, and take out the cotter pin from the adjusting nut. Run the adjusting nut up tight, then turn it back approximately one-quarter turn and replace the cotter pin and hub cap. When removing a wheel, note that the right-hand hubs are provided with right-hand threaded nuts and studs, and the left-hand wheels with left-hand threaded nuts and studs. The nuts and studs are marked "R" and "L" to distinguish the right-hand and left-hand threads.

(2) *Brakes.*—The brakes and brake control system require frequent inspection and adjustment to compensate for wear.

(*a*) Before any adjustment to the brake system is made, it is essential that the spring clips holding the chassis springs to the axle should be tight, and that the wheel bearings should be in proper adjustment as described in (1) above.

(*b*) The brake rod connections should be adjusted to be free of backlash, and yet to permit the brake system to return to the extreme released position, where the brake control lever should make an angle of approximately 115° with the brake rod which attaches to the brake control lever at the lower end. To adjust a rod length, remove the clevis pin and screw the threaded end yoke to give the proper length, or, at the brake control lever, turn the rod adjusting nut to the desired position.

(*c*) To adjust the brakes for wear, with wheel jacked up and brake released, remove the castellated nut (BBFX2B, sec. B-B, fig. 57) located in the backing plate and turn the cam (A41836) in the *same* direction in which the wheel revolves when the vehicle moves forward, until a slight drag can be felt when turning the wheel over by hand. Then turn the cam in the opposite direction until the wheel is just free of brake drag. Hold the cam and secure the castellated nut. Replace brake rod connections and adjust same as described in (*b*) above.

(*d*) To insure that the brake is fully released when making the adjustment described in (*c*) above, it is desirable, when conditions permit, to remove the brake rod connections entirely. After the adjustment is made, the brake rod connections must be replaced and adjusted as described in paragraph 29*c*(2)(*b*).

(*e*) The stud (A41833) which holds the brake shoes in position is to be removed only when relining shoes. This nut (BBBX2C) which holds the stud in place should be kept tight at all times.

(3) *Tires.*—Tires must be inspected frequently to insure that they are in serviceable condition and properly inflated.

(4) *Taillamp.*—The taillamp must be kept filled with kerosene, with glass clean and wick properly trimmed.

30. Sound locator trailers, M2A1 and M2A2.—*a. Description.*—(1) *General.*—The sound locator trailers, M2A1 and M2A2 (figs. 58 to 65, incl.), are mobile units arranged for towing by the

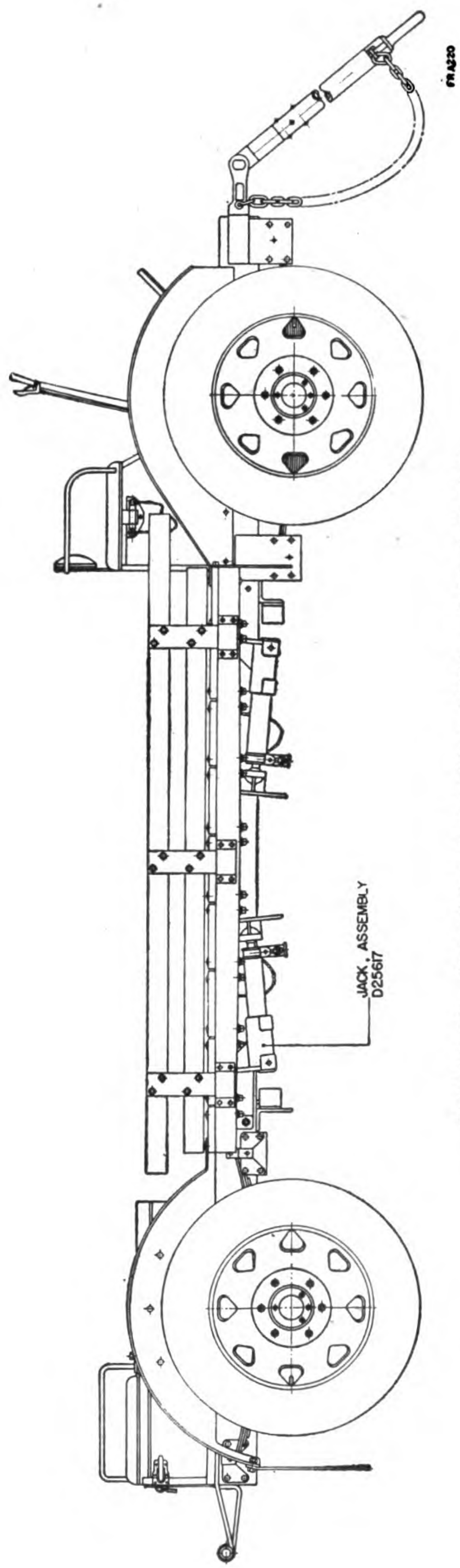

FIGURE 58.—Sound locator trailer, M2A1—right elevation.

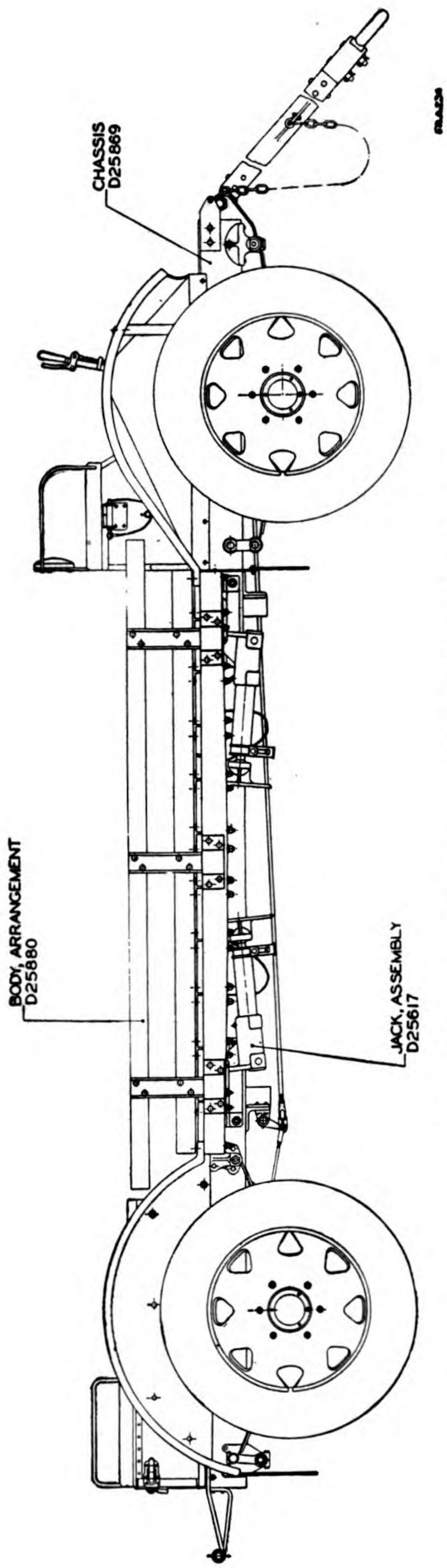

FIGURE 59.—Sound locator trailer, M2A2—right elevation.

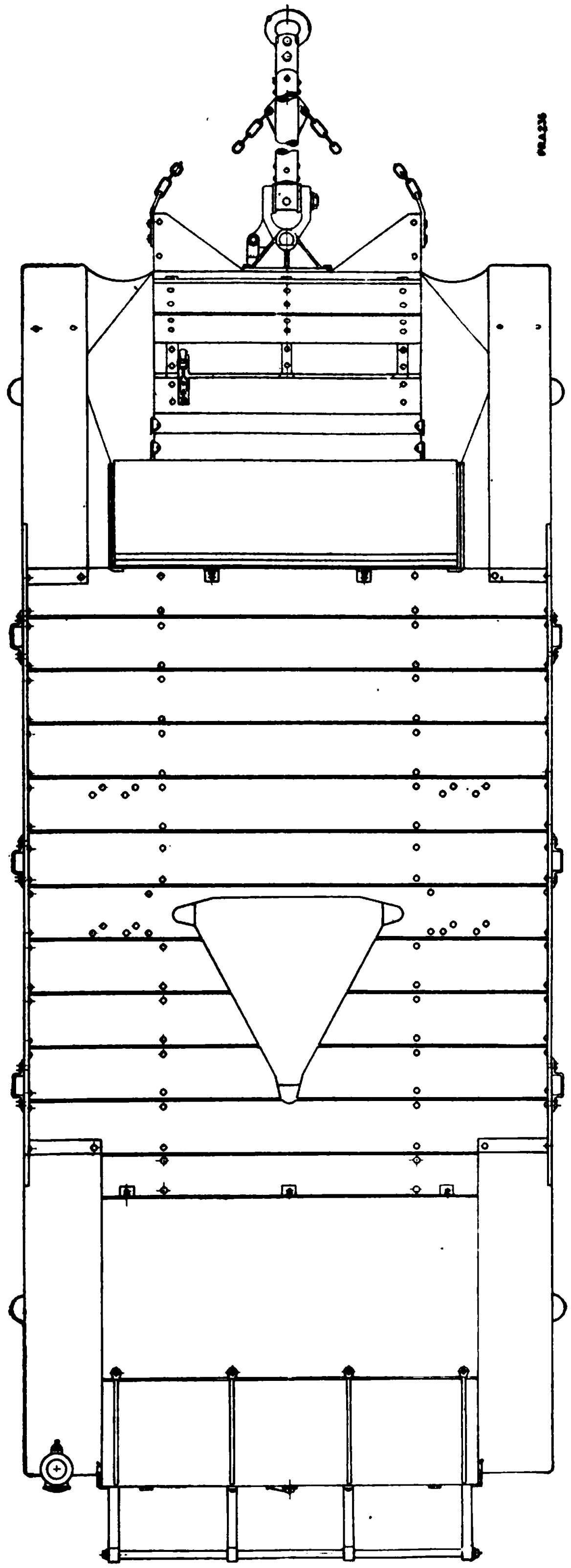

FIGURE 60.—Sound locator trailer, M2A2—plan.

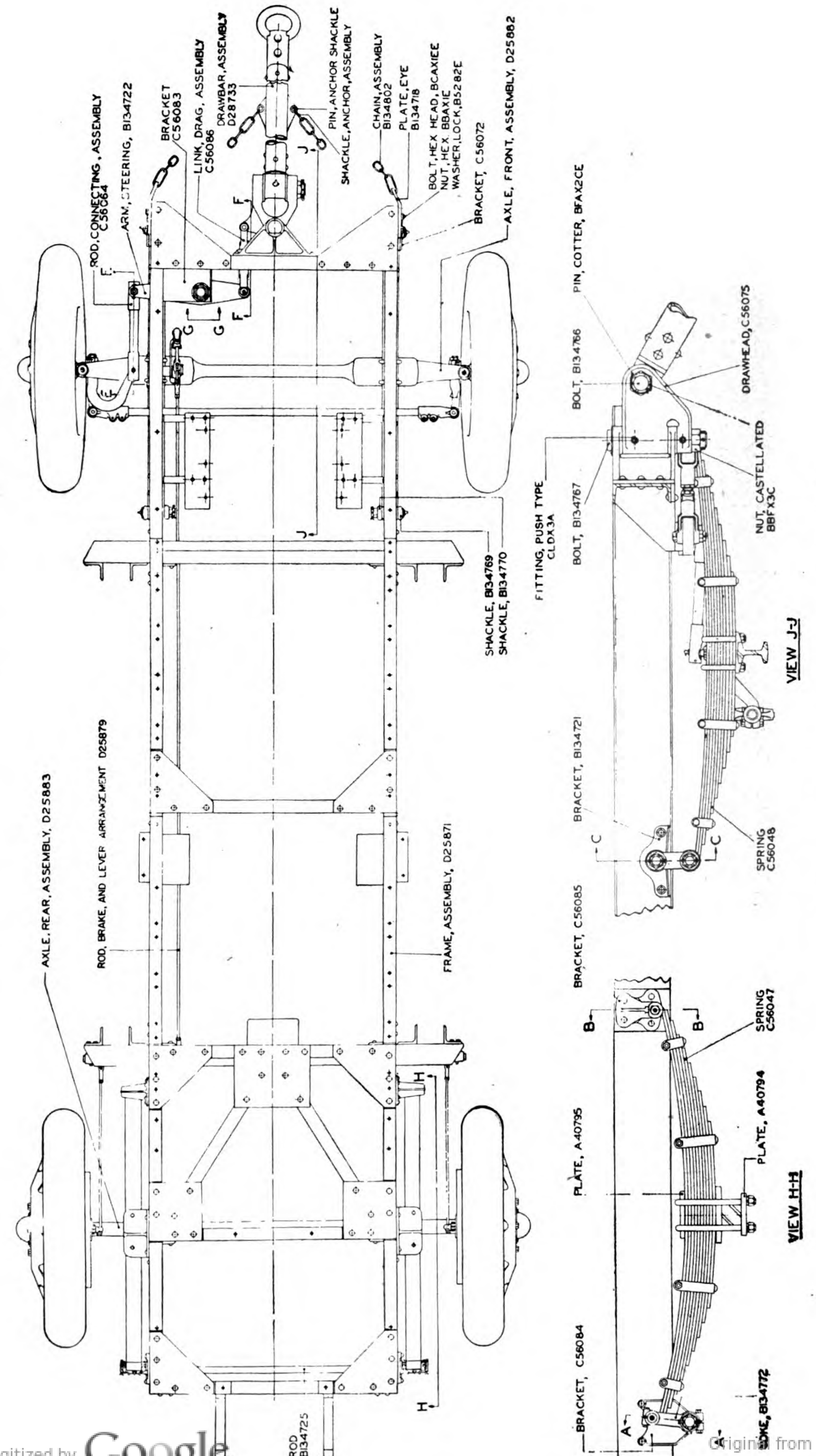

FIGURE 61.—Sound locator trailer, M2A2—chassis.

