

STUDER

PROFESSIONAL AUDIO EQUIPMENT

Service Information

A820 MCH UP-DATE

SI 110/87 E

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1. List of material for the A820 MCH Up-Date

The software and hardware kit contains:

One set will be delivered per A820MCH

1 pcs. PROM 1.820.999.23
(Order no. for blank PROM 512 x 8 50.14.0120 (TBP 28 S42N Texas Instruments) for future reference!)

5	Led distance-piece	55.03.0350
5	Inlay label white	55.03.0384
1	Inlay label yellow	55.03.0381
1	set of labels	No Number
5	LED	50.04.2152
29	Index label .81	1.010.081.43
5	Insulation-washer	1.010.015.50
2	Jumper	54.01.0021
24	Capacitor 2,2nF	59.06.0222
1	Relay	56.02.0105
24	Capacitor 10nF	59.06.5103
25	Index label .82	1.010.082.43
3	Wire	1.010.111.64
2	Wire	1.010.107.64
1	Wire	1.010.109.64
2	Wire	1.010.130.64
1	Wire	1.010.120.64
1	Wire	1.010.117.64
10	Shims 0.1mm	1.010.058.23
10	Shims 0.12mm	1.010.059.23
10	Shims 0.15mm	1.010.060.23
10	Shims 0.18mm	1.010.061.23
2	Potentiometer 2k	58.05.1202
2	Potentiometer 20k	58.05.1203
2	Resistor 9.1k	57.11.3912
2	Springs	1.010.127.37
6	Capacitor 4.7nF	59.06.0472
3	Index label .21	1.101.002.21
1	Index label .22	1.101.002.22
1	Index label .23	1.101.002.23

2 Cover TT-Sensor 1" 1.820.116.01 for each 1" transport
2 Cover TT-Sensor 2" 1.820.114.03 for each 2" transport

Documetation

One piece will be delivered per destination

1 Service-Info 110/87 10.85.5950

Necessary gauges

One piece of each will be delivered per destination

1 Gauge TT-Sensor 10.010.001.34
2 Weights 2" 10.010.001.35

Necessary software

The below number of items will be delivered per destination and should be duplicated locally

1 set TD software	14.10.87	(2 EPROM's)
1 set Master software	10.10.87	(3 EPROM's)
1 set Audio software	14.10.87	(3 EPROM's)
2 set VU-Panel software	1.820.988.21 41/87	(2 EPROM's)
1 set Paral. Ch. Remote IF	1.820.984.22 41/87	(1 EPROM)
1 set TLS 4000 Interface		
A820 MCH software	1.812.968.21 42/87	(1 EPROM)

(All EPROM's are of the type 27128 (16 K) 50.14.0125)

1 set TLS 4000 Synchronizer		
PCB software	1.812.910.23	(5 EPROM's)

(All EPROM's are of the type 2764 (8 K) 50.14.0113)

Tape tension sensor rollers and lifter pin

2 TT-Rollers 2"	1.820.165.00
1 Lifter pin	1.820.124.00

will be delivered to the destinations where an up-date is necessary. Decision where, is made by STI.

Set of assemblies and PCB's

The below number of items will be delivered to destination where a large number of machines have to be up-dated.

This material should make it possible to do a quick up-date at the customers by exchanging hole PCB's and assemblies instead of modifying them at the customers. The unmodified PCB's and assemblies can be taken back to the workshop to be modified for the next up-date.

1 Audio Alignm. KB	1.820.707.81
1 Master KB	1.820.817.81
1 Power Supply	1.820.350.81
24 Record Amplifier	1.820.811.81
24 Line Amplifier	1.820.715.82
1 Basis Board TD	1.820.704.81
2 Basis Board Audio	1.820.703.00

(As a reserve in case some connectors are faulty on the existing PCB)

1 Basis PCB.	
Audio Ctrl.	1.820.702.81
1 TT-sensor Left	1.820.387.00
1 TT-Sensor Right	1.820.388.00
1 Prestab. Roller	1.820.171.00
1 Pinch Roller Ass.	1.820.126.00

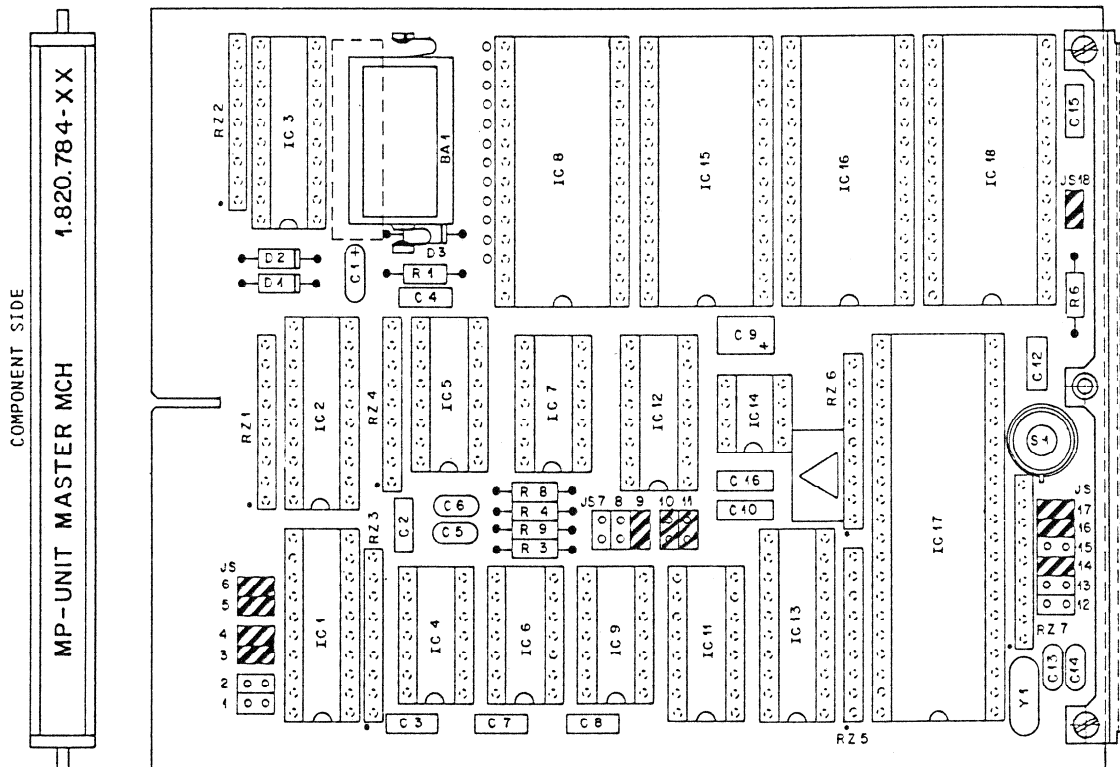
2. Modification procedure

MPU-TD control 1.820.781.00

- Remove EPROM's IC 16 (8000), IC 18 (C000) replace by new software TD 14.10.87. IC 16 (8000) IC 18 (C000).
- Insert an insulation-washer 1.010.015.50 underneath the cristal Y1, if the cristal is of the uninsulated type (shiny metallic surface)

MPU-Master 1.820.784.00

- Remove EPROM's IC 15 (4000), IC 16 (8000), IC 18 (C000) and replace by Master 10.10.87 IC 15 (4000), IC 16 (8000), IC 18 (C000)
- Insert 2 jumpers in position 10 and 11 (see layout 1.820.784.00)
- Insert an insulation-washer 1.010.015.50 underneath the cristal Y1, if the cristal is of the uninsulated type (shiny metallic surface)



INSERTED
 JS 3, 4, 5, 6, 9, 14
 16, 17, 18
 10, 11

MPU-Audio 1.820.782.00

- Carry out a parameter back up (see manual A820 MCH page 4/27).
Remove RAM IC 8 and erase its contents by short circuiting the pins with each other.
All variable parameters will now be lost. Insert RAM again.
Please note: This device is electrostatically sensitive.
- Remove EPROM's IC 15 (4000), IC 16 (8000) IC 18 (C000) and replace by Audio 14.10.87 IC 15 (4000), IC 16 (8000), IC 18 (C000).
- Insert an insulation-washer 1.010.015.50 underneath the cristal Y1, if the cristal is of the uninsulated type (shiny metallic surface)

MPU-VU-Panel 1.820.783.00

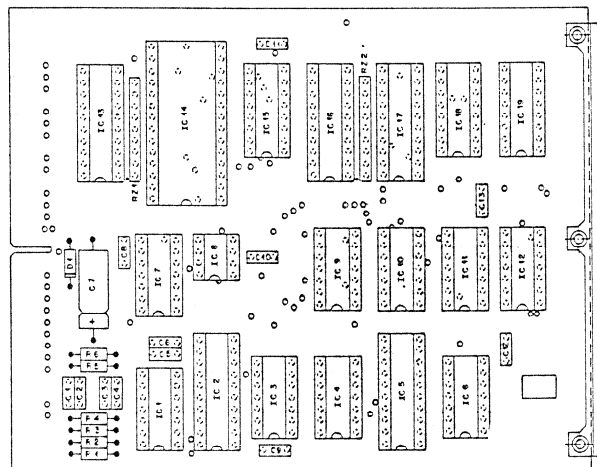
- Remove EPROM's IC 16 (8000), IC 18 (C000) and replace by software 1.820.988.21 41/87 IC 16 (8000), IC 18 (C000).
- MPU-VU-Panel 1.820.783.00 changes to index .21.
- Attach label .21 (1.101.002.21).
- Insert the insulation-washer 1.010.015.50 underneath the cristal Y1, if the cristal is of the uninsulated type (shiny metallic surface)

Serial Remote Interface 1.820.729.20

- Remove PROM IC 7 and replace by software 1.820.999.23.
- Serial Remote Interface changes to index .23.
- Insert the insulation-washer 1.010.015.50 underneath the cristal Y1, if the cristal is of the uninsulated type (shiny metallic surface)

Tape Deck Counter Timer 1.820.761.81

- Remove capacitors C1 - C6 330 pF and replace them by C1 - C6 4.7nF 59.06.0472.
- Tape Deck Counter Timer 1.820.761.81 changes to index .82.
- Attach label .82 (1.010.082.43).



