NAGRA KUDELSKI

INSTRUCTION MANUAL
MANUEL D´UTILISATION

NAGRA IS

KUDELSKI SA. 1033 CHESEAUX SWITZERLAND

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We guarantee the products of our own manufacture against any defect arising from faulty manufacture, for a period of one year from the date of delivery. This guarantee covers the repair of verified defects or, if necessary, the replacement of faulty parts, exclusive of any other indemnity.

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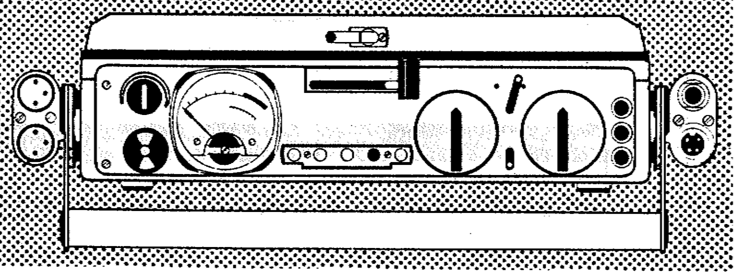
INSTRUCTION MANUAL



NAGRA IS

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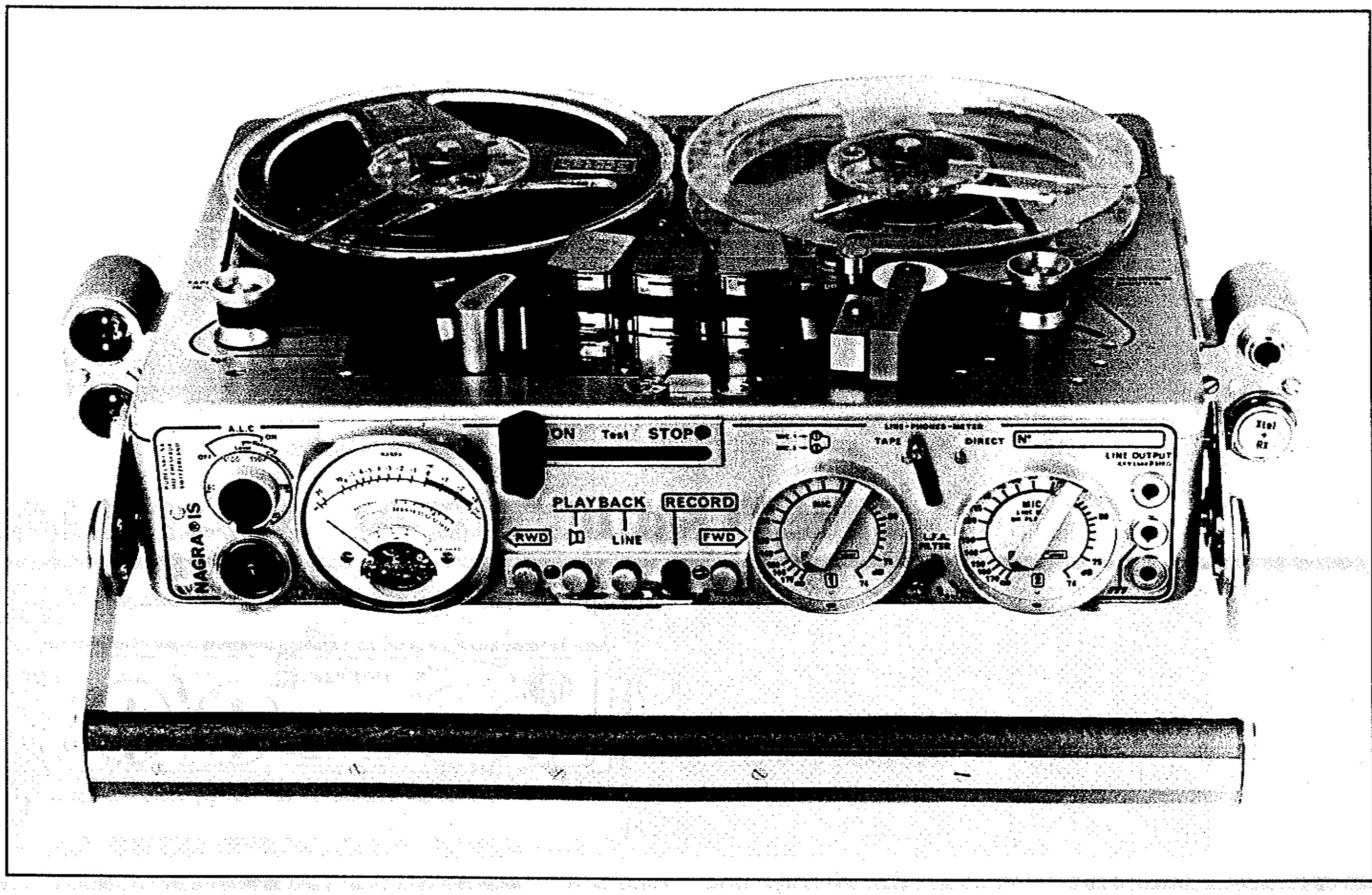
A.L.C
NAGRA IS
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PLAYBACK
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RWD
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TAPE
DIRECT
LINE OUTPUT
MIC

NAGRA IS

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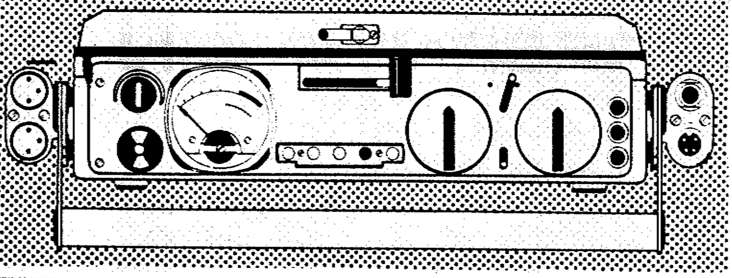


NAGRA IS

1 PRESENTATION

The NAGRA IS is a lightweight portable self-contained tape-recorder; its new design features three motors which ensure tape speed stability as well as fast forward and rewind.

There are four different NAGRA IS versions, NAB or CCIR:

TYPE	SPEED		MIKE PREAMPLI		FILTERS	METER CIRCUIT		REFE-RENCE GENE-RATOR	NEO-PILOT SYSTEM
	7.5 ips	3.75 ips	dynam.	condens. +12V or +48V		modulo	combined		
IS–D	●		●		●	●			
IS–DT	●	●	●	●	●		●	●	
IS–L	●		●	●	●		●	●	●
IS–LT	●	●	●	●	●		●	●	●

Each of these models can be fitted with an automatic level control (ALC) (2) as an option, which is described in full in Section 7.

Additionally, it is possible to obtain the following options upon request:

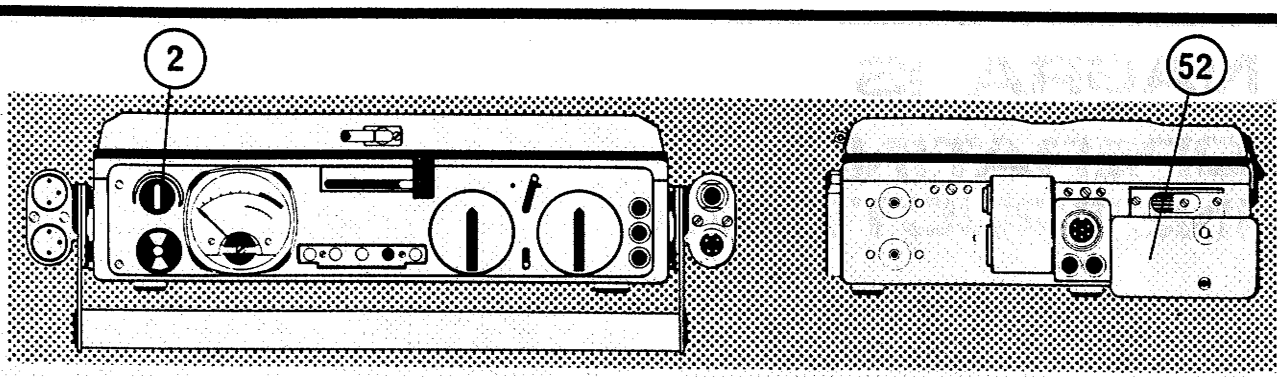
- universal microphone preamplifier with phantom power supply of +12 V, −12 V or +48 V T +12 V supply. These voltages are selected directly on the circuit.

- combined signal measurement circuit allowing choice between modulometer, Super-VU–meter or Peak-VU-meter. Selection is again made on the circuit.

- five different types of microphone sockets are possible, the choice being made upon placing order.

The power supply of the NAGRA IS is presented in a new form, the traditional battery compartment has been replaced by a removable compartment (52) . There are three types of interchangeable unit identical in size, which slip easily into place at the back of the recorder:

- one containing 8 D-type 1,5 V batteries (IBAT)
- one containing rechargeable nickel-cadmium cells (IACC)
- a mains supply unit which also acts as battery charger (ATI).



If the two microphone inputs are equipped with a universal microphone preamplifier with phantom power supply of +12V, −12V or +48 V, T +12 V, then the majority of professional microphones currently on the market can be used. A simple switch underneath the recorder enables selection corresponding to dynamic or condenser microphone. Accordingly, supply voltage is modified on the preamplifier inside the machine.

Separate record and playback heads enable monitoring during recording.

In addition to these obvious advantages for fieldwork, the NAGRA IS is also ideal for tape editing.

Switch (24) on the chassis between the two reels releases the reel-holder motors on position TEST allowing the tape to be wound freely by hand. Furthermore, heads are easily accessible.

Finally, all operations controlled by a simple keyboard are clearly printed on the chassis. Thus the numerous possibilities offered by the NAGRA IS are quick and easy to select.

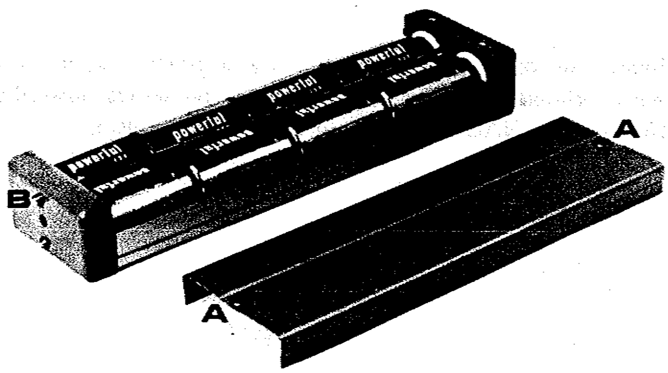
2.1

NAGRA IS preparation

2.1.1.
Power supply

The NAGRA IS is powered by a set of 8 D-type 1,5 V batteries contained in a removable compartment (52) which is fastened to the recorder itself by simple latches (51).

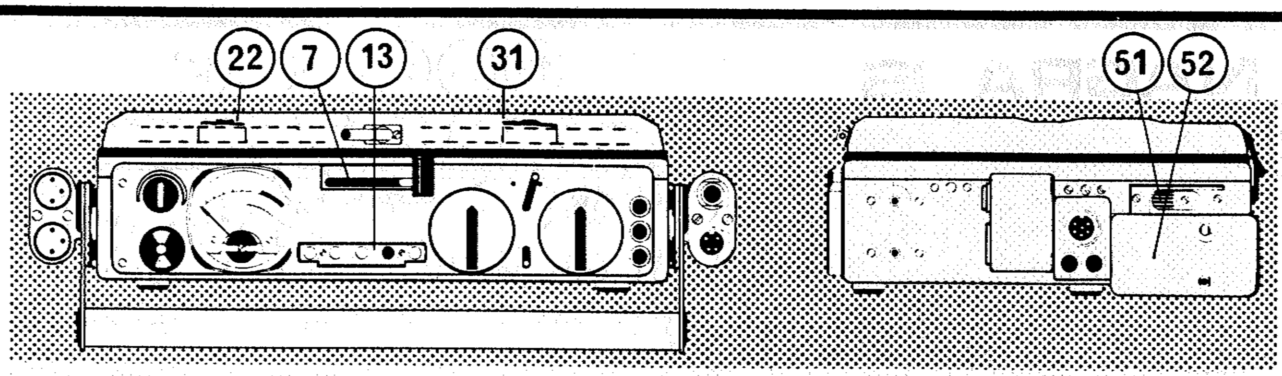
Remove the lid of the compartment by first giving the two screws A a quarter of a turn.



The 8 D-type 1,5 V batteries are placed in series in the compartment. A raised surround B on one of the spring-loaded contacts prevents the connection of a incorrectly inserted battery. In the improbable event that the current flow is, in fact, reversed, a diode in parallel to the battery compartment provides a second safeguard. A fuse C in the compartment itself protects the NAGRA IS from short-circuits or too high consumption.

The space available for batteries can be adjusted by means of a sliding contact on a threaded guide.

If necessary, when weight is a primary consideration, it is



possible to use 6 instead of 8 D-type batteries.

Replace the lid and fasten the compartment to the back of the NAGRA IS, the rounded corners on the outside and the terminals upwards. Slip the two pegs into the hooks on the NAGRA IS and lock in position.

The battery compartment can be interchanged with another containing rechargeable cells (IACC) or else by an external power supply unit (ATI). The latter can also be switched to function as charger for the IACC compartment.

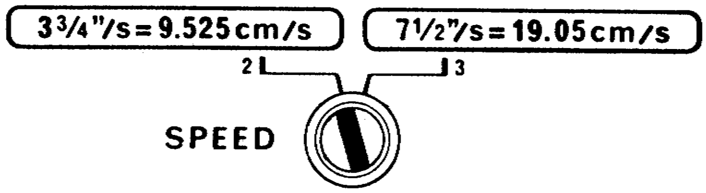
When the main selector (7) is on STOP and all the controls on the pre-selection keyboard (13) are released, the NAGRA IS is not powered.

IT IS THUS MOST IMPORTANT TO CHECK THAT THE ABOVE TWO CONDITIONS ARE RESPECTED IN ORDER TO AVOID BATTERY DISCHARGE WHEN THE RECORDER IS OUT OF USE.

However, if the recorder is likely to be unused for a lenthy period of time or during travel, it is preferable, as an absolute precaution, to temporarily remove the power supply compartment.

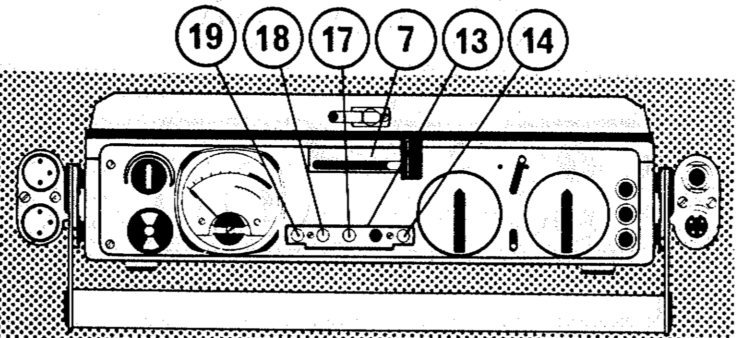
2.1.2. Choice of speed

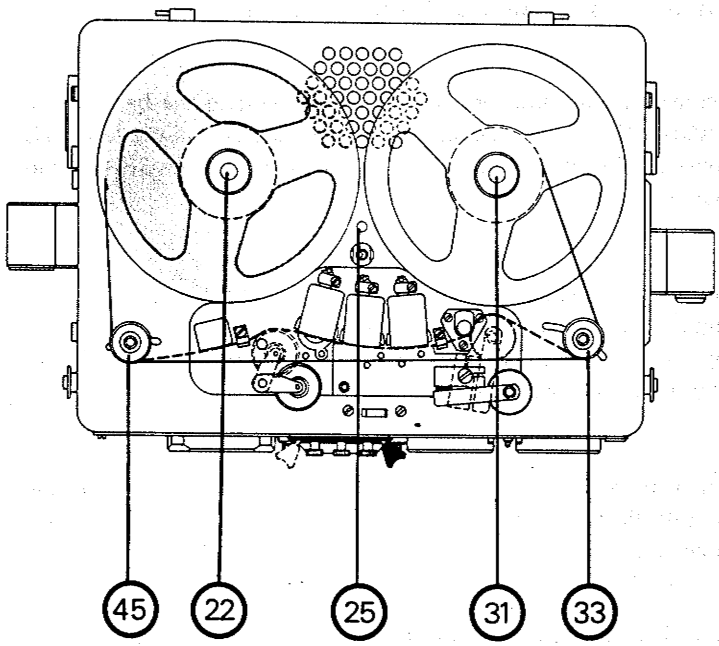
On the two-speed versions of the NAGRA IS (DT and LT), selector (25) is turned to the corresponding position (3.75 or 7.5 ips) by means of a coin or a screwdriver.



2.1.3. Tape loading

With the main selector (7) on STOP, place a full 5" reel on the lefthand reel holder (22) and an empty reel on the right (31). Secure the spools by means of spool retainers.





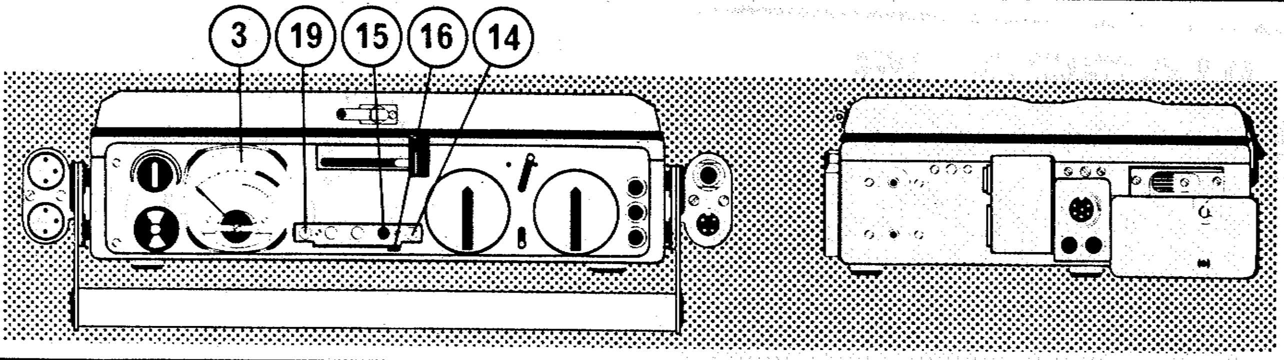
Thread the tape around the two tension rollers (45) and (33) and wind onto take-up reel. The tape will be brought into contact with the heads when the main selector (7) is in position TEST or ON.

2.2
Mechanical functions

2.2.1.
Fast forward and rewind

Press control (18) or (17) on the preselection keyboard (13) to power the NAGRA (batteries, cells or ATI). With main selector (7) on STOP, briefly press RWD control (19) to operate the fast rewind. A second quick touch on the same control stops the tape rewinding.

For fast forward the procedure is as above but using FWD con-



trol (14).

It is possible to pass directly from fast forward to fast rewind and vice versa without stopping tape motion simply by pressing alternately on RWD and FWD controls.

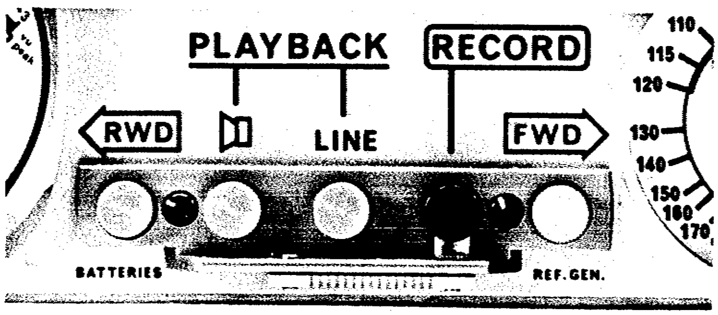
When the NAGRA is functioning on fast forward or on fast rewind and pressure on either control (19) or (14) lasts longer than one second, the tape will stop but will start up again as soon as pressure is released in the direction corresponding to the control pressed.

caution

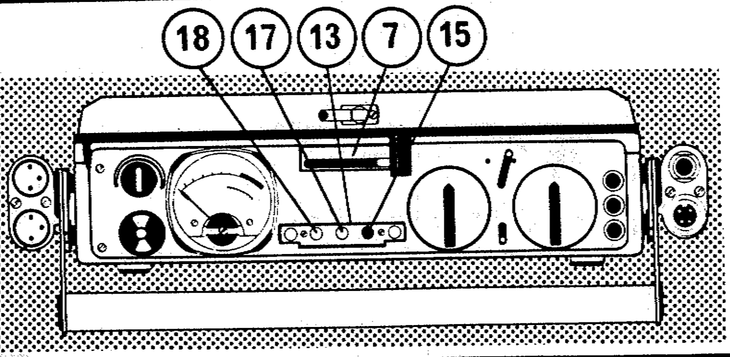
The NAGRA IS will also function on fast forward or rewind when the main selector (7) is in position TEST. However, the recorder's logic was not intended to operate in this way and it could arise that, near the beginning or end of a tape, it functions badly. **This does not mean there is a fault.** Furthermore, on TEST the tape is in contact with the heads which causes unnecessary head wear during fast tape transport.
When RECORD control (15) is depressed, the NAGRA IS will not function on fast forward or rewind.

2.2.2. Test

The safety lock of the RECORD control (15) has a dual role; it prevents accidental operation and consequent erasure of a recorded tape, but can also be used to maintain record mode during recording. Press RECORD control (15) and put main selector



(7) on position TEST; this enables adjustment of input levels and position of microphones best adapted to local accoustics, before the actual recording begins. Such adjustments are made and checked by using headphones or the built-in loudspeaker and reading level on the meter (3).



2.2.3.
Record

Adjustments are made as in TEST but with main selector (7) ON so that the tape is running.

2.2.4.
Playback

To reproduce a recorded tape, one of the two playback controls (17) or (18) is selected. On LINE (17), the signal is present at line output and on headphones. When control (18) is selected the signal is reproduced by the built-in loudspeaker and is also available at line and phones outputs. The tape runs as soon as the main selector (7) is ON. In passing from STOP to ON and vice versa, it is recommended to pause momentarily in the TEST position of the main selector (7).

2.2.5
Stop

To stop the NAGRA IS functioning in record or playback mode the main selector (7) is placed on TEST or STOP, thus the capstan motor is no longer turning and the pinchwheel released.

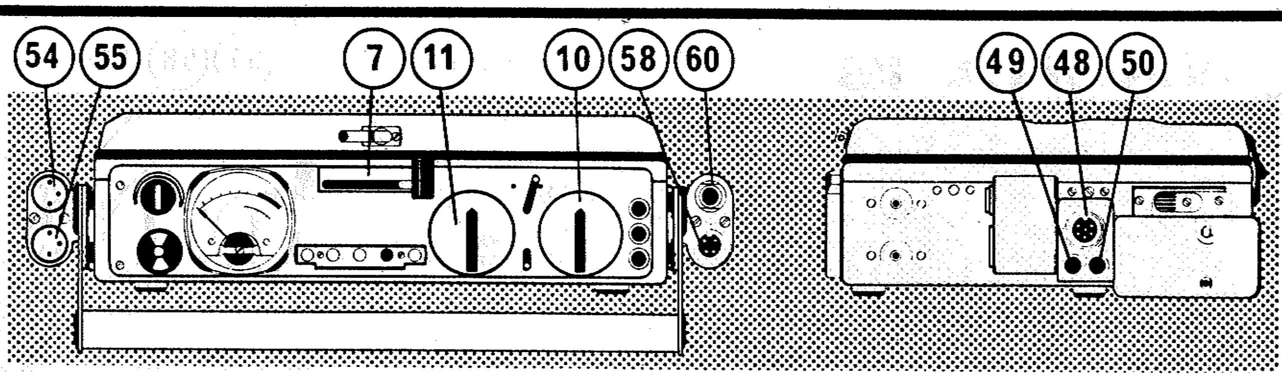
warning

Never stop the machine by releasing controls (15) (17) or (18) and leaving the main selector (7) ON. In this way, the +6 V power supply to the logical circuits is cut and the tape slackens. If the NAGRA IS is in record mode, a noticeable "click" will be recorded on the tape.

2.3 Inputs

2.3.1
General

The NAGRA IS has
- Two microphone inputs (54) and (55)
- One unbalanced voltage line input (49) and (50)
- One unbalanced current line input on 7-pin Accessory connector (48)
- ● on NAGRA IS-L and IS-LT, the pilot input is terminal 4 on pilot connector (58)

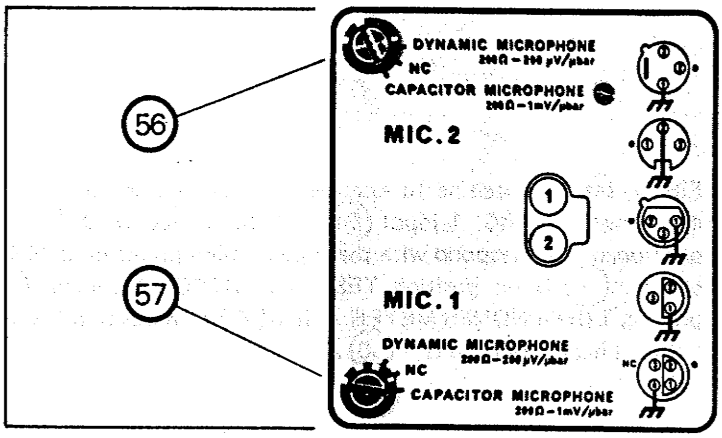


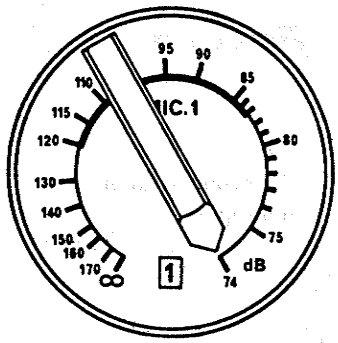
2.3.2 Microphone inputs

Microphone inputs (54) and (55) are located on the left side of the NAGRA IS. Input signal level is adjusted by MIC. 1 and MIC. 2 level controls (11) and (10) respectively.

If the recorder has a built-in ALC, this automatically controls level only on MIC. 1 input. MIC. 2 input remains manually adjustable.

Each microphone input can take condenser or dynamic microphones provided switches (56) and (57) on the base of the recorder are positioned correspondingly.





2.3.3. Line input

If a signal is applied to voltage line input (49) and (50) and LINE control (17) is pressed, level is adjusted by MIC. 2 level control (10). It is also possible to apply a current line input at terminal 6 of the Accessory connector (48).

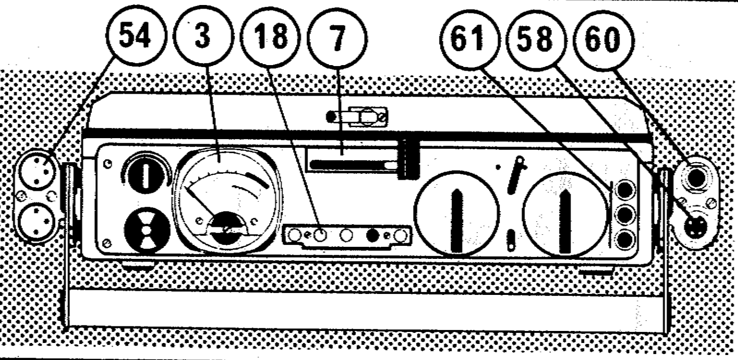
0 dB = 2.18 μA. Level adjustment is as above (2.2.2.).

With a line input, MIC. 2 input is disconnected.

Whatever input combination is used, signals are mixed to give the direct signal.

2.3.4. Pilot input

On the NAGRA IS-L and IS-LT, pilot input is terminal 4 of the pilot connector (58). A pilot signal is injected either from a camera or, by means of the Xtal shorting plug, from the crystal generator (terminal 3 of the same connector).



2.4 Outputs

The NAGRA IS has:

- One floating line output (61) with transformer. 0 dB = 4.4 V no load, max. level = 8.8 V (+6 dB), 600 Ω (1.55 V as an option)
- One headphone output (60) for mono jack, impedance 25 - 600Ω

And additionally on the IS-L and IS-LT versions:

- One pilot playback output (48)
- One crystal output at terminal 3 of pilot connector (58)

2.5 Record

2.5.1. Recording with one microphone

Firstly, set the machine to operate in record mode. Connect a microphone to MIC. 1 input (54) and check that switch (57) is positioned to correspond with the type of microphone used. Main selector (7) is on position TEST, and RECORD control (15) pressed. LINE-PHONES-METER switch (8) is on position TAPE. Connect headphones to jack (60).