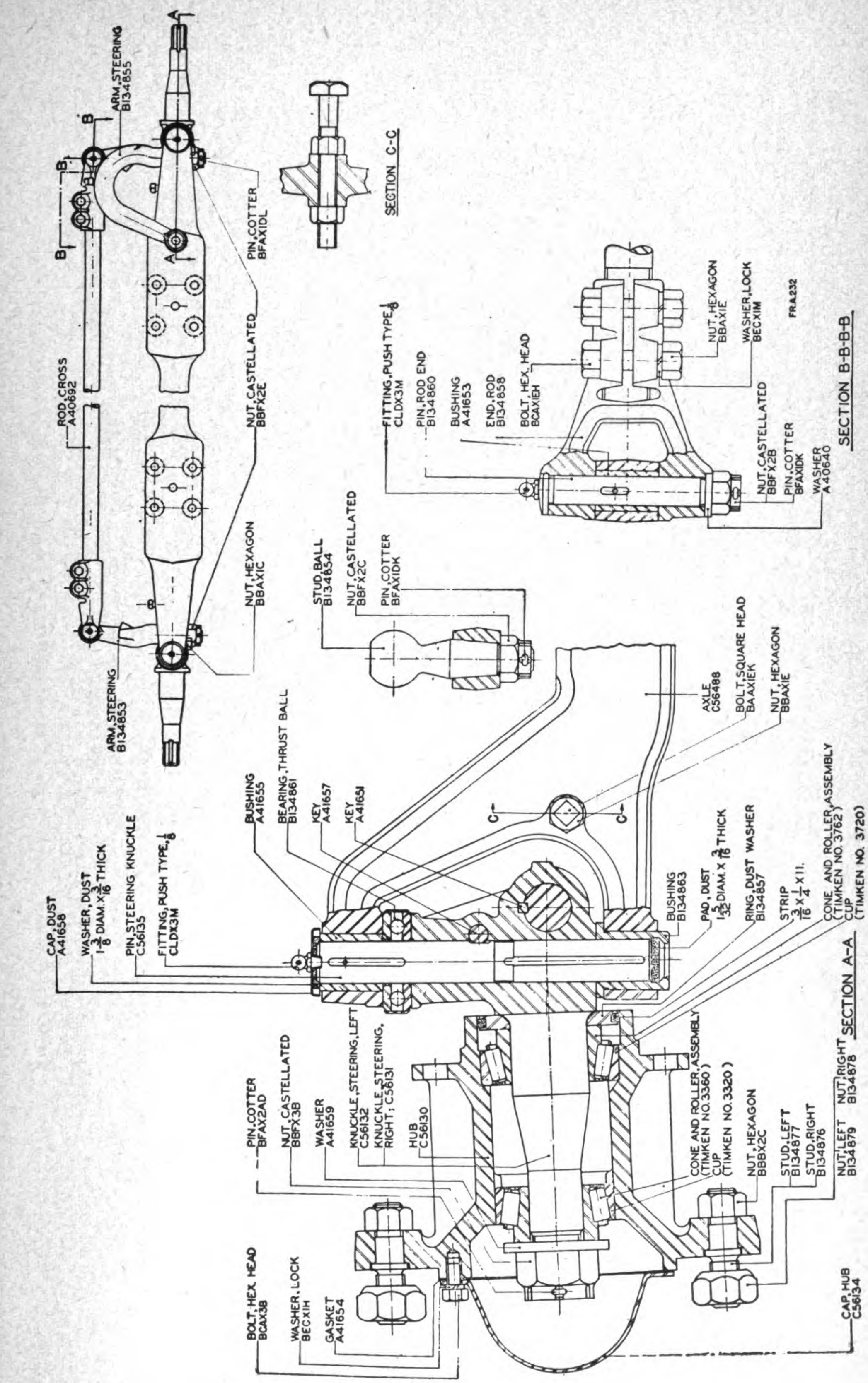

FIGURE 62.—Sound locator trailer, M2A1 and M2A2—front axle—assembled and sectioned views.

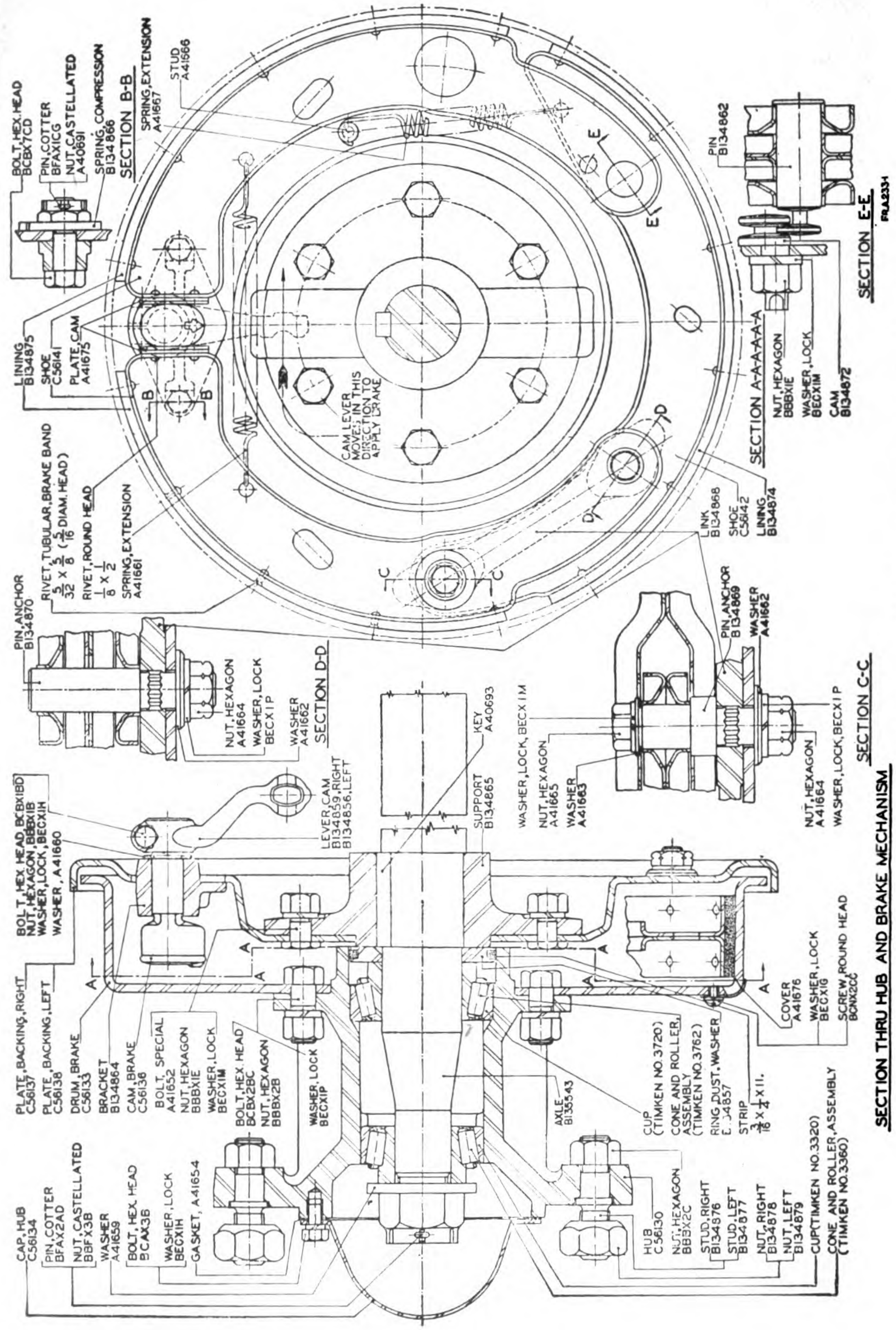

FIGURE 63.—Sound locator trailer, M2A1 and M2A2—rear axle—sectioned views.

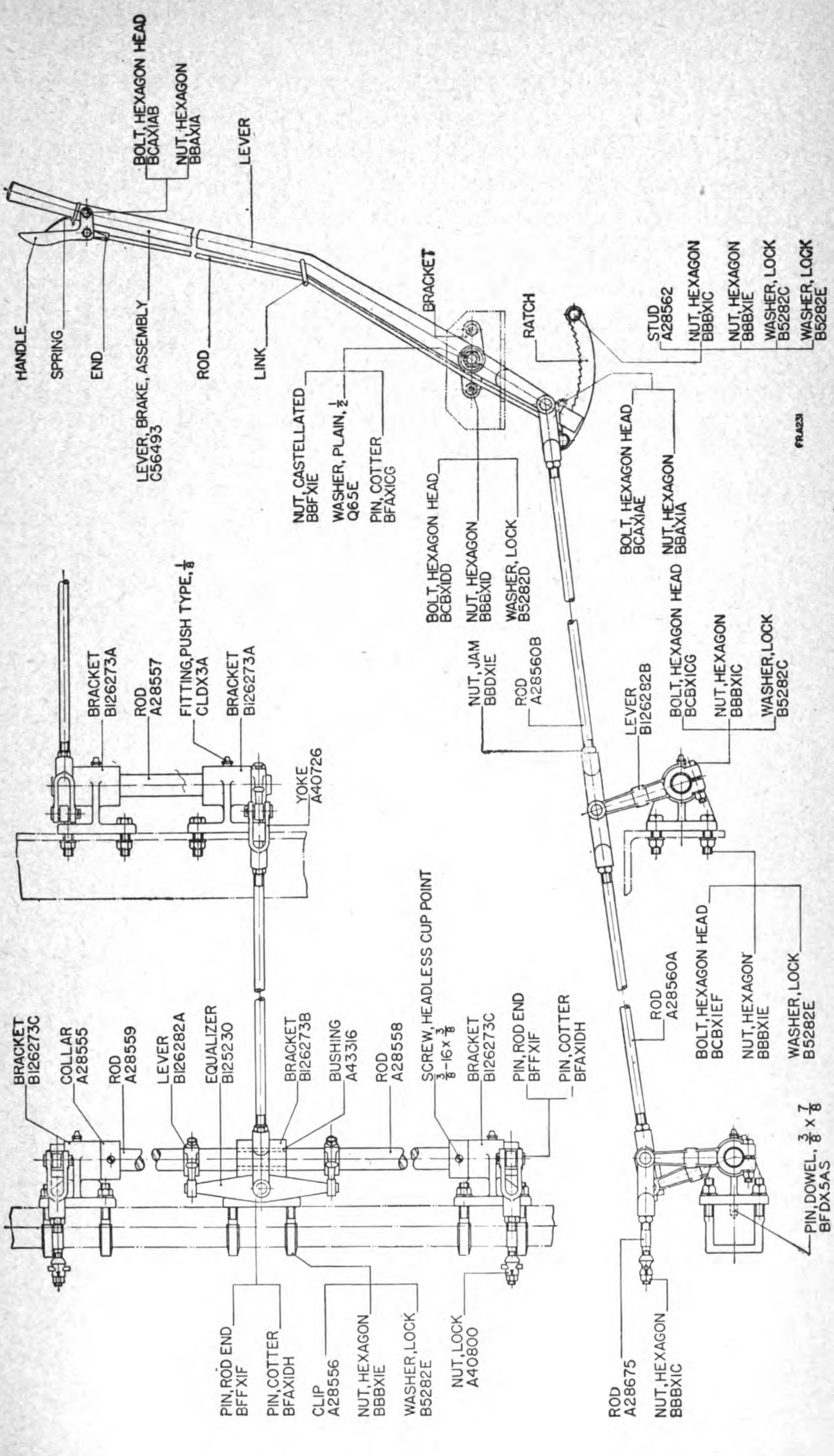

FIGURE 64.—Sound locator trailer, M2A1—brake rod and lever arrangement.

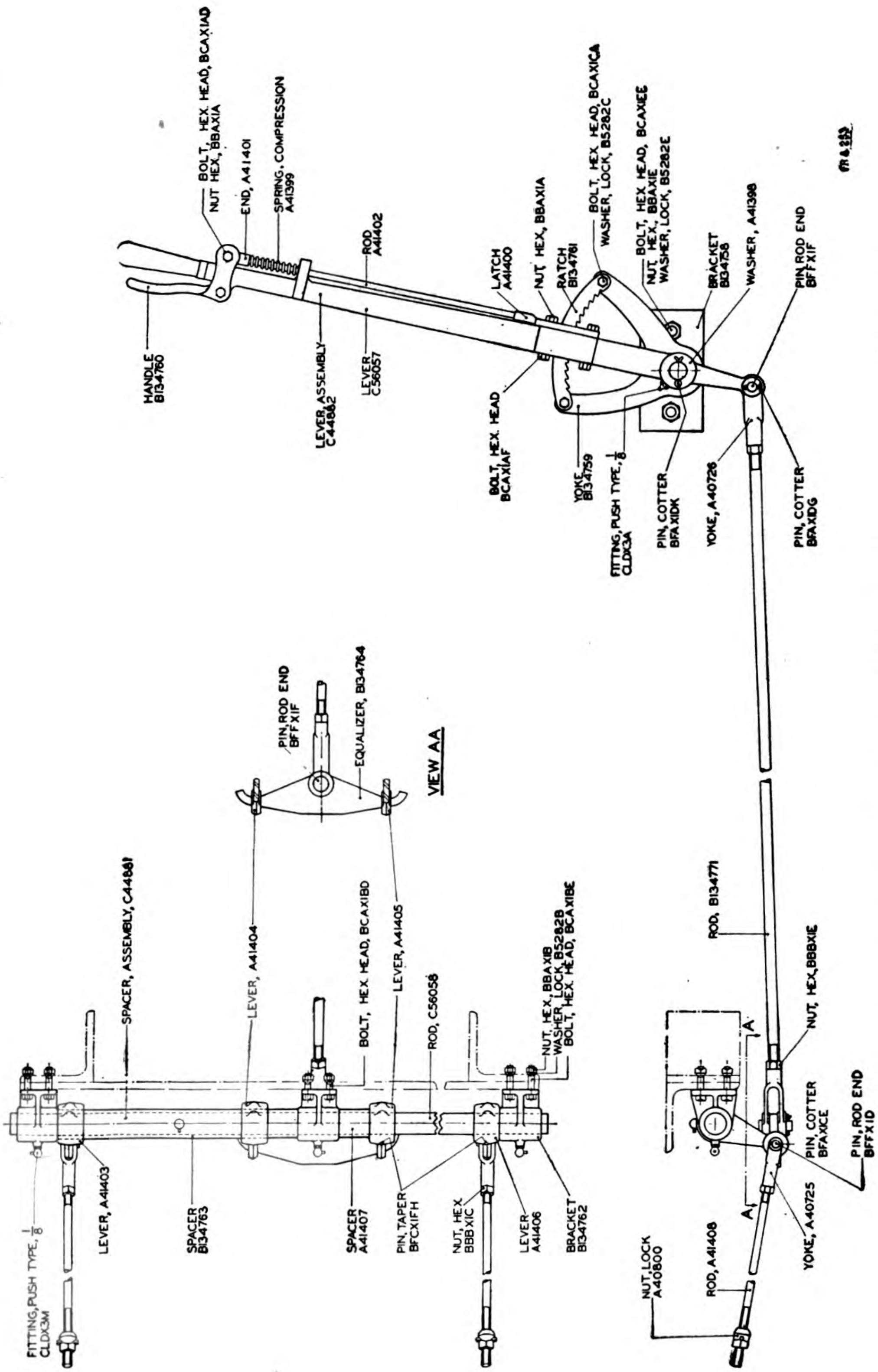

FIGURE 65.—Sound locator trailer, M2A2 and M2A3—brake rod and lever arrangement.

searchlight truck. They are all equipped with standard automobile wheels fitted with pneumatic tires, and with rear wheel brakes operated by means of a brake lever in the front end of the trailer. A taillight is provided for night driving.

(2) *Arrangement.*—(*a*) Seats for six men are located in the front and rear ends of the trailer. The front seat, which is removable, houses the acoustic corrector, while the rear seat has under it a chest containing a spare wheel and tire and a drawer for tools and accessories. The acoustic corrector is made available for operation by releasing the side trunk bolts and eyebolts, permitting the front seat and cover to be removed. The first two floor boards and the foot rest may also be removed for greater ease in operating the instrument. The chest under the rear seat is closed with trunk bolts and padlock.

(*b*) The platform of the body is provided with side rails held in place by means of stakes, thus making this space available for soldiers' packs and other equipment. These side rails are removable when in the operating position.