MPU Audio Remote IF 1.820.787.20
Parallel Channel Remote Interface 21.328.500.00

- Remove EPROM IC 18 (C000) and replace by new software 1.820.984.22 41/87 IC 18 (C000).
- MPU Audio Remote IF 1.820.787.20 changes to index .22.
- Attach label .22 (1.101.002.22).
- Insert an insulation-washer 1.010.015.50 underneath the cristal Y1, if the cristal is of the uninsulated type (shiny metallic surface)

MPU-VU-Panel 1.820.783.00
Audio Remote Control 21.328.501/503.00

- Remove EPROM's IC 16 (8000), IC 18 (C000) and replace by software 1.820.988.21 41/87 IC 16 (8000), IC 18 (C000).
- MPU-VU-Panel 1.820.783.00 changes to index .21.
- Attach label .21 (1.101.002.21).
- Insert the insulation-washer 1.010.015.50 underneath the cristal Y1, if the cristal is of the uninsulated type (shiny metallic surface)

TLS 4000 Synchronizer Board 1.812.106.22

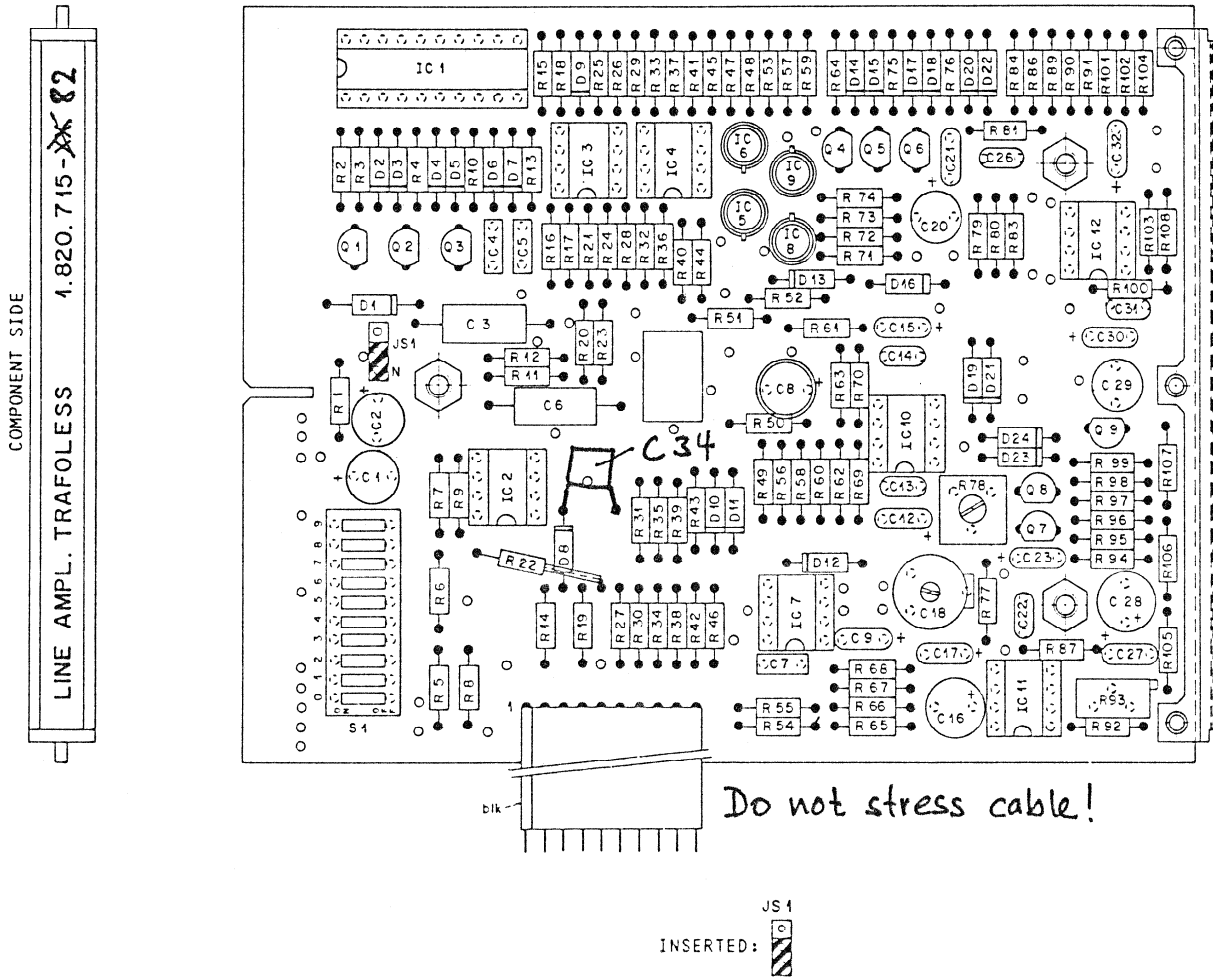
- Remove EPROM's IC 301, 304, 305, 317, 418 and replace by software 1.812.910.23 40/87 IC 301, 304, 305, 317, 418.
- TLS 4000 Synchronizer Board 1.812.106.22 changes to index .23.
- Attach label .23 (1.101.002.23)

TLS 4000 Interface MK I A820 MCH 1.812.134.20

- Remove EPROM IC 78 and replace by software 1.812.968.21 42/87 IC 78.
- TLS 4000 Interface MK I A820 MCH 1.812.134.20 changes to index .21.
- Attach label .21 (1.101.002.21)

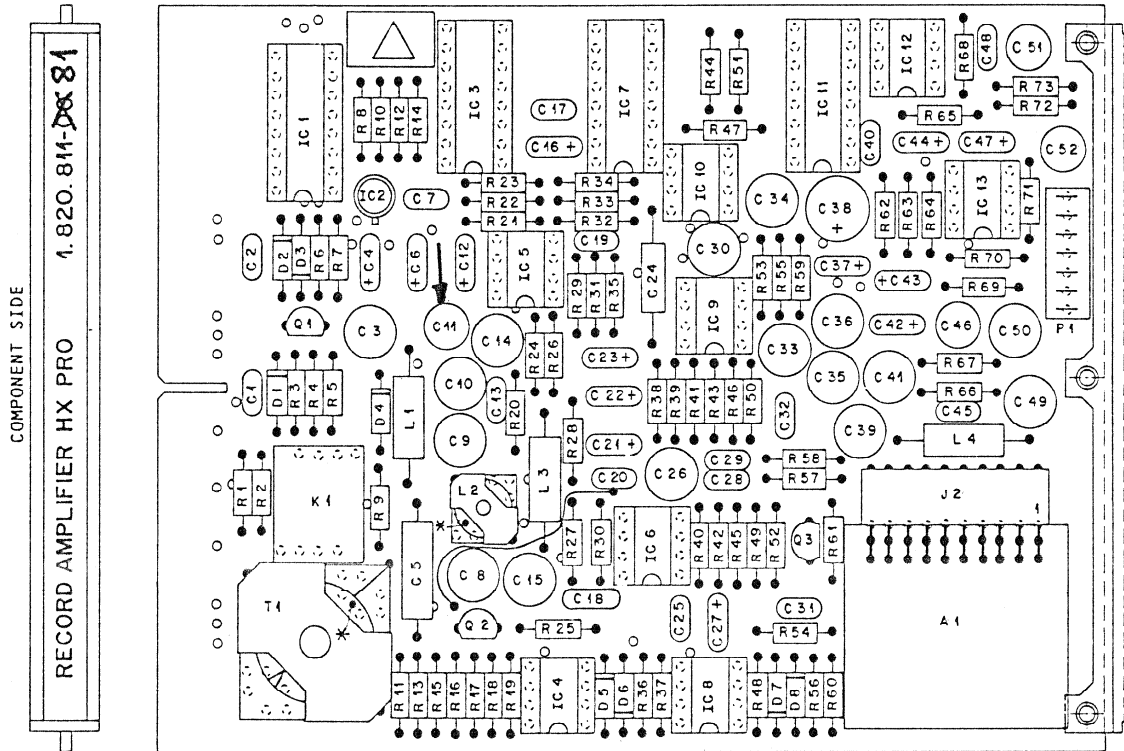
Line Amplifier 1.820.715.81

- Install additional capacitor C34 10nF 59.06.5103 parallel to resistor R36
- Attach index-label .82 1.010.082.43