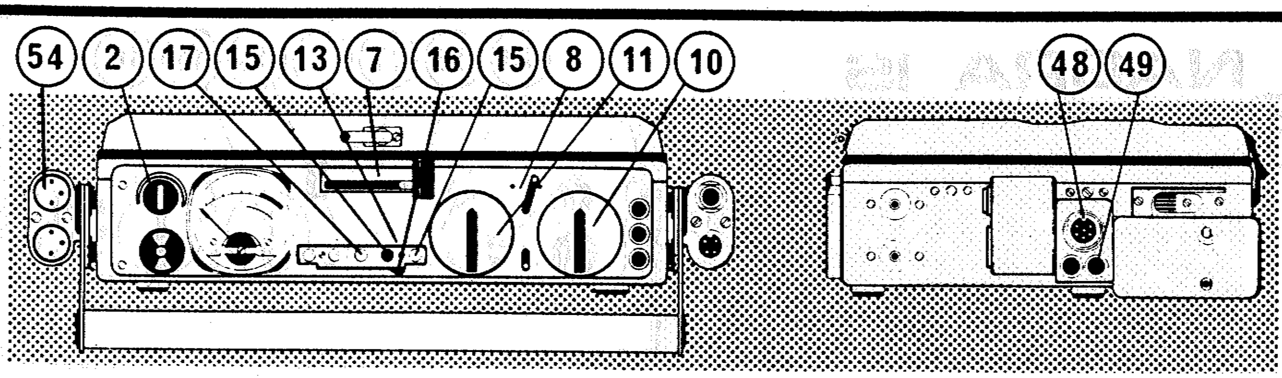
Level is adjusted by MIC. 1 level control (11) whereas MIC. 2 level control (10) is fully anti-clockwise. The NAGRA IS is now ready for recording.

Input level can be adjusted prior to actual recording by placing main selector (7) on TEST, so that the tape is not running, but headphones, line output and galvanometer are connected to the direct signal

Then to record, simply place main selector (7) on position ON. Headphones (60), line output (61) and galvanometer (3) are connected on tape which means that the signal recorded on the tape is observed.

2.5.2. Automatic recording

Only MIC. 1 input (54) can be connected to an automatic level control (ALC) (2). Section 7 gives a detailed description of ALC utilisation.



2.5.3. Double-input recording

Possible variations are as follows:

MIC. 1 manual	+	MIC. 2 manual
MIC. 1 automatic	+	MIC. 2 manual
MIC. 1 automatic	+	LINE voltage or current, manual
MIC. 1 manual	+	LINE voltage or current, manual

The method using a microphone input with a voltage line input is described below.

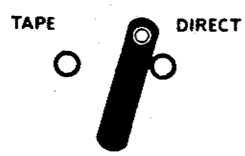
Prepare the NAGRA IS as given under **2.4.1.** Connect a microphone to MIC. 1 input (54), adjustment being made with MIC. 1 level control (11). Level of line current input (49) and (50) is adjusted by MIC. 2 level control (10). Controls (17) and (15) on the preselection keyboard are pressed.

2.6 Playback

2.6.1. With headphones and line output

As a safety measure to avoid accidental erasure of a tape being reproduced, slide the record safety device (16) into place to lock the RECORD control in the off position.

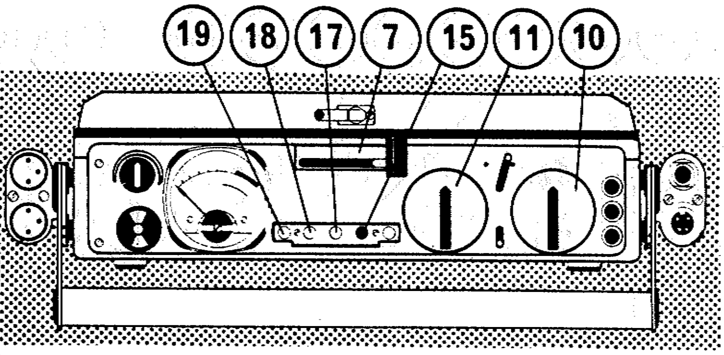
Once preparation of the recorder (**2.1.**) is complete, press control (17), LINE–PHONES–METER switch (8) on DIRECT, headphones plugged into jack (60) The playback signal is also available at line output (61). For the NAGRA IS to function in playback mode simply place main selector (7) to ON. MIC. 2 level control (10) allows simultaneous adjustment of both line and headphone output levels. MIC 1 level control (11) is fully anti-clockwise.



2.6.2. With headphones. Line output and built-in loudspeaker

Configuration is as above (**2.5.1.**) with the exception that control (18) is pressed instead of (17)

Since the loudspeaker is built into the chassis, the lid should be open during playback. MIC. 2 level control (10) enables simultaneous adjustment of headphones, line and loudspeaker output levels. MIC. 1 level control (11) is fully anti-clockwise.



2.7
Special uses

2.7.1.
Tape editing

For tape editing the NAGRA IS should be set up as follows:

- Lock RECORD control (15)
- Switch (24) to BRAKES RELEASED
- Main selector (7) on TEST; standstill brakes are released only in this position
- Press control (18)

It is now possible to identify the exact location of a sound on the tape by manoeuvring supply and take-up reels by hand.

For fast forward or rewind functions it is recommended to place main selector (7) on STOP so that the tape is not in contact with the heads, and to take up slack before pressing controls (14) or (19).

2.7.2.
Reporting amplifier

The NAGRA IS can be used as an amplifier for reporting. For this the recorder is set up as follows:

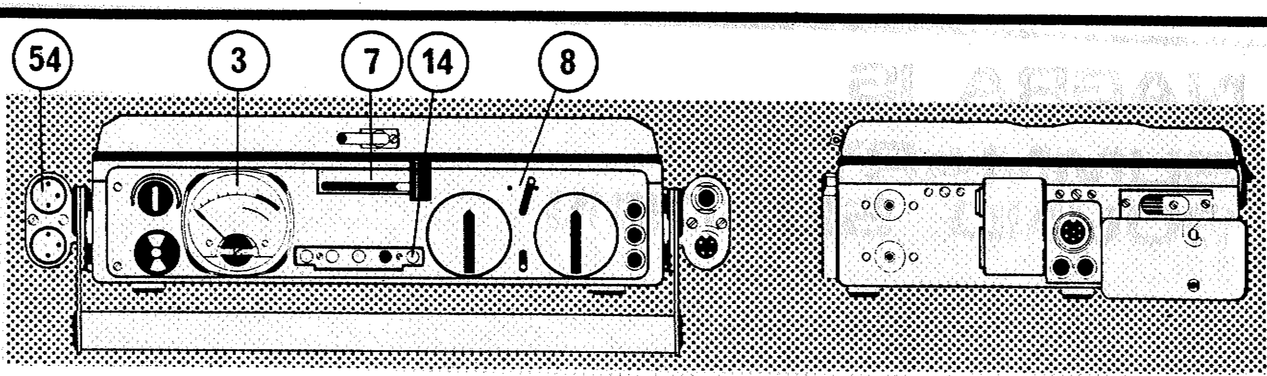
- A microphone is connected to MIC. 1 input (54) and input sensitivity adjusted with MIC. 1 level control (11), the reading being indicated on meter (3).
- LINE–PHONES–METER switch (8) on DIRECT and main selector (7) on TEST.

In this mode, the NAGRA IS is usually used to relay a commentary by telephone.

2.7.3.
Playback and microphone mixing on telephone line

The NAGRA IS can be connected directly to a telephone line since line output is floating; impedance transformer give 4.4 V, 600 Ω (1.55 V). The recorder is set up as above (2.6.2.).

When the main selector (7) is ON, a recorded signal is added to the microphone signal and is adjusted by MIC. 2 level control (10). It is thus possible to commentate a recording or to add noise effects to a spoken text.



54
3
7
14
8

3 SUMMARY OF SOUND SECTION

3.1 Direct and tape chains

3.1.1. General

The direct signal is the signal to be recorded. It is composed of the modulated signals from microphone and line inputs which have been amplified, filtered, controlled and mixed.

The tape signal is that which has been recorded on the tape and is reproduced by the NAGRA IS playback chain. As record and playback heads are separate, it is possible to monitor the quality of the recording whilst underway.

In record mode, the meter (3) enables the following controls:
- with main selector (7) on TEST, it measures the direct signal only, whatever the position of the TAPE–DIRECT selector (8)
- with main selector (7) ON, the TAPE–DIRECT selector allows two different readings:
  a) the direct signal level before it is recorded
  b) the tape signal level of the tape-recording.

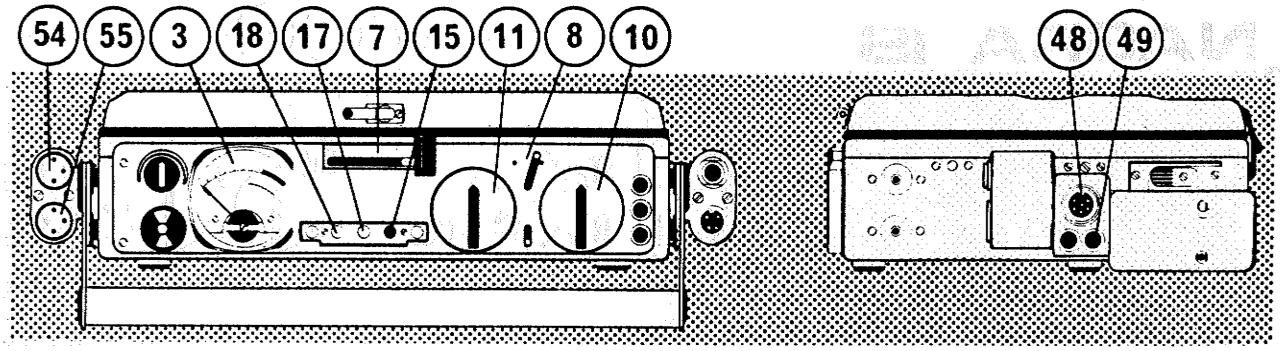
In playback mode, the reproduced signal is available at nominal level at line output when the TAPE–DIRECT selector (8) is on TAPE. When on DIRECT, level is adjusted with MIC. 2 control (10). In this way it is possible to superimpose a direct commentary on the reproduced signal by connecting a microphone to MIC. 1 input (54), adjusted by MIC. 1 level control (11).

Line output amplifier, which also supplies headphones output, can be switched to either TAPE or DIRECT by means of selector (8) on the front panel.

The built-in loudspeaker amplifier is fed by both tape and direct signals, but volume is not adjustable for the former. However, a 6 dB reduction is possible by pressing both PLAYBACK controls (18) and (17). On direct, the volume is adjustable by MIC. 2 level control (10).

3.1.2. "Audio" inputs

The NAGRA IS-L has four "Audio" inputs
- Two microphone inputs (54) and (55)
- One unbalanced voltage line input (49)
- One unbalanced current line input (48)



3.1.3.
Microphone inputs

The two microphone inputs (54) and (55) on the left of the NAGRA IS are connected to preamplifiers switchable to corresponding condenser or dynamic positions on the base of the recorder (56) and (57). Signals from these inputs are adjusted by level controls MIC. 1 (11) and MIC. 2 (10) on the front panel, the scale being given in dB. The meter reading is approximately equivalent to the sound level in phons (for 1 kHz) required to obtain a nominal recording level (0 dB on modulometer) using a microphone of average sensitivity.

3.1.4.
Line inputs

The NAGRA IS has an unbalanced line input controlled by the level control on the front panel marked "MIC. 2 LINE INPUT or PLAYBACK". There are two different input methods:

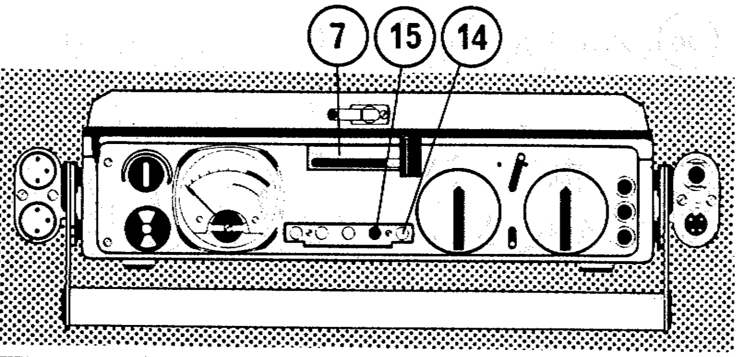
a) by means of voltage line input banana socket's (49) on the right side of the recorder: impedance 100 kΩ. Minimum voltage for 0 dB nominal level modulation with level control (10) fully clockwise: 218 mV. Max. voltage: 100 V. This is the maximum voltage that the input resistance and the printed circuit insulation can take, but in normal use should not go beyond 10 V in order to prevent the risk of crosstalk.

   The 100 V maximum is intended to periodically accept connection to a 100 V nominal sound distribution system.

b) by means of the 7-pole Accessory connector (48) on the right side of the recorder. In this case, a current drive is applied. For 0 dB modulation, level control (10) fully clockwise, 2.18 μA RMS is required. If possible, source impedance should be above 20 kΩ for if it is lower the signal-to-noise ratio is reduced.

   NB: If the source supplies a voltage output, this should be converted to current by inserting a resistance. If voltage is 218 mV, the resistance should be 100 kΩ. A 20 kΩ resistance would require a 43.6 mV voltage. At the extreme, for a 10 kΩ resistance, 2.18 mV could be sufficient; but below this the correction should be made by means of a transistor adaptor or even a transformer + resistance.

Current supply allows an easier mixing of signals but the main advantage is that it reduces interference induced magnetically in the lines, such as earthing defects: these voltages are in series with a very high impedance (pure current source) and produce only negligible interference.



3.1.5.
Reference generator

The reference generator enables level calibration as well as the recording of a reference signal at the beginning of a tape. It consists of an oscillator which, in direct mode, injects a composite signal of 1.1 kHz and 10 kHz at –8 dB. (= 0 Vu)

To calibrate, the RECORD control (15) is depressed, main selector (7) on TEST; the REF. GEN. control (14) is pulled to operate the oscillator and the meter will indicate –8 dB. If, however, the NAGRA IS is fitted with a combined circuit switched to either Super-VU-meter or Peak-VU-meter, the reading will be 0 VU.

To record the reference signal, the NAGRA IS is put into record mode, tape running, and the REF. GEN. control (14) is pressed; the signal is recorded as long as pressure is maintained.

It is useful to record a short sequence of this signal at the beginning of a tape to facilitate the subsequent adjustment of other machines for reproducing the recording. But the phenomenon of print-through should not be forgotten. It is a fact that in the course of time a recording is somewhat copied on the adjacent tape layers and has the effect of a sort of echo during the silences before and after a loud sound. Since the reference signal is a pure tone, it will also tend to copy and be even more audible than an ordinary sound. It is thus recommended that after recording the reference signal, the tape is left to wind without an input signal during one or two turns of the supply reel to avoid the print-through effect.

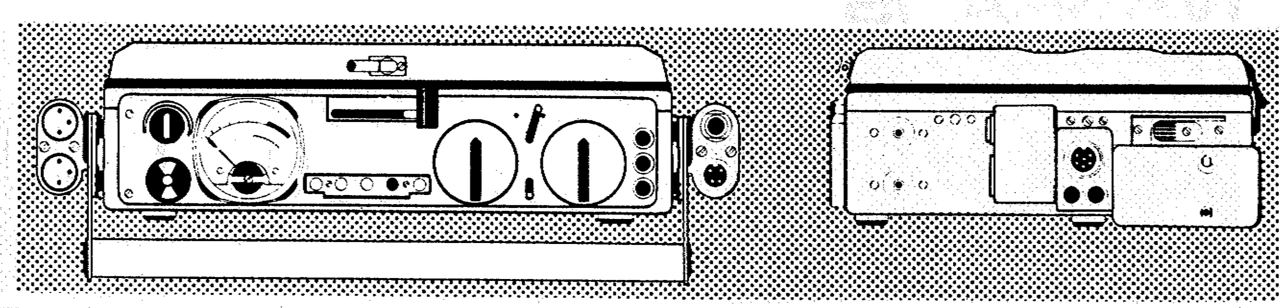
3.1.6.
Clapper

The recording of a short sequence of the reference generator signal can also be used as a clapper.

3.2. Adjustment of input sensitivity (modulation)

3.2.1.
Dynamic range

The dynamic range is the ratio between the strongest and the softest sound. For a symphony orchestra this range is very large, whereas for pop music it is generally much smaller.



Signal-to-noise ratio is related to the dynamic range. A soft sound should be considerably stronger than the noise level. Thus a high dynamic range requires a high signal-to-noise ratio. This ratio can be virtually equal to the dynamic range when the noise level is close to audibility threshold: the soft sound will be heard but not the noise.

3.2.2. Signal-to-noise ratio

The subjective perception of sound levels follows a logarithmic law; this is why a logarithmic unit has been adopted to measure sound levels - the decibel (dB).

3.2.3. Decibels

Each time the sound level is multiplied by 10, the representative number of decibels is increased by 10; thus, a 100-fold increase equals 20 dB, 1000-fold equals 30 dB, etc. It should also be observed that the level is proportional to the square of the amplitude. The voltage supplied by a microphone is proportional to the amplitude, or in other words, if the voltage is increased 10-fold, sound level increases a 100-fold corresponding to 20 dB.

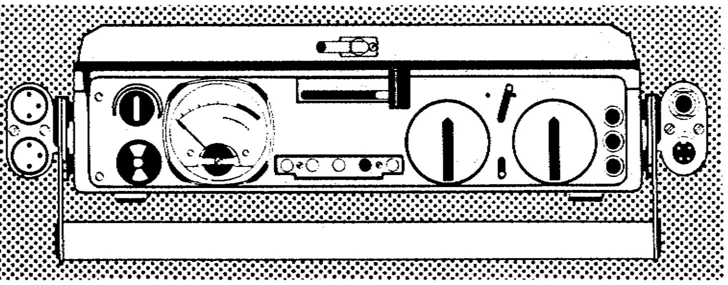
The decibel, then, measures a power ratio and not an absolute value. Taking as reference a sound corresponding to a pressure variation of 2×10^{-4} μbar (a value considered as audibility threshold at 1 kHz), we obtain a scale of absolute values. A 90 dB sound means 90 dB above 2×10^{-4} μbar. The frequency response of the human ear varies with the frequency, so this is compensated by filtering sound level measurements accordingly. In this way, decibels become phons related to 2×10^{-4} μbar.

NAGRA IS level controls are graduated in decibels related to 2×10^{-4} μbar. At 1 kHz, these decibels are the same as phons, but since the NAGRA IS is not equipped with psophometric filters, it cannot be said to incorporate a phon-meter.

If the level control is positioned to x dB, a x dB sound picked up by a normal microphone (0,2 mV/μbar on 200 Ω) and passed through a preamplifier of normal sensitivity, is reproduced at nominal level; the modulometer indicates 0 dB.

3.2.4. Dynamic compression

The ideal installation for recording and playback should reproduce exactly the sound levels recorded. The listener would hear just what the microphone heard. However, the human ear has a



dynamic range of 120 dB, whereas the NAGRA IS - with an exceptionally good signal-to-noise ratio - barely reaches 70 dB. Note that an average amateur recorder would reach, according to DIN standard, approximately 45 dB. So the kind of set-up we want is not feasible unless the recording is compressed and subsequently expanded on playback.

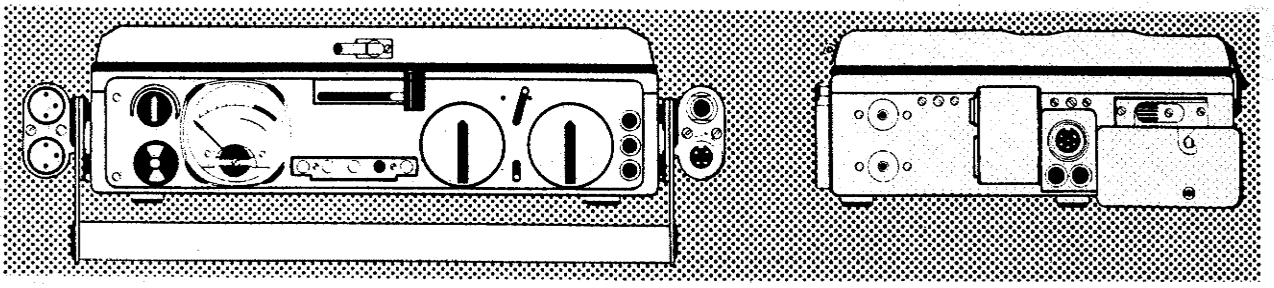
However, 120 dB dynamic range reproduction causes practical problems; the ambient noise of an apartment or cinema house is much higher than 0 phon. 120 phons become painful to listen and most annoying to neighbors! Thus, except in very special cases, audio dynamic range has to be reduced. The sound engineer is the person responsible for the choice of dynamic range and consequently the degree of compression required.

A classical record to be reproduced on HI–FI equipment can have a very high dynamic range. A chamber orchestra can be recorded with hardly any compression at all, whereas a symphony orchestra has to be slightly compressed: for this, the sound engineer must have an excellent knowledge of music and work with the score in front of him.

A program destined to be picked up on a car radio or a transistor in a noisy environment requires a restricted dynamic range. In practice, everything will be at maximum level. For television the dynamic range can be quite high, at least in countries where much of the population lives in detached houses; naturally, apartment blocks restrict maximum power. In all cases, evening programs must have a lower dynamic range since the volume is usually turned down and softest sounds should still be perceptible. Of course, in the evening ambient noise level is also lower.

For the cinema, dynamic range is selected according to the type of spectators who will come to see the film. In some countries, cinema houses are rather noisy due to comings and goings, chattering, eating, etc. A comedy causes laughter (at least it is hoped so . . .); dialogue following a joke should be recorded at high level or else it will be drowned by spectators' reactions. On the other hand, a suspense scene can use very soft sounds.

As a general rule for dialogue, effects are obtained not by the absolute sound level but by contrast; a burst of voices will be more effective if preceded by a moderate level sequence. This trick is well-known to cinema "mixers".



3.2.5.
At which point is the signal compressed ?

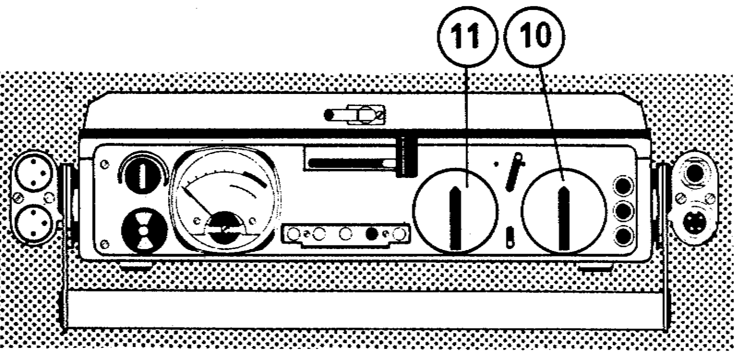
a) Recordings to be put on record.
The present-day signal-to-noise ratio of records is excellent so care must be taken that the tape does not add to background noise. If compression is required, it should be done during original recording otherwise as soft sounds increase tape noise will also increase. It would be difficult to use the complete dynamic range of the recorder without, from time to time, exceeding the maximum level. To avoid this it is prudent to work with two or three recorders in parallel but with input sensitivities varying by a few decibels. It will be the highest level recording that does not exceed the maximum level which will be selected; otherwise, during editing, the best sequences can be taken from each recording.

b) Recordings to be directly broadcast.
Compression must obviously be carried out at the time of recording. For reporting, etc. , the ALC is normally used; it tends to obtain maximum level, that is, it compresses to a great extent.

c) Recordings for broadcasting which are reworked in the studio.
Two methods are possible. As the NAGRA IS signal-to-noise ratio is greater than that of broadcasting, the entire NAGRA IS dynamic range is not required. Sensitivity could, for instance, be adjusted so that estimated loud sounds reach 0 dB, and as the NAGRA IS maximum level is +3 dB, there is a wide safety margin. Otherwise, compression can be carried out when necessary whilst working on the final recording in the studio.

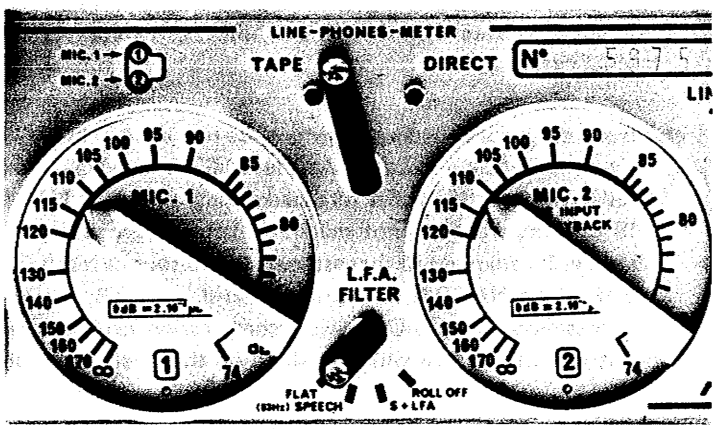
d) Cinema and television
Here, sound is always edited during final mixing. The important thing is to preserve the maximum of sound information. The wide dynamic range of the NAGRA IS means that loud sounds can be recorded below the maximum level, hence avoiding accidental distortion due to a loud burst of sound. It is also often helpful to use the ALC system, but this choice remains with the operator according to local conditions or other criteria. However, there is the problem of microphone and amplifier noise. Very often, this hampers recording more than tape noise so increasing the recorder's sensitivity does not help. Furthermore the risk of saturation would be greater.

The point "beyond which it is useless to go" is around 80 dB on the level control scale. This is easy to check: replace the microphone with a resistance equal to the nominal impedance of the



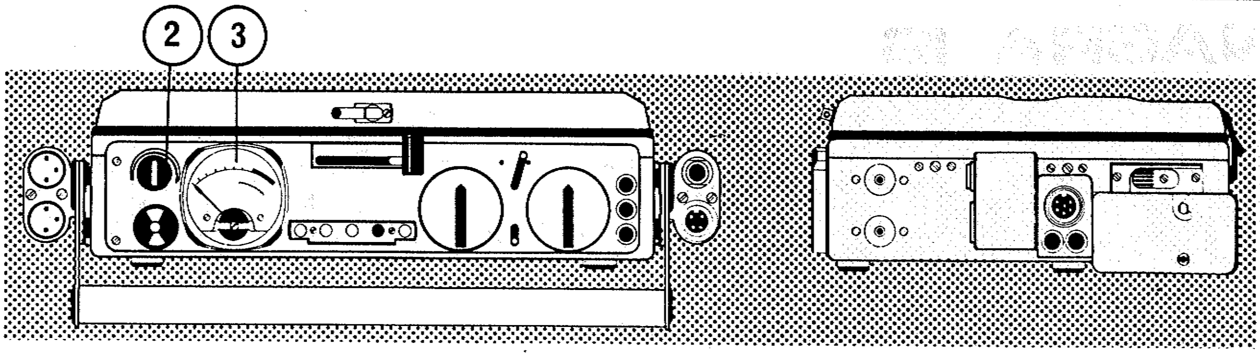
microphone to prevent ambient noise hindering measurements. Monitor the recording (TAPE) and use good headphones. Increase microphone sensitivity. Even with level control fully anti-clockwise, background noise will be audible. Turn level control clockwise; up to 90 dB background noise level hardly alters, but from 80 dB the noise of the resistance becomes predominant.

This point will, of course, vary according to the quality of the tape: with poor tape it will be around 78 dB, and with an excellent one, around 82 dB. This is also supposing that playback will be on a NAGRA IS or a recorder with similar performance. If an ordinary recorder that does not have such a quiet playback chain is used, it would be recommendable to increase input sensitivity above 80 dB.



On both the NAGRA IS level controls (10) and (11), the zone from 83 dB to 120 dB is marked in heavier print. This is intended as a reminder to the user of the useful operating zone. The lefthand limit (120 dB) is that beyond which the tape risks being saturated. The righthand limit (83 dB) is that beyond which tape noise becomes bothersome.

On the other hand, the problem is different if the recorded tape cannot be re-worked before broadcasting. In this case, the recording will have to be compressed when necessary even if microphone noise is greater than tape noise.



Microphone level controls are positioned so that the loudest sounds to be recorded do not exceed maximum level. Naturally, level controls for inputs not being used must be turned off. The active level controls can also be used as compressors, sensitivity being increased during soft sequences and vice versa.

3.2.6. Manual sensitivity adjustment

NAGRA IS can be equipped with an ALC system. It becomes functional when the knob (2) is ON and replaces manual control.

3.2.7. Automatic level control (ALC)

However, only MIC. 1 input can be automatically controlled, the other remaining manual.