(*c*) The trailer is equipped with four jacks (D25617) attached to the frame, which are used in leveling the sound locator turntable. These jacks are provided with pins with which they are held in place when in use as well as when in the traveling position.

b. Operation.—(1) To place the sound locator trailer in the operating position, proceed as follows:

(*a*) After disconnecting from the searchlight truck, jack up the trailer, and level the sound locator turntable by means of the four jacks suspended from the frame. The jacks must be held rigidly in position by means of the retaining pins provided. The two levels on the turntable are used in leveling the instrument.

(*b*) The side rails may be removed, if desired. The sound locator, however, may be operated without removing these side rails.

(*c*) Uncover the acoustic corrector. This is done by removing the eyebolts and releasing the side trunk bolts, permitting the front seat and cover to be removed. Also remove the first two floor boards and the foot rest. This permits the corrector operators to sit on the front floor board while in action.

(2) To place the sound locator trailer in the traveling position, the jacks are lowered and slung into position against the trailer frame, and the side rails, front seat box, and foot rest are replaced. The drawbar is then connected to the searchlight truck.

c. Care and adjustments.—(1) *Wheel bearings.*—If there is excessive play in the wheel bearing, jack up the wheel, remove the hub cap, and take out the cotter pin from the adjusting nut. Run the adjusting nut up tight, then turn it back approximately one-quarter turn and replace the cotter pin and hub cap. When removing a wheel, note that the right-hand hubs are provided with right-hand threaded nuts and studs, and the left-hand wheels with left-hand threaded nuts and studs. The nuts and studs are marked "R" and "L" to distinguish the right-hand and left-hand threads.

(2) *Brakes.*—The brakes and brake control system require frequent inspection and adjustment to compensate for wear.

(*a*) Before any adjustment to the brake system is made, it is essential that the spring clips holding the chassis springs to the axle should be tight and that the wheel bearings should be in proper adjustment as described in (1) above.

(*b*) The brake rod connections should be adjusted to be free of backlash, and yet to permit the brake system to return to the extreme released position, where the brake control lever (C56057) should make an angle of 110° to 120° with the brake rod (B134771). To adjust a rod length, remove the clevis pin and screw the threaded end yoke to give the proper length, or, at the brake control lever, turn the rod adjusting nut to the desired position.

(*c*) To adjust the brakes for wear, with the wheel jacked up and brake released, first loosen the cam locking nut (BBX1E, sec. E–E, fig. 63), located on the lower part of the backing plate, and turn the cam (B134872) in the *same* direction in which the wheel revolves when the vehicle moves forward, until a slight drag can be felt when turning the wheel over by hand; then turn the cam in the opposite direction until the wheel is just free of brake drag. Hold the cam and secure the locking nut. Replace brake rod connections and adjust same as described in (*b*) above.

(*d*) To insure that the brake is fully released when making the adjustment described in (*c*) above, it is desirable, when conditions permit, to remove the brake rod connections entirely. After the adjustment is made, the brake rod connections must be replaced and adjusted, as described in paragraph 30*c*(2)(*b*).

(*e*) The anchor pins are to be adjusted only when fitting relined shoes, when the anchor pin nuts are found to be loose, or when other adjustments fail to give results. The procedure is as follows:

1. Loosen the two nuts (A41664) which hold the anchor pins (B134869 and B134870) to the backing plate. These nuts may be identified by the notched corners. Note also that anchor pins pass through the backing plate in enlarged holes.

2. Adjust the eccentric cam (B134872, par. 30*c*(2)(*c*)) until the wheel can barely be turned with both hands.

3. Tap the ends of the anchor pins with a soft hammer or piece of hard wood to insure their shifting and assuming the correct position. Apply the brake slightly and force the wheel forward against the brake. Still holding the brake on, tighten the anchor pin nuts as tightly as possible with a 16-inch wrench.

4. Release brake and turn back the eccentric cam until the wheels are just free of drag.

5. This adjustment can be checked by loosening screw (BCNX2CC) and removing cover plate (A41676) from the hole in drum (C56133); then measure the distance between the shoe lining and the brake drum by inserting feeler gages. With the brakes released, the anchor ends of the auxiliary and secondary shoes should have approximately .005 inch clearance, and the toe ends of these two shoes should have about .010 inch clearance, or twice that at the anchor ends.

(3) *Tires.*—Tires must be inspected frequently to insure that they are in serviceable condition and properly inflated.

(4) *Taillamp.*—The taillamp must be kept filled with kerosene, with glass clean and wick properly trimmed.

31. Sound locator trailer, M2A3.—*a. Description.*—(1) *General.*—The sound locator trailer, M2A3 (figs. 65 to 71, incl., also figs. 7 and 8), is a mobile unit arranged for towing by the searchlight truck. It is equipped with standard automobile wheels fitted with heavy duty tires, and with rear wheel brakes operated by a hand lever in the front of the trailer. A taillight is provided for night driving.

(2) *Arrangement.*—(*a*) Seats for six men are located in the front and rear ends of the trailer. The rear seat, which is removable along with the rear platform and bumper assembly, houses the acoustic corrector and two chests containing tools and accessory equipment. The seat box is provided with hooks. In the rear, the hooks slide under keepers; in the front they are held in place by the rear platform and bumper assembly, which, in turn, is fastened to the frame of the trailer by means of two hand-operated bolts. A spare wheel and tire are stored under the front seat.

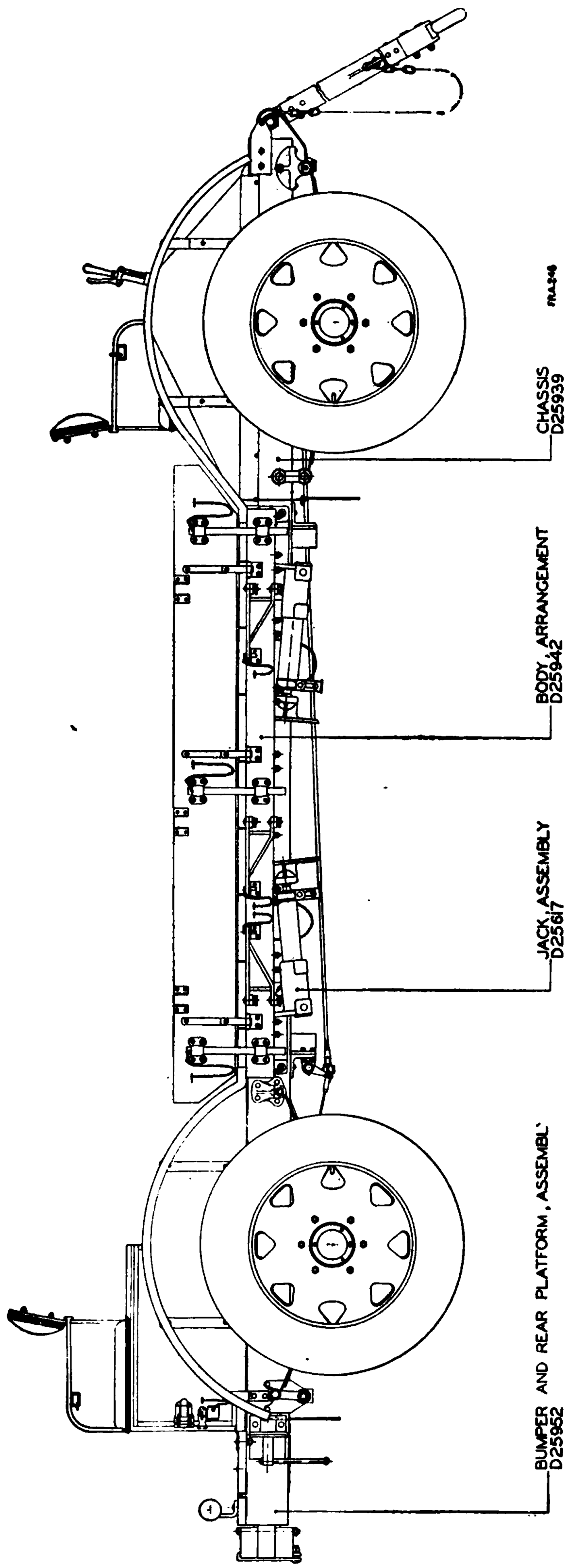

FIGURE 66.—Sound locator trailer, M2A3—right elevation.

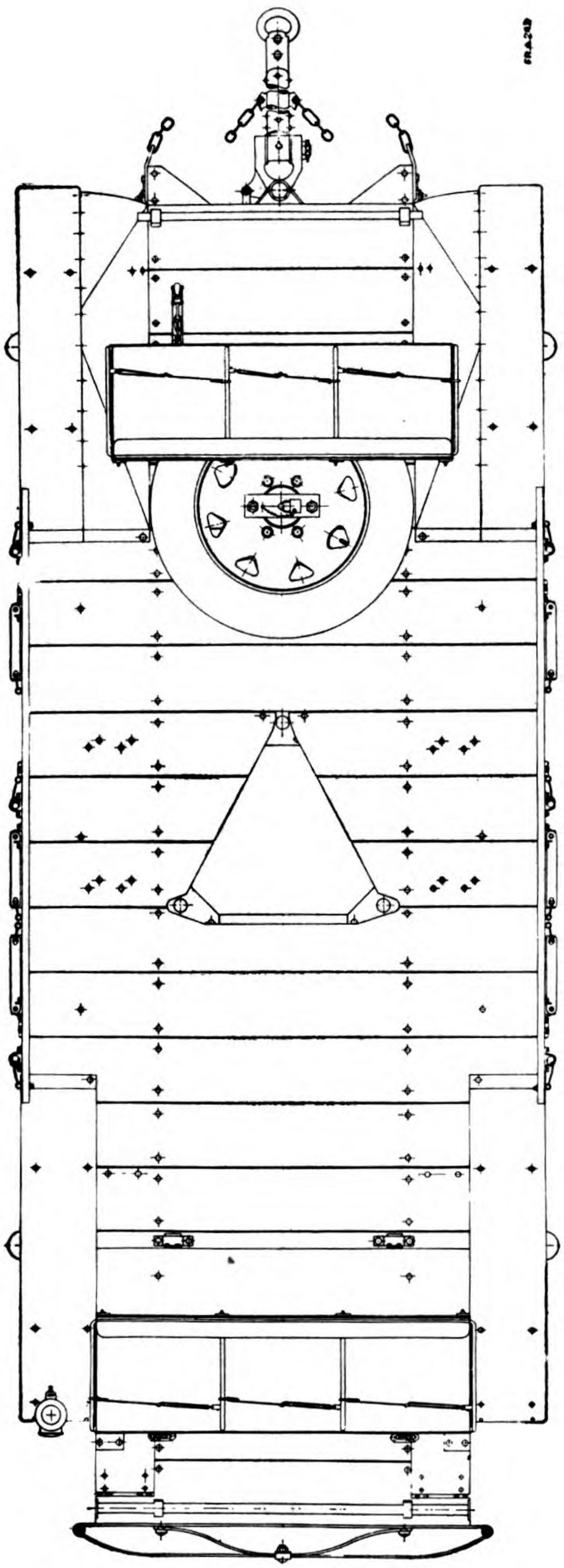

FIGURE 67.—Sound locator trailer, M2A3 and M2A4—plan.

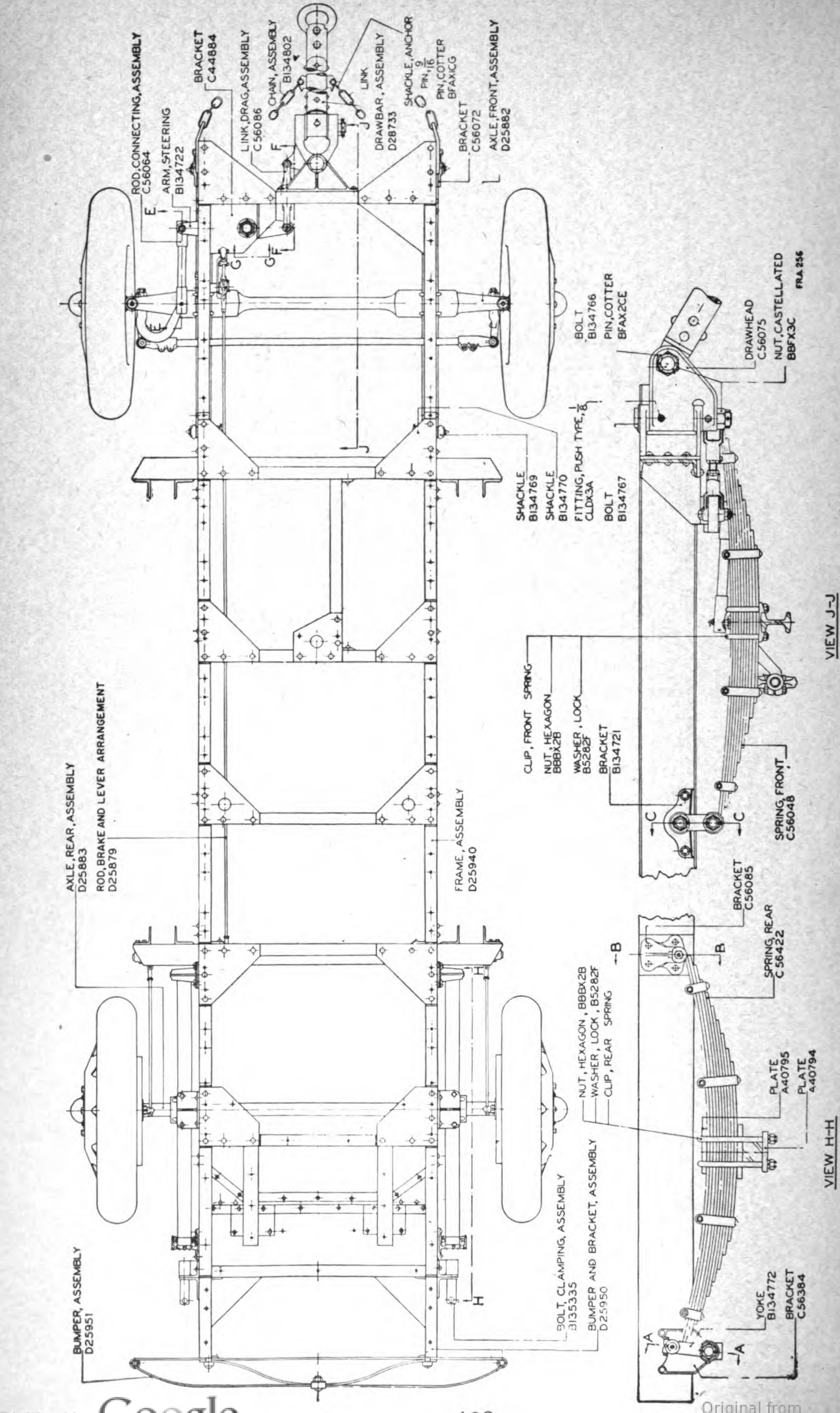

FIGURE 68.—Sound locator trailer, M2A3—chassis.