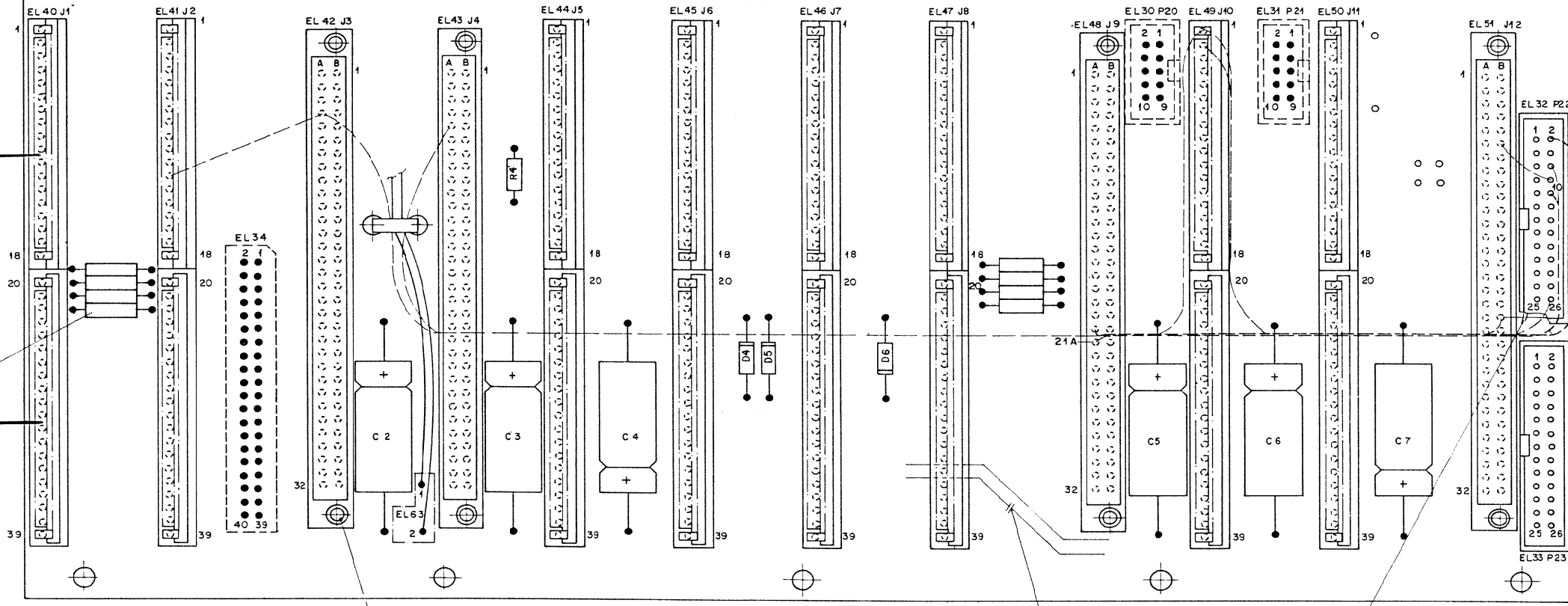
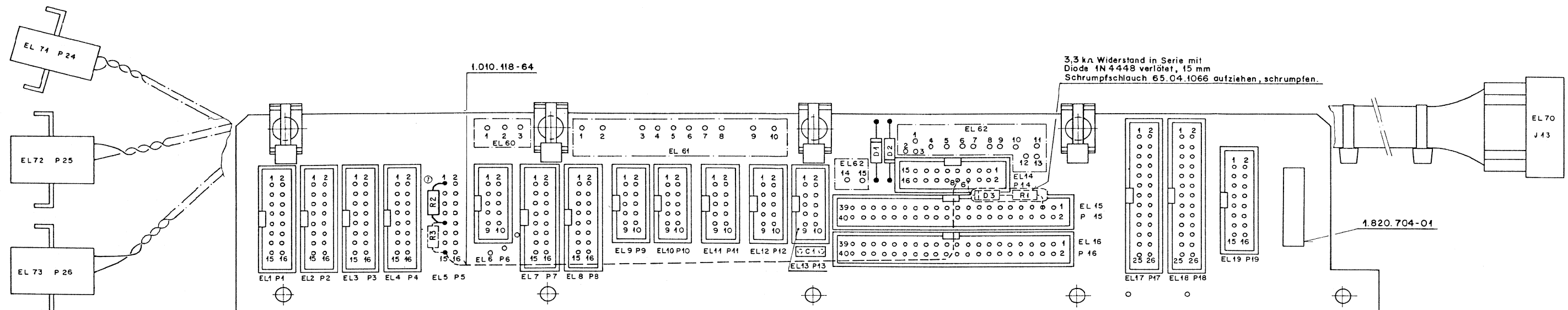


Record Amplifier HX-Professional 1.820.811.00

- Change capacitor C11 from 1nF to 2,2nF 59.06.0222
- Attach index-label .81 1.010.081.43



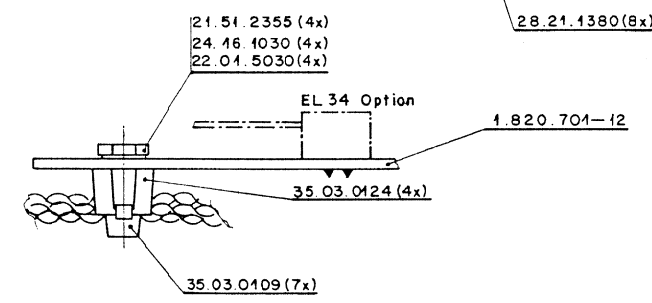
* YELLOW DOT



54.10.2015

5711.4000 (8x)

54.10.2026



Leiterbahn auf Bestückungsseite unterbrochen

Leiterbahn Lötseite unterbrochen
(Verbindung aufgehoben;
EL 51 Pin 19 B zu EL 32 Pin 16)

Cut track on soldering side between:
- EL 51 Pin 19 B and EL 32, Pin 16

Werkstoff	Norm-Nr.	Oberfläche	Güte	Änderung	3
	DIN-Bez.	Ben.			1
Abmessung					
Zugehörige Unterlagen	PL, LL	Freissolteranz	Maßstab	8.9.87	A.Ho
		+	2:1	Datum	Gez. Gepr. Ges. Index
Ersatz für		Ersetzt durch		Kopie für	
STUDER REGENSDORF ZÜRICH		BASIS BOARD TAPE DECK MCH		1.820.704-81	

Wire Wrap Verbindungen:

Lötseite, mit Acetatgewebe
65.02.2060 fixiert.

1.010.111-64 (3x)

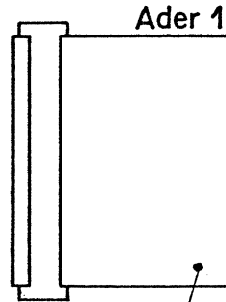
Verbindungen

P8, Pin6 zu J6, Pin1
P8, Pin8 zu J6, Pin2
P8, Pin26 zu J6, Pin8

1.010.107-64

Verbindung

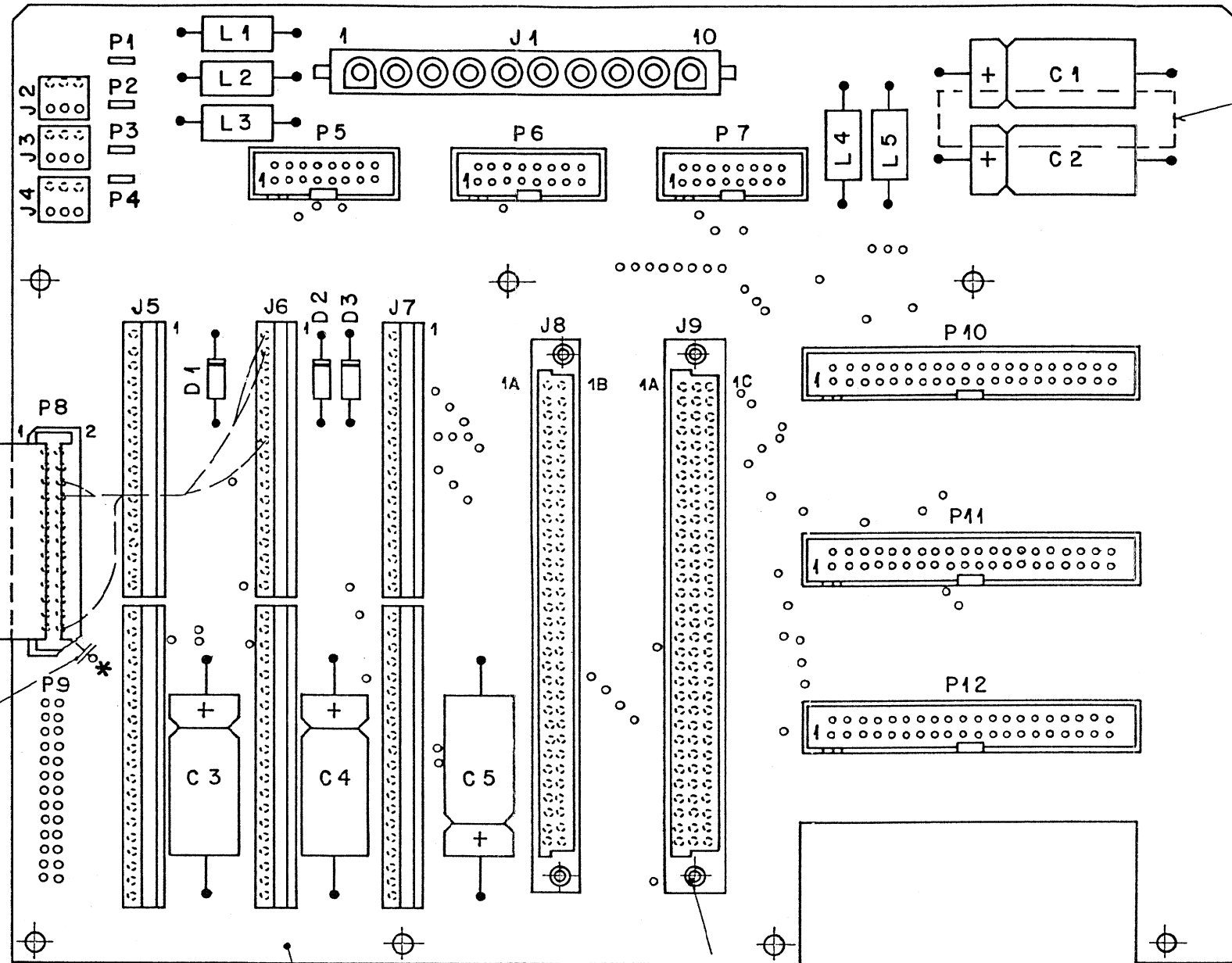
P8, Pin16 zu Lötauge *



1.023.112-01

Leiterbahn BS
unterbrochen

Cut track
on component side



1.820.702-11

28.21.1380 (4x)

In P10, P11 und P12 je 1Stk
Flachkabel 1.022.740-02 eingesteckt

Werkstoff	Norm-Nr.:	Oberfläche	Güte:	Änderung						③	
	DIN-Bez.:		Beh.:								②
	Abmessung:										
Zugehörige Unterlagen:		Freimasstoleranz:	Maßstab:	Ausgabe	8.9.87	A.Ho				①	
PL		±	1:1	Datum	Gez.	Gepr.	Ges.	Index			
Ersatz für:		Ersetzt durch:		Kopie für:							
STUDER REGENSDORF ZÜRICH		Benennung: BASIS BOARD AUDIO CONTROL MCH				Nummer: 1.820.702-81					

Power Supply 1.820.350.00

- Replace relay GRP 9, ELM 4 (56.02.0104 with grey tungsten contacts) by the new type of relay (56.02-0105 with shiny silver-cadmium contacts)

Basis PCB Tape Deck 1.820.704.00

- Unplug all PCB's , flat-ribbon cables and remove Basis Board from the metall-cage. It is necessary to carry out the following modifications in the machine itself (Basis Board is still connected with the rest of the machine with some wires).
- Install wirebridges:
 - 1.010.109.64 from EL41,Pin 12 to EL42,Pin 4A
 - 1.010.130.64 from EL42,Pin 4A to EL51,Pin 19B
 - 1.010.130.64 from EL43,Pin 5A to EL49,Pin 1
 - 1.010.120.64 from EL49,Pin 1 to EL32,Pin 6
 - 1.010.117.64 from EL49,Pin 2 to EL32,Pin 26
 - 1.010.107.64 from EL51,Pin 6B to EL32,Pin 8
- Attach wirebridges to the soldering-side with adhesive-tape.
- Cut track on soldering-side marked with "II" between EL51,Pin 19B and EL32,Pin 16.
- Attach index label .81
- See drawing 1.820.704.81

Note:

Already existing modifications, Please verify!