ALC operation is complex. Section 7 gives a simple theoretical explanation of the design and operation of this control as well as instructions for use.

3.3 Signal level measurement

The NAGRA IS has a signal level measuring device, meter (3).

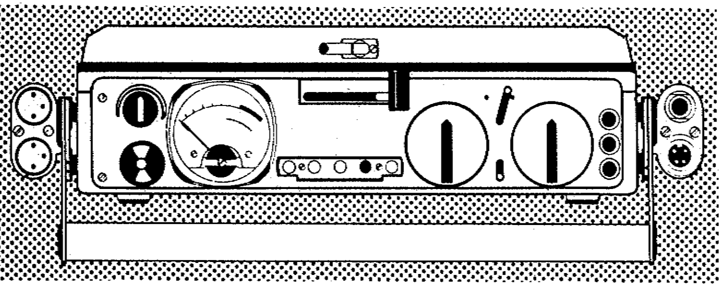
3.3.1. Modulometer, Super-VU-meter, Peak-VU-meter

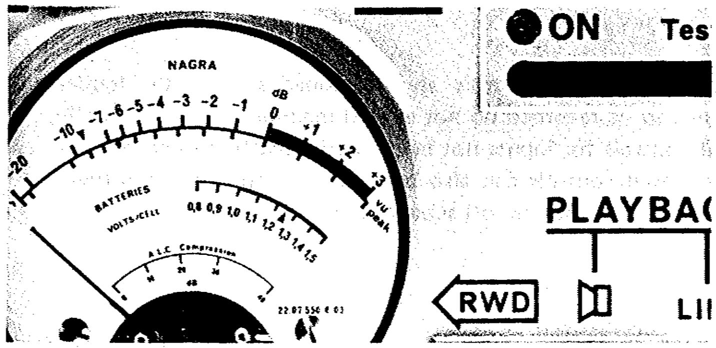
Two devices are available for measuring sound level: the modulometer and the VU-meter. Both are in fact voltmeters with a needle indicating the level, but their construction, and thereby their use, are different.

3.3.2. Modulometer

The modulometer measures the peak value of a signal. No matter what the form or level of the latter, the modulometer takes the greatest positive and negative value. It has a memory, for signal peaks can be of extremely short duration and there should be time for the needle to deflect and for the operator to observe this.

The main advantage of the modulometer is that it gives information of direct relevance for the tape; it is after all a signal peak which saturates the tape. An average signal value is important for the listener but not for the tape. In particular, when recording noise, modulometer indications are always exact however long the sound signal lasts.





3.3.3.
Super-VU-meter

A VU-meter is a simple rectifier voltmeter but with a standardised response time. If the signal to be measured is continuous (such as a whistle), the VU-meter indicates the value like the modulometer. But if the signal is intermittent (speech, for example), the VU-meter will indicate the average value, that is to say much lower than the instantaneous maximum values.

For speech recording, it has been observed that this average value is approximately 8 dB below the peak value. If VU-meter sensitivity is increased by 8 dB, a 0 VU indication is given when signal peaks reach their real maximum. This may seem a rather off-hand estimation, but proves to work well in practice. For noises, of course, VU-meter indications are quite inexact.

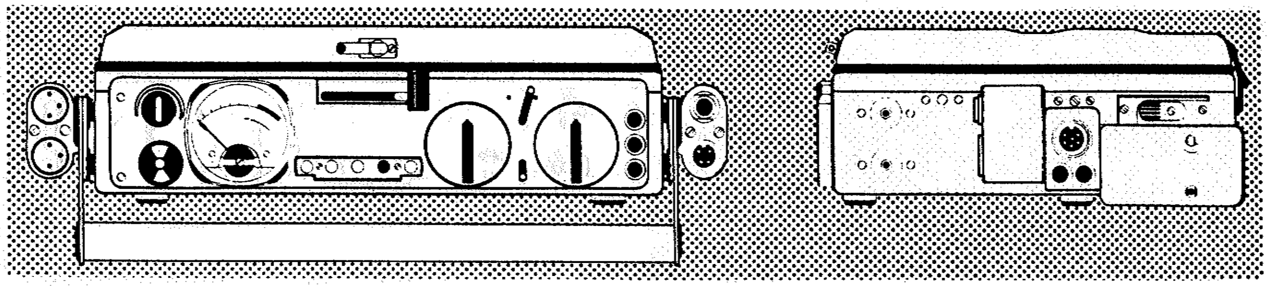
However, the VU-meter does have certain advantages:

a) Speech-music balance.
If speech and music are recorded together with a modulometer so that signal peaks do not exceed maximum level, the music will subjectively seem much louder. This is due to the more continuous characteristic of musical signals. Thus, for a mixed programme, speech should be recorded more strongly than music, either by over-modulating speech when the music is correct, or by under-modulating music for correct speech level.

It should be observed that a slight over-modulation of speech is not disastrous. The subjective deterioration of sound quality remains unnoticeable.

A VU-meter under-indicates speech level, so if a program is modulated at 0 VU, speech is over-modulated and music under-modulated. From this point of view, the VU-meter is more appropriate for mixed programmes where quality is not a primary consideration.

b) The VU-meter has a scale which is not logarithmic
For the needle to move, it is necessary that the level exceeds



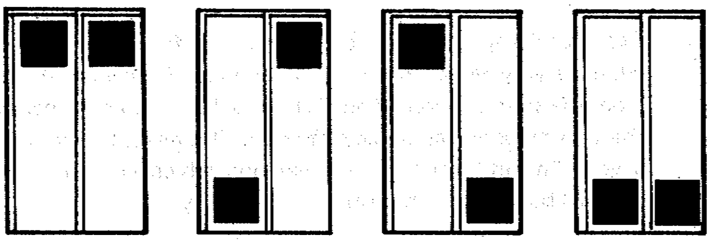
−20 dB. This causes the operator to compress more than is required, i.e. to increase the level of pianissimi.

The Super-VU-meter of the NAGRA IS is so-called to differentiate it from the standard VU-meter. In fact, it is exactly the same except that a time constant has been added to facilitate meter-reading and thus prevent ocular fatigue.

3.3.4.
Peak-VU-meter

This is a combination of a modulometer and a VU-meter. It associates the VU-meter advantages with regard to speech-music balance with those of the modulometer for signal peaks which could saturate the tape.

On the NAGRA IS versions with combined circuits, selection of metering method is made inside the recorder.

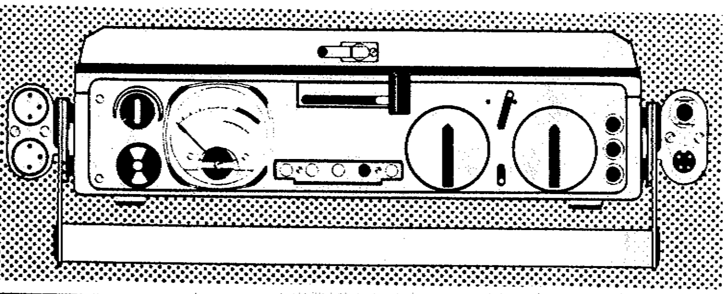


NC MODULO SUPER-VU PEAK-VU

3.3.5.
Remarks on calibration

The term "nominal recording level" is that which is usually considered as the maximum level (320 nWb/m). The word "nominal" has been used and not "maximum" as, in the case of the NAGRA IS, this level can be exceeded by 3 dB.

An 0 dB indication on the modulometer corresponds to nominal level. It is not measurable with a VU-meter since sensitivity has



been increased by 8 dB to compensate for the slowness of response and the needle would therefore exceed full scale deflection. Thus a signal of –8 dB, that is 8 dB below nominal level, produces on the VU-meter an indication of 0 VU, whereas on the modulometer it would give –8 dB. The calibration generator of the NAGRA IS gives a signal of –8 dB. This corresponds to 0 VU on the VU-meter.

3.4 Low frequency Roll-off attenuators

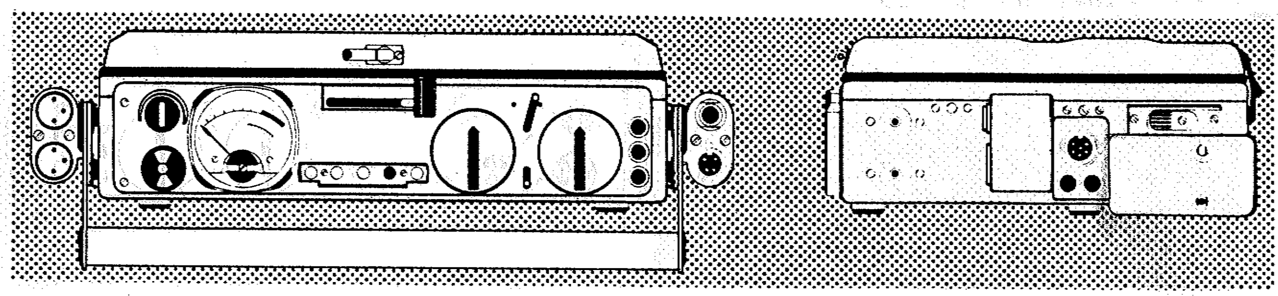
3.4.1. Why filter ?

Sound engineers have long known that in certain cases attenuation of low frequencies can improve the subjective quality of a recording, because:

a) Certain microphones (e.g. cardioid) have a frequency response which is very linear, but only if they are sufficiently distant from the sound source. Placed close to the latter (3–4 inches), the bass frequencies are accentuated. This gives, for example, a very "warm" voice, a phenomenon which certain singers exploit, but which diminishes intelligibility.

b) A sound studio is constructed and treated in such a manner as to reflect, in the same proportions, low and high frequency sounds. When the sound recording is made in any other room, carpets, curtains and other absorbant surfaces attenuate essentially the high frequencies, whereas the low frequencies are integrally reflected.

In the two cases a) and b), attenuation of low frequencies only re-establishes linearity. In case a) this is clear, but in b) is not the reality which we would have heard if the ear was put in place of the microphone ? The ear however is able to select sounds according to their direction and to subjectively attenuate reflected sounds. When recording in mono (and even in stereo such as it is practised today – that is in one plane), the microphone picks up all sounds without discrimination. Of course, the direct-



ional properties of the microphone can be used, but reflected bass frequencies can be behind the sound source and reach the microphone from exactly the same direction as the useful sound.

In addition to re-establishing linearity, it has been found that in certain cases, attenuation of low frequencies can improve the subjective result, although falsifying the reality. In particular, it can increase intelligibility. On the other hand, it is sometimes necessary to attenuate stage noises. In this case, choose the lesser evil.

3.4.2.
When should filtering be done ?

Two solutions are possible: filtering at the time of recording or at the time of editing. Method comparison:

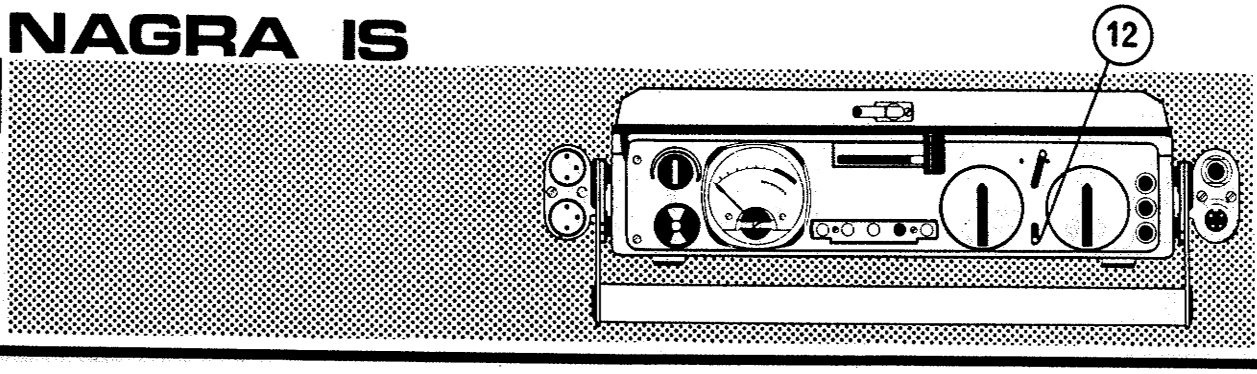
a) In filtering during editing (dubbing) it is easy to start again if an error has been made. On the other hand, if filtering is exaggerated during the recording, damage is practically irreparable.

b) In recording linearly, the tape is loaded with signals which produce a certain modulation noise. These signals will be eliminated at a later stage but the noise will remain.

c) Before dubbing, it is necessary to listen to the sound during the "rushes". An unfiltered sound is unpleasant and the producer may judge the result in a bad light.

CONCLUSION
It is recommended to filter during recording, but possibly slightly less than would seem necessary. There is little chance then of over-filtering, and the process can be completed during editing.

In any case, the use of very good headphones is strongly recommended. Headphones which cut very low frequencies should be mistrusted: they play the role of filter and mislead the operator.

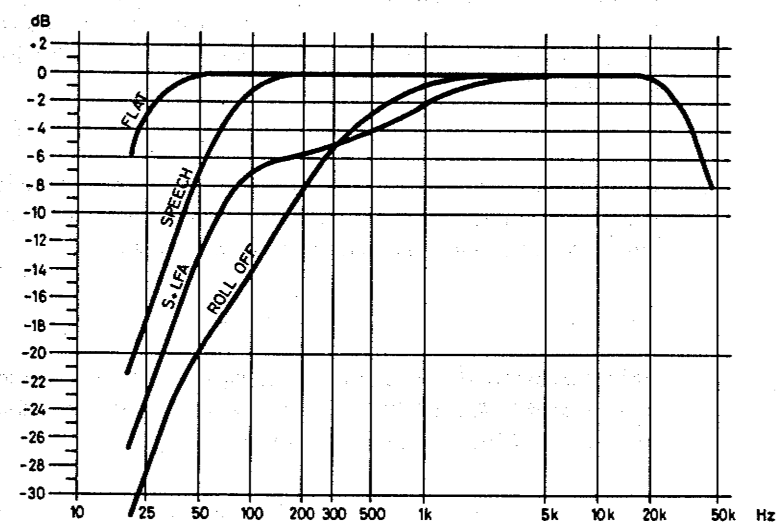


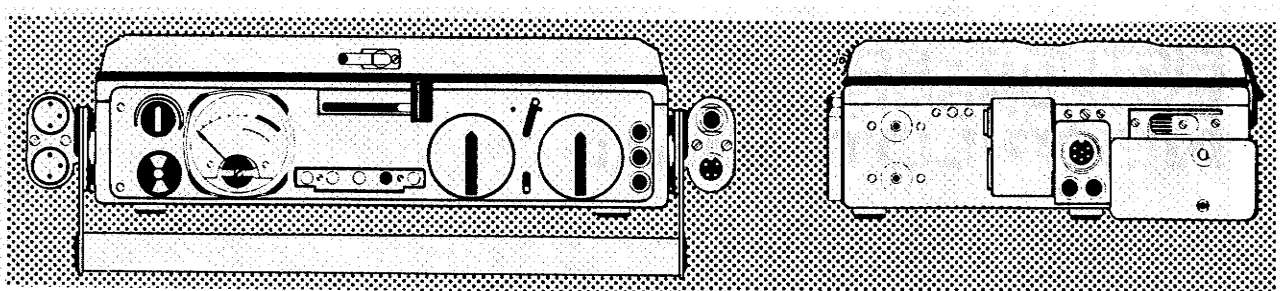
3.4.3.
Filter Selector

The 4-position filter selector (12) is found on the front panel between the two level controls. The four filters are:

- FLAT — Linear 30 - 20 kHz
- SPEECH — High-pass filter for speech attenuating unwanted bass frequencies (−7 dB at 50 Hz, 0 dB at 200 Hz)
- S + LFA — (Speech and Low Frequency Attenuator) As SPEECH filter but with greater attenuation for recordings to be made in noisy places, e.g. in a car (−13 dB at 50 Hz, −5.5 dB at 200 Hz)
- ROLL OFF — Maximum attenuation filter (−8 dB at 200 Hz)

The following graph clearly situates the frequency response of each filter.





NAGRA IS

4 PICTURE - SOUND SYNCHRONIZATION NEOPILOT SIGNAL

4.1 Introduction

The NAGRA IS-L and IS-LT are equipped with a Neopilot system which enables recording, in addition to the sound, of a synchronizing signal, called the pilot signal, which normally comes from the camera or a crystal generator.

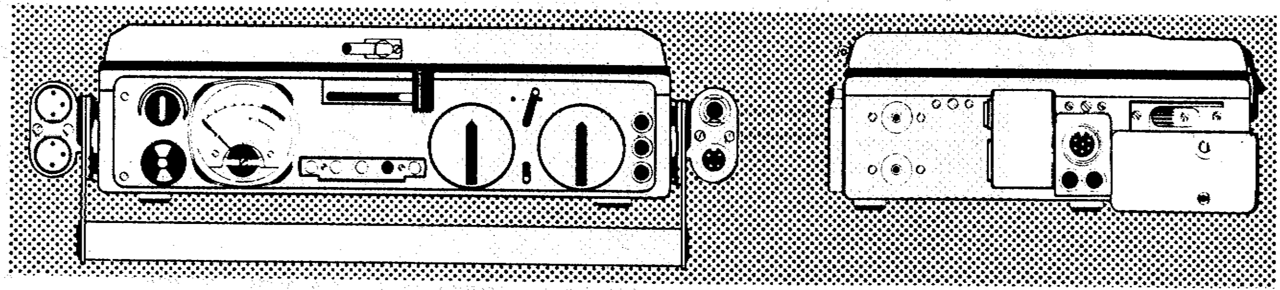
4.2 General

To obtain a film with synchronous sound it is necessary to keep the picture and the sound continually slaved to one another. The acceptable tolerance is in the region of 40 msec.

"Single system"
A simple process consists of recording the sound directly on to the same film base as the picture at the time of filming. The quality of sound thus obtained is not very good, and editing presents problems, so this process is only used in cases where the sound is not of much importance.

"Double system"
The camera takes the picture only. The sound is recorded on a separate machine but on a base material allowing subsequent synchronization. This can be directly on a perforated film, either optical or magnetic, or with "magnetic perforation" by recordin a synchronization signal (pilot) on a special channel.

In the case of recording on a film, the latter runs in synchronism with the camera film, e.g. the camera and the recorder can be powered by synchronous motors fed from a common supply.



4.2.1. Magnetic tape and pilot signal (Pilotton, Rangerton, Neopilot, etc.)

A high quality sound recording is obtained with a NAGRA IS, but it would be dangerous to edit the original. Furthermore, it is easier to work on a perforated magnetic film, so normal procedure is to transfer the sound track onto a work copy.

The length of a tape is subject to variation, however, and to ensure absolute synchronization, it is necessary to record a reference signal. In practice, this is done as follows:

Two channel recorder: one for the sound and one for the synchronization signal which comes from the camera. When the camera is rolling at its nominal speed (e.g. 24 frames/sec) the signal frequency is exactly 50 Hz (60 Hz in the USA and Canada). Thus 24 frames correspond exactly to 50 cycles of pilot signal.

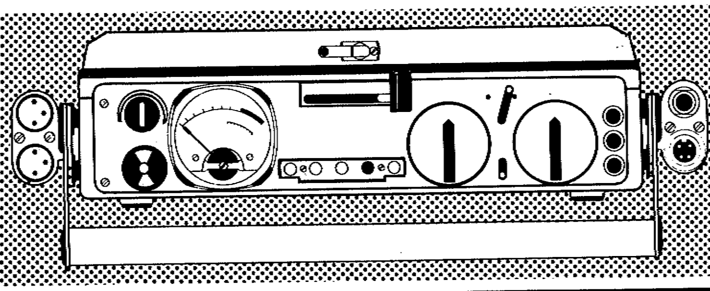
While transferring on to a perforated film, an electronic device called the synchronizer corrects either the speed of the playback recorder or that of the film recorder, according to the system, in such a way that for each 50 cycles of pilot signal, there are 24 perforations on the film (16 mm film).

The result is as if the recording had been made directly on a synchronous perforated film machine.

Various processes (Pilotton, Rangerton, Neopilot, Fairchild and Perfectone) differ only by the method used to obtain the second channel. The latter has only to record a small amount of information, and it would be a waste of tape to use a complete track analogous to a sound track for the recording of the pilot signal. In the original system (Pilotton) the recording of the pilot signal was achieved across the tape without bias. The installation of the system was easy, but the results were debatable because of the deterioration of the signal-to-noise ratio on the sound channel. Nevertheless, this system was widely used and when Kudelski created the Neopilot process, the objective was to eliminate the faults of the original Pilotton process, but all the while ensuring compatibility with the old system.

4.2.2. Use of non-synchronous motor camera

A synchronous motor has very poor efficiency. If it is powered from mains this is not of great consequence, but in working on location a direct current motor is much more suitable.



By coupling a silent camera run from a DC motor to a small AC generator producing 50 or 60 Hz when the camera runs at nominal speed, a pilot signal can be obtained as if a synchronous motor were being used. The other operations remain the same. However, it is necessary that the DC motor of the camera has a sufficiently accurate speed. The sound and the picture are in effect slaved to one another. The speed of projection is fixed. If the camera runs at an incorrect speed during the take, it is necessary to adjust the speed of the tape to ensure synchronism, and the sound tone will be distorted. In practice, an accuracy of ± 1 % is sufficient and reasonably easy to obtain. It is always advisable to keep check for it has been known for camera speeds to vary by more than 10 %.

4.2.3.
Synchronization without cables

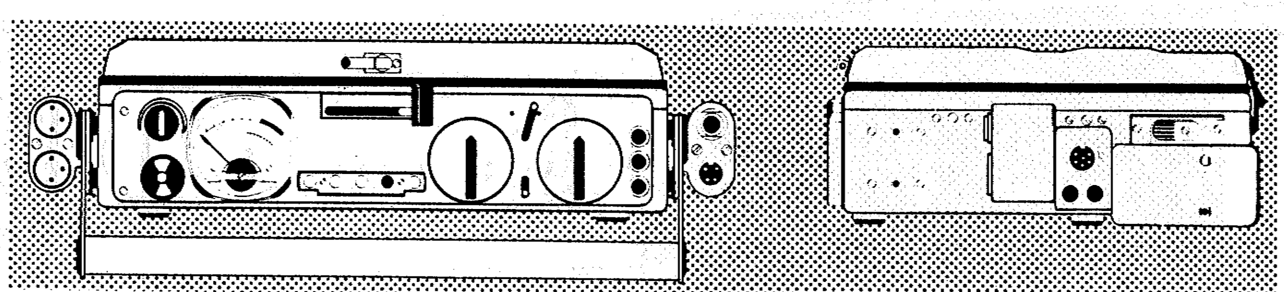
The processes described above necessitate a cable between the camera and the recorder. Several methods have been invented to eliminate this and are based on the transmission of the pilot signal by radio. Unfortunately, it is difficult to obtain a system which is 100 % reliable, because of the dead zones produced by standing waves.

In the end, experience has shown that by far the best process is by the crystal control. The camera motor is driven by a crystal oscillator (or tuning fork). Its speed then becomes exact to ± 0.001 % for a high quality device.

The pilot signal is supplied by a second crystal oscillator with similar accuracy to the first and which is contained within the tape recorder. In practice, this is the same as if the tape recorder received the pilot signal from the camera. The maximum possible error is about 0.002 % which is equivalent to one frame per 30 minutes of film.

4.2.4.
Working with several cameras and several recorders

With the crystal process described above, the number of cameras and tape recorders working in synchronism is unlimited. This opens greater possibilities for filming important sequences simultaneously or for reporting unique events. Note that one camera can start up while another is filming. With the traditional process of silent cameras equipped with synchronous motors fed from a common power supply, interference is sometimes caused as the motor starts up.



4.2.5.
Clapper and take

To obtain a synchronous sound it is not only sufficient that the sound and picture films run at the same speed but their starting points should equally coincide.

The traditional method consists in starting each take with a clapper board. On the clapper board are inscribed the signs allowing identification of the take, these being simultaneously announced into the microphone. Then the clapper board is operated in front of the camera and this makes it easy during editing to coincide the picture of clapper board closing with the noise it produces.

4.2.6.
Electrical clapper

The traditional clapper board is clumsy for reporting and is not practical when filming with several cameras simultaneously. In general, cameras used for reporting are fitted with an electric clapper: a small light bulb placed close to the film fogs the latter during the starting of the camera. Simultaneously, a signal (generally the power supply voltage) is transmitted by cable to the recorder; this signal is used in two ways:

- whistle clapper: the signal switches on an oscillator producing a whistle recorded on the sound track.

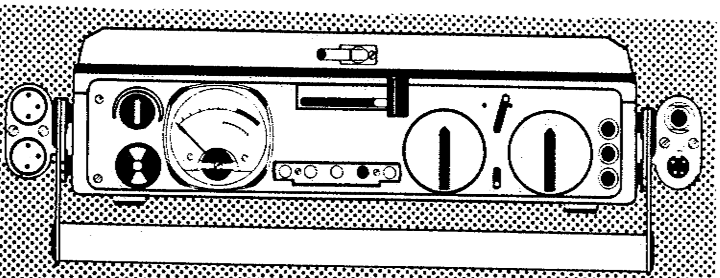
  Subsequent identification is easy but since the signal is recorded directly on the sound track, the latter cannot be used for any other purposes. Naturally, this method is only possible when working with one camera.

- pilot signal suppression clapper: the signal from the camera cuts the pilot signal instead of producing a whistle.

  In this way, the sound recording remains intact. This method is used when filming with several cameras.

4.2.7.
Sound transfer from the tape to perforated film

In order to edit the sound film by classical methods, it is necessary to transfer the sound from the tape on to a perforated film. To do this, a playback tape recorder (NAGRA) and a perforated film recorder are needed. Synchronism will be ensured if 50 cycles of the pilot signal correspond to 24 frames or perforations (16 mm film with 50 Hz pilot signal).



There are two possibilities:

a) Slaved film recorder
The tape is reproduced at nominal speed by a recorder without tape speed control and two signals are given:
- the sound which is transferred to the film recorder
- the pilot signal which, after amplification, is used to control the synchronous motor or the pulse motor used for transporting the perforated film.

b) Slaved playback recorder
The perforated film recorder is powered directly by an AC mains supply. The tape reproduced by the NAGRA IS, has its speed slightly corrected by an IESL synchronizer in such a manner that the playback signal is phase-locked with the mains reference-signal, available on the ATI mains supply unit. 1 V.

Method a) is the older. It allows the use of a playback recorder with an uncontrolled motor and it can correct very large speed errors, this being necessary at the time when portable tape recorders only had spring motors. This method, however, requires a costly power amplifier and other complex devices to ensure that short interruptions of the pilot signal do not disturb the sound.

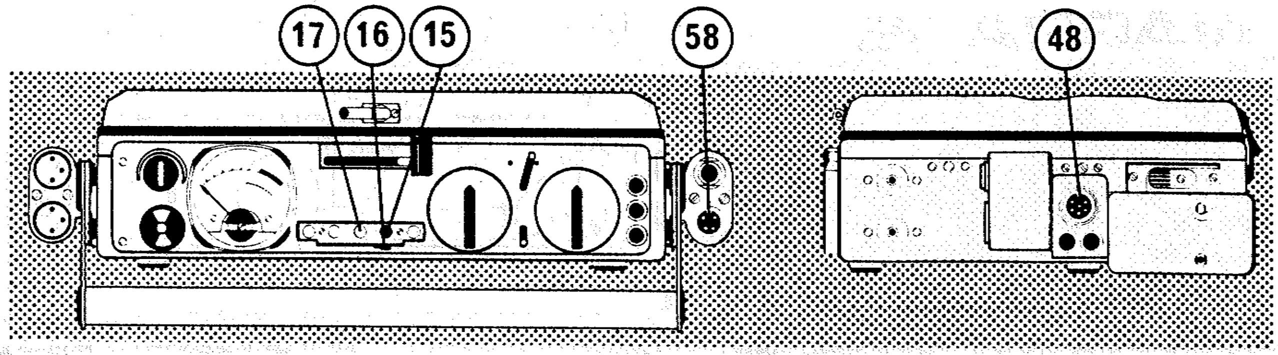
Method b) is perfect with modern cameras and a NAGRA IS for example.

4.2.8.
Filming on playback

Wherever it is difficult to record the sound during filming it is possible to use the method of filming on playback. The sound is previously recorded and, during the filming, it is reproduced in synchronism with the camera while the actors mime their roles. This method is particularly useful for singing and dancing together.

Technically, two methods are possible:

a) Playback and recording during filming: a playback tape-recorder sends the sound simultaneously into a loudspeaker and into a second recorder which re-records the sound along with the pilot signal. It is possible to transfer on a perforated film recorder by means of the IELS synchronizer.



b) Slaved playback: the playback tape-recorder and the camera are slaved one to the other. The speed of the NAGRA IS is slaved to the camera speed by means of the IESL synchronizer. When the camera itself is crystal controlled, the speed of the NAGRA IS will be controlled by the IESL synchronizer using as a reference the pilot signal supplied by the crystal oscillator of the NAGRA IS.