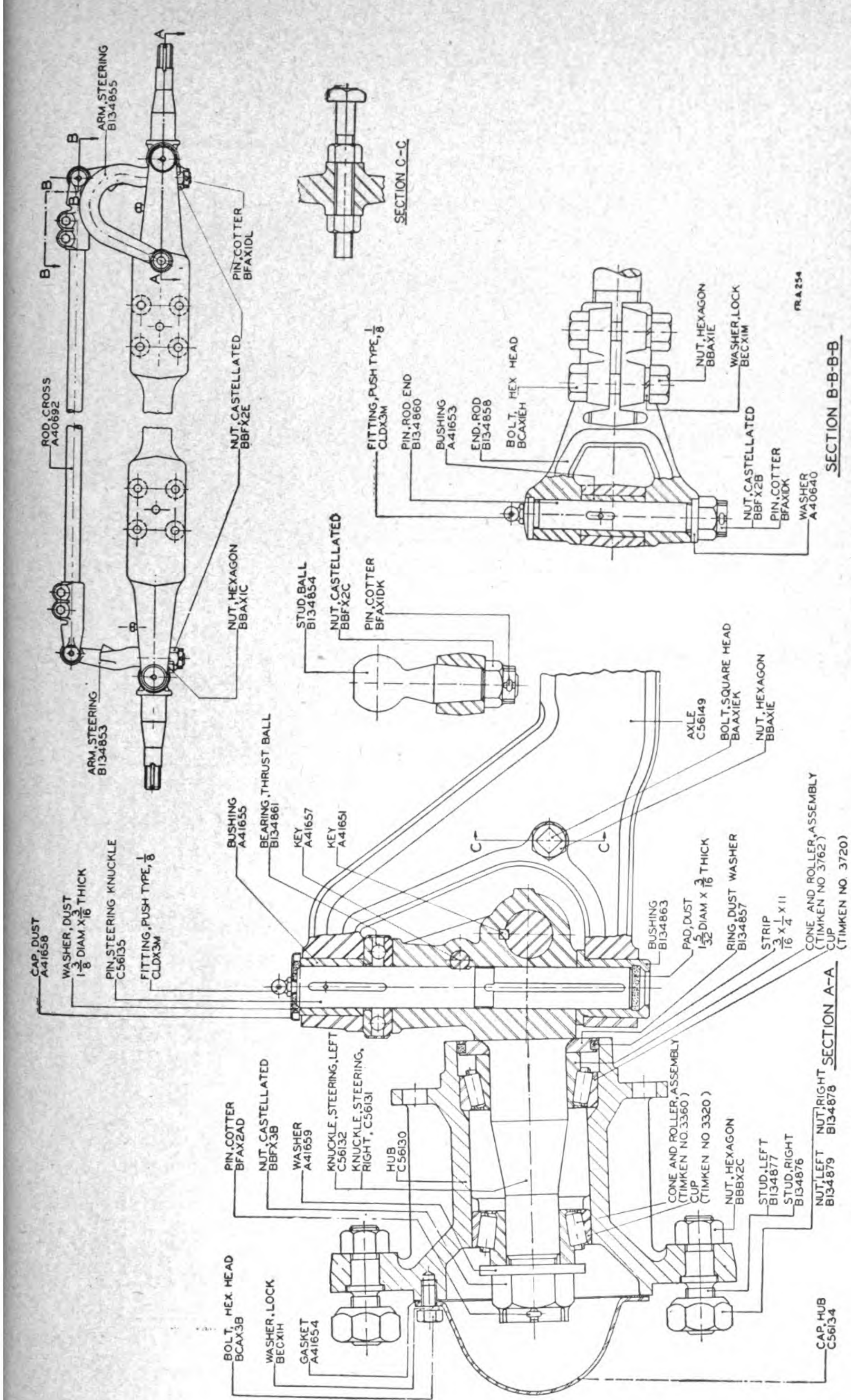

FIGURE 69.—Sound locator trailer, M2A3 and M2A4—front axle—assembled and sectioned views.

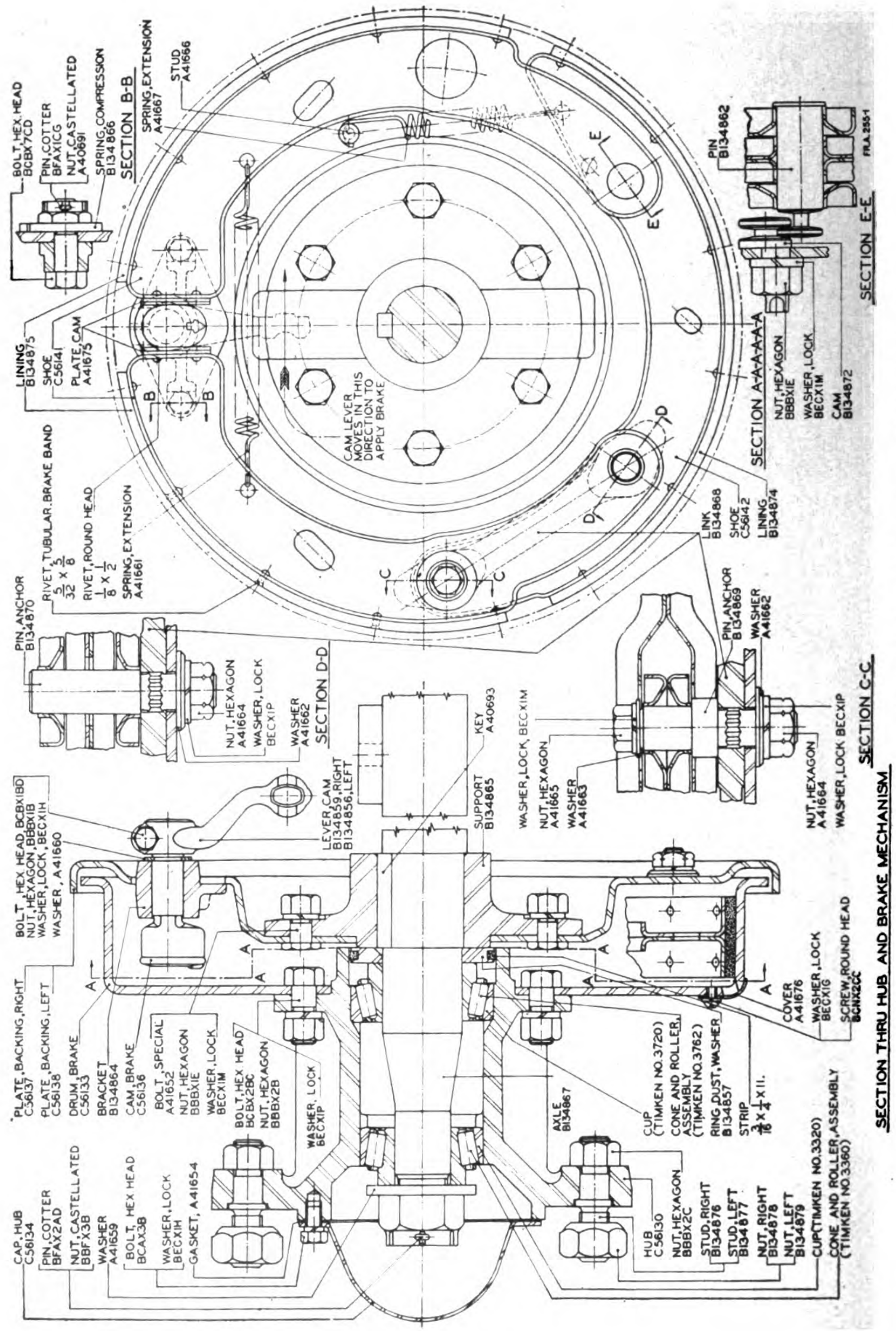

FIGURE 70.—Sound locator trailer, M2A3—rear axle—sectioned views.

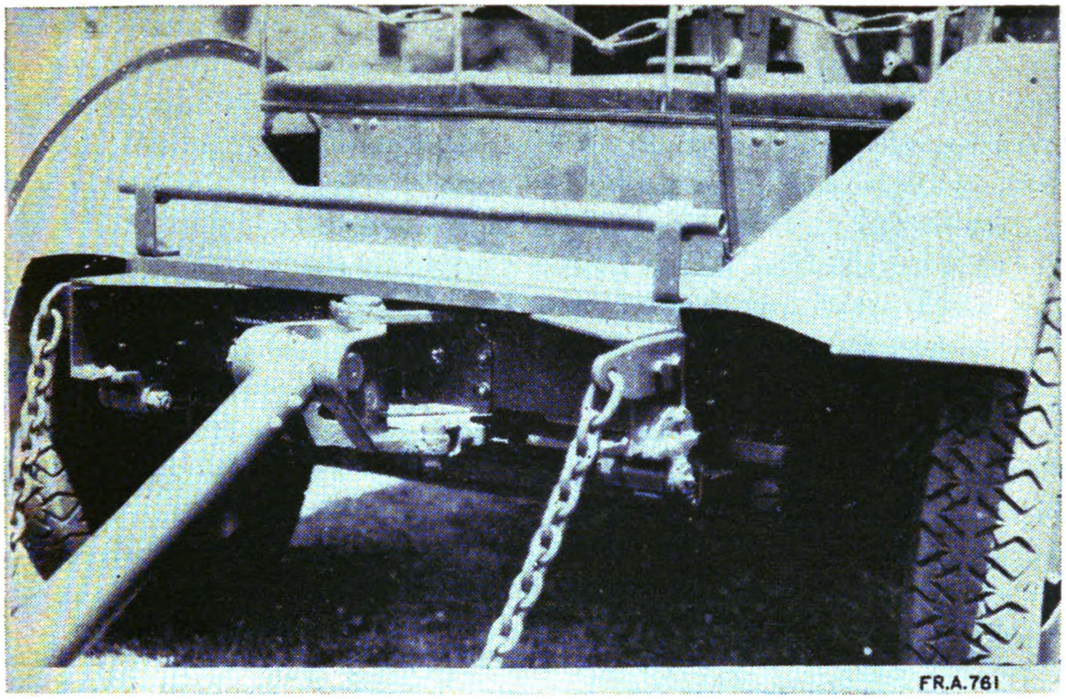

FIGURE 71.—Sound locator trailer, M2A3—arrangement of drawbar and steering mechanism.

(*b*) The trailer is provided with sideboards, thus making this space available for soldiers' packs and other equipment. These sideboards may be lowered when in the operating position and used to increase the area of the platform. Brackets are provided to support the boards in this position.

(*c*) The trailer is equipped with four jacks (D25617) attached to the frame, which are used in leveling the sound locator turntable. These jacks are provided with pins with which they are held in place when in use as well as when in the traveling position.

(*d*) The brake lever is located in the front of the trailer and may be operated from the front seat.

b. Operation.—(1) To place the sound locator trailer in the operating position, proceed as follows:

(*a*) After disconnecting from the searchlight truck, jack up the trailer, and level the sound locator turntable by means of the four jacks suspended from the frame. The jacks must be held rigidly in position by means of the retaining pins provided. The two levels on the turntable are used in leveling the instrument.

(*b*) If more platform space is desired, lower the sideboards by lifting out the retaining pins; then mount the boards upon the brackets provided, to form an extension of the platform. The sound locator, however, may be operated without lowering these sideboards.

(*c*) Uncover the acoustic corrector. To do this it is necessary to first remove the rear platform and bumper assembly by unscrewing the two hand-operated bolts. These bolts are made accessible by opening the hinged sections of the platform; then lift off the rear seat, which houses the corrector, after pulling it forward a few inches to free it from the keepers in the rear.

(2) To place the sound locator trailer in the traveling position, the jacks are lowered and slung into position against the trailer frame, and the sideboards, rear seat, and bumper assembly are replaced. The drawbar is then connected to the searchlight truck.

c. Care and adjustment.—(1) *Wheel bearings.*—If there is excessive play in a wheel bearing, jack up the wheel, remove the hub cap, and take out the cotter pin from the adjusting nut. Run the adjusting nut up tight, then turn it back approximately one-quarter turn and replace the cotter pin and hub cap. When removing a wheel, note that the right-hand hubs are provided with right-hand threaded nuts and studs, and the left-hand hubs with left-hand threaded nuts and studs. These are marked "R" and "L" to distinguish the right-hand and left-hand threads.

(2) *Brakes.*—The brakes and brake control system require frequent inspection and adjustment to compensate for wear.

(*a*) Before any adjustment to the brake system is made, it is essential that the spring clips holding the chassis springs to the axle should be tight, and that the wheel bearings should be in proper adjustment, as described in (1) above.

(*b*) The brake rod connections should be adjusted to be free of backlash, and yet to permit the brake system to return to the extreme released position, where the brake control lever (C56057) should make an angle of 110° to 120° with the brake rod (B134771). To adjust a rod length, remove the clevis pin and screw the threaded end yoke to give the proper length, or, at the brake control lever, turn the rod adjusting nut to the desired position.

(*c*) To adjust the brakes for wear, with wheel jacked up and brake released, first loosen the cam locking nut (BBBX1E, sec. E–E, fig. 70), located in lower part of backing plate, and turn the cam (B134872) in the *same* direction in which the wheel revolves when the vehicle moves forward, until a slight drag can be felt when turning the wheel over by hand. Then turn the cam in the opposite direction until the wheel is just free of brake drag. Hold the cam and secure the locking nut.

(*d*) To insure that the brake is fully released when making the adjustment described in (*c*) above, it is desirable, when conditions permit, to remove the brake rod connections entirely. After the adjustment is made, the brake rod connections must be replaced and adjusted as described in paragraph 31*c*(2)(*b*).

(*e*) The anchor pins are to be adjusted only when fitting relined shoes, when the anchor pin nuts are found to be loose, or when other adjustments fail to give results. The procedure is as follows:

1. Loosen the two nuts (A41664) which hold the anchor pins (B134869 and B134870) to the backing plate. These nuts may be identified by the notched corners. Note also that anchor pins pass through the backing plate in enlarged holes.

2. Adjust the eccentric cam (B134872, par. 31*c*(2)(*c*)) until the wheel can barely be turned with both hands.

3. Tap the ends of the anchor pins with a soft hammer or piece of hard wood to insure their shifting and assuming the correct position. Apply the brake slightly and force the wheel forward against the brake. Still holding the brake on, tighten the anchor pin nuts as tight as possible with a 16-inch wrench.

4. Release brake and turn back the eccentric cam until the wheels are just free of drag.

5. This adjustment can be checked by loosening screw (BCNX2CC) and removing cover plate (A41676) from the hole in drum (C56133); then measure the distance between the shoe lining and the brake drum by inserting feeler gages. With the brakes released, the anchor ends of the auxiliary and secondary shoes should have approximately .005 inch clearance, and the tow ends of these two shoes should have about .010 inch clearance, or twice that at the anchor ends.

(3) *Tires.*—Tires must be inspected frequently to insure that they are in serviceable condition and properly inflated.

(4) *Taillamp.*—The taillamp must be kept filled with kerosene, with glass clean and wick properly trimmed.

32. Sound locator trailer, M2A4.—*a. Description.*—(1) *General.*—The sound locator trailer, M2A4 (figs. 72 to 76, incl., also figs. 11, 12, 67, and 69), is a mobile unit arranged for towing by the searchlight truck. It is equipped with standard automobile wheels fitted with pneumatic tires, and with rear wheel brakes which are operable either by a vacuum system, from the towing vehicle, or manually by a lever on the trailer. A taillight is provided for night driving.

(2) *Arrangement.*—(*a*) Seats for six men are located in the front and rear ends of the trailer. The rear seat, which is removable along with the rear platform and bumper assembly, houses the acoustic corrector and two chests containing tools and accessory equipment. The seat box is provided with hooks. In the rear, the hooks slide under keepers; in the front they are held in place by the rear platform and bumper assembly, which, in turn, is fastened to the frame of the trailer by means of two hand-operated bolts. A spare wheel and tire are stored under the front seat.