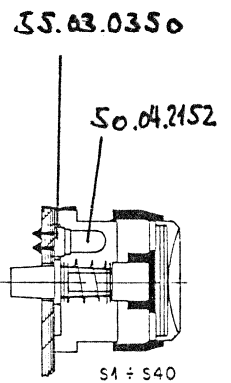
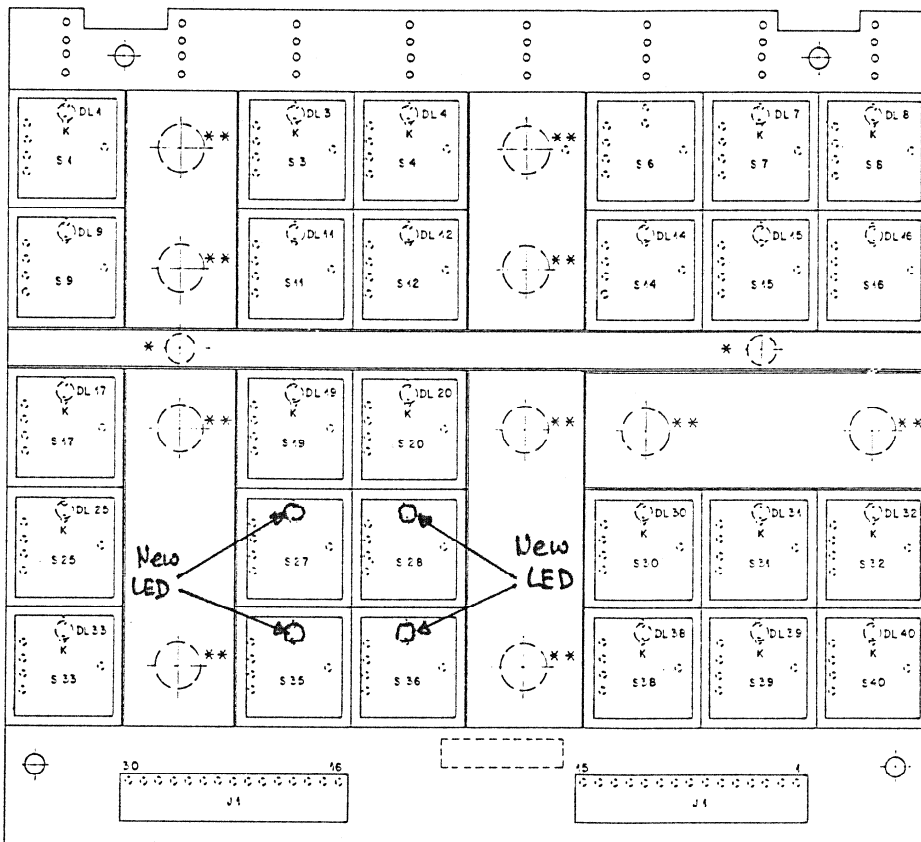
- Cut track on component-side marked with "II".
- Wirebridge between:
- 1.010.117.64 from EL48,Pin 20A to EL32,Pin 2
 - 1.010.116.64 from EL48,Pin 21A to EL32,Pin 10

Basis Board Audio Control 1.820.702.00

- Unplug all PCB's, flat-ribbon cables and remove Basis Board from the metall-cage.
- Install 3 wirebridges 1.010.111-64 on the soldering-side between: P8,Pin6 to J6,Pin1
P8,Pin8 to J6,Pin2
P8,Pin26 to J6,Pin8
- Install 1 wirebridge 1.010.107-64 on the soldering-side between: P8,Pin16 and the soldering-pad markes with "*".
- Attach wirebridges to the soldering-side with adhesive-tape.
- Cut track on the component-side marked with "II", see also drawing 1.820.702.81.
- Attach index label .81

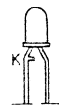
Master Keyboard Audio 1.820.817.00

- Install 4 additional LEDs 50.04.2152 in the positions: CHANNEL ON, CHANNEL OFF, NRS ON, NRS OFF. Put a distance-piece 55.03.0350 between LED and PCB.
- Remove old labels by attaching a piece of adhesive-tape to the inlay-label and pull the inlay-label away.
- Install new inlay-labels white 55.03.0384 with cut-out for LED in the above positions.
- Attach index-label .81 1.010.081.43



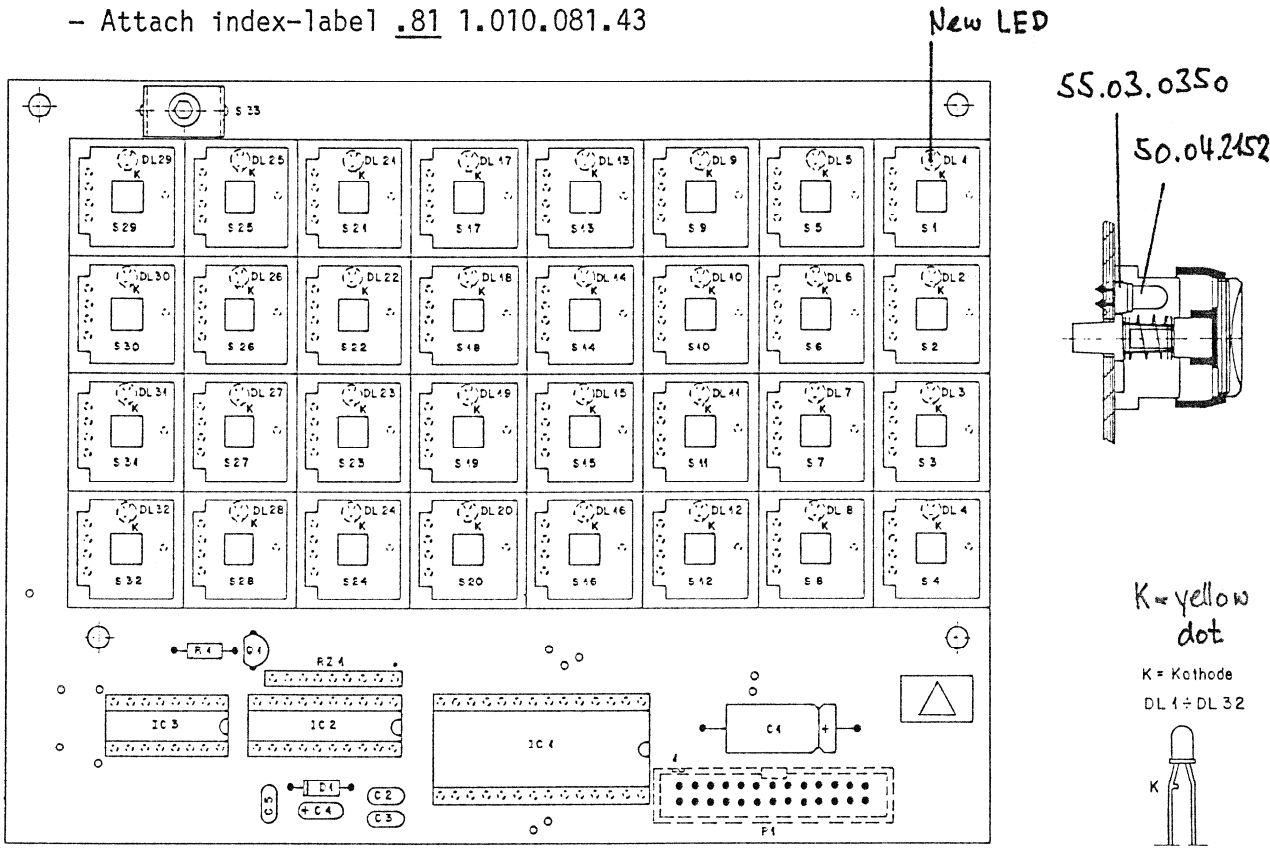
K = Yellow dot

K = Kathode
DL 1 ÷ DL 40



Audio Alignment Keyboard 1.820.707.00

- Install one additional LED 50.04.2152 in the top right-hand corner for the push-button "NRS-ALIGN". Put a distance-piece 55.03.0350 between LED and PCB.
- Remove old labels by attaching a piece of adhesive-tape to the inlay-label and pull the inlay-label away.
- Install new labels: NRS-ALIGN, UNCAL-MODE, MANUAL-ALIGN, AUTO-ALIGN. Use in position "NRS-ALIGN" the new inlay-label white 55.03.0384 with cut-out for the LED
- Attach index-label .81 1.010.081.43



METER SECTION			ALIGNMENT SECTION				NRS
METER ON	M REF ↓	M REF ↑	AUTOREC ALIGN	AUTOPAR ALIGN	MANUAL ALIGN	STORE START	NRS ALIGN
0 dB	-10 dB	-20 dB	REPRO LEVEL	REPRO TREBLE	REPRO BASS	REF TAPE PRESET	UNCAL MODE
30 Hz SWEEP >	1 kHz SWEEP >	10 kHz SWEEP >	RECORD LEVEL	RECORD TREBLE	RECORD BIAS	BIAS PRESET	MANUAL ALIGN
GEN ON	GENFREQ ↓	GENFREQ ↑	CHANNEL <	CHANNEL >	PARAM ↓	PARAM ↑	AUTO ALIGN
GENERATOR SECTION			ALIGNMENT SECTION				NRS

Labelling

Replace label "FADER" with label "AUDIO REM IF".

Putting into operation

- Switch tape recorder ON. The error message "Audio Data lost" will appear because the RAM on the MPU-Audio has been erased.

Reload the audio-parameters. (see A820MCH Manual page 4/27)

- The LC-display of the tape deck will show "Default keys loaded". Check programming of the soft keys and reprogram one key. This action deletes the error message "Default keys loaded". Check the programming of the "Audio Keys-Mode" and "Tape Deck Keys-Mode" for proper setting.

- Set "Library Wind Speed" and "Max. Wind Speed" to the recommended values. The values are now adjustable for tape sort A and B.