4.3 synchronous sound recording with the NAGRA IS

4.3.1. Standard device for pilot synchronization

The NAGRA IS-L and IS-LT versions are equipped with a complete Neopilot system, i.e. a pilot signal recording circuit, playback circuit, crystal generator, stroboscope + LED, and a rotary indicator to show the presence of a pilot signal.

4.3.2. Connections

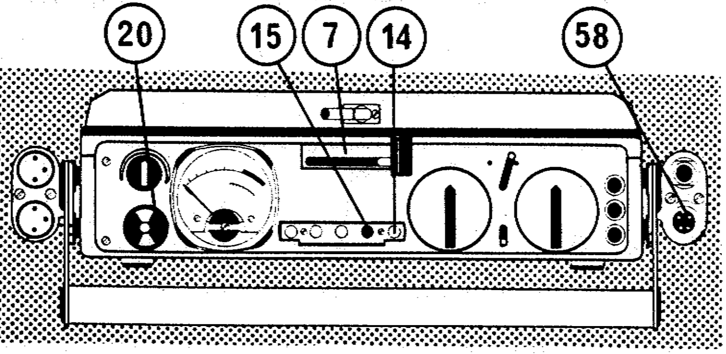
Pilot connections are found on the right side of the NAGRA IS. The pilot signal to be recorded is injected into terminal 4 of the 4-pole pilot socket (58). The built-in crystal generator pilot signal is available at terminal 3 and can be reinjected by the Xtal shorting plug (59) which bridges terminals 3 and 4. Terminal 2 is for the clapper: three different methods are possible as described below.

The pilot signal reproduced from the tape is available at terminal 5 of the 7-pole Accessory socket (48).

4.3.3. Crystal generator

The crystal-controlled generator supplies a 1 V signal at 50 Hz or 60 Hz frequency according to option.

The signal is directly available at terminal 3 of the 4-pole socket (58). The pilot generator functions as soon as one of the preselection controls (15) (16) or (17) is pressed and mains selector 7 is in position TEST or ON. To record this signal, the Xtal shorting plug (59) has to be connected to the socket (58).



4.3.4.
Record and playback

In record mode, pilot input receives a signal between 1 V and 10 V from the camera or the built-in crystal generator. The rotary indicator (20), the stroboscope (41) and the pilot output (terminal 5 of socket (48)) are connected on the direct chain.

4.3.5.
Electrical clapper

In playback mode, the 1 V pilot signal is available at terminal 5 of socket (48).

a) Standard versions of the IS-L and IS-LT have a reference generator enabling the recording of a sequence of this signal. It is obtained by applying a voltage between +6 V and +14 V to terminal 2 of pilot socket (58). This voltage could come, for example, from the camera

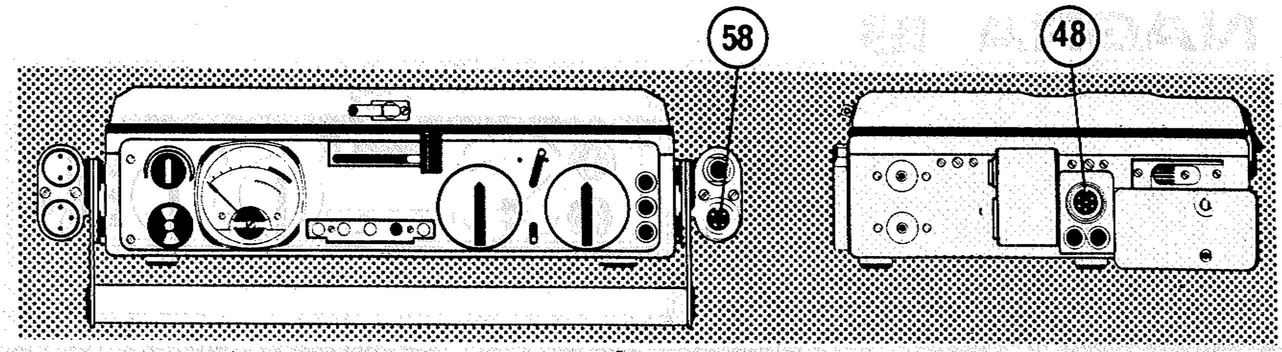
b) Upon request, these models can be prepared so as to function with a clapper involving interruption of the pilot signal.

4.3.6.
Stroboscope

In both record and playback modes, the stroboscope led is operated by pressing the fast rewind control (14). The light emitting diode (42) functions as long as the rotary indicator shows the presence of a pilot signal. The stroboscope serves as a check on tape transport by injecting a 50 Hz or 60 Hz signal from the crystal generator via shorting plus (59), from the electrical network or an external source. The stroboscope also enables a check on camera speed when working with a pilot signal relayed by cable, as well as on the correct operation of the external synchroniser IESL.

4.3.7.
Recording of synchronous sound

Once the recorder is set up, press RECORD control (15) and inject pilot signal to terminal 4 of socket (58) simply by passing main selector (7) to ON. The pilot indicator (20) shows the presence of a pilot signal by a white cross. If there is no pilot signal the indicator remains black.



4.3.8.
Pilot signal transmitted by cable

When the camera is running at nominal speed, a 50 Hz or 60 Hz signal is supplied, with a voltage of 1 – 2 V. Signal distortion caused by the camera is not important for operation since the NAGRA IS reconstitutes a pure sine wave. The majority of professional cameras supply sufficient voltage during start-up to power terminal 2 of the 4-pole socket (58) and thus enable operation of the electrical clapper.

4.3.9.
Synchronous recording without cable

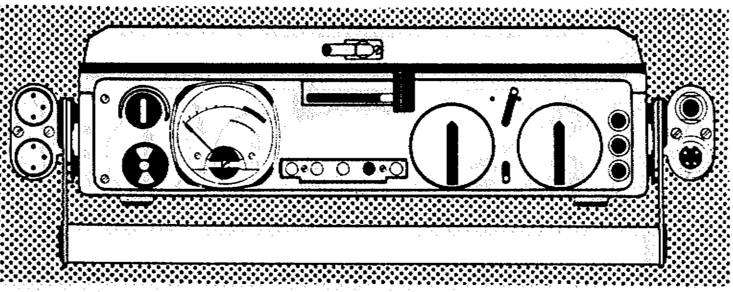
The internal pilot generator is a clock supplying a signal with a frequency of 50 Hz or 60 Hz ± 0.001 % ; temperature induced fluctuations are negligible. This device is used for recording without a connection cable between the camera and the NAGRA.

4.3.10.
To record

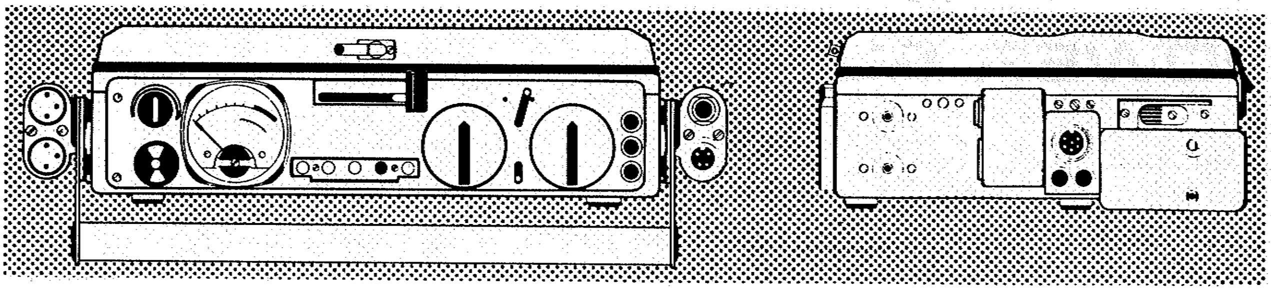
The crystal generator signal available at terminal 3 of the pilot connector (58) has to be re-injected into the NAGRA by bridging terminals 3 and 4. For this, a shorting plug (59) is supplied, or otherwise a simple bridged plug can be used. The plug system was deemed preferable to a switching system to reduce the risk of errors.

4.4 NAGRA IS to perforated film recorder connection (Transfer)

By means of the IESL synchronizer, the NAGRA IS can be synchronized with the internal signal of the crystal generator or with an external signal with a voltage of 0.4 to 10V, as for example the one delivered by the ATI.
The IESL will be connected to the connector (58) and to the socket (48) of the NAGRA IS.



A meter on the upper face indicates as well the phase reserve as the lack of either the playback or crystal signal.
A defective working of the synchronizer caused by insufficient phase reserve, by a lack of pilot signal or of crystal signal, or even by too an important deviation of synchronism between both sources immediately activates the reference generator.



5 POWER SUPPLY

5.1

General

The NAGRA IS battery compartment contains eight 1,5 V batteries (nominal voltage) conform with CEI (R 20 type) or ASA (D or L90 types) standards. Each battery contains a central positive electrode, the compartment box being the negative electrode (except in some rare cases). Polarity is usually indicated by + and – symbols. Maximum diameter is 34 mm (1 3/8 ins) and maximum length 65 mm (2 1/2 ins). If battery length is slightly less, the space in the compartment can be adapted by means of a sliding contact on a threaded guide. This eliminates any longitudinal play. If there is too much lateral play, packing with cotton wool or other similar material suffices.

5.1.1.
Supply voltage

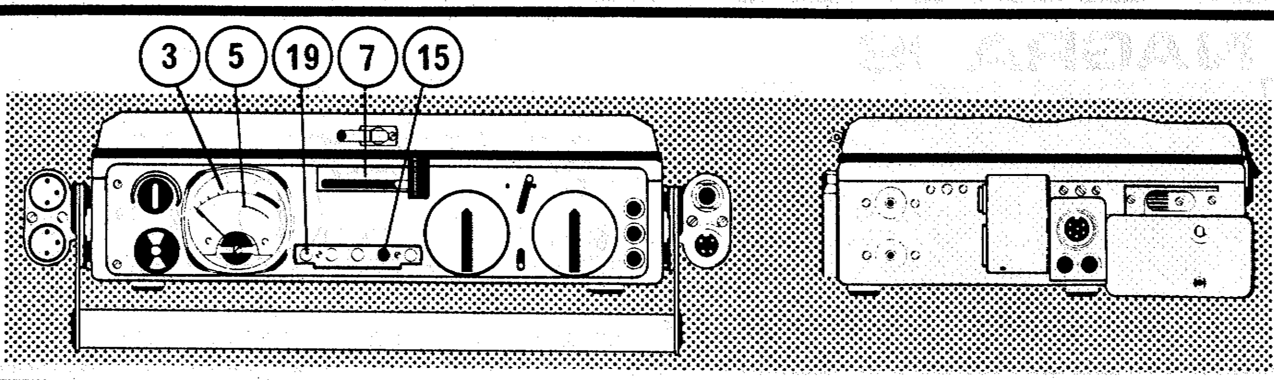
Eight new carbon-zinc batteries give a total output of 12 V; the NAGRA IS still functions correctly with 7.2 V for both speeds at normal temperatures. An internal voltage stabiliser means that the NAGRA IS functions independently of the power supply voltage except on fast winding when the speed is directly proportional to this voltage.

5.1.2.
Danger of reversed power supply

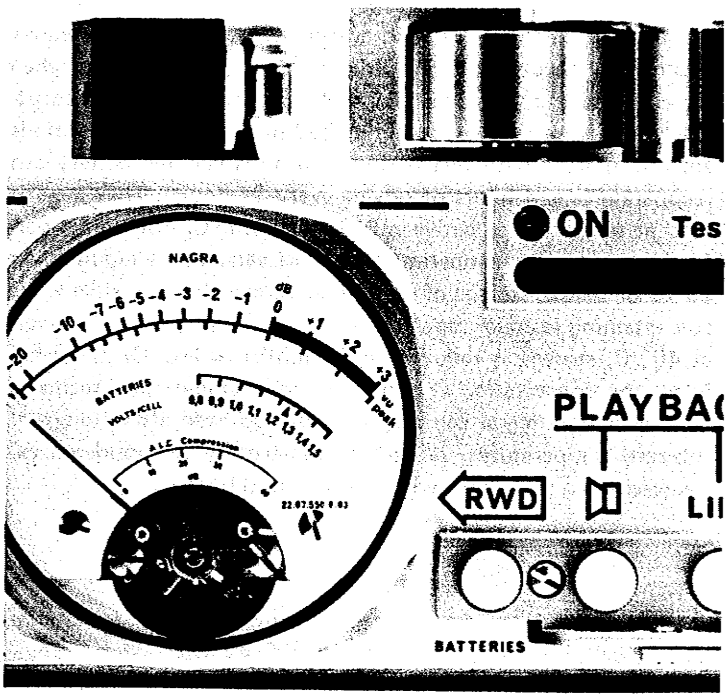
A diode placed in parallel with the power supply short-circuits the latter if polarity is reversed. However, some cells supply sufficient current for the NAGRA wiring to become so hot that insulation decomposes and corrosive agents are released. To prevent this, a 2.5 A fuse has been incorporated in the power supply wiring to protect the circuits.

5.1.3.
Measuring power supply voltage and battery/cell state

Press RECORD control (15) on preselection keyboard (13) with main selector (7) on STOP. Upon pressing BATTERIES control (19) the meter (3) indicates on scale (5) the average voltage of each power supply element. To obtain total voltage, simply multiply this figure by eight.

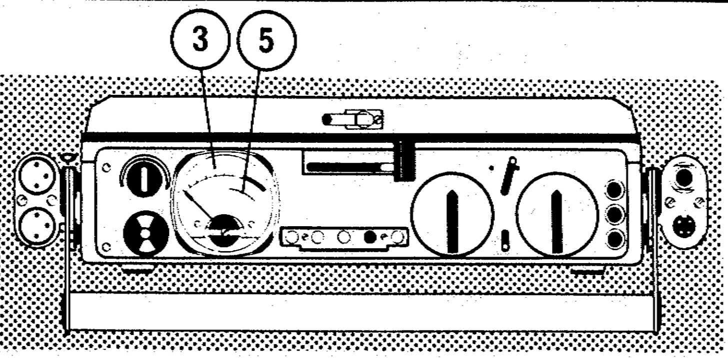


Point 1.25 V on the scale 5 indicates the minimum voltage.



5.1.4.
Batteries and rechargeable cells

The following information has been extracted from the literature of certain suppliers. This is not to be interpreted as indicating that the products of these suppliers are an exclusive selection for NAGRA recorders. Rights are reserved as to the exactitude of figures published. In general, the performance of a battery or rechargeable cell depends considerably on the conditions and length of storage before it is put into service.



5.2
Batteries

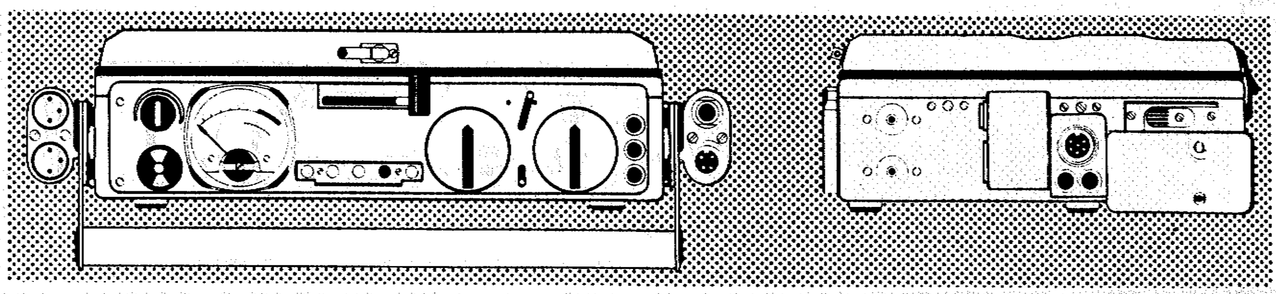
5.2.1.
Classical "Leclanché" batteries (carbon zinc)

They are light, cheap and sold everywhere. Their capacity varies enormously according to the rhythm of use: it is mediocre when drawing heavy current, excellent for weak currents and acceptable for average currents (approx. 350 mA) if the service periods are interspersed with rest periods during which the battery can recuperate (e.g. 4 hours of service every 24 hours). They may be used at temperatures between 0° C and $+50^\circ$ C. For similar performance at lower temperatures, special versions are required. At 20° C or below, storage of more than 12 months is possible while still retaining residual capacity between 75 and 90 % . However, at 40° C, storage is reduced to 3 months or less. On the other hand, the conservation at extremely cold temperatures seems to be excellent; integral capacity is preserved even after storage at sub-zero temperatures. A carbon-zinc battery is considered exhausted when its on load voltage drops to 0.9 V/cell.

5.2.2
Manganese dioxide alkaline batteries

These are a recent invention. Their capacity at the currents which are normally used is considerably better than that of the classical Leclanché type. They may be used between -20° C and $+71^\circ$ C. Discharge being constant, there is no need for interruption of use to enable recuperation. Their weight is 50 % higher and they are also more expensive.

They are recommended in the following cases:
- temperatures outside the limits for ordinary batteries
- long storage times
- restrictions of weight and volume per hour of recording.



5.2.3. Mercury batteries

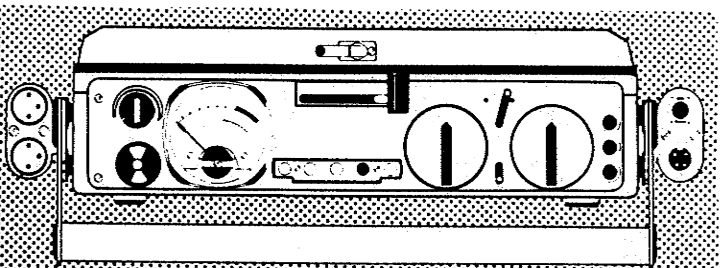
Capacity and storage time are greater than for manganese cells, but weight and price are higher too and low temperature performance less good, lowest limit being +10° C except for certain special types.

In most cases, polarity is the reverse of classical cells, i.e. the case constitutes the positive pole. Apart from a special model which has been put into a second case to re-establish the normal polarity (WONDER PILAT), their use in the NAGRA requires an adaptor. In view of the danger of reversal, the greatest care is recommended when using mercury cells. It should be noted that the voltage of mercury cells remains practically constant and equals 1.2 V for the period of discharge. It is thus impossible to know the residual capacity in measuring their voltage.

Mercury cells should not be discarded as a safeguard against environmental pollution.

5.2.4. Danger of battery leakage

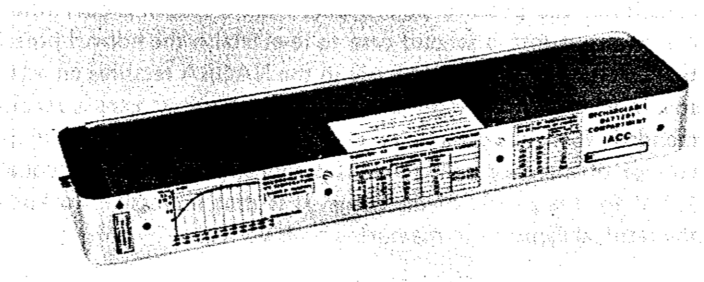
Electrical energy is released by a chemical reaction greatly modifying the battery components. If a battery is discharged, considerable damage could be caused by the leakage of a corrosive liquid. The battery check should therefore be made quite frequently and if a recorder is out of operation for several weeks, the battery should be removed. Some batteries are sealed and risks of leakage are thus reduced.



5.3
Rechargeable battery compartment (IACC)

5.3.1.
Description

The advantages of using rechargeable cells led to the design of this compartment. Weighing 1 lb. 13 oz., it contains 12 cells linked to prevent accidental polarity reversal. It is attached to the NAGRA IS in the same way as the battery compartment (IBAT).

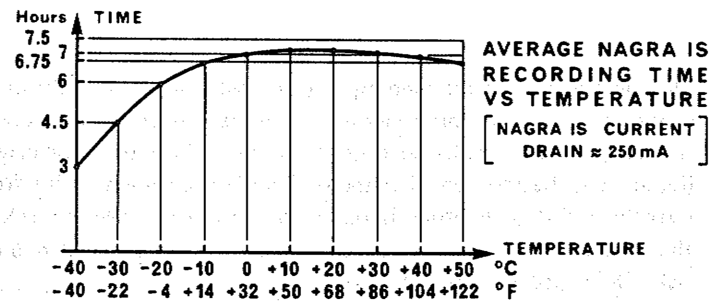


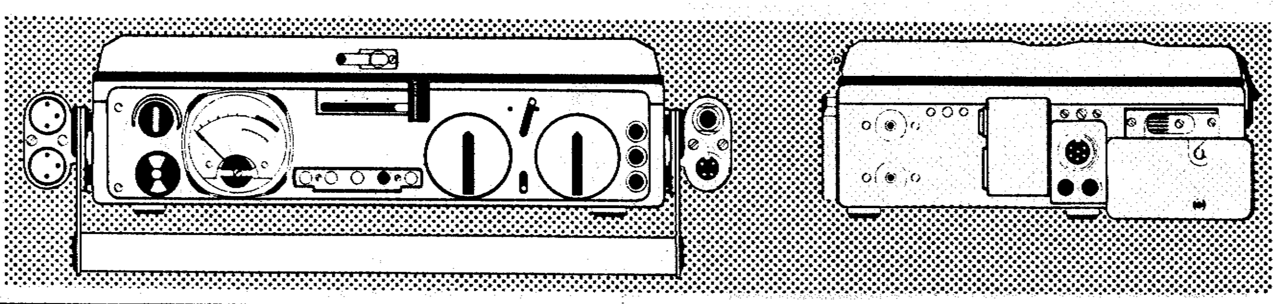
Data printed on the outside gives:

- maximum charging current and charging time in relation to temperature

EFFECT OF TEMPERATURE ON CHARGING CURRENT				
TEMPERATURE °C	TEMPERATURE °F	MAX.CHARGING CURRENT mA	CHARGING TIME Hours	
+50 + 5	+122 + 41	720	3.5	
0	+ 32	360	6	ATI on 0.35 A
-10	+ 14	180	11	ATI on 0.17 A
-20	- 4	90	21	
-30	- 22	54	34	

- average recording time versus temperature. It can be observed that down to -10^{0}C, influence is negligible and at -40^{0} C three hours recording is still possible.





storage conditions. It is seen that heat harms charge retention and the IACC should be stored below +20° C.

EFFECT OF TEMPERATURE ON RETENTION OF CHARGE		
TEMPERATURE		AVERAGE STO--RAGE TIME for 50% loss of charge
°C	°F	DAYS
+60	140	3.5
+40	104	12
+30	86	25
+20	68	50
0	32	150
-10	14	1500

RECHARGEABLE BATTERY COMPARTMENT

IACC

N°

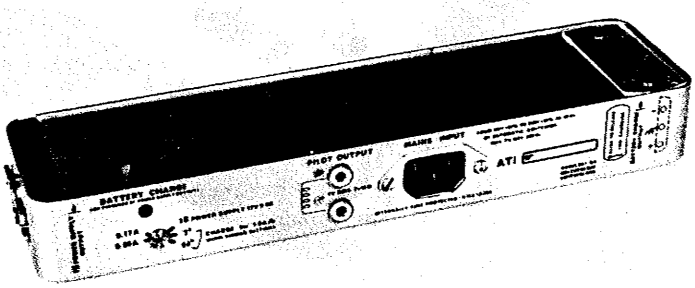
Since cold slows down chemical reactions. an ideal storage place is the refrigerator.

5.3.2 Charge

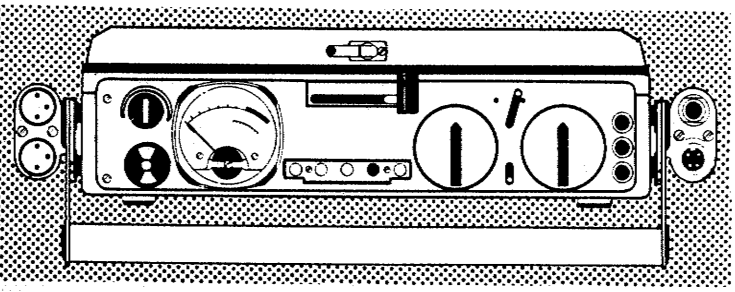
The mains supply unit ATI is used to recharge the IACC.

5.4 Mains power supply ATI

5.4.1 Power supply



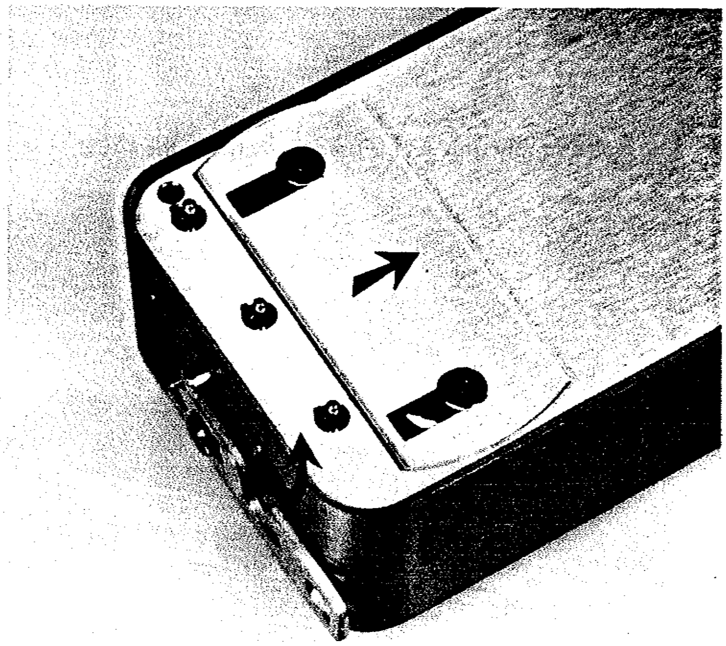
This unit weights 1 lb. 13 oz. and is attached to the NAGRA IS in the same way as the IBAT and IACC units.



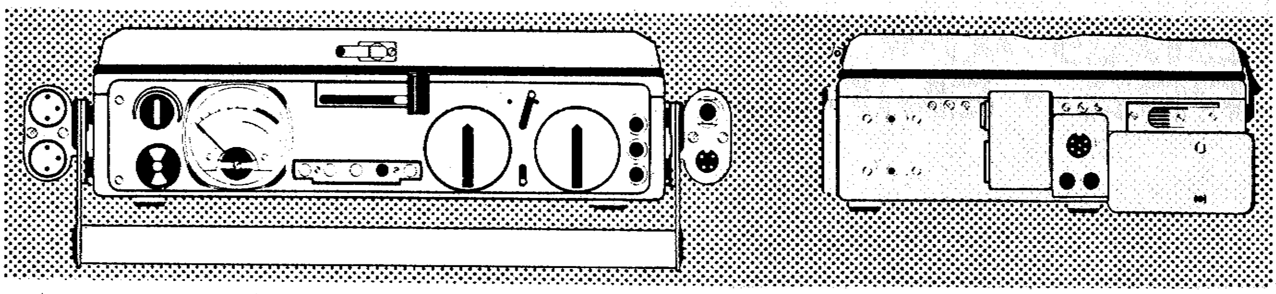
It is very easy to use: simply plug into the mains. An automatic switch-over to 110 V or 220 V avoids any risk of error. The only operation required is to set the selector to IS power supply 12 V. 0.4 A using a coin loade, a LED lights up. A 1 V pilot signal at mains frequency is avialable at the two banana sockets and is useful when working with synchronous motor cameras powered by the same mains, or with the IESL synchronizer

5.4.2.
Charger

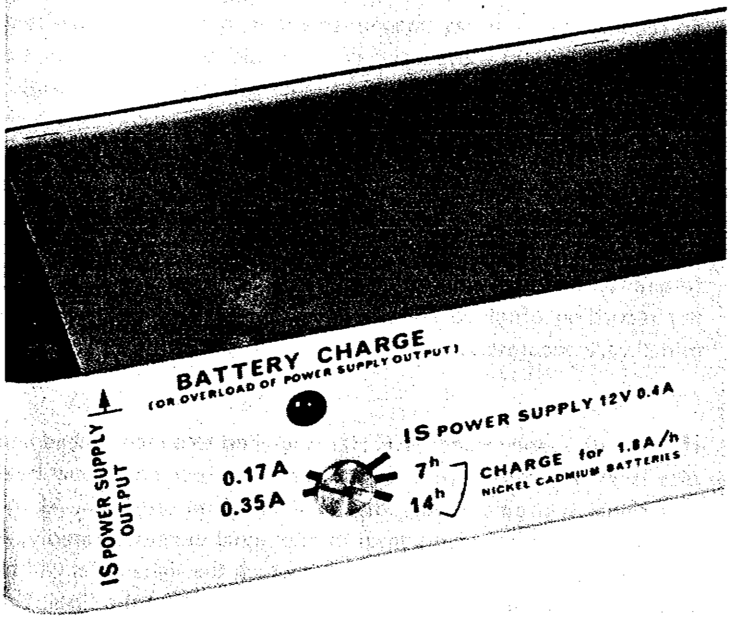
The ATI also serves as a charger for the IACC unit. Slide the transparent protection back to release the three spring-loaded contacts. Turn and secure the two end fasteners in vertical position. Place the IACC unit on top as shown in diagram, ensuring that the two sets of contacts are face-to-face. Slip studs into notches and secure firmly.