(*b*) The trailer is provided with sideboards, thus making this space available for soldiers' packs and other equipment. These sideboards may be lowered when in the operating position and used to increase the area of the platform. Brackets are provided to support the boards in this position.

(*c*) The trailer is equipped with four jacks (D25617) attached to the frame, which are used in leveling the sound locator turntable. These jacks are provided with pins with which they are held in place when in use as well as when in the traveling position.

(*d*) The sound locator trailer, M2A4, is equipped with vacuum power brakes. The system is composed of two mechanically operated brakes, one on each rear wheel, operated by a vacuum power cylinder and its accessory apparatus. This system is operable when connected to, and towed by, a vehicle equipped with a vacuum power system. The brake system is also operable manually by the hand brake lever, located near the front seat, to serve as a parking brake; and as an emergency brake in case the trailer becomes free from the towing vehicle.

1. The brakes are the Bendix Brake Company's double action "Duo Servo" (two shoe), 16 by 2½ inches, cable-controlled brakes. Figure 74 shows the arrangement of these brakes.

2. The brakes are operated by the vacuum power unit, a product of the Bendix Products Corporation, shown in figure 75.

3. Two hose lines run from the towing vehicle to the trailer. The vacuum line is installed on the right-hand side (facing the front of the trailer as viewed from the towing vehicle), and the air line is installed on the left-hand side. The hose connections are made by pulling out the plugs from the female hose couplings on the trailer and inserting the male couplings on the hose ends. The couplings are plainly marked "Vac" and "Air", respectively.

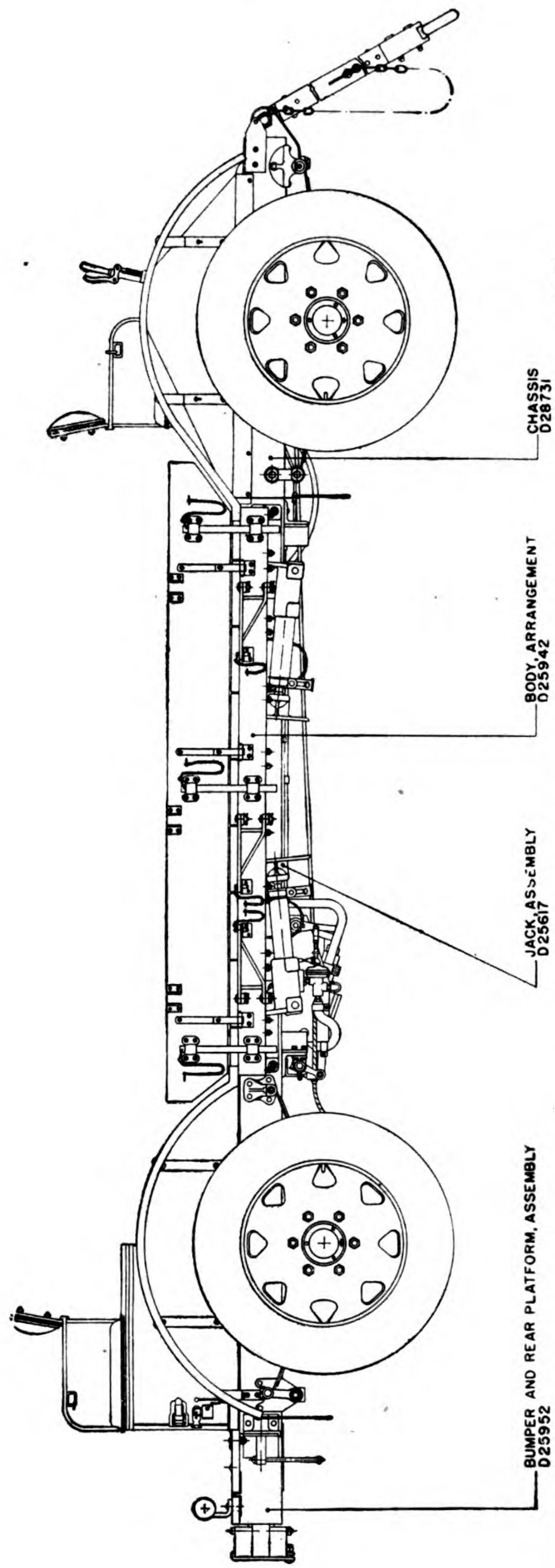

FIGURE 72.—Sound locator trailer, M2A4—right elevation.

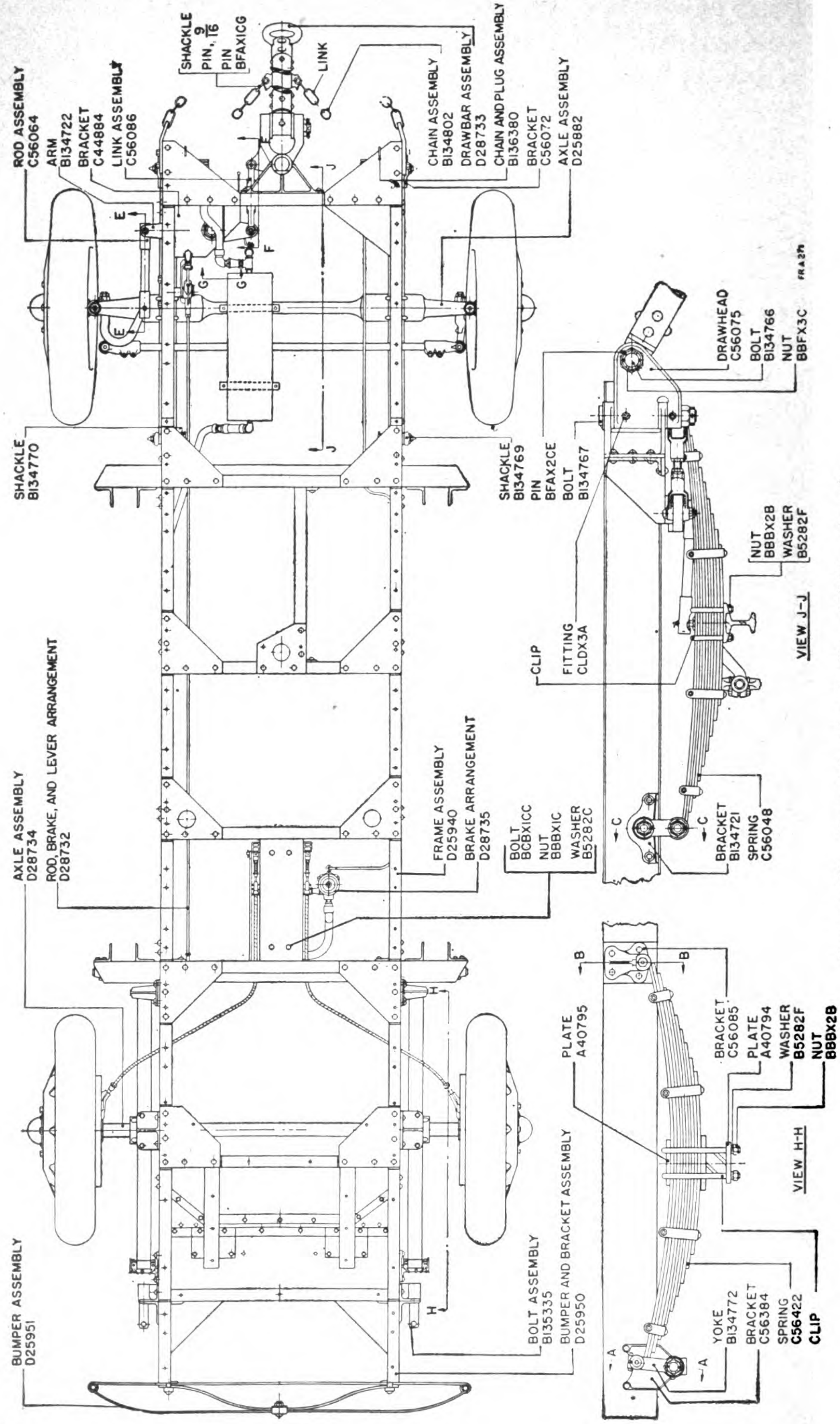

FIGURE 73.—Sound locator trailer, M2A4—chassis.

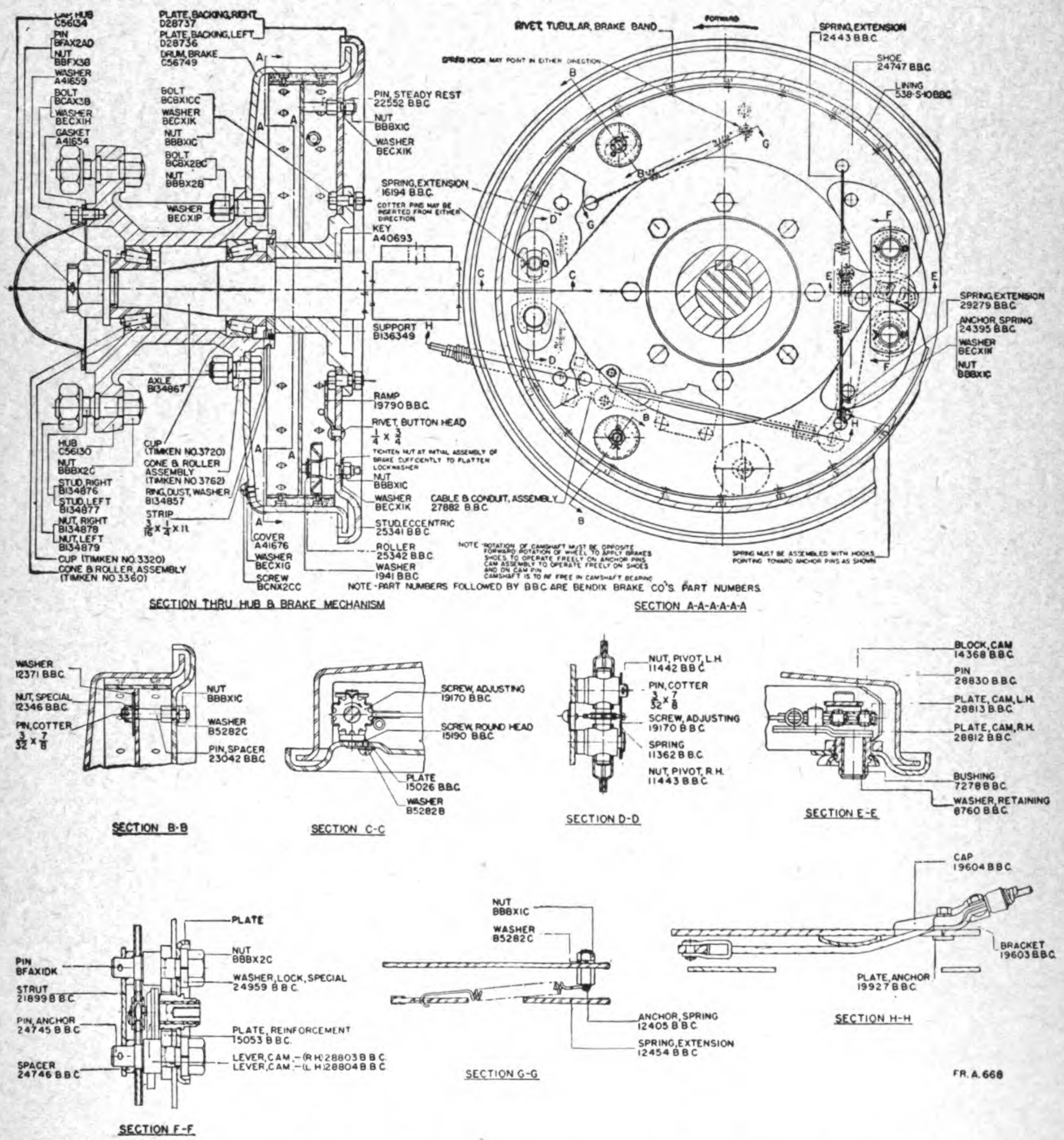

FIGURE 74.—Sound locator trailer, M2A4—rear axle—sectioned views.

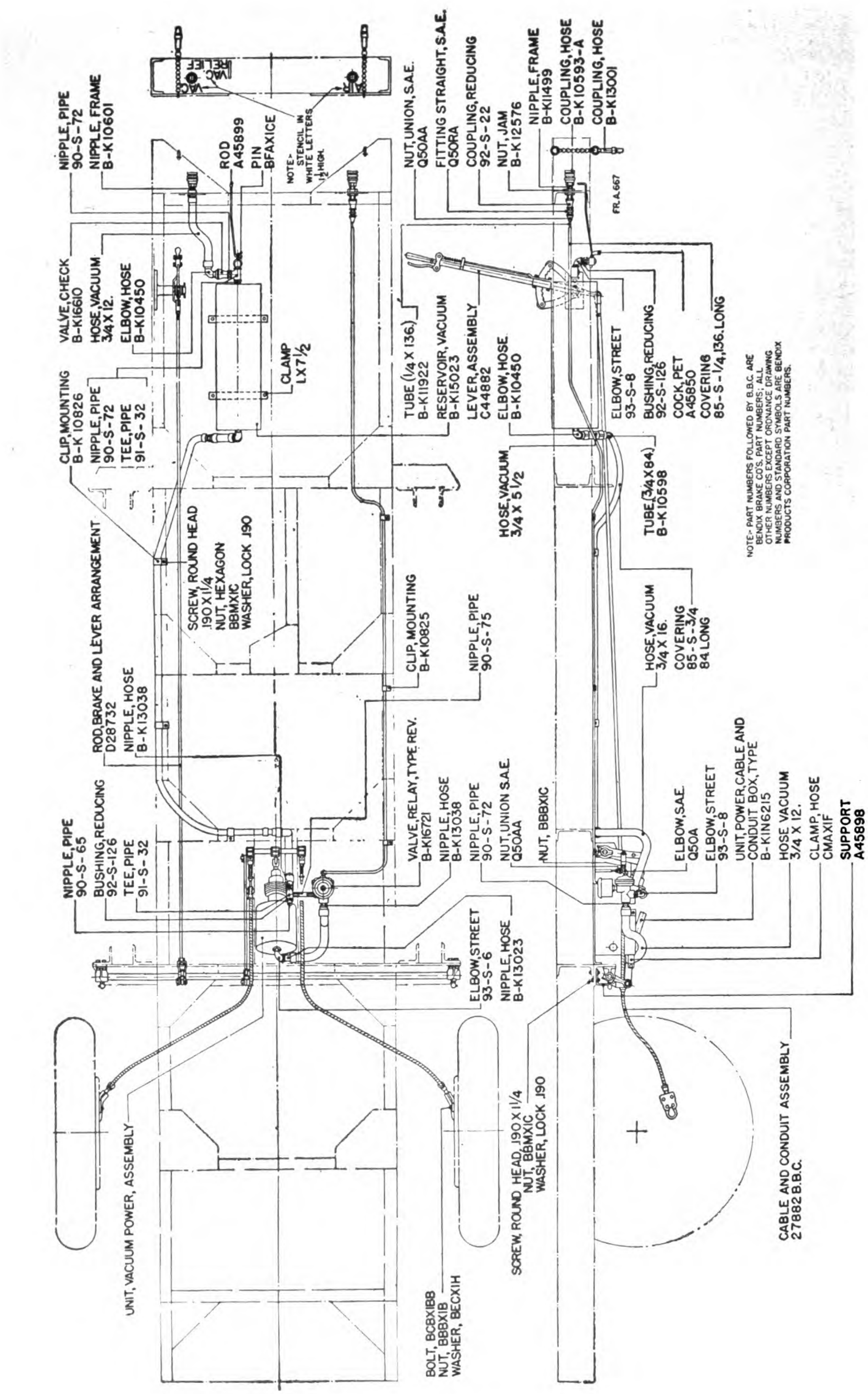

FIGURE 75.—Sound locator trailer, M2A4—brake control.