Recommended Max. Wind Speed for:

Agfa 468	max.	10m/s
Agfa 469	max.	10m/s
BASF SPR 50LH	max.	10m/s
BASF 911	max.	15m/s
Ampex 456	max.	15m/s
Scotch 226	max.	15m/s
Scotch 250	max.	15m/s

- Check the setting of the equalization according to the below table:

			24CH	8/16CH
7.5"	CCIR	REPRO	7C	7C
7.5"	CCIR	REC	D3	C8
7.5"	CCIR	SYNC	97	97
7.5"	NAB	REPRO	69	69
7.5"	NAB	REC	DE	D6
7.5"	NAB	SYNC	85	85
15"	CCIR	REPRO	4F	4F
15"	CCIR	REC	C0	C0
15"	CCIR	SYNC	58	58
15"	NAB	REPRO	69	69
15"	NAB	REC	AA	AA
15"	NAB	SYNC	79	79
30"	CCIR/NAB	REPRO	2C	2C
30"	CCIR/NAB	REC	D3	D3
30"	CCIR/NAB	SYNC	2C	2C

- It is in any case necessary to realign the internal NRS-System.

3. Tape Tension Sensor 2" Left 1.820.157.00, Right 1.820.158.00

Tape Tension Sensor Arm (Amorphous-metal foil type)
1.820.162.00 (2")

- Replace tape tension sensor arm with amorphous-metal foil by tape tension sensor roller 1.820.165.00 (2").
Some tape tension sensors are already modified!
- Remove the little pin (H), then install the roller.

Tape Tension Sensor PCB 1.820.772.00

- Replace R7 (2 kohm) by 25-turn 2 kohm potentiometer 58.05.1202 for better adjusting accuracy.
- Replace R9 (20 kohm) by a 25-turn 20 kohm potentiometer 58.05.1203 for better adjusting accuracy.
- Replace R8 (18 kohm) by 9.1 kohm 57.11.3912 for new gain setting.
- The PCB 1.820.772.00 changes to 1.820.877.00

Step 1

Preadjusting the spring

- Remove existing spring
- Install new spring and turn 3 spring-coils into the threaded pin (D).
- Adjust for a distance of 2mm between nut (B) and (F), by loosening locknut (B) and turning threaded pin into the counter piece (E). Fig. 1.

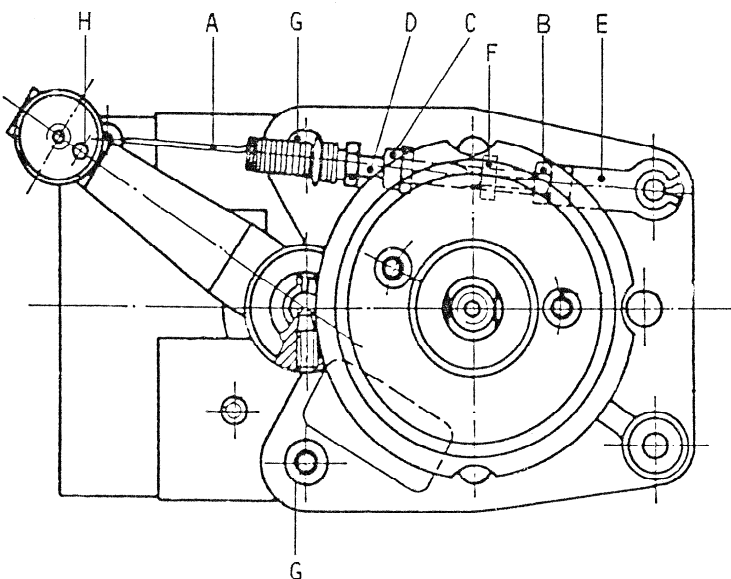


Fig. 1

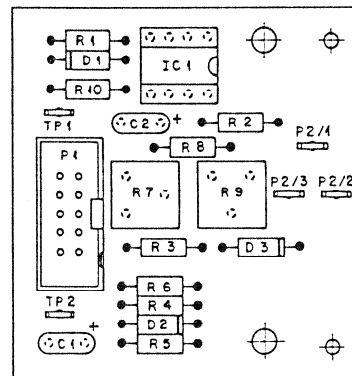


Fig. 2

Step 2

Electrical adjustment of the tape tension sensor

- Remove guide roller and prestabilizer roller (left) or tacho roller (right), respectively.
- Connect digital voltmeter to the two test points TP1 ("+") and TP2 (ground).
- Insert gauge (10.010.001.34) for adjusting the tape tension sensors according to Fig. 3, adjust with R7 (Offset-Adjust) to a voltage of 0.400 V +/- 20mV.
- Insert gauge (10.010.001.34) for adjusting the tape tension sensors according to Fig. 4, adjust with R9 (Gain-Adjust) to a voltage of 2.400 V +/- 50mV.
- Recheck the adjustment alternatively and realign if necessary.

Note:

A voltage of 0...-200mV (average -50...-150mV) should result in neutral position of the tape tension sensor. A repositioning of the tape tension sensor end stop is necessary if this voltage does not result.

- Loosen screws (G) and reposition the mechanics.
- Check voltage in neutral position again.
- If the desired voltage is not adjustable by repositioning the end stop, then the white plastic driver piece (A) needs to be adjusted Fig. 5.
- Check voltage in neutral position again.
- Recheck the adjustments of R7 and R9 again.

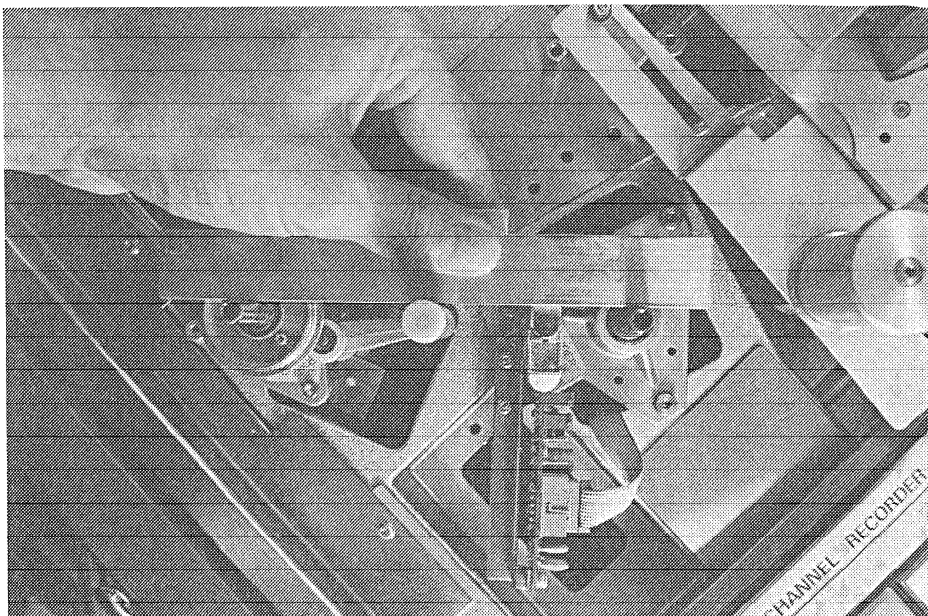


Fig. 3

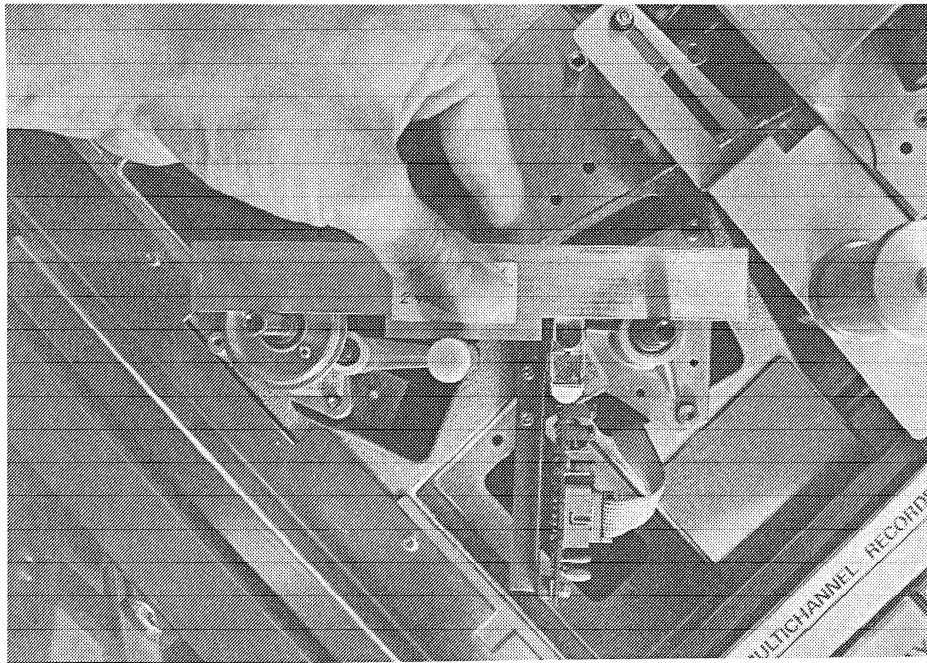


Fig. 4

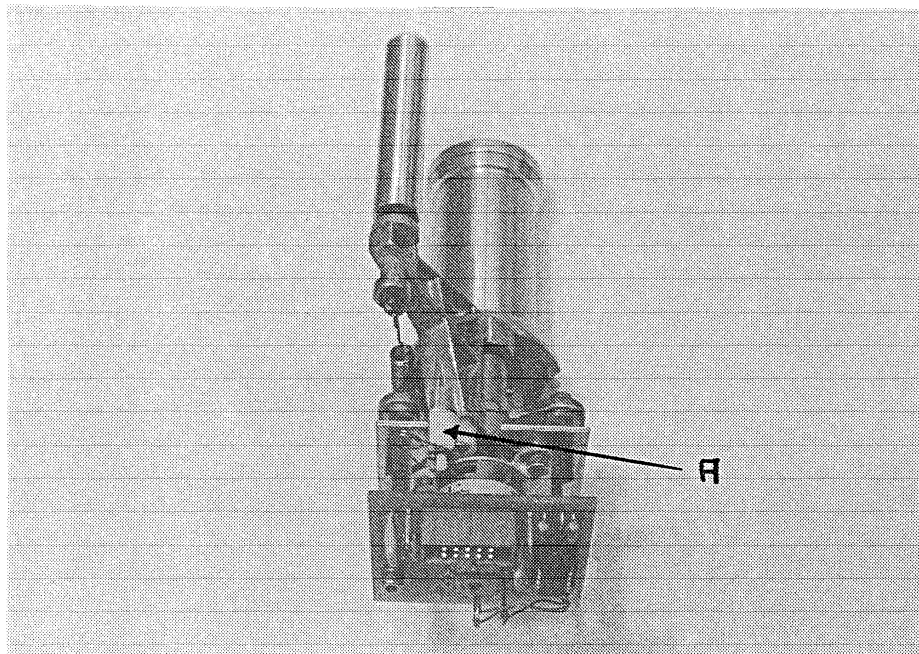


Fig. 5

Step 3

Adjusting the tape tension spring

The offset and the gain must be checked and aligned, if necessary, before this adjustment is made.