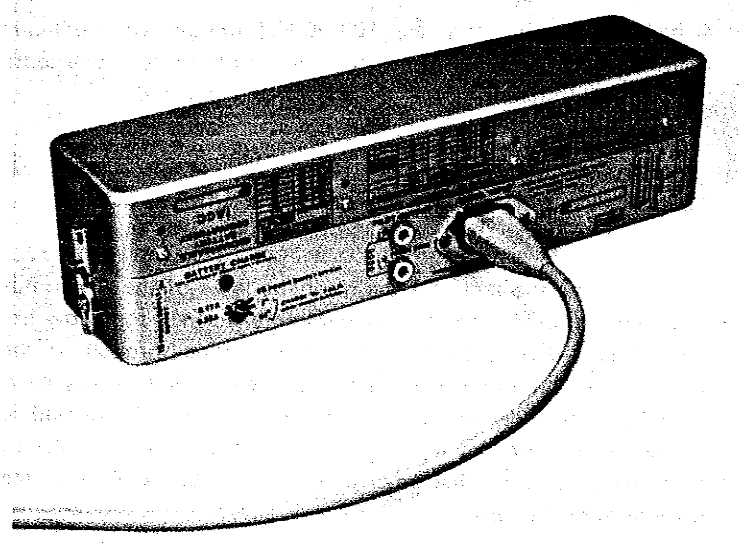
Turn switch to "CHARGE FOR 1.8 A/H" using a coin, and select 7 or 14 hours. A 7-hour charge is selected when time is limited; intensity being twice that of the normal charge, it reduces the life of cells. It is therefore recommended to charge usually with an 0.17 A current on position 14 H.



Plug into mains: the LED remains alight throughout the charging period. Once the charge is complete, remove IACC unit, disconnect from mains and slide transparent protection back over contacts.



After charging, separate IACC from ATI and disconnect mains plug. Slide transparent protection to cover the three spring loaded contacts.



NAGRA IS

6 BIAS AND PRE-EMPHASIS

6.1 Bias

6.1.1. General

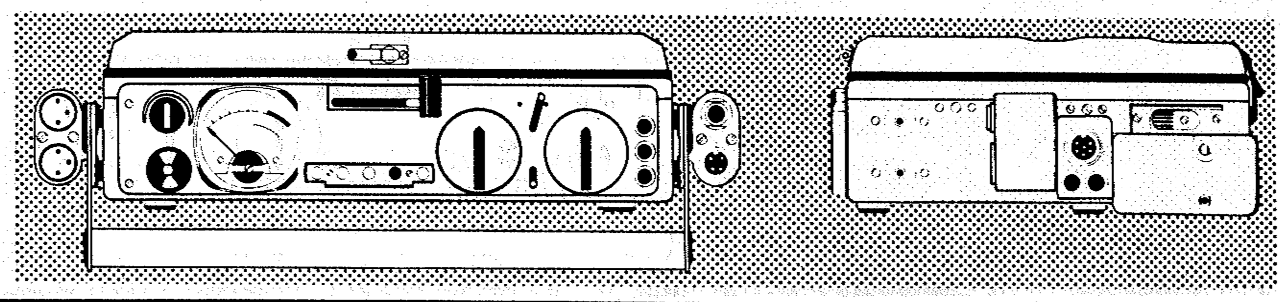
To record, that is to say, magnetize a tape, it has to be submitted to a magnetic field above a certain threshold. Below this value, no permanent magnetization will be produced. To reach the threshold, and pass into the linear part of the magnetization curves, a high frequency signal is superimposed upon the low frequency signal representing the sound. The peaks of the high frequency signal always deviate into the linear region and the low frequency signal determines, in effect, the extent of deviation. This is called high frequency bias. Its amplitude influences notably the quality of the recording obtained and therefore the level should be determined very accurately.

6.1.2. Effect of bias signal amplitude on the recording

If a low frequency signal (400 Hz) is applied to a record head and bias level is varied, several effects can be observed. A low level bias signal will give a weak distorted signal on playback. As the bias level increases, so the level of the signal increases, rapidly. A maximum will then be reached, after which the signal level will be very slowly reduced. The maximum can be called the "point of maximum efficiency". It also corresponds to the point where distortion is minimum. The fact that the signal level goes down very slowly as the bias signal becomes too great, renders the determination of the optimum point rather difficult.

A high frequency signal (e.g. 10'000 Hz) will give its maximum level for a noticeably lower bias level which corresponds to a point where a low frequency signal would become distorted.

This is due to the fact that the magnetic layer of the tape is not infinitely thin. The point of maximum efficiency for a low frequency corresponds to an optimum recording throughout the whole of the magnetic layer. The outside part will in fact be over-biased and, to a certain extent, even partially erased. The middle of the layer is further away from the heads, hence the loss of high frequencies. On the other hand, an over-bias will lower the noise level of the tape.



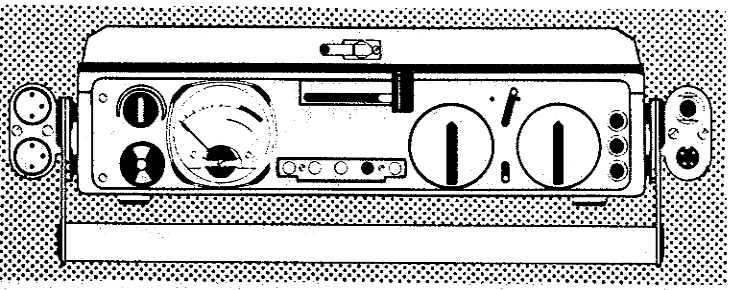
6.2
High frequency pre-emphasis

A tape's signal-to-noise ratio is perhaps the least satisfactory of its characteristics and great efforts have been made to improve this. It is possible to imagine, for example, a tape recorder which sends into the record head a current proportional to the input signal, independent of the frequency (recording at constant current). Experience shows that the tape becomes saturated for a given current in the record head irrespective of the frequency. At high frequencies, saturation takes on a special characteristic. The harmonics that saturation produce are outside the spectrum which the playback head can reproduce. Therefore, a tape saturated in high frequencies does not give a distorted signal; simply an increase of the recording current does not produce an increase of the recorded signal.

In effect, the tape becomes a limiter which, in addition, alters the sound of the recording.

A tape recorded unter these conditions (constant current) should be reproduced by a head followed by an amplifier fitted with frequency response correctors so that the result will be linear.

It can be seen that for the kind of sounds usually recorded, high frequency level is noticeably lower than that of middle frequencies. To be exact, high frequency peaks can have a large amplitude but their duration is very short and limiting will go unnoticed.



From the idea of emphasizing high frequencies during recording and attenuating them during playback, the noise level of the tape which is particularly annoying with high frequencies, is effectively reduced. This is known as pre-emphasis. It is used universally in disc recording and frequency modulation radio transmission as well as in magnetic recording. This universality is very important, for if there is pre-emphasis in one link of a chain, it is useless not to have it in the other links, since high frequency peaks will in any case be limited in the link which has the strongest pre-emphasis. On the other hand, the gain in signal-to-noise ratio is preserved in each link. In short, recourse to pre-emphasis is universal, as it has been found that the possible limiting of high frequency peaks is less annoying than the high noise level without pre-emphasis.

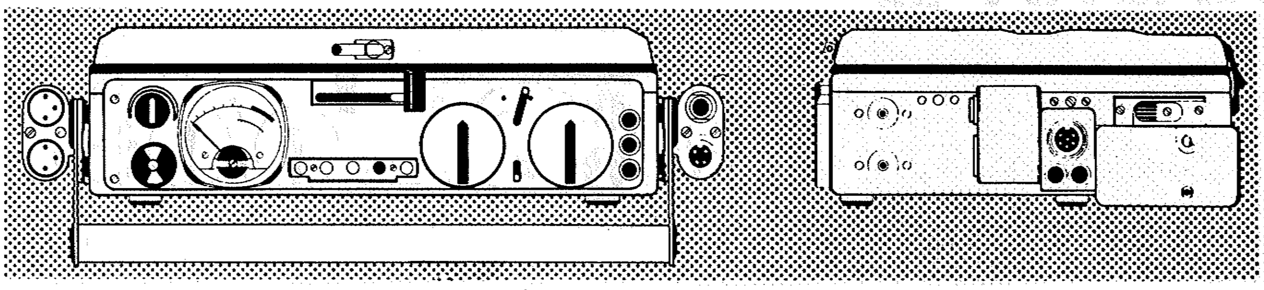
How much pre-emphasis can be accepted ? The question is complex, for it depends upon the type of sound to be recorded. The sound spectrum varies with different languages, and it is for this reason that the standards for pre-emphasis vary from one country to another.

For practical reasons, it is not the pre-emphasis which has been standardized in the case of magnetic recording but the playback chain. The recorder should be adjusted so that a tape produced on it and reproduced on a standard playback chain has a linear response.

6.3

Relations between pre - emphasis and bias

The American NAB standard at 7.5 ips requires a greater pre-emphasis than the European CCIR standard. In Europe, it is normal to slightly over-bias the tape. This gives a slightly better signal-to-noise ratio, but reduces the recording level of high frequencies. The final result is practically identical to that obtained with the NAB standard without over-bias. The strongest pre-emphasis of the NAB standard gives approximately the same



improvement in signal-to-noise ratio whereas the tapes become saturated at practically the same high frequency signal level. The NAB standard relies upon a heavier pre-emphasis and the CCIR on a higher bias level.

6.4

Practical conclusions

The result is:

a) It is possible to modify pre-emphasis within certain limits by adjusting the bias level but still remaining within the limits of the standards.

b) To record sounds particularly rich in high frequencies, it is possible that tapes allowing high recording level of high frequencies could give better results.

c) It is necessary to determine which link in the chain gives the greatest pre-emphasis. If all links pre-emphasize to the same degree, this will produce the most rational chain. However, if one link becomes saturated, it is better for this to be the magnetic tape for the saturation of high frequencies does not lead to audible distortion, which is not the case with a frequency modulation transmitter (or rather, the corresponding receiver).

6.5

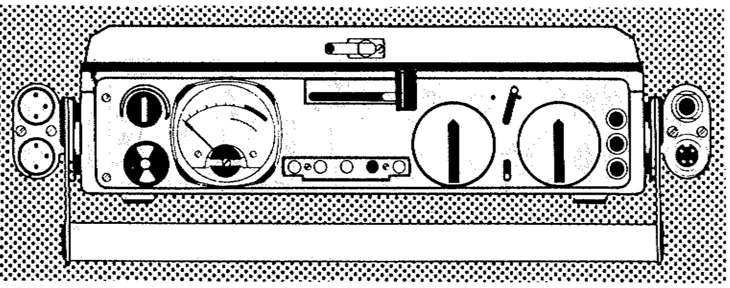
Determination of the bias level

6.5.1. Tape characteristics

Quality tapes available on the American or European market are very similar to one another from the point of view of optimum bias level. This permits adjustments to be made very close to the point of maximum efficiency.

6.5.2. General procedure

It is necessary to use a reference tape whose characteristics are well known, above all in relation to other tapes on the market.



The normal reference tape for NAB standard is Scotch 208 manufactured by 3.M. For CCIR standard, AGFA-GEVAERT PER 525 tape has been adopted as reference.

Generally, we determine the bias level which gives the greatest efficiency. The signal used will be of fairly low frequency (400 Hz). To locate the peak of the curve more easily, two points, E1 and E2, are plotted. Point E1 is an underbias level which lowers playback level by 1 dB; E2 is an over-bias level which lowers playback signal by 0.5 dB. The asymmetrical form of the curve justifies the difference in the playback levels of E1 and E2. It is evidently necessary to use a sufficiently regular tape so that sensitivity variations are not confused with loss of level due to under and over-biasing.

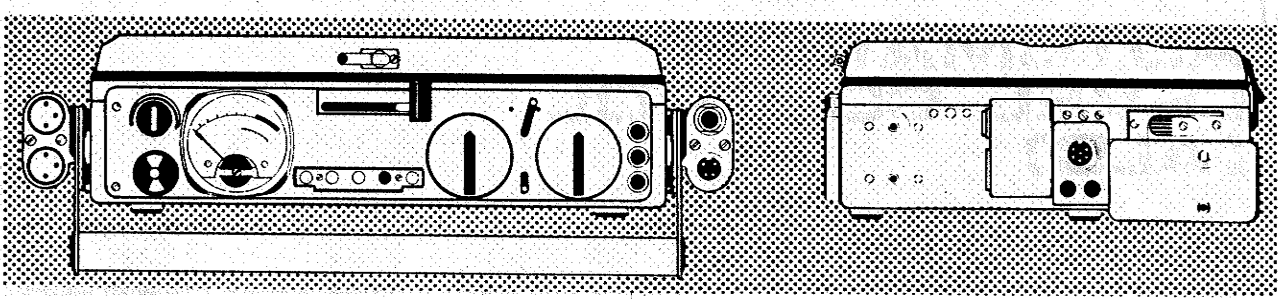
The maximum efficiency bias level, Em, will be the geometric mean of E1 and E2. This is found by multiplying E1 by E2 and taking the square root of the product. The working point will be Em x K where K is the coefficient of over-biasing. However, for the NAGRA IS in particular, the K-factor is adjusted using a K-meter with 0.05 accuracy.

NAB standard: NAGRA IS using American tapes, K = 1.1.

CCIR standard: NAGRA IS using European tapes, K = 1,05

VARIATIONS OF K

The preceding rules take into account the diverse characteristics of tapes available today. If a recorder is used with only one specific type of tape it is possible to use a K value which will be optimum for the conditions. K-values from 1 to 1.3 are possible. A small K-value can be used if the sounds to be recorded are rich in high frequencies, or if the tape is of low quality for high frequencies. An above average K-value can be used in the opposite case.

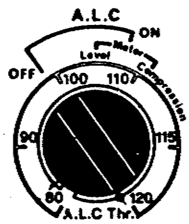


NAGRA IS

7 AUTOMATIC LEVEL CONTROL (ALC)

7.1
Automatic level control

7.1.1.
For what purpose ?

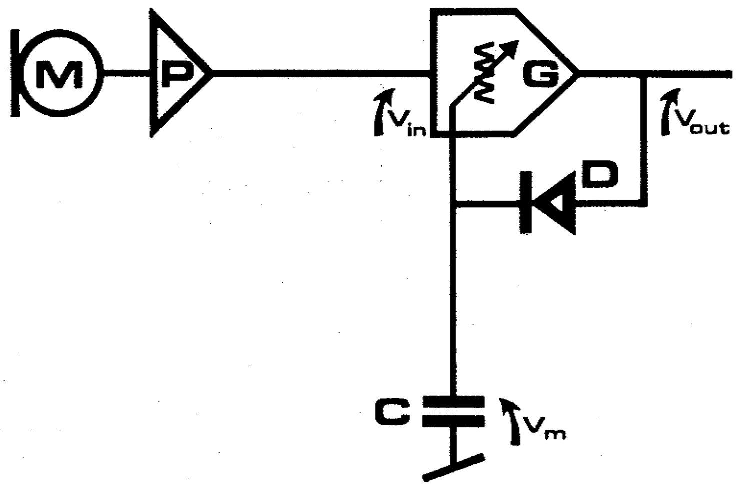


A field reporter using a tape recorder is obliged to take care of the interviewee, handle the microphone and at the same time adjust input level to ensure good reproduction of his recording.

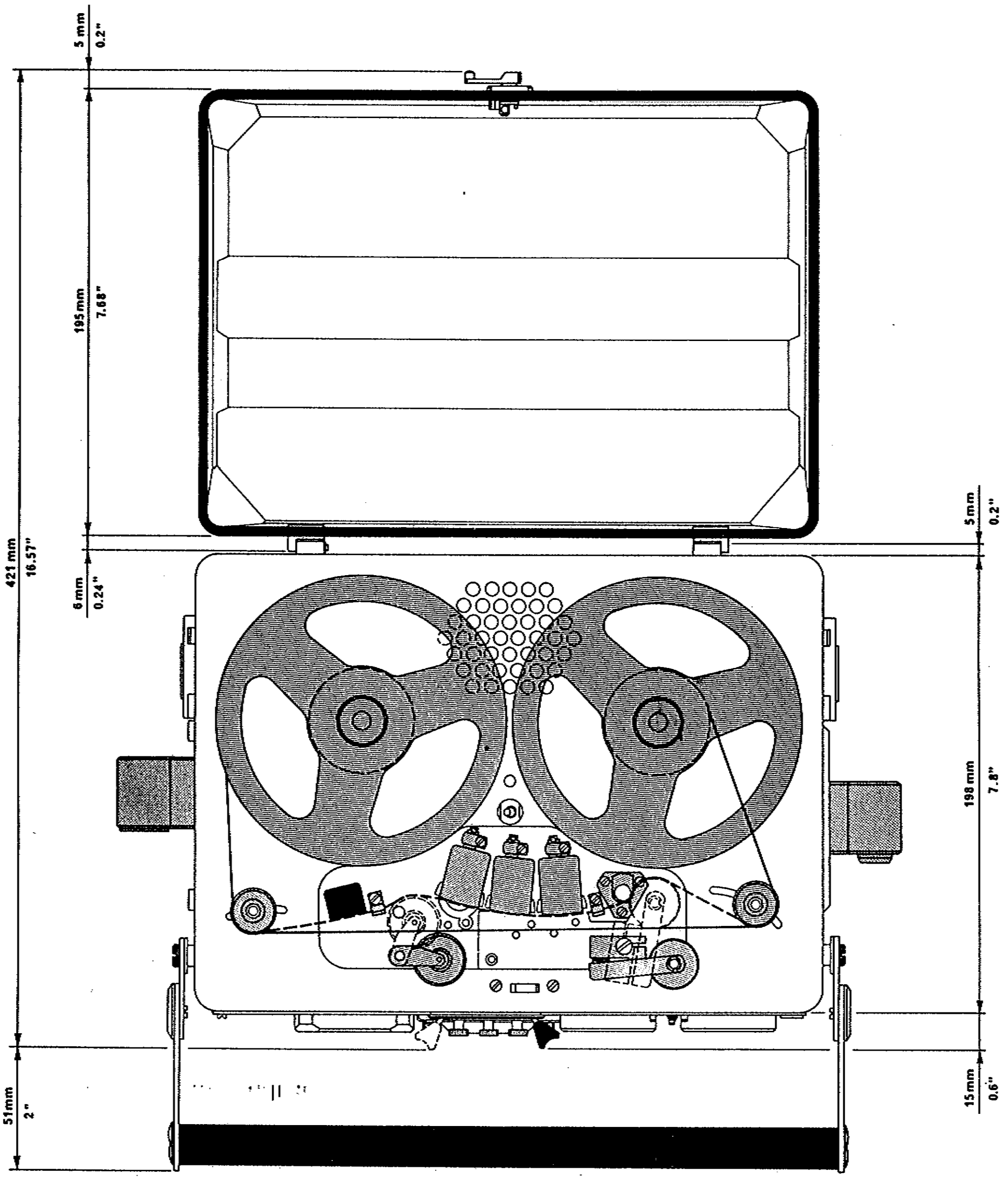
Thus, in order to alleviate the operational tasks and thereby enable the reporter to concentrate more on the interview itself, the NAGRA IS can, upon request, be fitted with an ALC device. This internal accessory automatically adapts the sound level to a nominal recording level. In other words, an insufficient sound level is amplified, whereas loud sounds are attenuated.

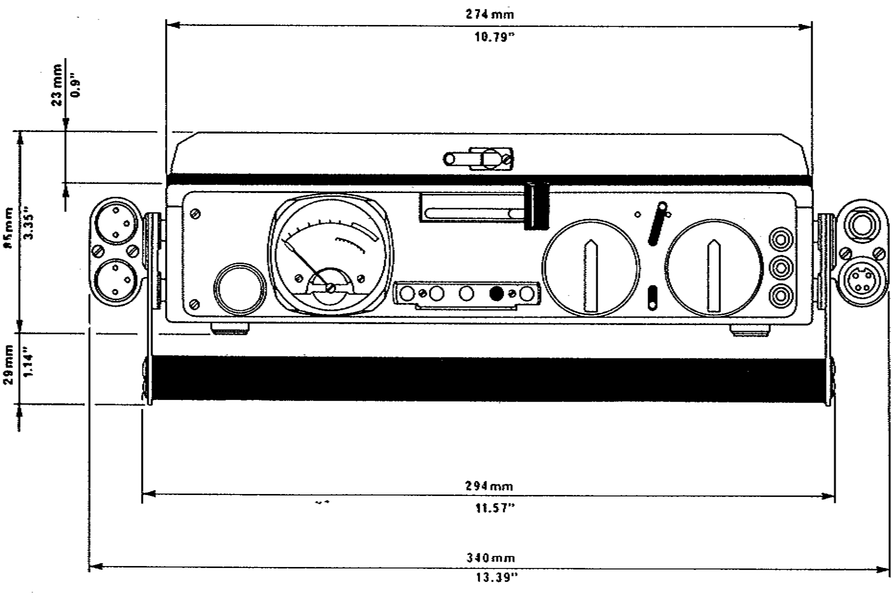
7.1.2.
Basic principle

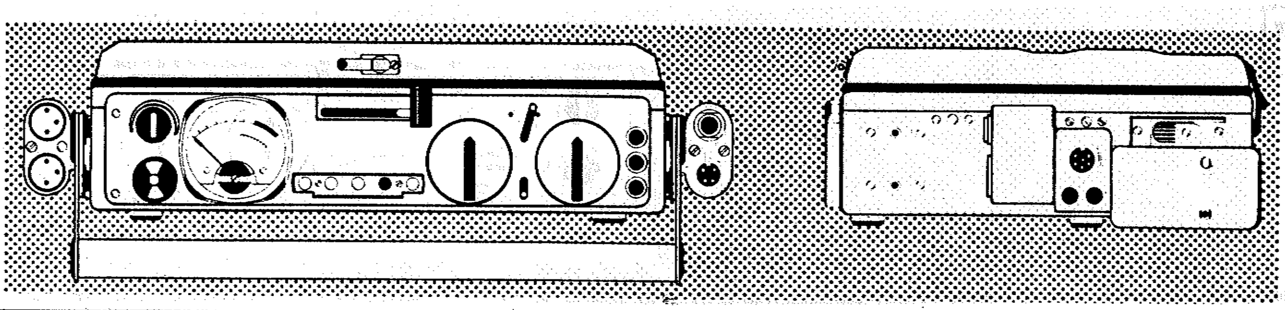
The signal from microphone M is first amplified by low-noise preamplifier P which has a high dynamic range. The latter must be able to amplify without distortion all signals from the microphone (for an average sensitivity dynamic microphone, i.e. 0.2 mV/µbar, signal amplitude can reach 100 mV).



In the following amplifier G, gain is adjusted by DC voltage. Then the corrected amplified signal charges the memory condenser C


5 mm
0.2"
195 mm
7.68"
421 mm
16.57"
6 mm
0.24"
51mm
2"
5 mm
0.2"
198 mm
7.8"
15mm
0.6"

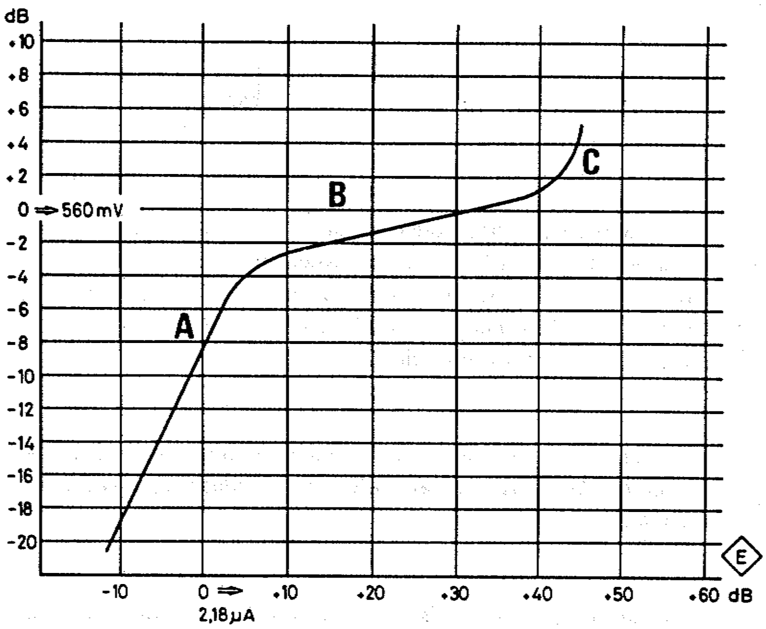

274 mm
10.79"
23 mm
0.9"
3.35"
29mm
1.14"
294mm
11.57"
340mm
13.39"



with a Vm voltage proportional to the output voltage Vout.

Vm voltage is used to vary amplifier G gain which is less when Vm voltage is greater.

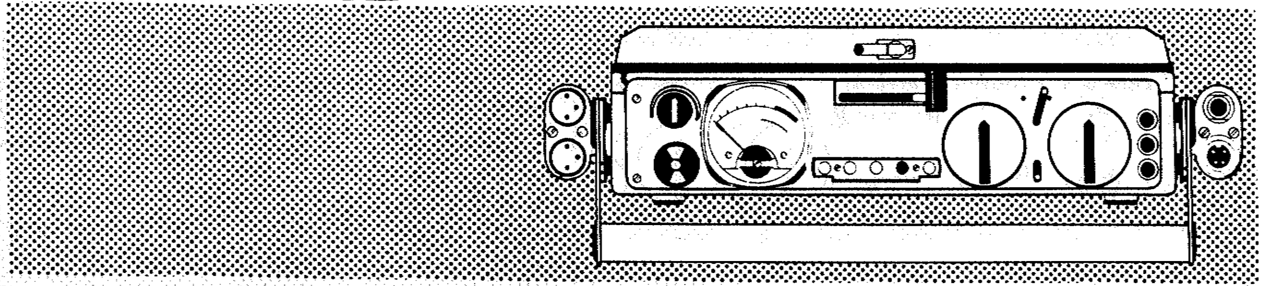
The above constitutes a simple automatic level control.
Compression characteristics of such a device are shown below:



The linear part B corresponds to the zone where theALC is operative. It will be observed that an input signal variation of 35 dB is converted to an output signal variation of only 3 dB.

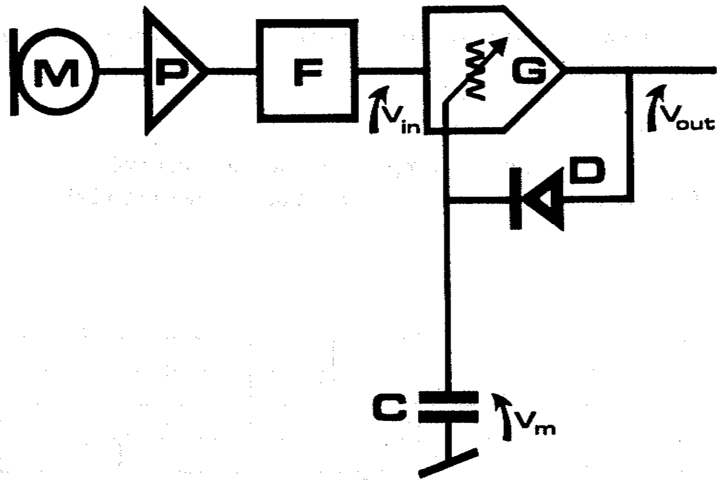
The linear part A shows that for an input signal variation of 20 dB we also obtain a 20 dB variation at output, from which can be deduced thatt the amplifier gain is constant in this zone.

The part C corresponds to the appearance of saturation of the adjustment unit (diode, condenser, amplifier).



7.1.3.
High pass filter requirement

The ALC system described above is still very incomplete. To effectively carry out its task several accessories are required, and firstly a high-pass filter F.