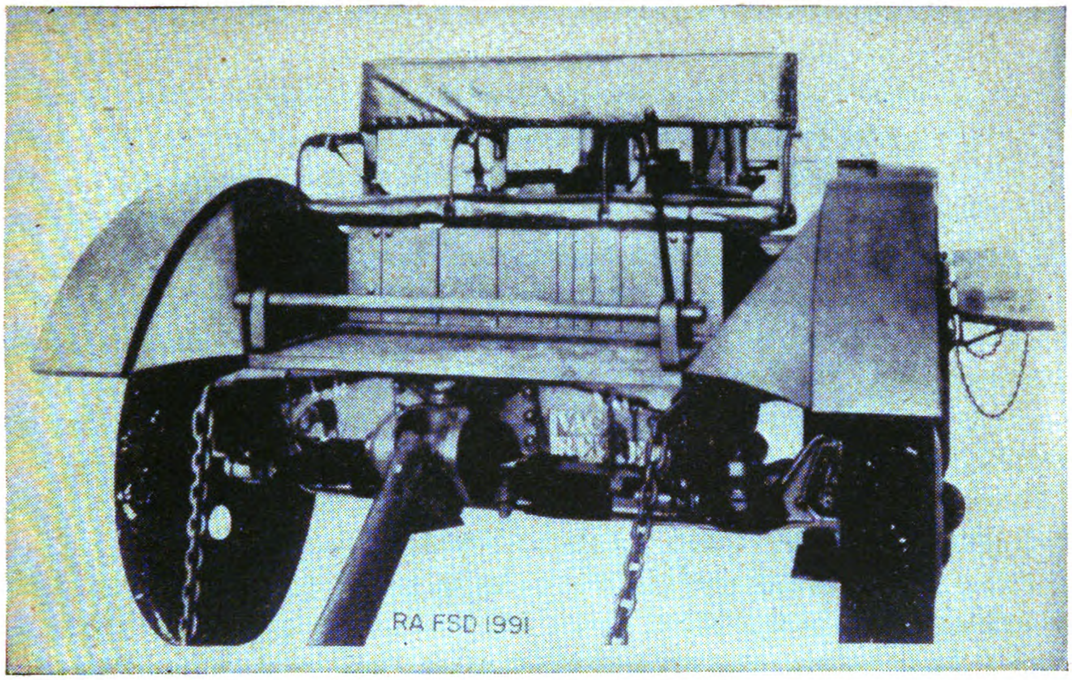

FIGURE 76.—Sound locator trailer, M2A4—drawbar and steering mechanism.

4. The vacuum line leads through a hose and a check valve (B–K10627A) to a 1,050 cubic inch capacity vacuum reservoir (B–K15023). The function of the check valve (B–K10627A) is to maintain the maximum vacuum in the reservoir at all times, and to prevent loss of vacuum if the trailer should, for any reason, become disconnected from the towing vehicle. The vacuum reservoir is provided with a pet cock (A45850) through which the vacuum may be released, if desired.

5. A copper tube line (B–K10598) from the vacuum reservoir is connected to the cylinder of the power unit, keeping the chamber behind the piston always evacuated.

6. The air line is connected by the copper tube (B–K11922) to the relay valve (B–K13860), which is, in turn, connected to the cylinder of the power unit, in front of the piston. The function of the relay valve is to admit air in front of the piston, controlled according to the air pressure in the air line, which is, in turn, controlled by the operator of the towing vehicle. The resulting motion of the piston is transmitted through the piston rod of the power unit to the mechanical brake system.

7. The trailer brakes are thus under the control of the operator of the towing vehicle. If the trailer becomes disconnected therefrom for any reason, the trailer brakes are automatically applied and held.

8. Manual control of the trailer brakes is also possible through the brake lever (C44882) located near the front seat, which is connected mechanically to the brakes.

b. Operation.—(1) To place the sound locator trailer in the operating position, proceed as follows:

(*a*) Disconnect the trailer from the searchlight truck. Insert the plugs into the vacuum and air hose couplings immediately after disconnecting the hose lines, to exclude dirt and water. If it is necessary to move the trailer after the hose lines have been disconnected, first release the brakes by turning the vacuum relief rod (A45899), which is located near the vacuum hose coupling. This rod operates the pet cock (A45850), which is open when the bent portion at the front end of the vacuum relief rod is vertical (the position shown in fig. 75).

(*b*) Jack up the trailer and level the sound locator turntable by means of the four jacks suspended from the frame. The jacks must be held rigidly in position by means of the retaining pins provided. The two levels on the turntable are used in leveling the instrument.

(*c*) If more platform space is desired, lower the sideboards by lifting out the retaining pins; then mount the boards upon the brackets provided, to form an extension of the platform. The sound locator, however, may be operated without lowering these sideboards.

(*d*) Uncover the acoustic corrector. To do this, it is necessary to first remove the rear platform and bumper assembly by unscrewing the two hand-operated bolts. These bolts are made accessible by opening the hinged sections of the platform. Then lift off the rear seat, which houses the corrector, after pulling it forward a few inches to free it from the keepers in the rear.

(2) To place the sound locator trailer in the traveling position, the jacks are lowered and slung into position against the trailer frame, and the sideboards, rear seat, and bumper assembly are replaced. The drawbar and hose couplings are then connected to the searchlight truck. The vacuum relief rod (A45899) must be turned so that the bent portion at the front is horizontal before traveling; otherwise there can be no vacuum in the reservoir, and the brakes cannot be controlled from the towing vehicle.

c. Care and adjustments.—(1) *Vacuum power unit.*—About every 60 days, 2 ounces of light Class A lubricating oil, Navy symbol 1042 (SAE 10W), should be placed in the cylinder of the vacuum power unit. To do this, remove the pipe plug located in the end plate and inject the oil; then remove the clevis pin and turn the piston rod several times.

(2) *Wheel bearings.*—If there is excessive play in a wheel bearing, jack up the wheel, remove the hub cap, and take out the cotter pin from the adjusting nut. Run the adjusting nut up tight, then turn it back approximately one-quarter turn and replace the cotter pin and hub cap. When removing a wheel, note that the right-hand hubs are provided with right-hand threaded nuts and studs, and the left-hand hubs with left-hand threaded nuts and studs. These are marked "R" and "L" to distinguish the right-hand and left-hand threads.

(3) *Brakes.*—The brakes and brake control system require frequent inspection and adjustment to compensate for wear.

(*a*) Before any adjustment to the brake system is made, it is essential that the spring clips holding the chassis springs to the axle should be tight, and that the wheel bearings should be in proper adjustment, as described in (2) above.

(*b*) The rod and cable connections should be adjusted to be free of backlash, and yet to permit the brake system to return to the extreme released position. To adjust a rod or cable length, remove the clevis pin and screw the threaded end yoke to give the proper length. When shortening linkages to remove backlash, do not expand the brake shoes away from the anchor pins (24745 B. B. C., sec. F–F, fig. 74); the cam blocks (14368 B. B. C., sec. E–E, fig. 74) should come only into light contact with the ends of the brake shoes.

(*c*) To adjust a brake to compensate for brake lining wear, proceed as follows:

1. It is essential that the brake rod and cable connections be properly adjusted, as described in (*b*) above, before attempting to adjust brakes for wear.

2. With the rear wheels jacked up and brakes released, loosen the locking nut (BBBX1C, fig. 74) on the eccentric stud (25341 B. B. C.) located in the lower part of the backing plate. Turn the eccentric stud in the *same* direction in which the wheel revolves when the vehicle is moving forward until a slight brake drag can be felt when turning the wheel over by hand; then turn the eccentric stud in the opposite direction until the wheel is just free of brake drag. Hold the eccentric stud and secure the locking nut.

3. Remove the cover plate (15026 B. B. C., sec. C–C, fig. 74), located in the front part of the backing plate, and, with a screw driver, turn the notched wheel of the adjusting screw (19170 B. B. C.) *toward* the rim of the backing plate until a slight drag can be felt when turning the wheel over by hand. Then back off the adjusting screw until the wheel is just free of brake drag.

4. With the wheels still jacked up, apply the brake slightly. Try the holding effect of the brake by pulling each wheel over by hand. If the effect is not equal, loosen the adjusting screw on the tighter wheel until the brake drag is the same on both wheels. Replace the adjusting screw hole cover plates.

(*d*) Readjustment of the anchor pins is necessary if the anchor pin nuts have been loosened, or if the previously described adjustments fail to give results.

1. Before making this adjustment, jack up the wheels and disconnect the brake cables at the cross-shaft levers of the vacuum power unit.

2. Loosen the two anchor pin nuts (BBBX2C, sec. F–F, fig. 74) located in the rear part of the backing plate and remove the cover plate (15026 B. B. C., sec. C–C, fig. 74) in the front part of the backing plate.

3. With a screw driver, turn the notched wheel of the adjusting screw (19170 B. B. C.) *toward* the rim of the backing plate until the brake drag is so great that the wheel can barely be turned with both hands.

4. Then, with a hammer, tap the anchor pins (24745 B. B. C.) to assure their assuming the correct position, and again tighten the anchor pin nuts as tight as is possible with a long wrench.

5. Turn back the adjusting screw (19170 B. B. C.) until the wheel is just free of brake drag. Adjust the eccentric studs and equalize the brake action, as described in paragraph 32*c*(3)(*c*), and reconnect the cables. Covers (A41676) are removable for inspection of brakes.

(*e*) The vacuum power system requires no adjustments and little attention.

1. The hose and tube connections should be inspected frequently to insure that they are free from leaks which would reduce the efficiency of the system.

2. The air cleaner on the relay valve should be cleaned at least every 6 months. To do this, remove the cover, which is held in place by a screw through its center, and remove the hair. Wash the hair with dry-cleaning solvent and saturate with light Class A lubricating oil, Navy symbol 1042 (SAE 10W). Clean the holes in the shell of the cleaner and replace the hair in the shell.

(4) *Tires.*—Tires must be inspected frequently to insure that they are in serviceable condition and properly inflated.

(5) *Taillamp.*—The taillamp must be kept filled with kerosene, with glass clean and wick properly trimmed.

33. Sound locator trailer, M3.—*a. Description.*—(1) *General.*—The sound locator trailer, M3 (figs. 77 to 82, incl., also, figs. 9 and 10), is light in construction and is intended for towing by hand for short distances over prepared or cleared runways. It is provided with wide steel-rimmed wheels to secure the needed bearing area required when operating on soft terrain. The rear wheels are equipped with brakes operated by means of a hand lever.

(2) *Arrangement.*—(*a*) The trailer is provided with four jacks, attached to the frame, which are used in leveling the sound locator turntable. These jacks are provided with pins with which they are held in place when in use and also when in the traveling position. Four turnbuckles (C56546) are also attached to the frame of the trailer. These are used to secure the trailer to anchor bolts or stakes driven into the ground, while in operation.

(*b*) Provision is made for mounting the acoustic corrector on the rear of the trailer. The corrector housing consists of a rainproof metal box (D25850) provided with handles, trunk bolts, and lock, which fits over the corrector.

(*c*) The brake lever is located on the right side of the platform. It may be operated by a person walking alongside of the trailer.

b. Operation.—(1) To place the sound locator trailer in the operating position, proceed as follows:

(*a*) After drawing the trailer to its desired position, jack it up and level the sound locator turntable by means of the four jacks suspended from the frame of the trailer. The jacks must be held rigidly in position by means of the retaining pins provided. The two levels on the turnable are used in leveling the instrument.

(*b*) Secure the trailer to anchor bolts or stakes, driven into the ground, by means of the four turnbuckles which are attached to

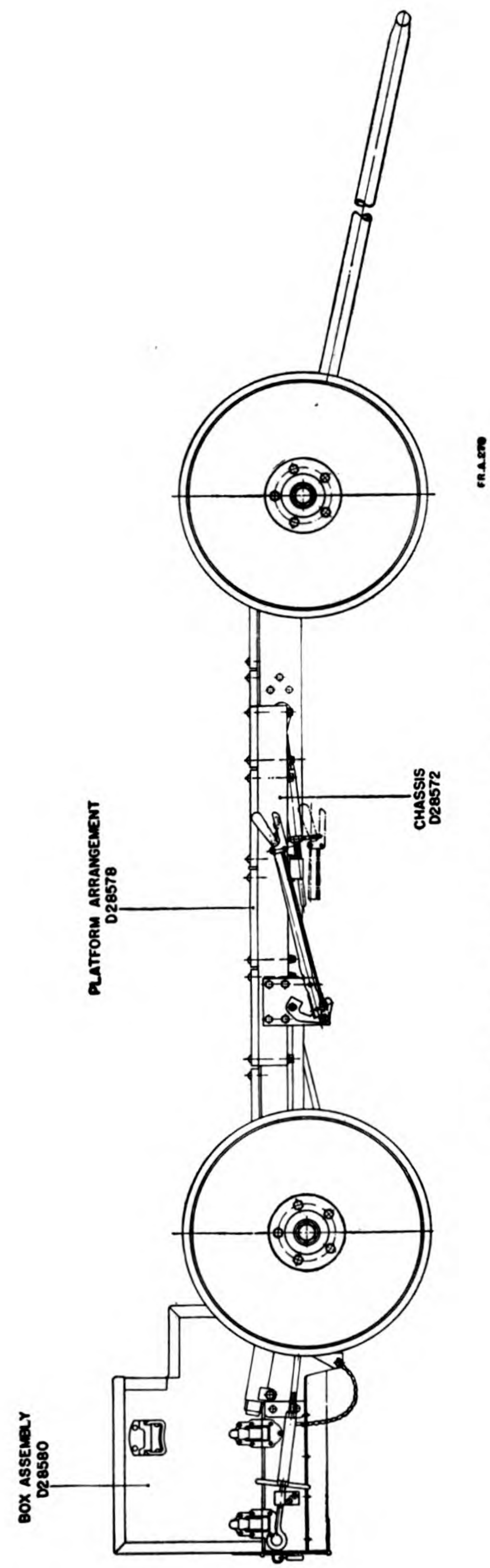

FIGURE 77.—Sound locator trailer, M3—right elevation.