- Install guide and prestabilizer/tacho rollers.
- Install adjusting device (part No 10.010.001.31 also used for A820 1/4", 1/2") on the tape transport according to Fig. 6.
- Connect digital voltmeter to the two testpoints.
- Loosen locknut (B) of threaded pin (C).
- Hook on small weight 120g (10.010.001.35).
- * Adjust the voltage to 200mV +/- 30mV by turning the threaded pin (C) (voltage increases when turning out the threaded pin).
- * Tighten the locknut (B), the voltage must remain between the indicated limits.
- * Hook on the large weight 520g (10.010.001.35).
- * Adjust the voltage 2.2V +/- 50mV by turning the adjusting pin (D) (voltage rises when the spring is elongated)

The adjustments identified with "*" influence each other and must be repeated several times in the same sequence, if necessary.

- Secure threaded pin (C) (locknut (B) and adjusting pin (D) with locking paint.

Tape Tension Sensor 2" Left 1.820.157.00 changes to 1.820.387.00
2" Right 1.820.158.00 changes to 1.820.388.00

The above TT-Sensors are used for 1" and 2" tape transports.
In future, there will be a tape tension sensor for 1" transports only!

Note 1: It might be necessary to cut off one coil of the spring during the adjustment procedure, if the desired values can not be achieved!

Note 2: The distance between locknut (B) and nut (F) must not exceed more than 3.5mm.
The spring should be slightly prestressed in neutral position.

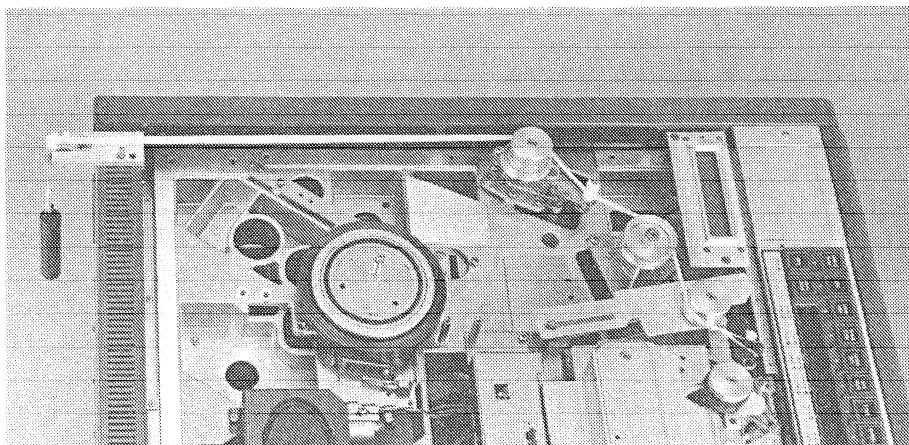
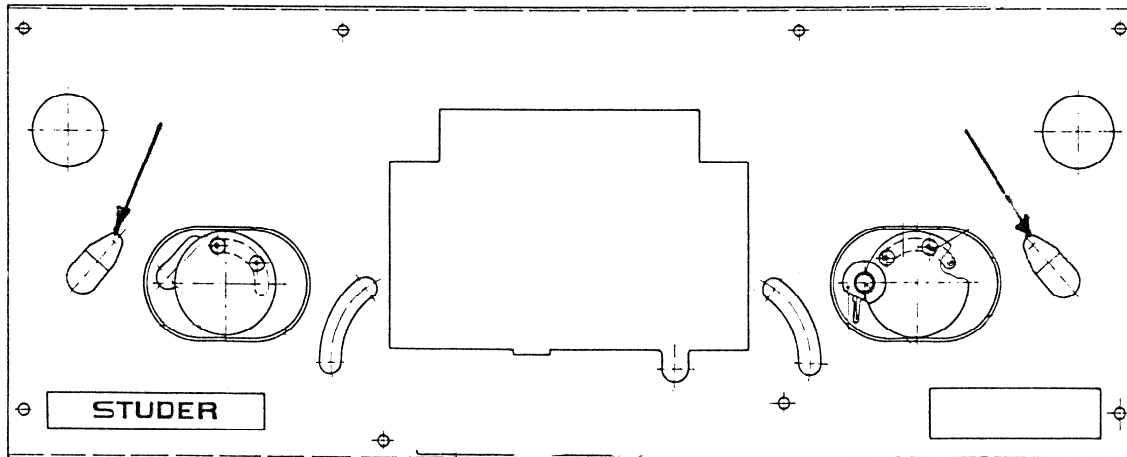


Fig. 6

Cover Tape Tension Sensor 1.820.116.01 1", 1.820.114.03 2"

- The modified covers for the tape tension sensor have a deeper cut-out which gives the tape tension roller more space to deflect (approx. 3mm).
- Replace existing covers by the new type of covers.



Pinch Roller Force Adjustment

- The pinch roller force has been increased from 0.9 kp (+/- 0.1 kp) to 1,2 kp - 1,3 kp to overcome pinch roller slipping.
- Performe a pinch roller adjustment according to the A820CH manual section 3.3.6 but with 1.2 kp - 1.3 kp pinch roller force.

Lifter Pin 1.820.124.00

- Replace the lifter pin (with amorphous-metal foil) 1.820.124.00 by a lifter pin 1.820.124.00 without amorphous-metal foil. Some lifter pins have already been replaced!

Note:

The tape will now run on the aluminium support of the lifter pin. The position of the ceramic guides is factory adjusted. Adjust lifter pin after replacing.

Adjusting the lifter pin

- Remove the headblock cover
- Switch recorder to STOP. The tape must be seperated from the capstan shaft by a few tenths of a millimeter.
- Should this not be the case, loosen the locknut (opening across flats 5.5mm) and adjusting scrw (opening across flats 5.5mm) to such a point where the tape just does not touch the capstan shaft in STOP mode.
- Retighten locknut.
- Reinstall soundhead cover.

4. Tape Tension Adjustment

Perform a tape tension adjustment according to the A820MCH manual section 3.3.8 after the adjustment of the tape tension sensors and the lifter pin.

The tape tension values for 2"- versions remain the same except the value in STOP-EDIT mode changes from 300g to 350g. New tape tension values for 1"- versions have been made.

See below list:

2" TAPE TENSIONS				1" TAPE TENSIONS			
		Tentelometer between rollers No.			Tentelometer between rollers No.		
		Left reel, 1	2, 3	5, 6	Left reel, 1	2, 3	5, 6
PLAY		3.8 N ±0.1 N 380 p ± 10 p	4.5 N ±0.1 N 450 p ± 10 p		3.0 N ±0.1 N 300 p ± 10 p	3.5 N ±0.1 N 350 p ± 10 p	
REV. PLAY		4.5 N ±0.1 N 450 p ± 10 p	3.8 N ±0.1 N 380 p ± 10 p		3.5 N ±0.1 N 350 p ± 10 p	3.0 N ±0.1 N 300 p ± 10 p	
>	4.0 N ±0.1 N 400 p ± 10 p				3.0 N ±0.1 N 300 p ± 10 p		
STOP EDIT	3.5 N ±0.1 N 350 p ± 10 p				3.5 N ±0.1 N 350 p ± 10 p		

5. Alignment of Tape Guiding across the Magnetic Heads

Introduction

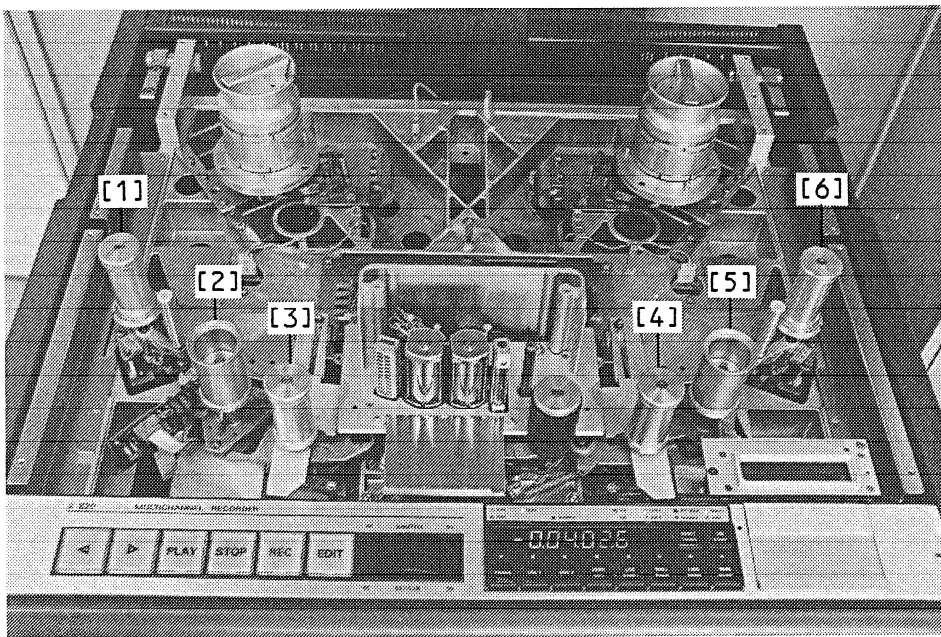
The tape transport mechanism must be correctly aligned before attempting any adjustments to the tape guiding across the heads. Check tape tension by referring to section 3.3.8 of the A820 multichannel manual and chapter 4 of this SI.

Note:

If the tape is transported across the heads with reasonable accuracy, do not attempt any realignment. However, should re-alignment be unavoidable, the necessary adjustments must be carried out meticulously and with great care. The use of the listed alignment gauges is absolutely essential.

Required Tools and Gauges

- Precision gauge 2" (A80/A800/A820 50,75 mm) 10.010.001.05
- Reference gauge 1" + 2" (A80/A800/A820) 10.010.001.01
- Tentelometer 2" 10.300.001.02
- Virgin tape
- Spacer disc 0,1 mm 1.010.058.23
- Spacer disc 0,12 mm 1.010.059.23
- Spacer disc 0,15 mm 1.010.060.23
- Spacer disc 0,18 mm 1.010.061.23
- Micrometer
- Feeler gauge



5.1. Checking Tape Guiding and its Stability

- Check tape tension by referring to section 3.3.8 of the A820 multichannel manual and chapter 4 of this SI.
- Remove headblock cover and take off the tape lifter pin.