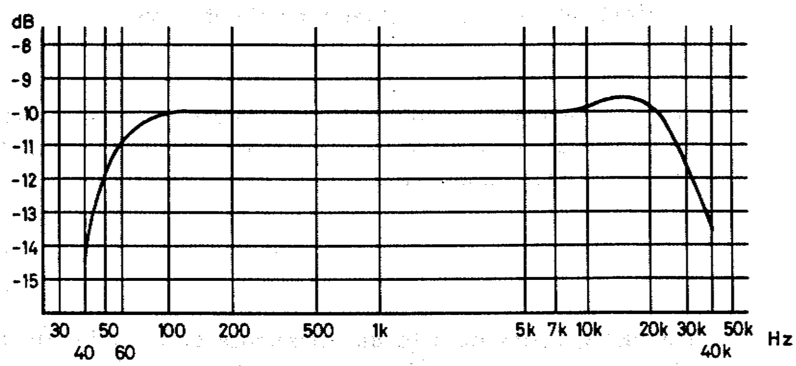


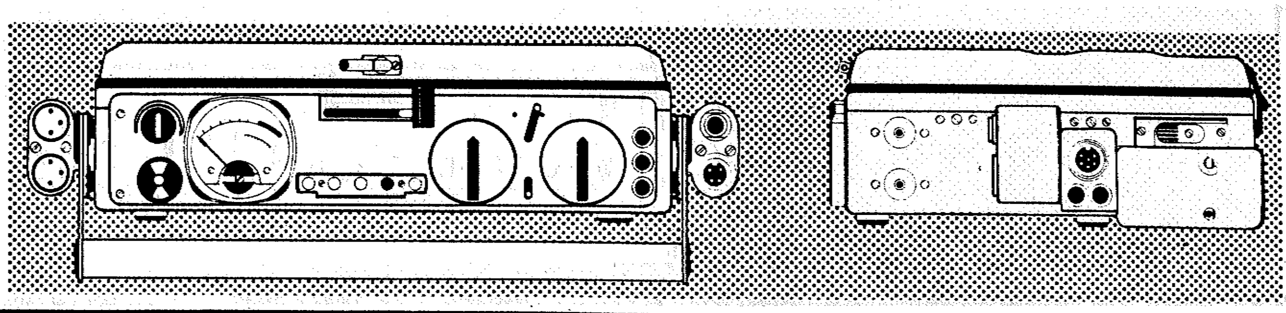
This accessory is positioned before the variable gain amplifier G. Indeed, if a recording is made where the level of infrasounds is higher than the useful signal (e.g. in a car or near an open window), the adjustment of amplifier gain would be influenced and the useful signal would "die away".

To summarize, it can be said that it is most important that at amplifier G input a signal no longer includes very low frequency signals.

At high frequencies, this phenomenon does not occur due to the low level of signals above 8 kHz.

Filter F characteristics are represented below:

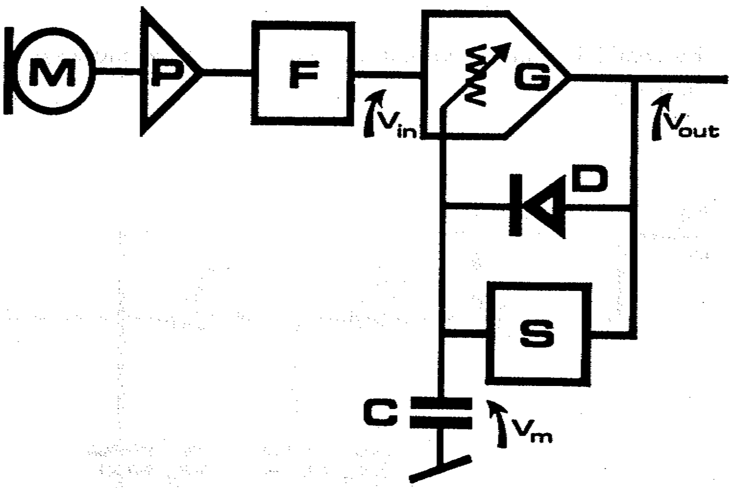




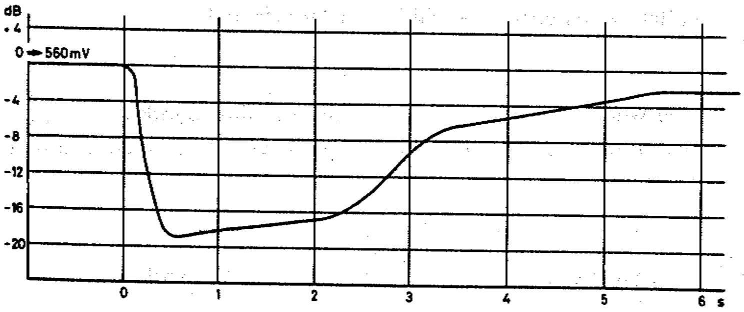
7.1.4.
Memory limitation

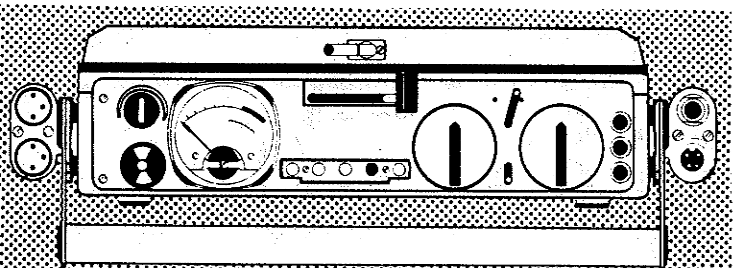
In our diagram, the condenser C constitutes a very rudimentary memory. For instance, if a recording is being made where signal amplitude varies a great deal, the condenser will memorize the largest correction required but neglect low amplitude signals. Such a situation arises when, for example, an interview begins in a noisy place and without interrupting the discussion both parties move to quieter surroundings.

Thus, memory time must be limited by discharging the condenser and this is carried out by silence detector S which is activated when the absence of Vout signal lasts more than 2 seconds.



Following a sudden −20 dB decrease of the useful signal, the recuperation curve would be as follows:





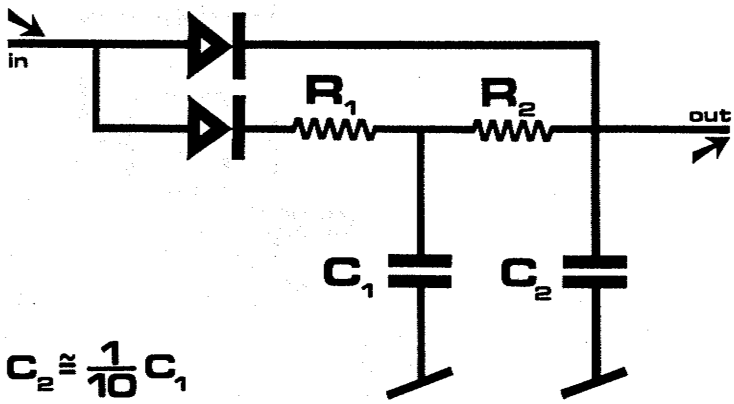
7.1.5.
Memory insensitivity to short sharp shocks

The simple condenser memory described will, however, function quite differently depending on whether load constant is great or small. In the latter case, the memory takes into consideration the shortest pulses and memorizes them, meaning that throughout memory limitation phase following such a sound, recording level of the useful signal will remain "reduced".

The tape, however, will not receive any signal capable of saturating it.

On the other hand, a greater load constant will integrate short signals and thereby saturate the tape or recording circuits.

By combining these two points, we have the real memory system of the ALC.

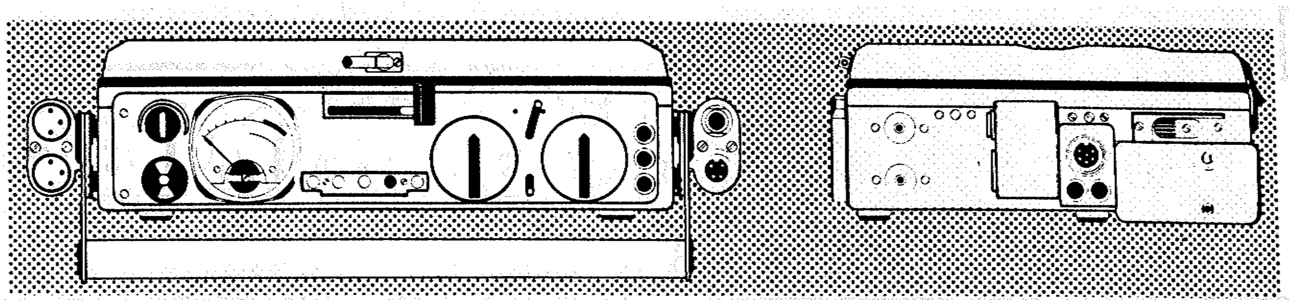


$$C_2 \cong \frac{1}{10} C_1$$

A very short signal at IN input quickly charges C_2 and the output voltage immediately acts upon the variable gain amplifier. The same signal, integrated by $R_1 C_1$ has no effect on C_1, but C_2 will rapidly discharge through R_2 into C_1. Since $C_1 = 10 \times C_2$, the voltage at its terminals will be hardly affected.

The whole operation takes a matter of milliseconds, but both the recording amplifier and the tape have been protected against saturation.

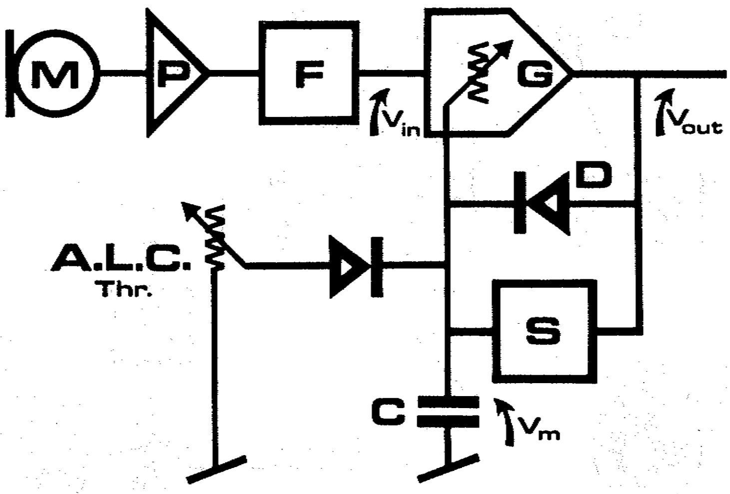
At a more uniform recording level, C_1 and C_2 work in parallel.



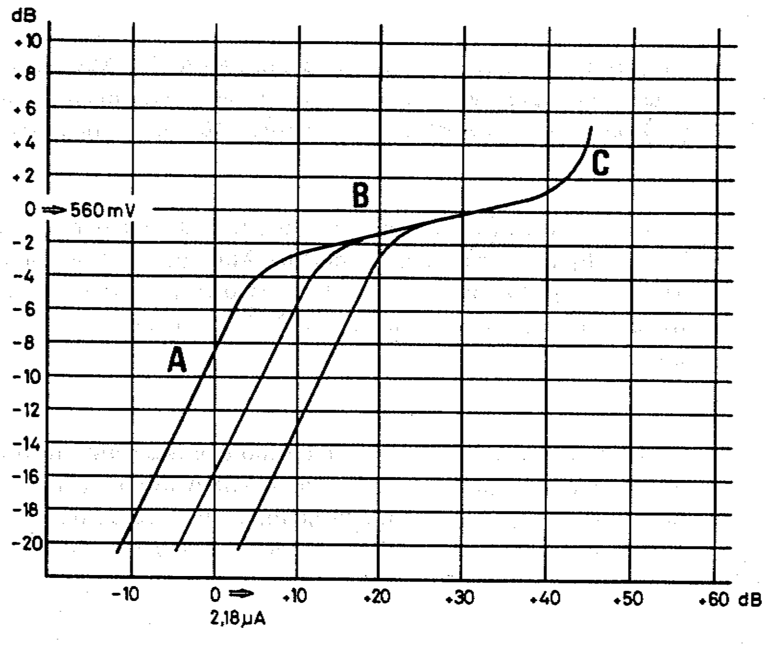
7.1.6. Another accessory - manual adjustment

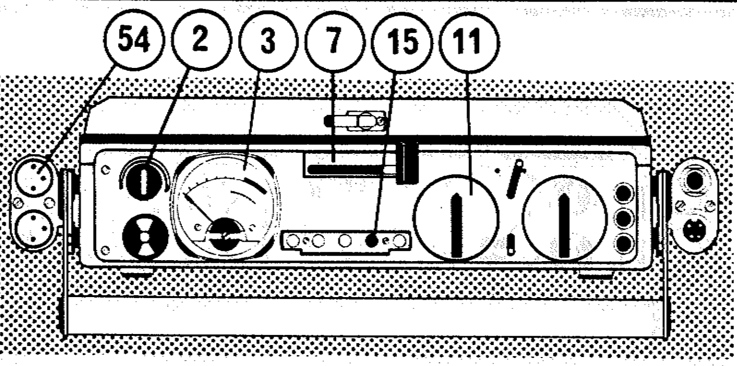
If an interview takes place where noise level is comparable to a restaurant or a busy street, etc., this will present a problem for the operator during long silences.

In the preceding paragraph, it has been shown that after 2 sec. silence the silence detector will discharge the condenser until the useful signal is picked up again. But for the recording, this will be heard as an annoying increase of ambient noise level. So to avoid this effect, the operator has at his disposal a manual control of the ALC. He can, then, select the point where compression begins and thus limit the active zone of the ALC. In this way, the ALC is used as limiter.



This adjustment produces a compression curve as shown below.

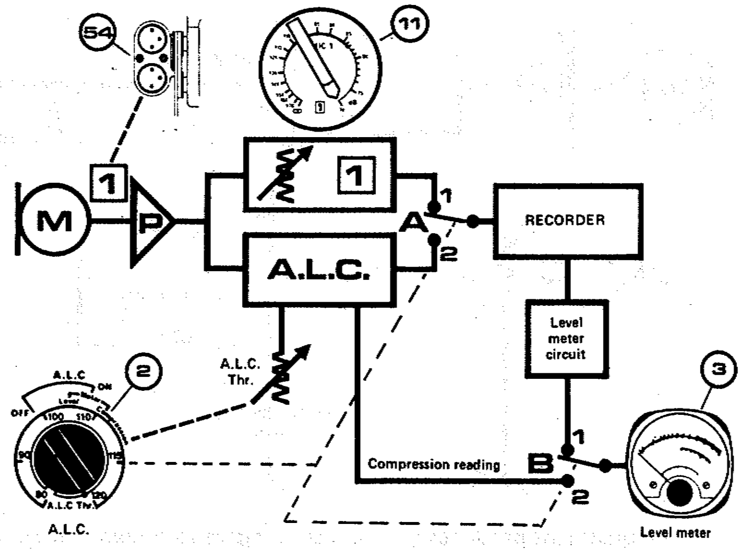




7.2
How to use the automatic level control

7.2.1. Setting up

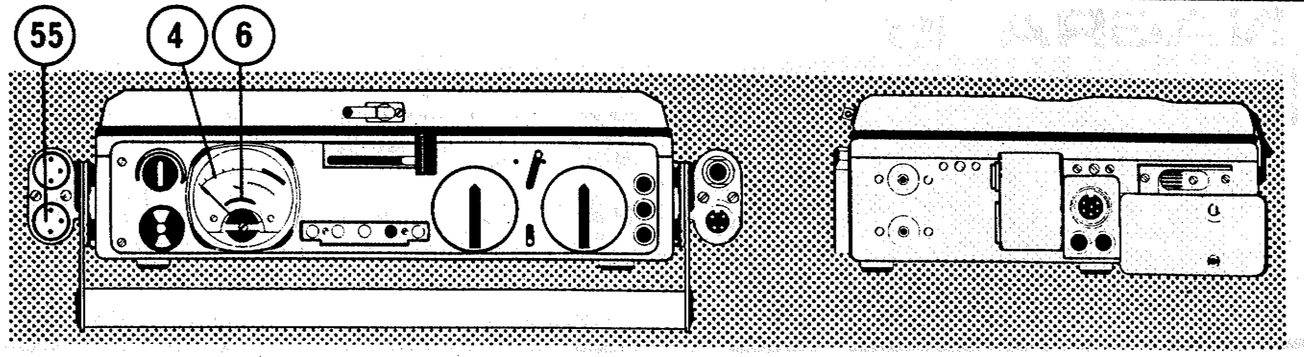
In the following text, reference is made to the synoptic diagram.



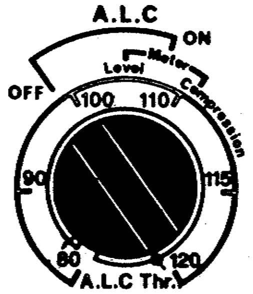
Only MIC. 1 input (54) can be connected to the ALC. Plug in microphone, preselect record mode (15) and place main selector (7) on TEST. Turn MIC. 2 level control 10 fully anticlockwise.

With ALC knob (2) in OFF position, turn the outer ring ALC. THR. fully anti-clockwise, so that the ALC system is out of use. The NAGRA IS thus connected on its own metering circuit (3) (modulometer, Super-VU-meter or Peak-VU-meter, according to option).

Create a mid-range sound level that is more or less constant (background music is quite suitable). The NAGRA IS configuration is now as shown on the synoptic diagram, i.e. A and B both switched to 1. MIC. 1 level control (11) can now be adjusted for an 0 dB reading on the meter.



7.2.2. ALC operation



Turn knob (2) to ON LEVEL. After a few seconds, the meter will show approximately 0 dB if the sound level in the room is sufficient. In this configuration, A is switched to 2 and B to 1. It will be observed that MIC. 1 level control (11) is disconnected.

Turn knob (2) to ON COMPRESSION and meter (3) will indicated on scale (6) at which point the ALC compression curve is activated. Adjust signal level to obtain 30 dB compression (if necessary, by placing the microphone closer to the sound source). If the volume of the music is suddenly turned down the compression reading will descend to a lower value after the 2 sec. required for the silence detector to become operative. But as soon as the signal is brought back to its original level, the needle will immediately indicated 30 dB.

Now place the knob (2) on ON LEVEL and carry out the same operation. Sound level corresponding to 30 dB compression will be read at 0 dB on meter (scale 4).

When the source volume is reduced, the meter will give a quantitative reading; that is to say, if the level is reduced by 20 dB, the meter indicates 20 dB, and after two seconds returns to approximately –2 dB position.

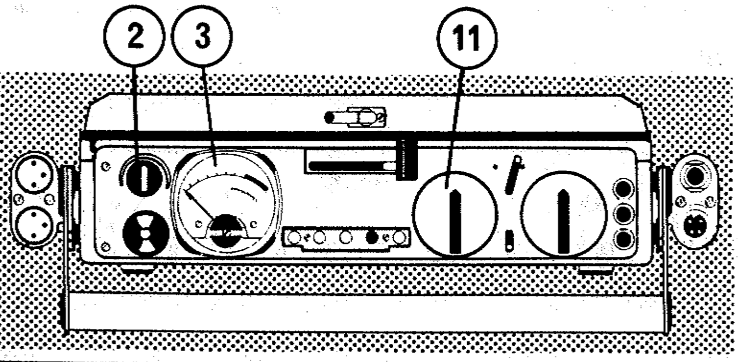
7.2.3. ON LEVEL or ON COMPRESSION

Using one microphone input, it is clear from the above that more useful information is obtained using the ALC in position ON COMPRESSION. This enables checking from time to time whether the compressor is nearing saturation point (high sound level) or inversely the minimum threshold.

However, with two microphones (MIC. 1 with ALC and MIC. 2 with manual level control) it is better to use the ON LEVEL position to control the mixing of the two signals. Note that during recording it is possible to pass from one position to the other if required.

7.2.4. How to use the ALC THRESHOLD

It will often be observed during an interview that the active zone of the compressor is too little. (e.g. 20-25 dB, with loud bursts reaching 30 dB). Under such conditions it is clear that during silences lasting longer than 2 sec. the compressor will "recuperate" the basic 20 dB compression and increase background noise level by 20 dB.

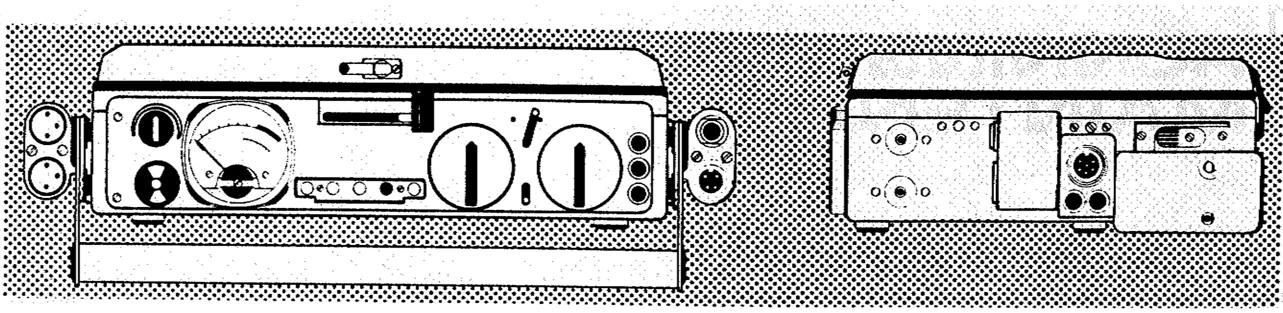


7.2.5.
ALC THR. scale

This is avoided by measuring on TEST the minimum compression rate required in position ON COMPRESSION and then by turning the ALC THR. ring clockwise until the needle indicates approximately 15 dB. Thus, during a prolonged silence, the background noise level will increase by 5 dB only, which is well within acceptable limits.

Switch off the ALC and adjust recording level manually with MIC. 1 level control (11) to obtain 0 dB on the meter (3), scale (4). Supposing that the musical signal causes the needle to oscillate between –10 dB and 0 dB and the level control indicates 100 dB, it can be said that the signal's amplitude is between 100 dB –10 dB = 90 dB and 100 dB –0 dB = 100 To operate the ALC in such a way that background noise does not become a nuisance during silences, the ALC THR. ring is turned to 90. On the other hand, in order to prevent strong sounds saturating the tape, the ALC THR. ring is turned to 100. Above 100 dB the signal is compressed.

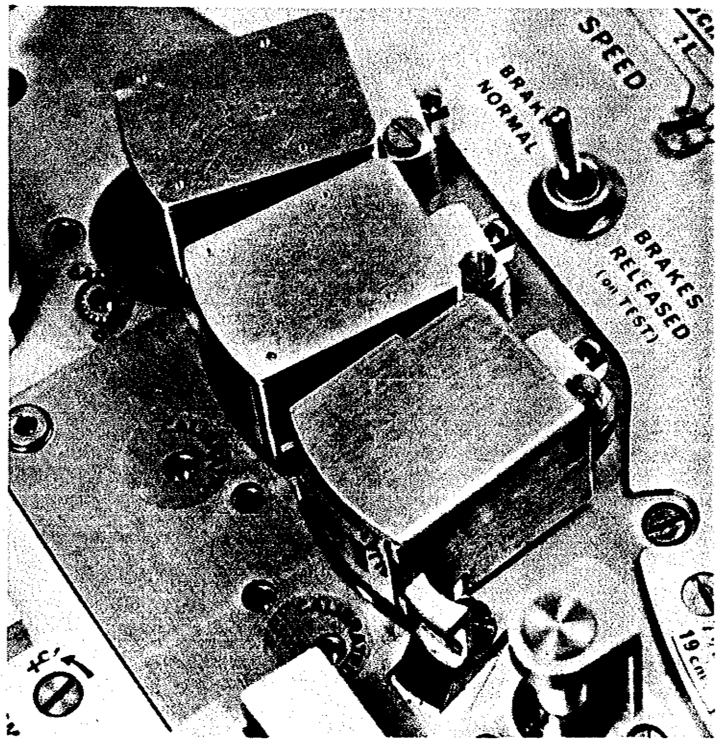
In both cases, the ALC is used as a limiter.



NAGRA IS

8 RUNNING MAINTENANCE

8.1 Magnetic head

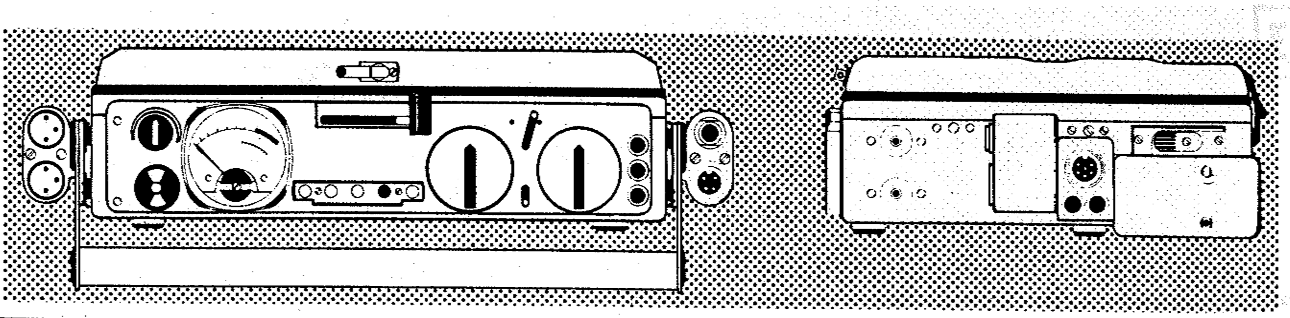


8.1.1. Head care

Head to tape contact must be impeccable. However, certain tapes tend to leave deposits on the heads which, fortunately, are visible to the human eye. Dirt particles on the playback head would give reproduction constantly lacking in high frequency. Should, however, the high frequency come and go quickly at a regular rhythm (1–10 times a second), it is the head azimuth which is at fault.

Dirt deposits on the record head would cause abnormally low level recording and sound distortion. Similarly, the erase head would function badly.

Such dirt particles are most simply removed by rubbing gently with cotton tips or a soft rag moistened with alcohol or water. Care should be taken not to use chlorinated solvants, such as trichlorethylene, which can soften resinous components used in the head assembly.



8.1.2.
Head azimuth adjustment

Theory

The actual recording and reproduction process of magnetic tape takes place as the latter moves across the respective head gaps. In order to obtain faithful reproduction, it is essential that the angle between the tape and the record head gap be identical to that formed with the reproduce head gap. Any slight variation between these two angles would result in a loss of reproduction level. This phenomenon is even more marked the shorter the wave length (i.e. ratio between tape speed and frequency of recorded signal). The end result would be a recording lacking in high frequency.

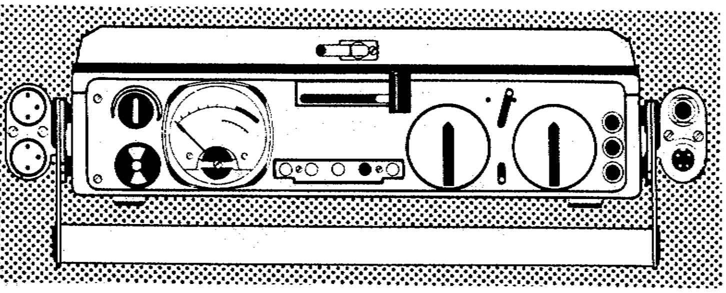
Nowadays to enable the use of different tapes, head azimuth is standardized: the angle between the gap and the tape along the line of its path when viewed from the front must be 90°. Special recorders have been constructed with optical alignment of heads for the production of test tapes to enable subsequent azimuth adjustment.

It should be noted that if a machine with an incorrect azimuth has been used, the recording can still be recovered. All that is required is the readjustment of the reproduce head in consequence. The latter can be re-oriented by ear so as to obtain the maximum treble level. Naturally, this method is also used for tapes which have become misshapen due to bad spooling or climatic conditions. If the tape itself is curved, azimuth adjustment becomes more delicate and depends on the relative position between heads and guides.

Indeed this is partly the reason why the use of very low tape speeds, i.e. below 3.75 ips, is limited: a sufficiently accurate azimuth adjustment is difficult to achieve, unless one works not across the whole tape width but on one narrow track only. Azimuth error tolerance is in fact improved the narrower the track

Treble level variation due to azimuth error

If azimuth angle is very gently disturbed, treble level is at first only slightly lowered but becomes more and more attenuated as the azimuth error becomes greater. A curve representing such attenuation in relation to azimuth error would rise and fall very



sharply but with a rounded peak. This is very important, for if azimuth is adjusted simply by selecting the maximum it is not evident that this is the centre of the curve. Then, if record and reproduce errors are added, the tape could be recorded outside tolerance limits. For using the test tape the reproduce head is adjusted, a tape is then recorded and the record head adjusted with reference to the reproduce head. Thus, the record head azimuth accumulates all errors of adjustment of both heads.