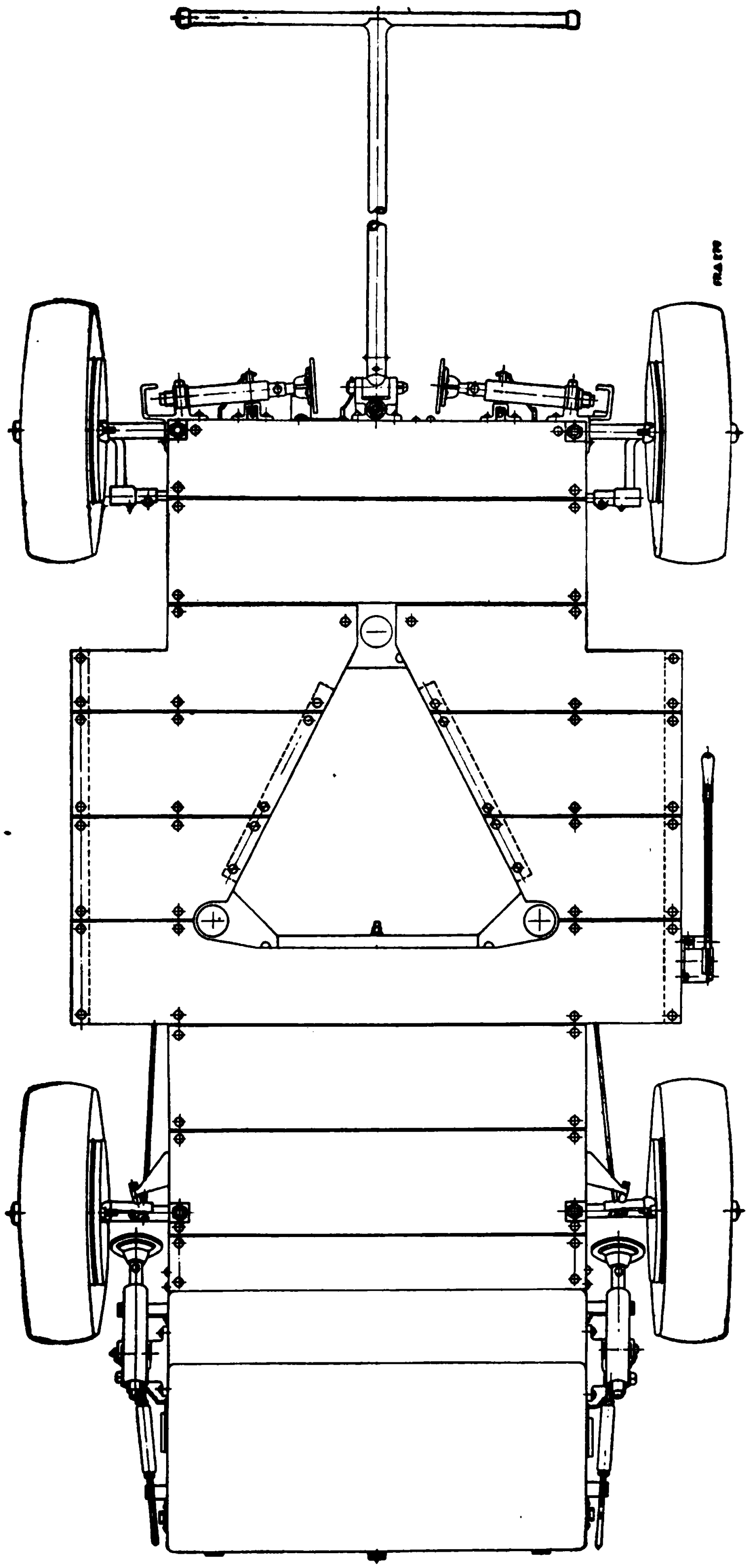

FIGURE 78.—Sound locator trailer, M3—plan.

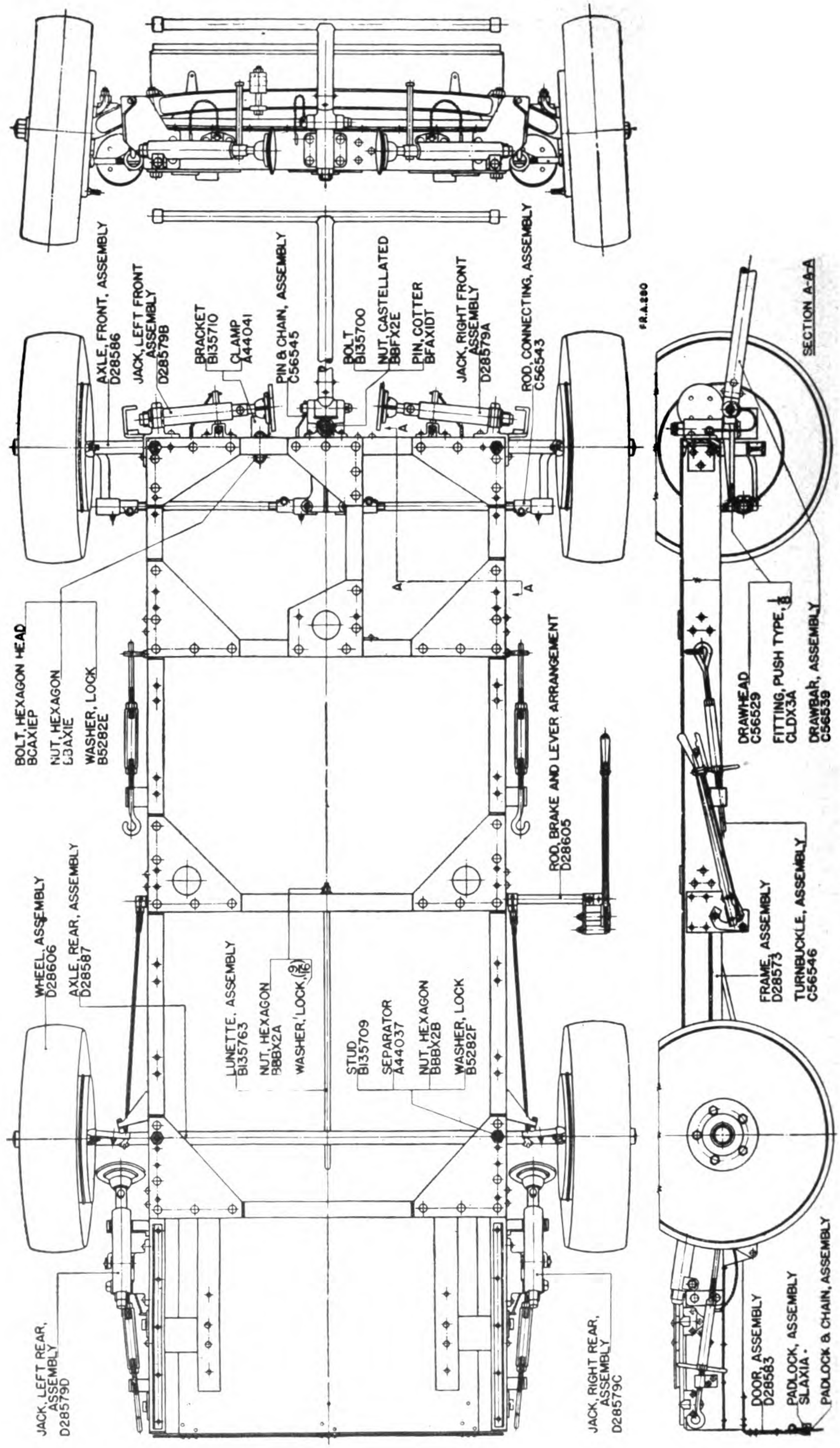

FIGURE 79.—Sound locator trailer, M3 chassis.

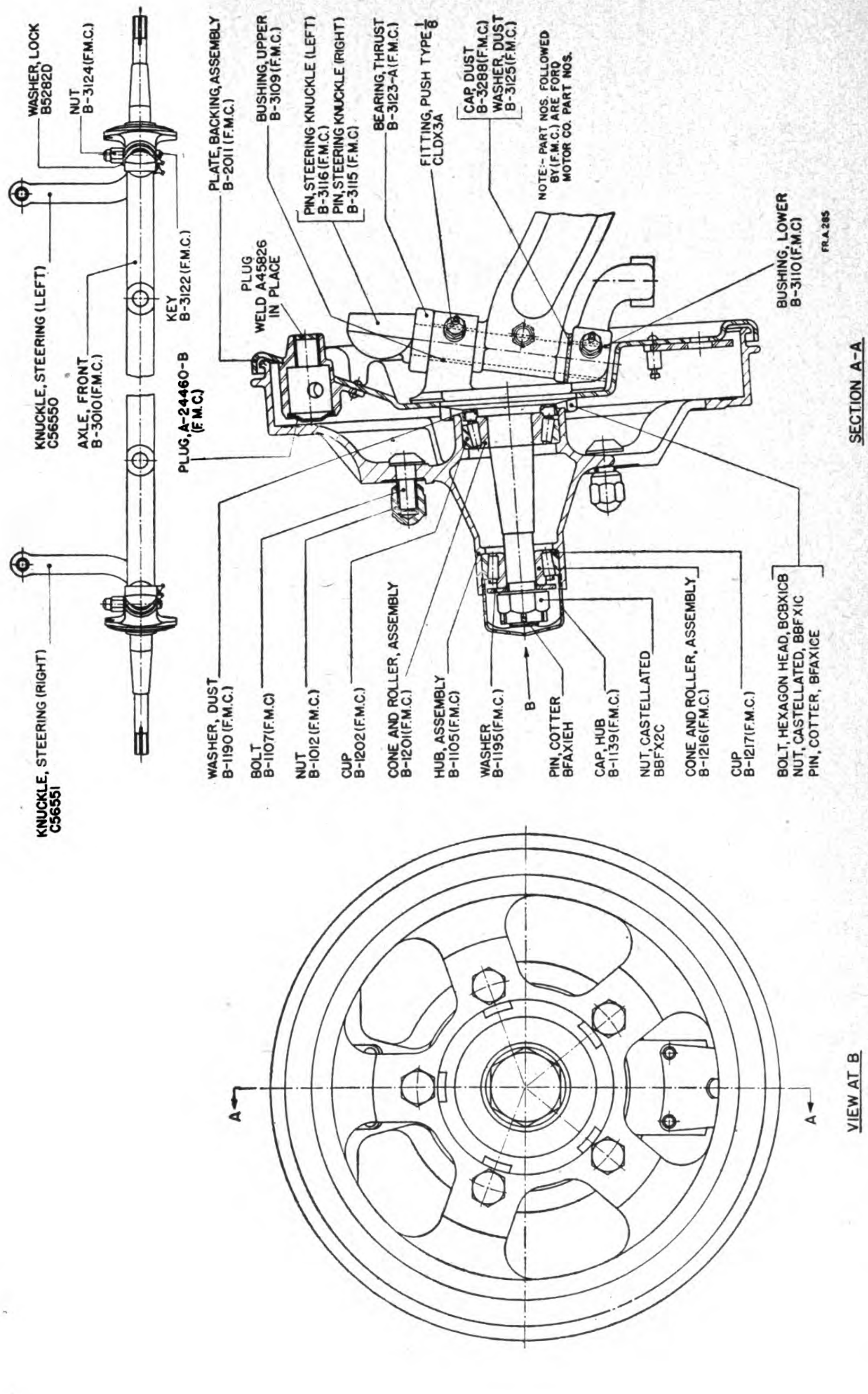

FIGURE 80.—Sound locator trailer, M3—front axle—assembled and sectioned views.

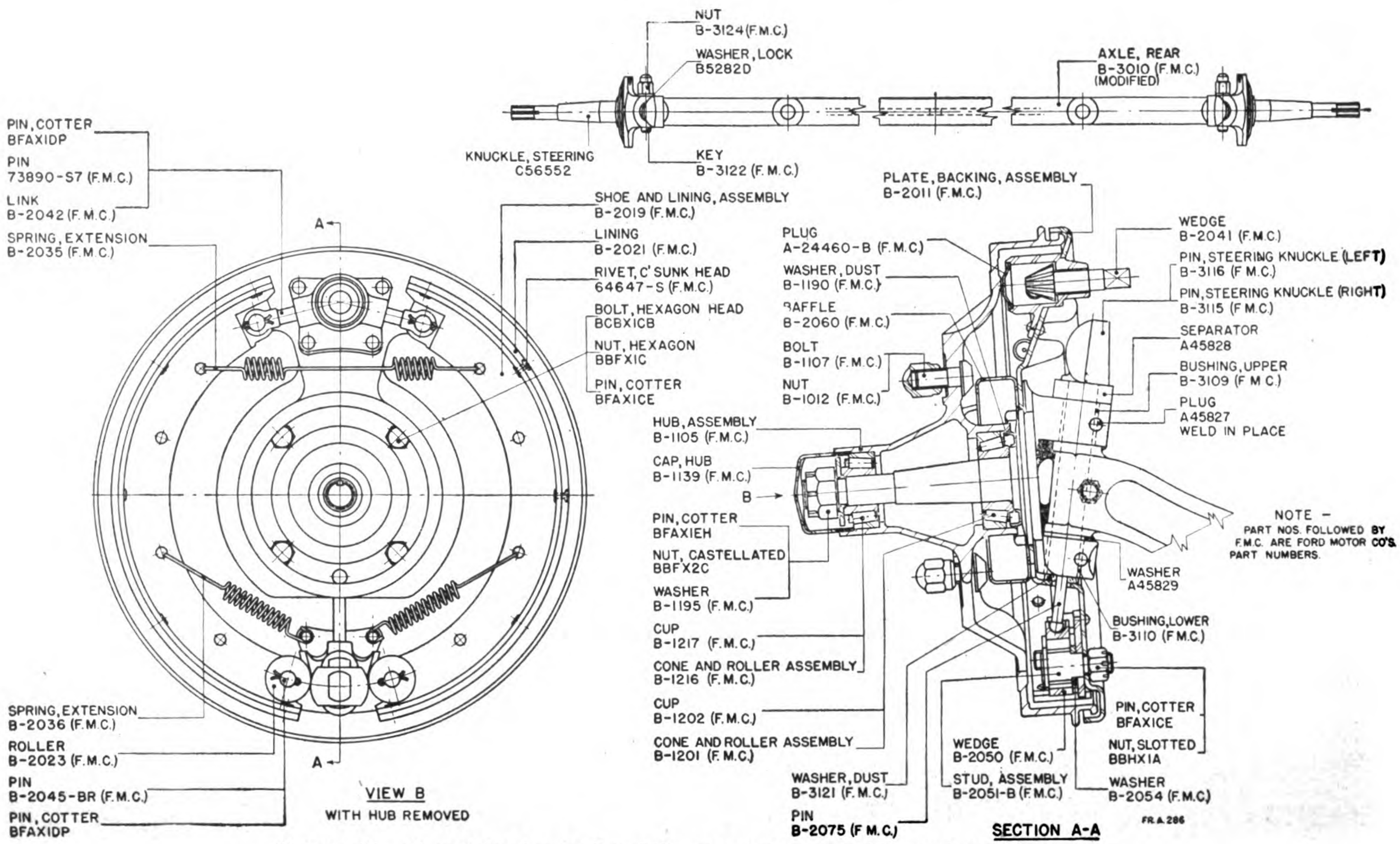

FIGURE 81.—Sound locator trailer, M3—rear axle—assembled and sectioned views.