Step 1

Run the tape in the shuttle-mode forward and backwards at approx. play speed. Observe the tape movement at the points where it contacts the heads. The tape must run exactly centered in the undercut section of the head (Fig. 1). If tape guiding is perfect, the shiny headface must be fully covered by the tape (no up and down weave). In case the tape tends to run off towards the top or bottom, tape guiding needs to be readjusted.

Step 2

Load recorder with tape and start it at 30 ips in play.

Observe tape movement across the heads. To the left of the capstan shaft, gently push with one finger against the edge of the running tape in an upward and downward direction.

See Fig. 2 and 3

The resulting instability of tape guiding will cause the tape to run off in the initiated direction. With a perfectly aligned system the tape will return by itself and stabilize in the normal path when letting it run undisturbed again. If guiding is misaligned, the tape will not return to its normal path. Tape guiding has to be realigned.

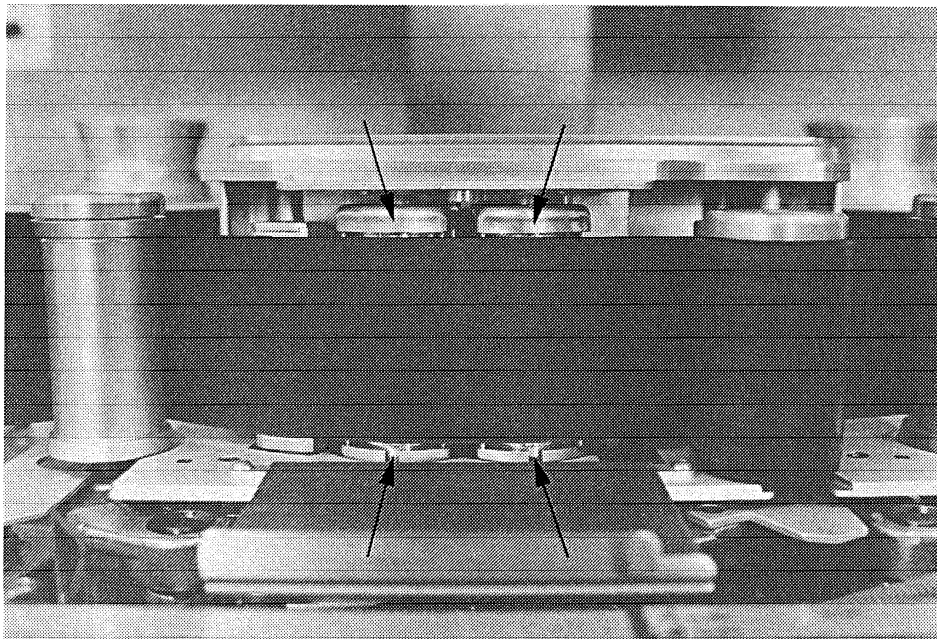


Fig. 1

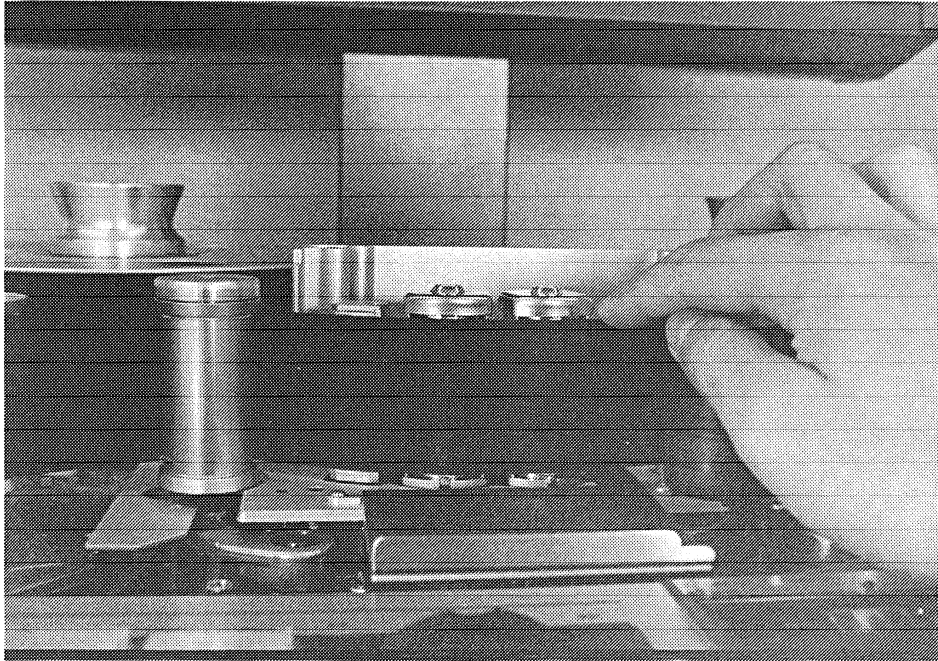


Fig. 2

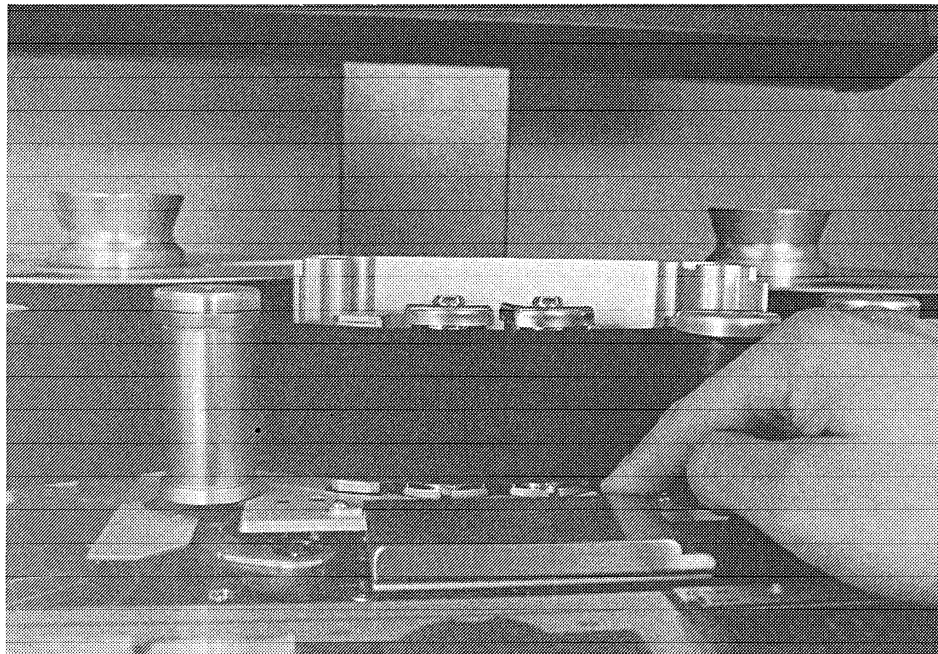


Fig. 3

5.2 Testing for correct Tape Guiding

- Reinstall tape lifter pins. Check adjustment.
- Load recorder with tape and start in the play mode at 30 ips. Check tape tension by referring to section 3.3.8 of the A820 multichannel manual and chapter 4 of this SI.
- Observe tape as it runs across the heads. The tape must neither contact nor display a tendency to contact the edges of the guide rollers and the tape lifter pins. At lower tape speeds the tape develops a tendency to run downwards, thereby exposing the head's shiny face slightly. This, however, is normal and is caused by gravity. See Fig. 1.

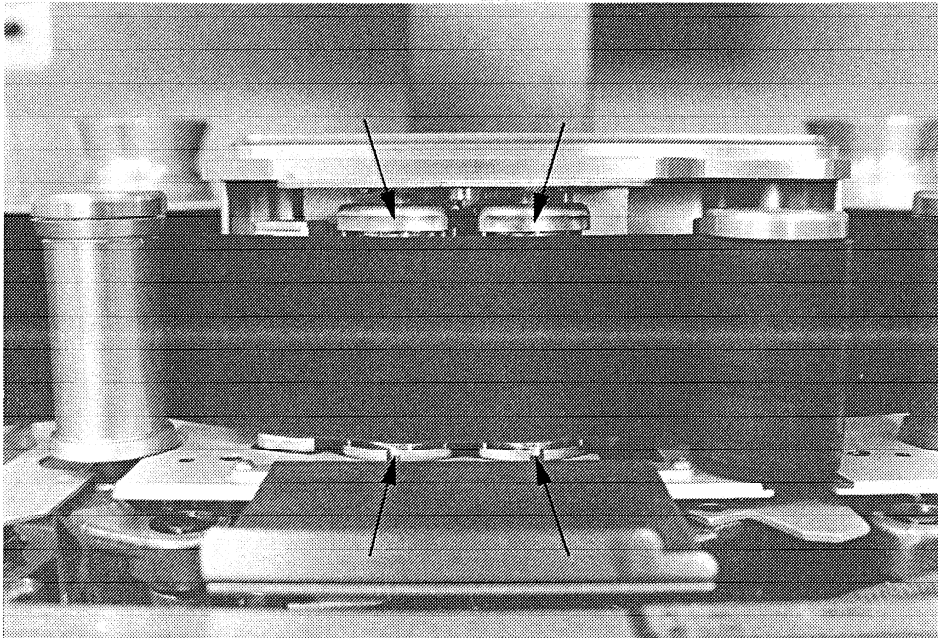


Fig. 1

6. Adjustment of Tape Guiding

6.1 Checking Roller Alignment

Step 1

Using the gauges, check alignment of rollers 1, 5 and 6. The height of each roller is correct if it sits in the center of the tolerance band. In other words, the gauge must clear the roller edges by equal distances on the upper and lower side. See Fig. 5 and 6.