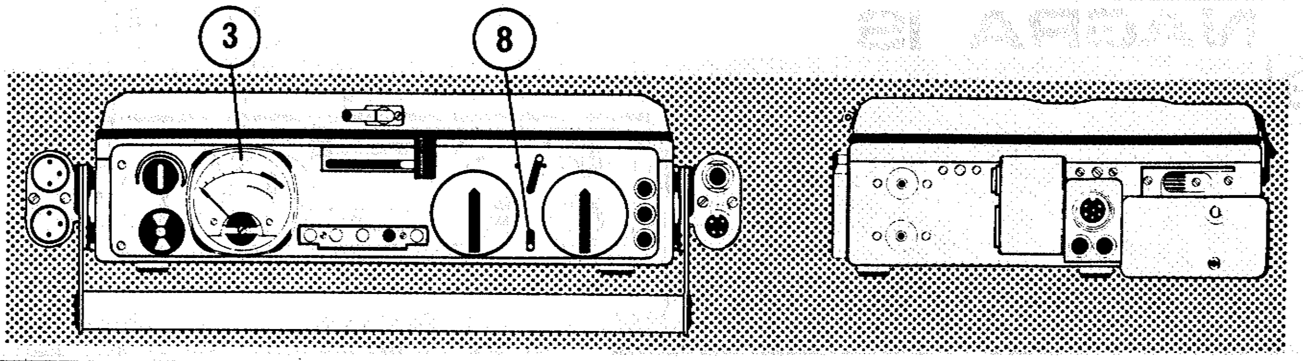
Consequently, optimum results are obtained if azimuth is adjusted at the peak of the curve. This is done by selecting two points around the maximum corresponding to a certain treble attenuation and then taking the mid-point.

Secondary maxima

If we continue to put the azimuth out of alignment whilst observing reproduction of a treble signal, it will be seen that after passing a minimum level, the signal increases to a so-called secondary maximum level. However, whereas the principal maximum corresponds to the correct angle and is applicable to all frequencies, the secondary maximum is dependent upon a precise frequency signal. If this frequency changes, the position of the secondary maximum is moved. In other words, the secondary maximum corresponds to a useless adjustment and should be avoided. If the recorder is more or less in order and only requires a more accurate adjustment, azimuth modifications will be very slight and there would be no risk of mistaking the secondary maximum. On the other hand, if it is a question of reassembly and a complete azimuth adjustment is necessary, it is advisable to first take a fairly low frequency (1 then 3 kHz) to make a rough adjustment thereby ensuring that secondary maxima fall well outside such a frequency range.

Head alignment on the NAGRA IS

NAGRA IS heads are mounted on cam-like disc's which, when turned, vary head azimuth. The outer edge of each washer is cogged and driven by gear mechanism visible in front of each head.



The disc is turned by means of an "Allen" key 2.5 mm. It is recommended to demagnetize the key beforehand since it induces very low frequencies in the reproduce head which hinder the operation.

Height of Neo-pilot Head

The central head on the NAGRA IS is for recording and reproducing the pilot signal. Since its azimuth is not critical but its height must be correct, the cam disc beneath it does not vary the angle but raises or lowers the head. Therefore, before carrying out azimuth adjustments, first check that the Neo–pilot head is correctly positioned. The tape should systematically pass between tow grooves on the head and a sufficiently accurate adjustment can be made by eye.

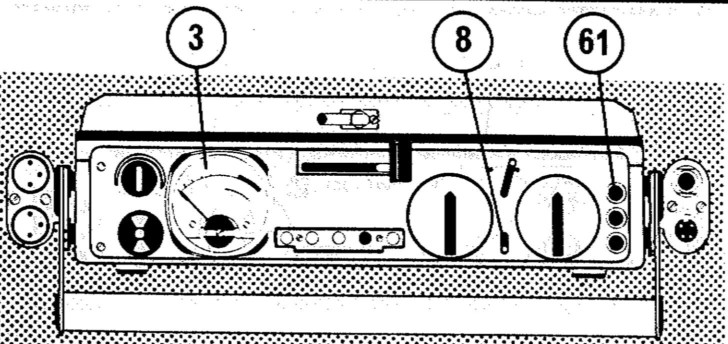
8.1.3.
Azimuth alignment procedure

Reproduce head

Play the azimuth section of test tape at 7.5 ips, LINE–PHONES–METER switch (8) on DIRECT, and level reading on modulometer (3). With MIC. 1 level control fully anticlockwise, it is usually necessary to turn MIC. 2 level control completely clockwise, or almost, in order to obtain an adequate output of around −10 dB, since test tapes are recorded between −10 dB and −20 dB.

By inserting an Allen key in the head pinion, adjust to maximum output as viewed on the meter. Ensure that the real maximum is found by establishing left and right hand points where the signal decreases by 1-2 dB and centre the pinion between them.

Correct adjustment corresponds to stable output. Errors due to curvature of the tape are virtually imperceptible at the peak of the treble attenuation curve but become marked outside this zone. After optimum adjustment, the azimuth key is very carefully removed.



Record head

There are two possible methods.

a) Classical
In this case, an audio frequency generator capable of producing a 1, 3, 10 or 15 kHz signal, an audio frequency voltmeter and an oscilloscope are required.

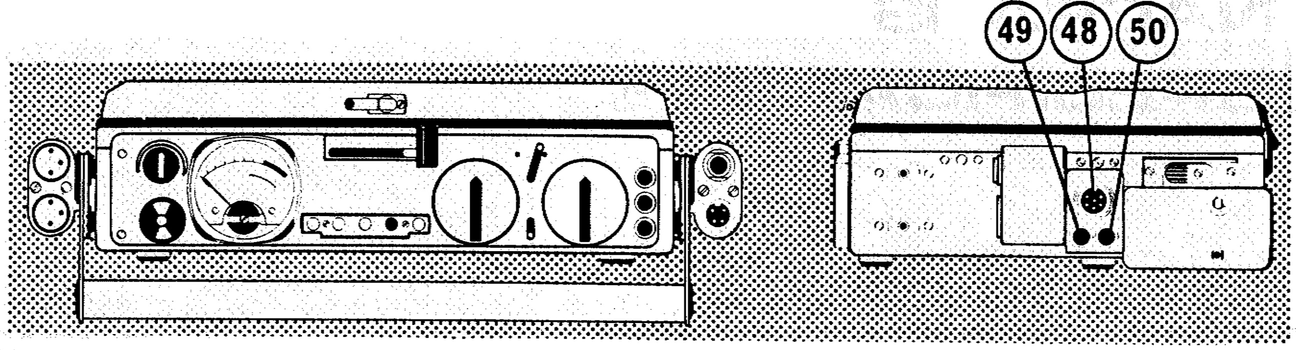
Procedure:

- The generator signal enters the NAGRA IS at line input (49) (50) and the level is adjusted to read –15 dB on the scale (4) of the meter (3).
- The voltmeter is connected to line output (61). The signal to be measured will give approximately 0.8 RMS. LINE–PHONES–METER switch (8) on TAPE.
- Thread tape and record. Voltmeter indicates the signal reproduced.
- Beginning with 1 kHz, frequency is increased until the output signal begins to drop by one or two decibels, and then align record head. Finalize adjustment at 12 kHz by centring between two attenuation points.

b) By ear
Due to the fact that the classical method requires the use of voluminous instruments, another method, just as accurate, has been developed; in this case, only a reference generator and a high quality headset are required.

Procedure:

- Once the reproduce head has been adjusted as above, thread a tape on the machine.



- Record reference generator signal and listen to output signal with headset (LINE–PHONES–METER switch (8) on TAPE).
- Adjust record head azimuth to obtain maximum treble output (10 kHz), cross-checking with direct sound to appreciate desired results. Ascertain two points either side of the optimum which indicate equal treble attenuation and centre azimuth between them.

8.2 Guide, capstan and pinchweel

With intensive use the tape leaves a deposit on the guides, capstan and pinchwheel which hampers tape transport. These are cleaned like the heads with cotton tips or a soft rag moistened with water or alcohol.

Warning

Warning: when cleaning pinchwheel, do not let liquid run down the spindle as this will wash out the lubricant in the bearings.

8.3 Motors

These are overhauled and cleaned at the factory only.

8.4 Lubrication

Not noramlly necessary but if required it is best carried out by the local NAGRA agent.

9 SPECIFICATIONS

9.1 Size and weight

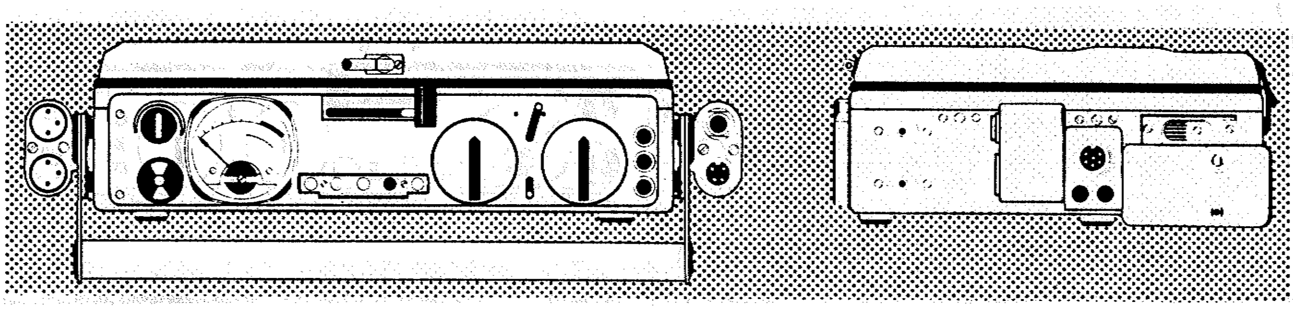
Size of box itself, lid closed, no knobs, handles or handle mountings	274 x 198 x 85 mm (11 x 8 x 3.4 ins)
Overall size, without removable handle	340 x 218 x 85 mm (13.6 x 8.75 x 3.4 ins)
Thickness of anticorodal sheet used for the box	2 mm (0.08 ins)
Thickness of tapedeck	3 mm (0.12 ins)
Empty weight, without tapes or batteries	3.7 kg (8 lb 2 oz)
Weight with ordinary batteries and 5" spools of tape	4.5 kg (9 lb 14 oz)

9.2 Power supply

DC voltage, negative to earth	+7.2 V to +12 V
Consumption on	
TEST	95 mA
LINEPLAYBACK	200 mA
RECORD - L and LT versions	320 mA
RECORD - D, DE & T versions	310 mA
FAST REWIND	345 mA
STAND–BY position	1,3 mA
Type of batteries used	
8 CEI standard	R20
8 ASA standard	D and L 90

Approximate battery life:

- 2 hours every 24 hours (50 % record, 50 % playback)	
Eveready 1150 carbon batteries	16 hours
Eveready E 95 managnese batteries	40 hours
- continuous use	
Eveready 1150 carbon batteries	9 hours
Eveready E 95 manganese batteries	26 hours
Rechargeable cells	10 hours



9.3 Tape

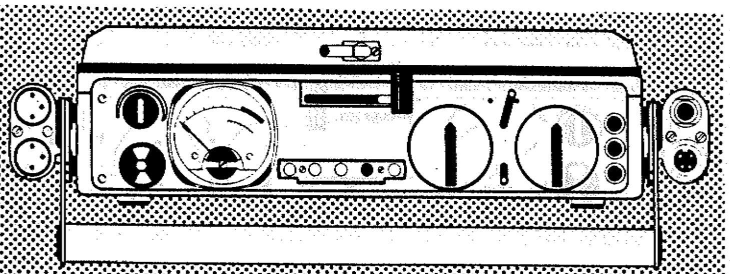
Nominal width	6.25 mm (1/4 in)
Acceptable thicknesses	12-50 μm (0.5 to 2 mils)
Maximum diameter of reels, lid open or closed	127 mm (5 ins)
Recording time, 1.5 mils tape, 7.5 ips	22 min.
Rewind time with 5 ins reel, 1.5 mils tape:	
Mains ATI Cells IACC Batt. IBAT	about 80 s

9.4 Transport

Switchable, nominal speeds	19.05 cm/s (7.5 ips) 9.525 cm/s (3.75 ips)
Nominal speed stability in relation to temperature, position of the recorder, distribution of the tape between the reels and voltage supply	± 0.1 %
Wow and flutter, peak-to-peak value, DIN 45 507 weighted	
7.5 ips	± 0.11%
3.75 ips	± 0.15%

9.5 Amplifier chain

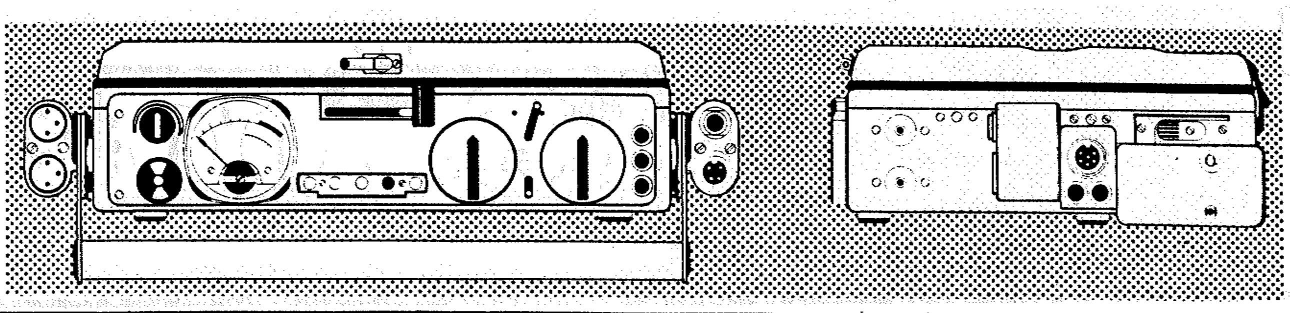
Nominal microphone sensitivity (dynamic mike) minimum input level for 0 dB	182 μV
Nominal microphone sensitivity (condenser mike), minimum input level for 0 dB	1.1 mV



Overall frequency response, mike input 200 Ω, unloaded line output from 50 Hz to 15 kHz	± 1 dB
Total distortion at 0 dB, 20 mV input, output load 600 Ω	<0.15%
Input voltage for +40 dB, 1 kHz, for distortion ⩽ 1 %	65 mV
Noise level of mike preamplifier, ASA A weighted, ref. 1 mW, load 200 Ω	124 dBm
Preamplifier contribution to mike thermal noise: margin in relation to theoretical minimum thermal noise	3 dB
Line voltage input, impedance 100 kΩ, minimum voltage for recording at 0 dB	218 mV
Maximum tolerated voltage	100 V
Line current input, minimum current to record at 0 dB	2.18 μA

9.6 Automatic level control

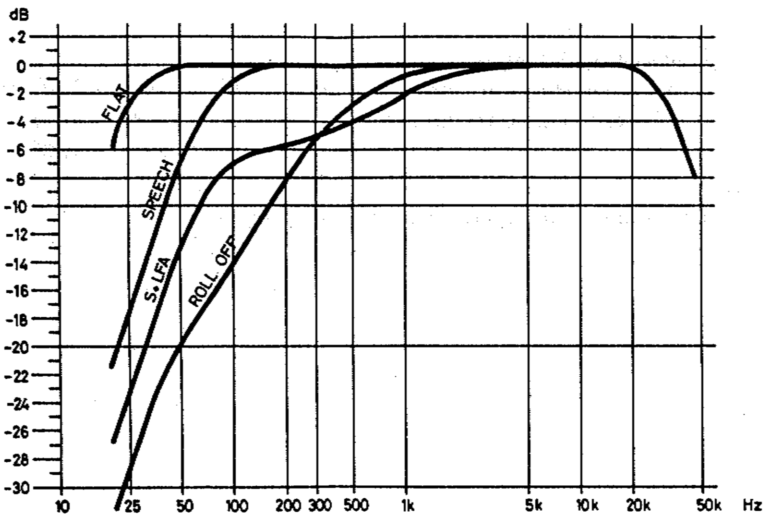
Mike input voltage at beginning of compression for recording at nominal level	350 μV
Recovery time	8 sec.
Average distortion at 1 kHz, 3rd harmonic	<1.5%
Frequency response from 50 Hz to 15 kHz	± 1 dB
Signal-to-noise ratio of threshold adjustment	40 dB



9.7 Filters

	Attenuation
· FLAT	–4 dB at 20 Hz
· SPEECH	–7 dB at 50 Hz
· S + LFA	–13 dB at 50 Hz
· ROLL OFF	–8 dB at 200 Hz

For exact curves, see "Filter frequency response" graph below:

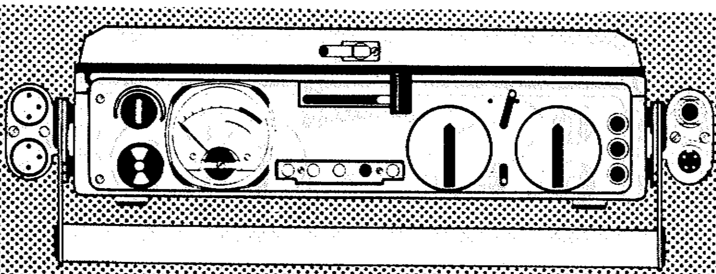


9.8 Reference generator

Composite 1.1 kHz/10 kHz sine wave signal	level 0 VU = –8 dB ± 0.2 dB

9.9 Outputs

Line output voltage unloaded for 0 dB on modulometer	4.4 V
Line output impedance at 1 kHz	80 Ω
Maximum output voltage on 600 Ω for < 1 % distortion	
at 63 Hz	8.8 V
at 1 kHz	8.8 V



Headphone output voltage on 50 Ω for 0 dB on modulometer — 0.4 V ± 0.1 V

9.10 Built-in loudspeaker

Power output of the amplifier — 250 mV

9.11 Operating conditions

Tolerated temperatures
- with manganese batteries — –20 to + 70° C (–4 to + 160° F)
- with external power supply — –30 to + 70° C (–22 to + 160° F)

The recorder functions correctly in any position

9.12 Meter

9.12.1. Modulometer

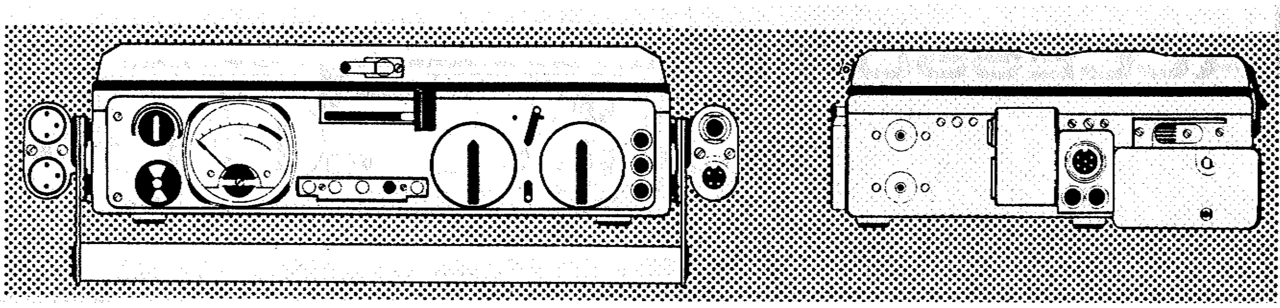
Integration time for –2 dB	5 msec ± 20 % (option 10 msec ± 20 %)
Usable scale	–20 dB to +3 dB
Frequency response from 50 Hz to 15 kHz	± 1 dB

9.12.2. Super-VU-meter

Integration time at –2 dB	170 msec ± 20 %
Scale	–20 dB to +3 dB
Frequency response from 50 Hz to 15 kHz	± 1 dB

9.12.3. Peak-VU-meter

Combination of Modulometer and Super-VU-meter
Maximum of two indications



9.13 Record - reproduce chain

Nominal recording level which is also the maximum peak level (MPL)	0 dB = 320 nWb/m
Tape used for tests:	
CCIR standard	PER 525/LGR 30
NAB standard	3M 176-7 or 208
Erase efficiency at MPL	77 dB
Frequency response, recording at −20 dB	
7.5 ips CCIR & NAB from 50 Hz to 15 kHz	± 2 dB
3.75 ips CCIR & NAB from 50 Hz to 10 kHz	± 3 dB
* Distortion at MPL, 0 dB	
3rd harmonic	< 1%
2nd harmonic	< 0.5%
at +3 dB 3rd harmonic	< 2%
* Signal-to-noise ratio of playback chain alone, motor running and dummy tape, ASA A weighted, MPL	72 dB
Signal-to-noise ratio in record-reproduce mode, MPL at 7.5 ips, ASA A weighted	
NAB	63 dB
CCIR	62 dB

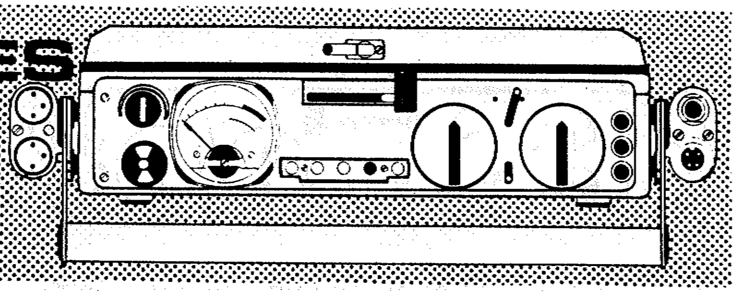
9.14 Pilot chain

Tolerable voltage input of pilot signal, impedance > 4.7 kΩ	0.25 V at 10 V
Pilot signal output voltage	1 V

* *For recorder with pilot, distortion is increased by about 0.5 % and signal-to-noise ratio reduced by 2 dB.*

NAGRA IS

10 ACCESSORIES



10.1.

Cables carring case

10.1.1.
Cables for sound accessories

CR — 5 ft. microphone cable with 1 female 3-pole Tuchel plug and 1 female 3-pole Cannon plug
Weight: 4 oz

QCR — 5 ft. microphone cable with 1 female 3-pole Tuchel plug and 1 male 3-pole Cannon plug
Weight: 3 1/2 oz

CC — 33 ft. extension cable with 1 male 3-pole Cannon plug and 1 female 3-pole Cannon plug. Under no circumstances can this cable be used to connect a microphone with a male 3-pole connector to a NAGRA with female 3-pole Cannon microphone sockets (NAB model)
Weight: 14 oz

CS — 10 ft. shielded cable with two conductors and earth (radio, amplifier, etc.)
Weight: 8 oz

10.1.2.
Cables for synchronization accessories

QCP — Spare-pilot cable ATN-2 and ATI
Weight: 3 1/2 oz

QCE — 33 ft. synchronisation cable for Eclair NPR camera
Weight: 14 oz

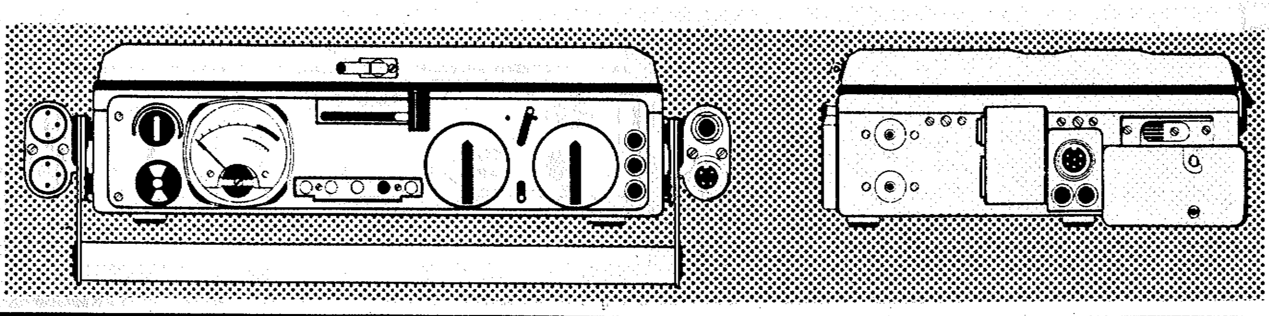
QCX — 33 ft. synchronisation cable for Arriflex ST, BL and Bolex 16 PRO cameras
Weight: 14 oz

10.1.3.
Carrying case

IHT — Standard beige leather carrying case with 2 side pockets
Weight: 1 lb 7 oz

IHP — Carrying handle
Weight: 5 oz

IHC — Spare strap
Weight: 3 1/2 oz



10.2
Power supply Accessories

IBAT Interchangeable compartment for batteries or rechargeable cells
Weight: 7 oz

IACC Interchangeable rechargeable cell compartment for DSM monitor and NAGRA IS
Weight: 1 lb 13 oz

ATI Combined mains power supply and battery charger
- NAGRA IS power supply, 110-240 V ± 10 %, 50/60 Hz. Supplies a 1 V signal at mains frequency for the pilot signal when using a camera with synchronous motor powered by same mains
- Battery charger using IACC compartment. Switchable 0.35 A or 0.17 A: charging time 7 hours or 14 hours respectively.
  Size: 11 x 2 3/4 x 1 1/4 ins
  Weight: 1 lb 13 oz

10.3
Test tapes

IEC Set of 3 test tapes (9.5 cm/s, 19 cm/s, 38 cm/s)

NAB Set of 3 test tapes (3 3/4 ips, 7 1/2 ips, 15 ips)

IEC Multifrequency test tape 9.5 cm/s

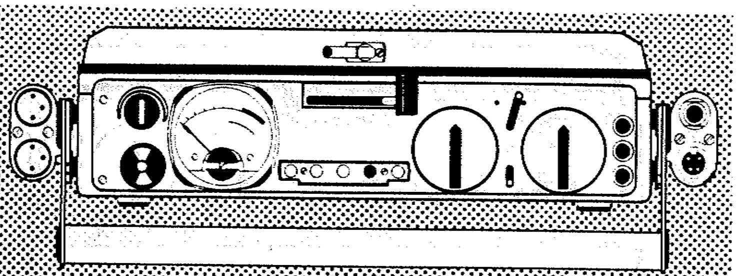
IEC Multifrequency test tape 19 cm/s

NAB Multifrequency test tape 3 3/4 ips

NAB Multifrequency test tape 7 1/2 ips

10.4
Microphone and headphones

We also stock a wide range of condenser and dynamic microphones, as well as a selection of headsets, of which up-dated lists are available on request.



10.5

Miscellaneous accessories

DSM Field monitor and amplifier adaptable to all NAGRA models. Internal power supply, mains 110/220 V, 48 - 440 Hz, or IACC rechargeable cell compartment. Battery charger incorporated. 2 loudspeakers, treble & bass, power output 20 W RMS mains powered, 8 W cell powered. Frequency response 60 - 16 000 Hz ± 3 dB. External speaker output, +1 unbalanced input, 2 balanced line outputs, 1 dynamic microphone input. 3-position filter
Size: 12 3/4 x 5 x 9 1/2 ins
Weight: 13 lb 13 oz

10.6

IESL accessorie

The IESL synchronizes the NAGRA IS to which it is connected with the internal signal of the crystal generator or with an external signal of 0.4 to 10V.
A meter indicates phase reserve and lack of either playback or crystal signal.