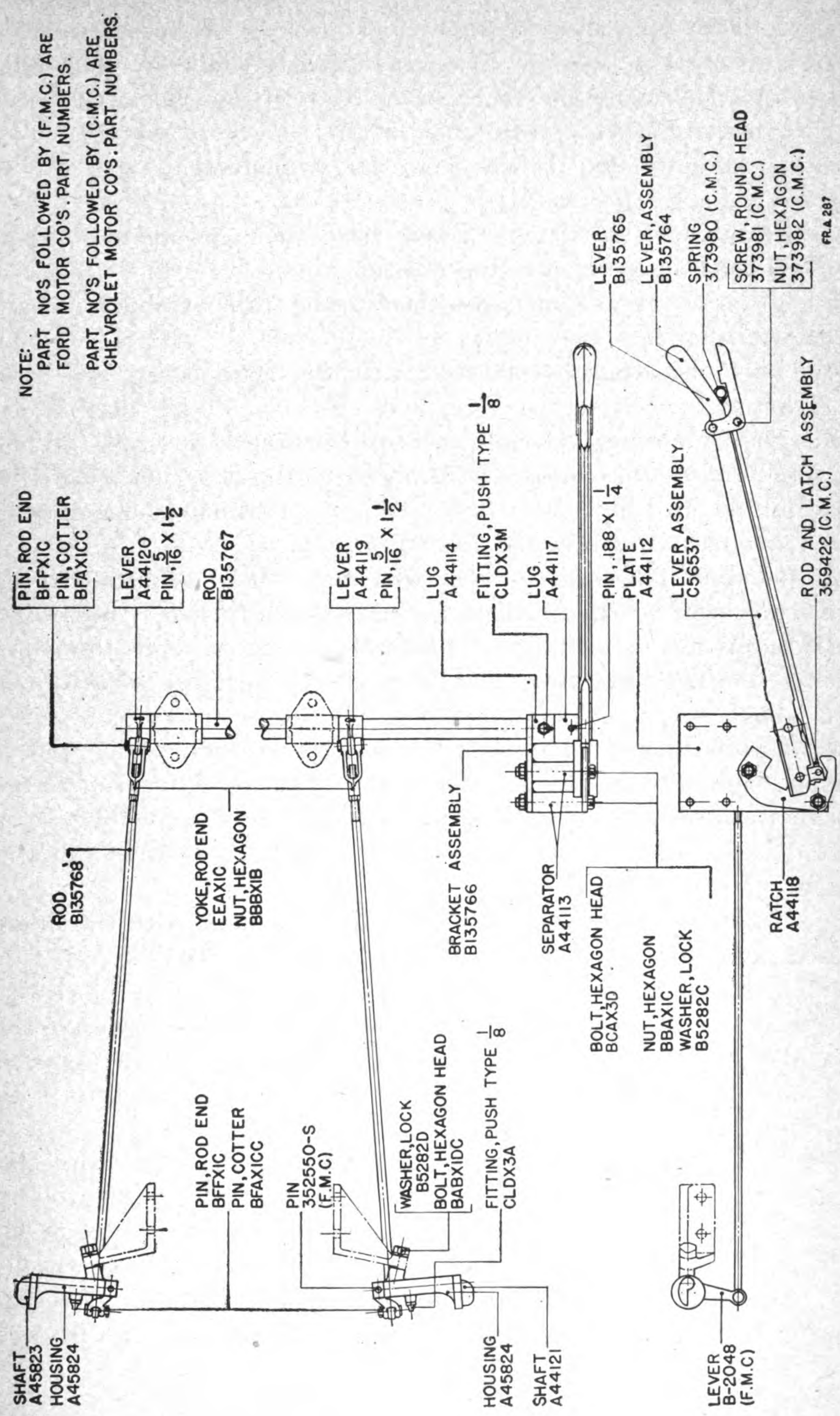

FIGURE 82.—Sound locator trailer, M3—brake rod and lever arrangement.

the trailer frame. Check the levels on the turntable, and readjust the jacks and turnbuckles if the previous leveling has been disturbed.

(*c*) Uncover the acoustic corrector. This is done by unlocking the padlock, releasing the trunk bolts, and lifting the metal cover clear by means of the handles.

(2) To remove the trailer from its emplacement, proceed as follows:

(*a*) Remove the turnbuckle hooks from their ground fastenings and hook them in their traveling position.

(*b*) Lower the jacks and fasten them to the trailer frame by means of the retaining pins provided.

(*c*) Cover the acoustic corrector with the metal cover, and lock.

c. Care and adjustments.—(1) *Wheel bearings.*—If there is excessive play in a wheel bearing, jack up the wheel, unscrew the hub cap, and remove the cotter pin from the adjusting nut. Run the adjusting nut up tight, then turn it back approximately one-quarter turn and replace the cotter pin and hub cap.

(2) *Brakes.*—The brake system will rarely need adjustment. It should, however, be examined periodically and adjusted if necessary.

(*a*) Before any adjustment to the brake system is made, the wheel bearings should be examined and, if necessary, adjusted as described in (1) above.

(*b*) The brake rod connections should be adjusted to be free of backlash and yet to permit the brake system to return to the extreme released position. To adjust a rod length, remove the clevis pin and screw the threaded end yoke to give the proper length and replace.

(*c*) To adjust the brake shoes, jack up the wheel, with the brake released, and turn the brake adjusting wedge (B–2041 (F. M. C.), fig. 81) located at the top of the backing plate, in a clockwise direction until a slight brake drag can be felt when turning the wheel over by hand. Then turn the adjusting screw in the opposite direction until the wheel is just free of brake drag. Adjust both rear wheels in this manner.

(*d*) With both rear wheels jacked up, apply the brake slightly. Try the holding effect of the brake by pulling each wheel over by hand. If the effect is not equal, loosen the adjusting wedge on the tighter wheel until the brake drag is the same on both wheels.

34. General care and lubrication.—*a.* The drawbar, steering knuckle, steering arm, and jacks are provided with Alemite fittings and should be completely lubricated after every 500 miles of operation. For this, use medium lubricating grease, chassis, summer grade, for summer operation; and light lubricating grease, chassis, winter grade. At the same time, the wheel gun is provided for this purpose. At the same time, the wheel bearings should be hand-packed, using grease, wheel bearing, heavy duty grade, for summer operation; and grease, wheel bearing, regular grade, for winter operation. Excessive lubrication of the rear wheel bearings should be avoided to prevent grease from getting on brake linings.

b. The clevis connections and other moving parts not provided with Alemite fittings should be kept well lubricated, using the oiler provided. Use light Class A lubricating oil, Navy symbol 1042 (SAE 10W).

c. The trailer must be inspected frequently for loose or missing bolts, nuts, wood screws, and other parts; also for open chain links. Any such condition must be remedied at once.

d. The trailer, M3, has steel rimmed tires; all other trailers have rubber tires mounted on wheels. The tires have the following size markings: 7.00–24 Ex. Ply—10 Ply 36×6 HD. This tire replaces the old tire having the following markings: 36×6, 10 Ply HD. The inner tube, size B–24 or 36×6, is to be used with the above-mentioned tires. The load rating and inflation pressure of the former tire is 2,575 pounds and 70 pounds per square inch and of the latter 2,500 pounds and 80 pounds per square inch. The tires must be inspected frequently to insure that they are in serviceable condition and properly inflated at all times.

Section VI

CORRECTION FORMULAS

35. Correction formulas.—The following formulas are presented for calculation of the corrections for some of the errors arising from various causes in the computations of the sound locators and acoustic correctors. Symbols used in these formulas are defined with the formulas only if they are not used elsewhere. For symbols in general use throughout this manual, see appendix I.

a. Table of sound velocities.

Table of sound velocities	
Velocity of sound in air	Temperature
Feet per second	*°F.*
1, 039	−10
1, 061	+10
1, 083	+30
1, 105	+50
1, 132	+75
1, 160	+100

b. Corrections for wind drift.

$$dA = \tan^{-1}\frac{W \sin (A_W - A')}{V_S \cos \epsilon'}$$

$$d\epsilon = -1{,}020\frac{W \cos (A_W - A') \sin \epsilon'}{V_S} \quad \text{(mils)}$$

or

$$d\epsilon = -57.3\frac{W \cos (A_W - A') \sin \epsilon'}{V_S} \quad \text{(degrees)}$$

Symbols

A_W—Azimuth of direction *from* which wind is blowing.
V_S—Velocity of sound (see table, par. 35*a*).
W—Wind velocity (ft. per sec.).

c. Parallax corrections, horizontal base (difference in angle due to horizontal distance between sound locator and searchlight).

$$dA = \tan^{-1}\frac{b \sin (A_o - A_b)}{H_x \cot \epsilon_o - b \cos (A_o - Ab)}$$

$$d\epsilon = \frac{b \sin^2 \epsilon_o \cos (A_o - A_b)}{.017\ H_x} \quad \text{(degrees)}$$

or

$$d\epsilon = \frac{b \sin^2 \epsilon_o \cos (A_o - A_b)}{.001\ H_x} \quad \text{(mils)}$$

Symbols

A_b—Azimuth of base line viewed *from* sound locator.
b—Horizontal distance (in feet) between sound locator and searchlight (ordinarily 400 ft.).

d. Parallax corrections, vertical base (difference in angle due to vertical distance between sound locator and searchlight).

$$d\epsilon = h\frac{\cos \epsilon_0 \sin \epsilon_0}{.017\ H_x} \quad \text{(degrees)}$$

or

$$d\epsilon = h\frac{\cos \epsilon_0 \sin \epsilon_0}{.001\ H_x} \quad \text{(mils)}$$

dA is negligible

In the above, h is the difference in level (in feet) between sound locator and searchlight. Sign is *positive* when sound locator is *above* searchlight.

Appendix I

GLOSSARY

Acoustic corrector.—An instrument for determining and applying angular corrections to the azimuth and elevation data, as obtained by the sound locator, for the travel of the airplane during the sound lag time and also for other effects.

Acoustic wind.—A fictitious wind, constant in velocity and direction, which is assumed to have the same effect on a sound wave as do the winds actually encountered.

Altitude (H).—The vertical distance (in feet) to a point in space from a horizontal reference plane containing the sound locator.

Angular rate.—Angular velocity.

Angular travel error.—The angular travel error is the error which is introduced into a predicted angle obtained by multiplying an instantaneous angular velocity by a time. It is brought about by the fact that, during that time, the angular velocity does not remain constant under conditions of straight-line flight, at constant speed and altitude.

Angular travel method.—A method of determining data based upon the rate of angular travel of the target in azimuth and elevation. Corrections based on the angular travel method are denoted by the subscript "x."

Angular velocity (Σ).—The rate of change of direction expressed in angular measure. In aerial sound location, angular velocity pertains to the apparent position of the target and is measured in its two components, the apparent vertical angular velocity (Σ'_e), or rate of change of elevation, and the apparent lateral angular velocity (Σ'_a), or rate of change of azimuth.

Apparent (apparent azimuth (A′), apparent elevation (ϵ'), etc.).—A term denoting an element of data pertaining to the apparent position of the target. Symbols pertaining to the apparent position are denoted by the prime accent (′).

Apparent position.—The former position of an airplane in flight, from which the sound seems to the listener to emanate at any instant.

Arbitrary corrections.—Corrections to sound locator data which are applied to correct for conditions or observed deviations, after the sound lag corrections have been applied.

Azimuth (A).—The horizontal angle, measured clockwise from the north (or zero) to the line joining the sound locator and the objective.

Backlash.—The lost motion or "play" in a mechanical system.

Binaural.—Having or relating to two ears; involving the use of two ears.

Binaural balance.—A condition attained in sound location wherein the sound seems to come from directly in front of, or directly in the rear of, the listener's head (the direction depending on the particular listener).

Binaural intensity effect.—One of the two effects contributing to the binaural sense. This effect indicates a source of sound to be on the side of greatest intensity. It is comparatively unimportant in aerial sound location.

Binaural phase effect.—The other effect contributing to the binaural sense. This effect depends on the fact that, unless the listener be facing the source, each sound wave will arrive at one ear a fraction of a second before it arrives at the other. The resulting sensations, transmitted to the brain, are analyzed with the result that the sound seems to emanate from the right or left, as the case may be; if the listener then turns his head a corresponding amount, the sound waves then arrive at both ears simultaneously and thus seem to come from the front.

Binaural sense.—Ability of the individual to determine directions binaurally.

Comparator.—An instrument for indicating and controlling the relation between the data determined by the sound locator and the data indicated by the pointing of the searchlight.

Datum point of known azimuth.—A fixed point, the azimuth of which has been accurately determined.

Elevation (ϵ).—The vertical angle between the line of position and the horizontal.

Horizontal range (R).—The length of the base of the vertical right triangle in space, the vertical side of which is the altitude and the hypotenuse of which is the line of position.

Leveling.—The process of adjusting an instrument so that all vertical or horizontal angles may be measured in true vertical or horizontal planes.

Line of position.—The line of position of a point is the straight line connecting the point of origin with that point. The point of origin is usually a gun, a searchlight, or a position finding instrument.

Mil.—The $1/6400$ part of a circle. For practical purposes, the arc which subtends a mil at the center of a circle is equal in length to $1/1000$ of the radius ($1° = 17.78$ mils).

Orientation.—The process of adjusting the azimuth indicating devices of searchlights or sound locators or both, so that they will read correct azimuths when pointed in any direction.

Parallax.—The angle subtended at a certain point by a line connecting two other points.

Present (present azimuth (A_o), present elevation (ϵ'_o), etc.).—A term denoting an element of data pertaining to the present position of the target. Symbols pertaining to the present position are denoted by the subscript "o."

Present position.—The position of the target when the searchlight beam is projected thereon.

Range.—*See* Slant range, Horizontal range.

Rate.—Angular rate.

Refraction.—The deflection from a straight path suffered by the direction of propagation of a sound wave in passing obliquely from one medium to another.

Slant range (D).—The hypotenuse of the vertical right triangle in space, the vertical side of which is the altitude and the base of which is the horizontal range.

Sound lag corrections (lateral (δ_x) and vertical (σ_x)).—Approximate corrections for the travel of the target during the sound lag time, based on the angular travel method.

Sound lag time (t_s).—The time required for the sound emitted by the airplane to reach the listener.

Sound location.—The process of locating an object by means of the sound emitted. Aerial sound location is often referred to as aerial sound ranging.

Sound locator.—An instrument for locating the position of an aerial target by the sound it emits. It accentuates and utilizes the ability of a person to determine the direction of a sound source by means of the binaural sense.

Sound ranging.—*See* Sound location.

Synchronization.—A process in which the values indicated by all receivers of an electrical data transmission system are made to agree exactly with the values set on the corresponding transmitters.

Temperature refraction.—Refraction occurring between strata of air at different temperatures.

Wind azimuth (A_w).—The azimuth of the direction *from* which the acoustic wind is blowing.

Wind drift.—Shift in the apparent position of the sound source due to uniform motion (constant in speed and direction) of air between the source and sound locator.

Wind refraction.—Refraction occurring between strata of air moving at different velocities.

Wind velocity (W).—The velocity of the acoustic wind.

Appendix II

LIST OF REFERENCES

1. Standard nomenclature list.

Matériel, sound locator ---------------------------------- SNL F-120

2. Technical manuals.

Data transmission system, M4 ---------------------------------- TM 9-1656

Cleaning and preserving materials, TM 9-850 (now published as TR 1395-A).

[A. G. 062.11 (2-12-41).]

By order of the Secretary of War:

G. C. MARSHALL,
Chief of Staff.

Official:

E. S. ADAMS,
Major General,
The Adjutant General.

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