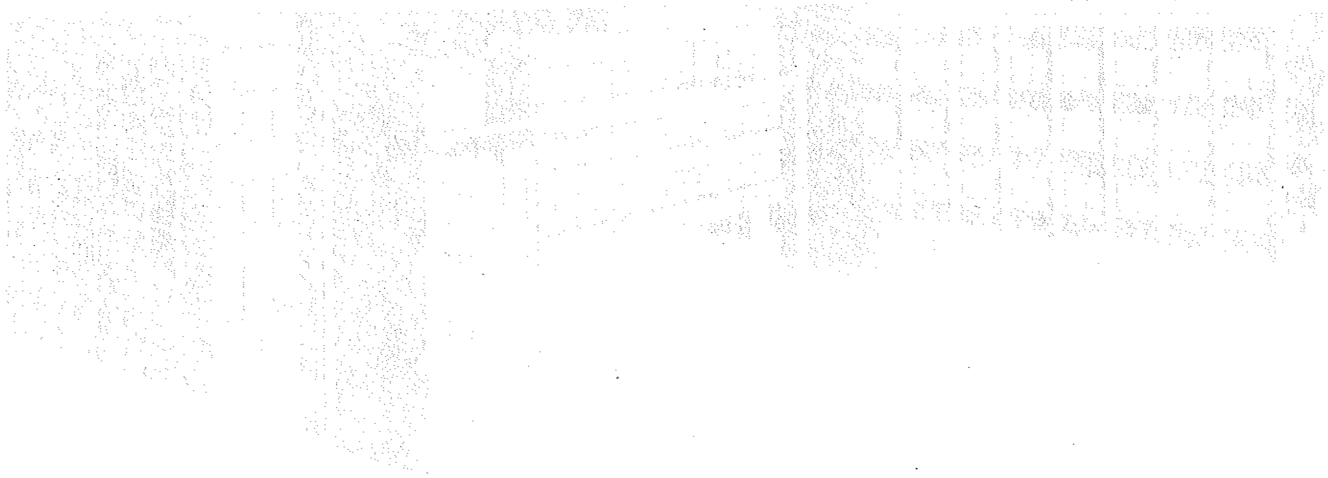
10.7

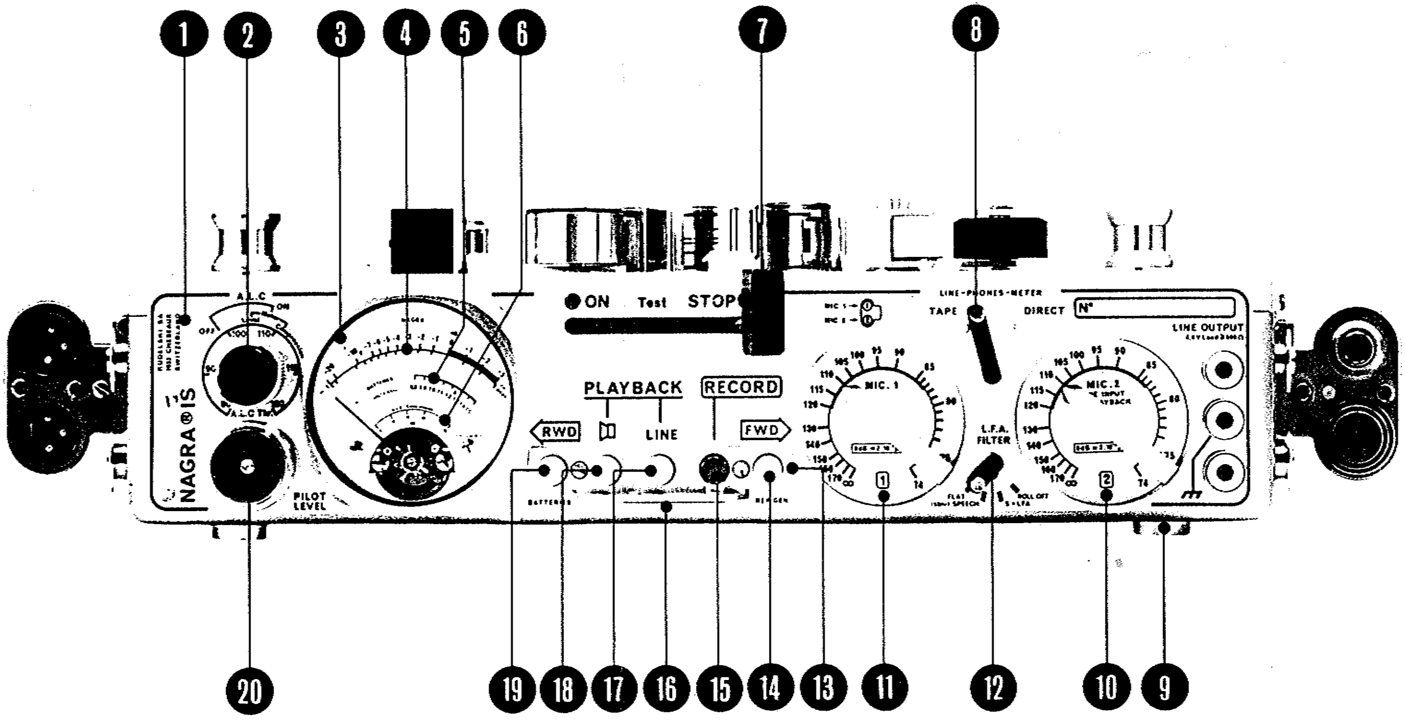
Miscellaneous instruments

MAG Electronically-controlled degausser for recorder tape-deck, 220-240 V mains
Size: 11 x 8 1/2 x 2 ins
Weight: 4 lb 3 oz

MAG Electronically-controlled degausser for recorder tape-deck, 110-117 V mains
Size: 11 x 8 1/2 x 2 ins
Weight: 4 lb 3 oz

AST Stabilized power supply for laboratory measurements, 30 V - 1 A max., voltage and current regulation, with measurement control instrument
Size: 14 x 8 3/4 x 5 1/2 ins
Weight: 11 lb 11 oz

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A.L.C
ON Test STOP
LINE-PHONES-METER
TAPE
DIRECT
N°
LINE OUTPUT
MIC. 1
MIC. 2
PLAYBACK
LINE
RECORD
RWD
FWD
L.F.A. FILTER
NAGRA IS
PILOT LEVEL
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19
18
17
16
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11
12
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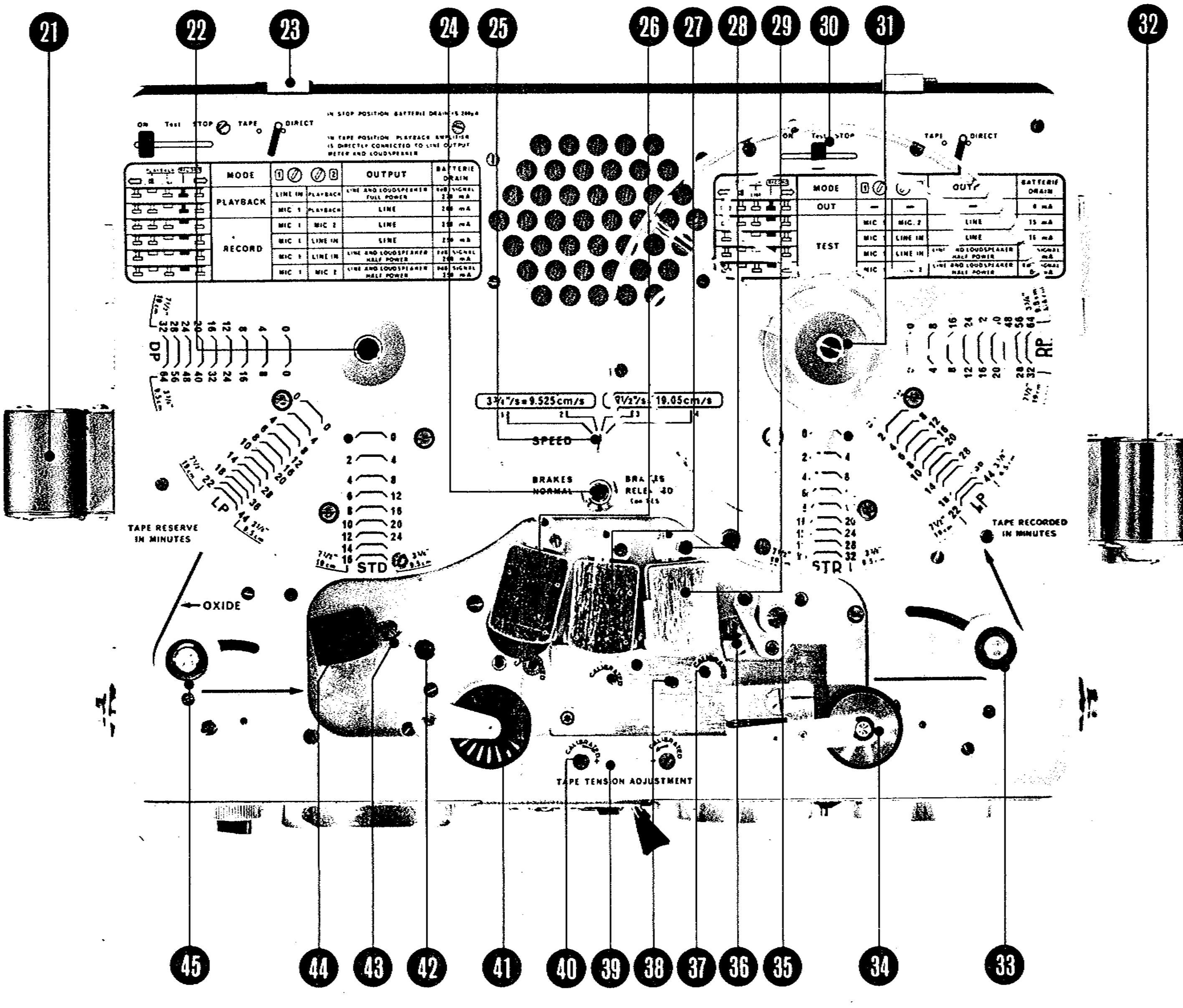
9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MODE
OUTPUT
PLAYBACK
RECORD
TEST
DP
LP
STD
3¾"/s = 9.525cm/s
7½"/s = 19.05cm/s
SPEED
BRAKES NORMAL
BRAKES RELEASED
TAPE RESERVE IN MINUTES
OXIDE
TAPE RECORDED IN MINUTES
TAPE TENSION ADJUSTMENT
45
44
43
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41
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37
36
35
34
33

1. **Interchangeable Plate**
Plaquette interchangeable
Auswechselbarer Frontplatten-Teil

2. ALC **Outer Ring: automatic level control compression setting (Optional)**
Inner Button: ON and OFF switch of the ALC, with level meter switching (compression or level)
Couronne: réglage de compression du régulateur automatique de sensibilité (option)
Bouton: mise en action du RAS avec commutation de l'indicateur de niveau (compression ou niveau)
Stellring: Kompressions-Einstellung des autom. Empfindlichkeits-Regulators (auf Wahl)
Stellknopf: Einschaltung des ALC, mit Umschaltung des Pegel-Anzeigers (Pegel od. Kompression)

3. **Level Meter**
Indicateur de niveau
Pegel-Anzeiger

4. **Scale indicating the available level on line output**
Echelle indiquant le niveau disponible en sortie ligne
Anzeigeskala des Nutzpegels

5. **Scale indicating the average voltage per battery cell**
Echelle indiquant la tension moyenne des éléments de piles
Anzeigeskala der mittl. Batterie-Zellenspannung

6. **Scale indicating the compression level of the ALC**
Echelle indiquant la compression du régulateur automatique
Anzeigeskala des ALC-Kompression

7. **Main Selector**
Sélecteur principal
Hauptwahlschalter

8. **Tape-Direct Selector**
Sélecteur Tape-Direct
Wahlschalter Tape-Direct

9. **Anti-Slip Pads**
Pieds antidérapants
Gleitfeste Füsse

10. MIC-2 **Micro 2 Input, Line Input or Playback Level Control**
Potentiomètre du niveau entrée micro 2, entrée ligne ou lecture
Potentiometer für Pegelregulierung des Mikrophoneinganges 2 des Linieneinganges oder der Wiedergabe

11. MIC-1 **Micro 1 Input Level Control**
Potentiomètre du niveau entrée micro 1
Potentiometer für Pegelregulierung des Mikrophoneinganges 1

12. **4-Position Filter Selector**
Sélecteur de filtre à 4 position
Filterwahlschalter, 4 Positionen

13. **Preselector Keyboard**
Clavier de présélection
Vorwahl-Drucktasten

14. FWD **Fast Forward, Reference Generator Control**
Touche d'avance rapide et du générateur de référence
Taste für Vorlauf und Ref.-Generator

15. RECORD **Record Control**
Touche d'enregistrement
Aufnahmetaste

16. **Record Button Locking**
Verrouillage de la touche d'enregistrement
Aufnahmetasten-Verriegelung

17. LINE **Line and Headphones Control**
Lecture en ligne et au casque
Hörwiedergabetaste Linie und Kopfhörer

18. **Line, Headphones, and Loudspeaker Playback Control**
Lecture en ligne, au casque et au haut-parleur
Hörwiedergabetaste Linie und Kopfhörer und L.S.

19. RWD **Fast Rewind and Battery Check Control**
Touche de retour rapide et contrôle des piles
Rücklauf- und Batterienkontrolltaste

20. **Pilot Indicator (IS-L/LT)**
Voyant pilote (IS-L/LT)
Pilotschauzeichen (IS-L/LT)

21. **Left Connector Lug**
Porte-prise gauche
Linker Anschlussbuchsen-Träger

22. **Left Reel Support**
Porte-bobine gauche
Linker Spulenträger

23. **Lid Hinge**
Charnière de couvercle
Deckelscharnier

24. BRAKES **Holding Brake Control Switch**
Desserrage des freins de parc
Bremslüftung

25. SPEED **Speed and Tape Selector (IS-DT/LT)**
Sélecteur de vitesse et de bande (IS-DT/LT)
Geschwindigkeits- und Bandwahlschalter (IS-DT/LT)

26. **Record Head**
Tête d'enregistrement
Aufnahmekopf

27. **Pilot Head (IS-L/LT)**
Tête pilote (IS-L/LT)
Pilotkopf (IS-L/LT)

28. **Head Squaring Screw**
Vis d'équerrage de la tête
Lotstellschraube des Kopfes

29. **Playback Head**
Tête de lecture
Wiedergabekopf

30. **5" Reel**
Bobine 13 cm
13 cm-Spule

31. **Right Reel Support**
Porte-bobine droit
Rechter Spulenträger

32. **Right Connector Lug**
Porte-prise droit
Rechter Anschlussbuchsenträger

33. **Take-up Reel Tension Arm**
Tensiomètre de bobine réceptrice
Bandzugsensor für Aufwickelspule

34. **Pinch Wheel**
Contre-cabestan
Andruck-Rolle

35. **Capstan**
Cabestan
Kapstan

36. **Fixed Tape Guide**
Guide-bande fixe
Feste Bandführung

37. **Head Azimuth Adjusting Screw**
Vis d'azimutage de la tête
Nivelierstellschraube des Kopfes

38. **Head Setting Screw**
Vis de fixation de la tête
Kopf-Befestigungsschraube

39. **Lid Closing Hook**
Crochet de fermeture du couvercle
Deckelverschluss

40. **Tape Tension Adjustement (unwind and take-up sides)**
Réglage de tension de la bande (bobine débitrice et receptri
Bandzug-Regulierschraube (Aufwickelspule und Abwickelsp e)

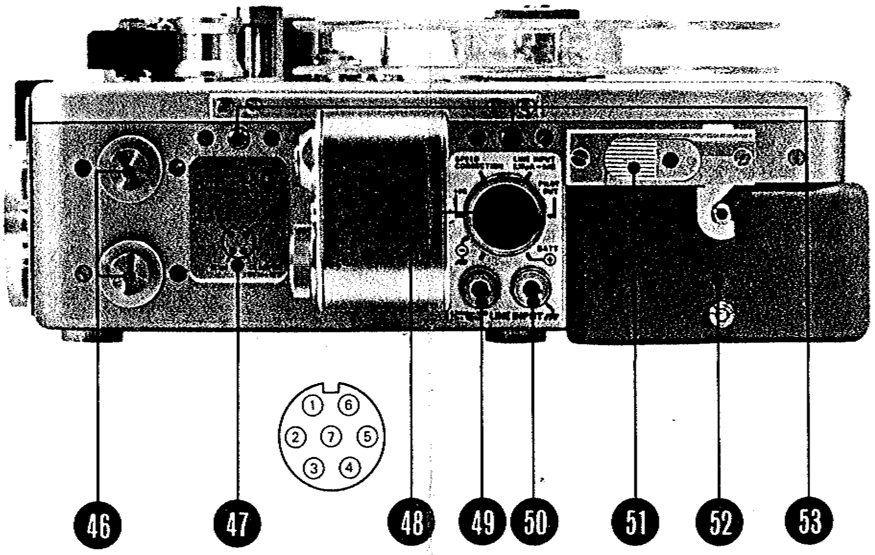
41. **Stroboscopic Wheel (50 or 60 Hz)**
Galet stroboscopique 50 ou 60 Hz)
Stroboskoprolle (50 oder 60 Hz)

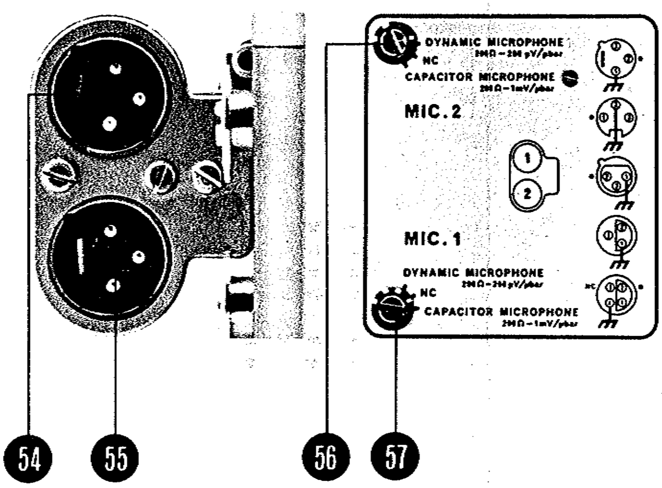
42. **Stroboscope LED**
Diode électroluminescente du stroboscope (IS-L/LT)
LED des Stroboskops

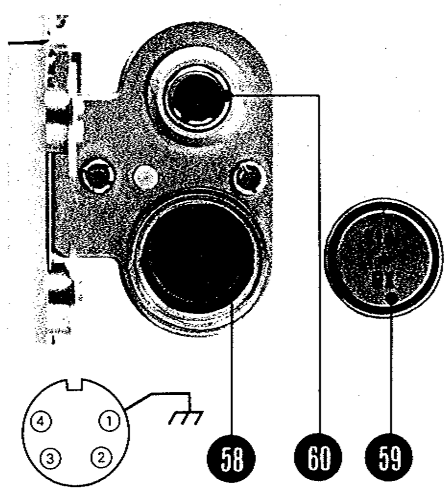
43. **Fixed Tape Guide**
Guide-bande fixe
Feste Bandführung

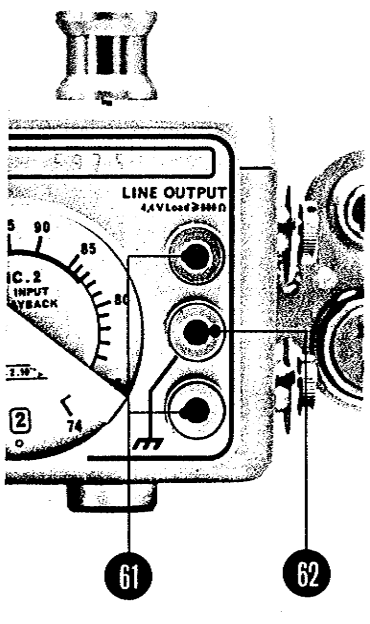
44. **Erase Head**
Tête d'effacement
Löschkopf

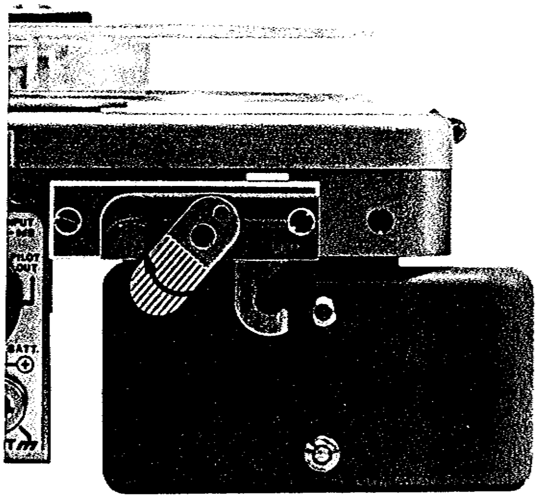
45. **Supply Reel Tension Arm**
Tensiomètre de bobine débitrice
Bandzugsensor für Abwickelspule











BATTERY COMPARTMENT INSTALLATION

MISE EN PLACE DU BOITIER A PILES

EINSETZEN DER BATTERIENBEHAELTER

46 Anchors for Carrying Strap or Handle with Fastening Screws
Ancrage de courroie ou de poignée avec vis de serrage
Tragriemen- oder Traggriff-Befestigungsschrauben

47 Right Connector Lug Plate
Plaquette porte-prise droit
Schild zu rechtem Anschlussträger

48 7-Pole Accessory Connector
1. Tape speed correction - possibility to stop the tape by grounding
2. + 6V stabilized output, available to feed an accessory (I max = 50 mA).
3. Ground of the recorder used only for current line input
4. Voltage output protected by a 250 mA fuse, available to feed an accessory. Cannot be used to externally power the NAGRA IS
5. 1V pilot playback output (50 or 60 Hz) (IS-L/LT)
6. Current line input, OdB min = 218 μA Umax = 100V
7. Ground for accessoiries (switched)

Prise accessoires à 7 pôles
1. Correction vitesse de défilement. Possibilité d'arrêt par mise à la masse
2. Sortie 6V stabilisée (50 mA max), disponible pour alimenter un accessoire
3. Masse de l'appareil utilisée uniquement pour l'entrée en courant de la ligne
4. Sortie tension batterie protégée par fusible de 250 mA, disponible pour alimenter un accessoire. Ne peut pas servir à alimenter le NAGRA IS par une alimentation externe
5. Sortie lecture pilote (50 ou 60 Hz),1V,(IS-L/LT)
6. Entrée ligne en courant, OdB min = 218 μA, Umax = 100 V
7. Masse pour accessoire (commutée)

7-polige Zusatz-Buchse
1. Laufgeschwindigkeits-Korrektur; Anhalte-Möglichkeit durch Masseschluss
2. Stab. 6V-Ausgang für Zusatzgeräte (max. 50 mA)
3. Geräte-Masse, für strommässigen Linieneingang
4. Batterie-Ausgang für Zusatzgeräte (max. 50 mA) (geschützt durch 250 mA-Sicherung) Nicht als externe An-Speisung des NAGRA IS benützbar!
5. Pilotwiedergabe-Ausgang (50 oder 60 Hz),1V, (IS-L/LT)
6. Linieneingang (strommässig),OdB min = 218 μA, Vmax = 100 V
7. Masse für Zubehör

49 Voltage Line Input, OdBmin = 218 mV, input impedance = 100 kΩ, Umax = 100 V
Entrée ligne en tension,OdBmin = 218 mV, impédance d'entrée 100 kΩ, Umax = 100 V
Linieneingang (spannungsmässig),OdBmin = 218 mV, Umax = 100 V, Eingangsimpedanz 100 kΩ

50 Ground Connection Available for Voltage Line Input
Masse disponible pour entrée ligne en tension
Masse für spannungsmässigen Linieneingang

51 Rapid Fastening Latches of the Batiery Compartment
Dispositif de fixation rapide du boîtier à piles
Schnellspannverschluss für Batterienbehälter

52 Removable Battery Compartment
Boîtier à piles ou à accumulateurs
Batterie- oder Akku-Behälter

53 Locking Screws (loosen both screws by 5 turns and lift the lid to open the recorder)
Vis de fermeture de l'appareil (dévisser les deux vis de 5 tours, retirer le couvercle pour ouvrir l'appareil)
Geräte-Verschluss-Schrauben (5 Drehungen genügen zum öffnen des Oberteils; zuerst Deckel abheben)

54 Mic 1 Input
Dynamic type: 200 μV/μbar, reserve = + 50 dB
b) Condenser type (+ 12 V, - 12 V, + 48 V phantom, or T + 12 according to option) : 1 mV/μbar reserve + 50 dB

Entrée micro 1
a) Version dynamique: 200 μV/μbar, réserve + 50 dB
b) Version condensateur (fantôme + 12 V, -12 V + 48 ou T + 12 selon option): 1mV/μB, réserve = + 50 dB

Mikrophon-Eingang 1
a) Dynamische Version: 200 μV/μbar, Reserve + 50 dB
b) Kondensator-Version: 1 mV/μbar, Reserve + 50 dB (auf Wunsch + 12 V, - 12 V, + 48 V Phantomspeisung und T + 12 V)

55 Mic 2 Input: characteristics identical to mic 2 input
Entrée micro 2, caractéristiques identiques à l'entrée micro 1
Mikrophon-Eingang 2, identisch mit Mikrophon-Eingang 1

56 Dynamic-Condenser Switch Corresponding to MIC 2 (with dynamic-condenser micro preamplifier)
Commutateur dynamique-condensateur MIC 2 (avec préamplificateur micro dynamique et condensateur)
Dynamisch/Kondensator-Umschalter zu Mikrophon-Eingang 2, (mit entsprechendem Mikrophon-Vorverstärker)

57 Dynamic-Condenser Switch Corresponding to MIC 1
Commutateur dynamique - condensateur MIC 1
Dynamisch/Kondensator-Umschalter zu Mikrophon-Eingang 1

58 Pilot Connector
1. GROUND
2. CLAPPER: reference oscillator or crystal pilot generator control input
3. XTAL: 50 or 60 Hz internal crystal pilot generator output
4. PILOT IN: pilot signal input

Connecteur pilote
1. MASSE
2. CLAPPER: Entrée de commande du générateur à quartz et du générateur de référence
3. XTAL Sortie du générateur à quartz 50 ou 60 Hz
4. PILOT IN: Entré signal pilote

Pilotschaltungs-Buchse
1. MASSE
2. CLAPPER: Referenzgenerator oder Kristallgenerator-Steuereingang
3. XTAL: Interner 50 Hz- oder 60 Hz- Kristallgenerator Ausgang
4. PILOT IN: Pilot-Eingang

59 Injection Plug: bridges pin (3) (from quartz generator) and pin (4) (pilot input)
Bouchon d'injection du signal quartz. Etablit une connection entre la borne 3 (générateur à quartz) et la borne (4) (entrée pilote)
Pilotsignal-Eingabestecker; verbindet Anschluss 3 (des Quarzgenerators) mit Anschluss 4 (Pilot-Eingang)

60 Mono Headphone Jack; impedance 25 to 600 Ω
Prise de casque mono,25 - 600 Ω
Monokopfhörer-Anschluss, 25 - 600 Ω

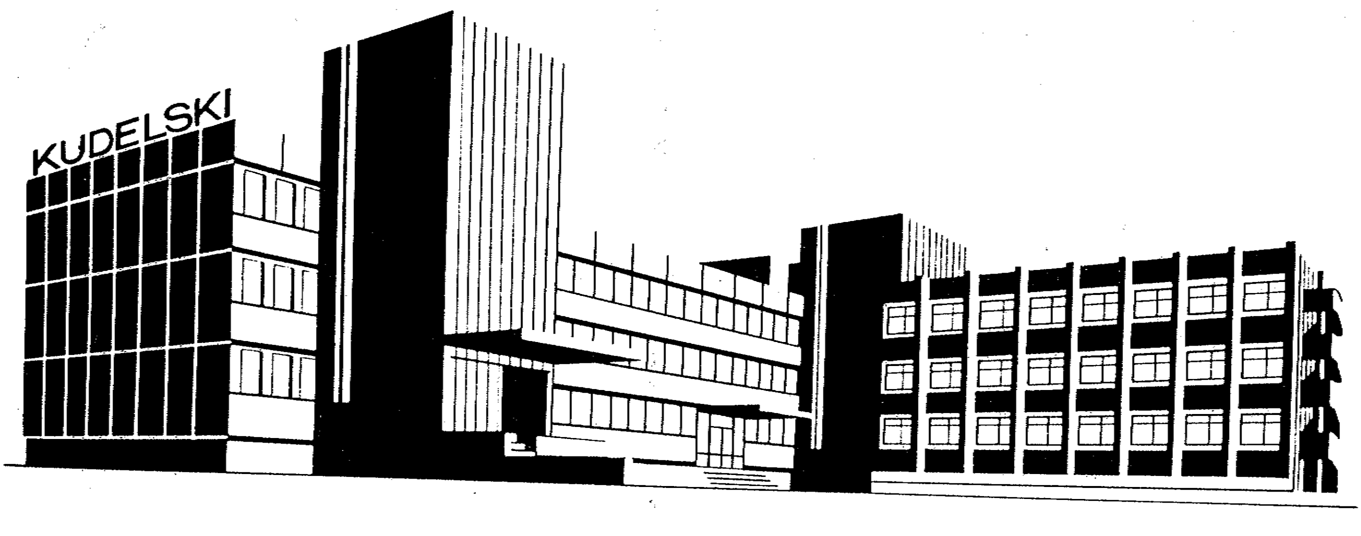
61 Floating Line Output, through Transformer, OdB = 4,4 V no load, max level = 8,8 V (+6 dB)
Sortie ligne flottante par transformateur, OdB = 4,4 V à vide, niveau max = 8,8 V (+6dB)
Gleitender Linienausgang über Transformer, OdB = 4,4 V bei Leerlauf, max Pegel = 8,8 V (+ 6dB)

62 Ground Connection
Masse de sortie
Masse-Ausgang

KUDELSKI SA

1033 CHESEAUX LAUSANNE
SWITZERLAND

TEL.(021) 91 21 21
TELEX: 24 392



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