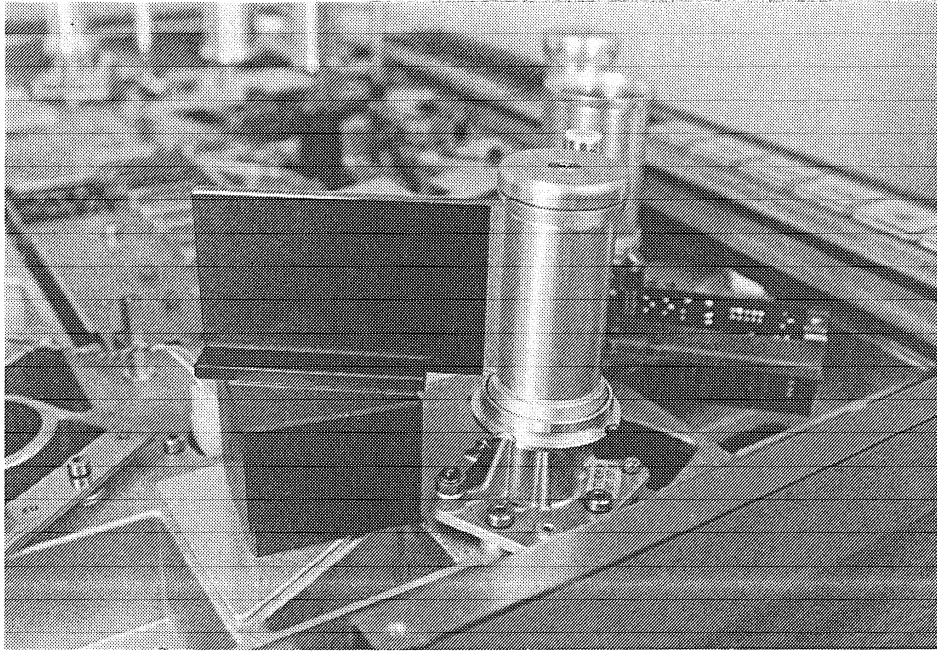


Fig. 5

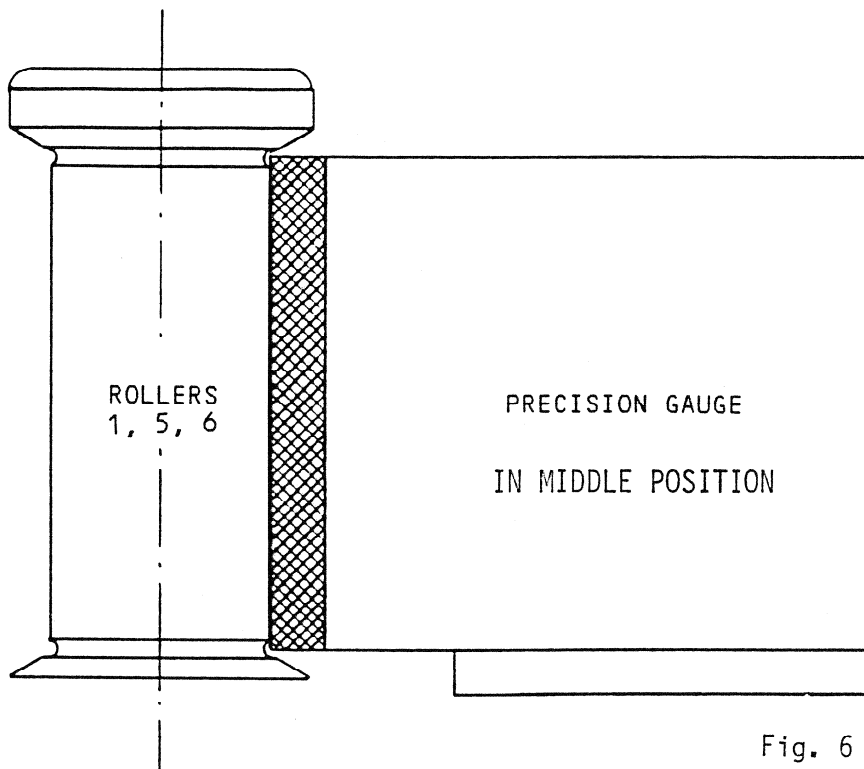


Fig. 6

6.1 Checking Roller Alignment

Step 2

Use gauge to check the alignment of roller 2. The roller is positioned correctly if it sits towards the lower end of the tolerance band which means the gauge touches the roller's upper edge slightly, yet without binding. See Fig. 7 and 8.

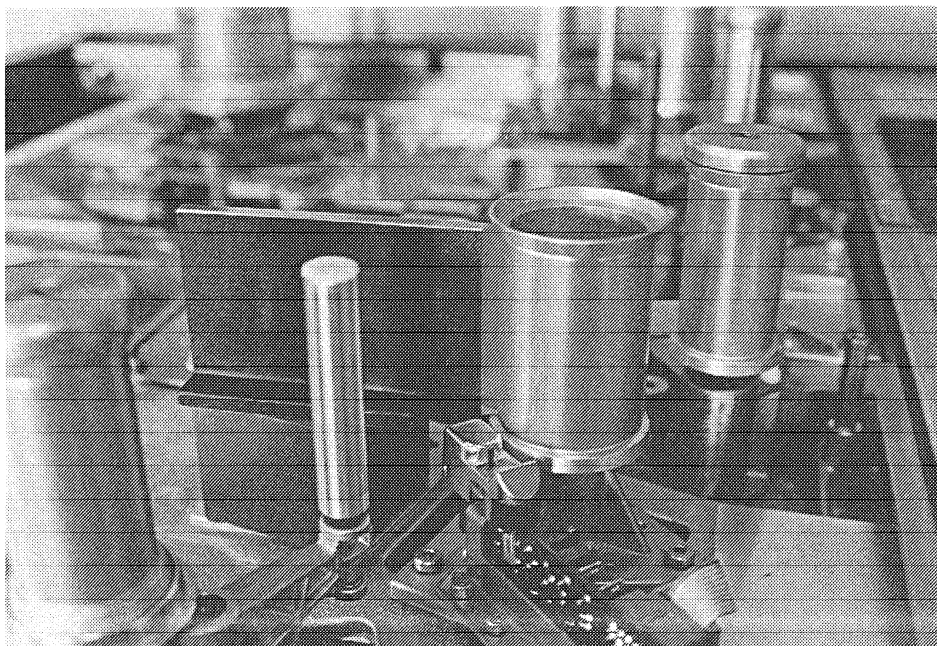


Fig. 7

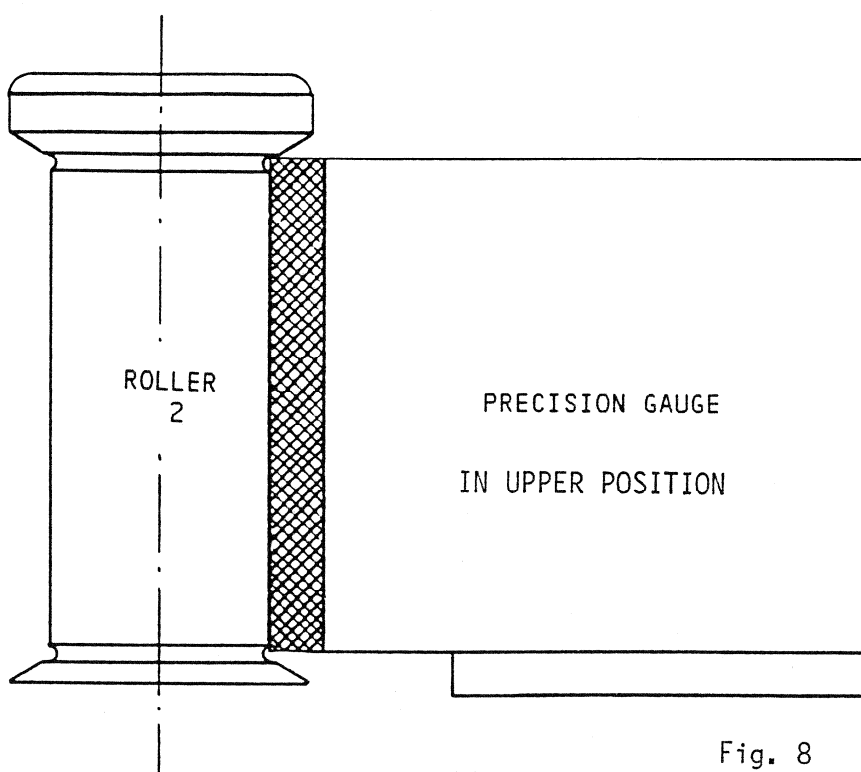


Fig. 8

6.1 Checking Roller Alignment

Step 3

Use gauge to check alignment of rollers 3 and 4. The rollers are adjusted correctly if they are positioned towards the upper end of the tolerance band which means the gauge touches the roller's lower edge slightly, yet without binding. See Fig. 9 and 10.

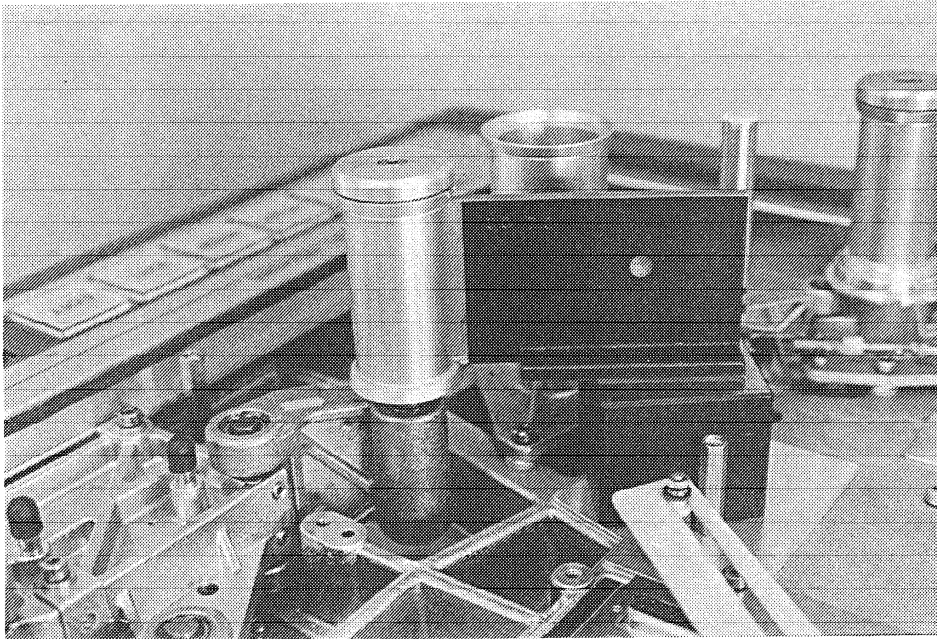


Fig. 9

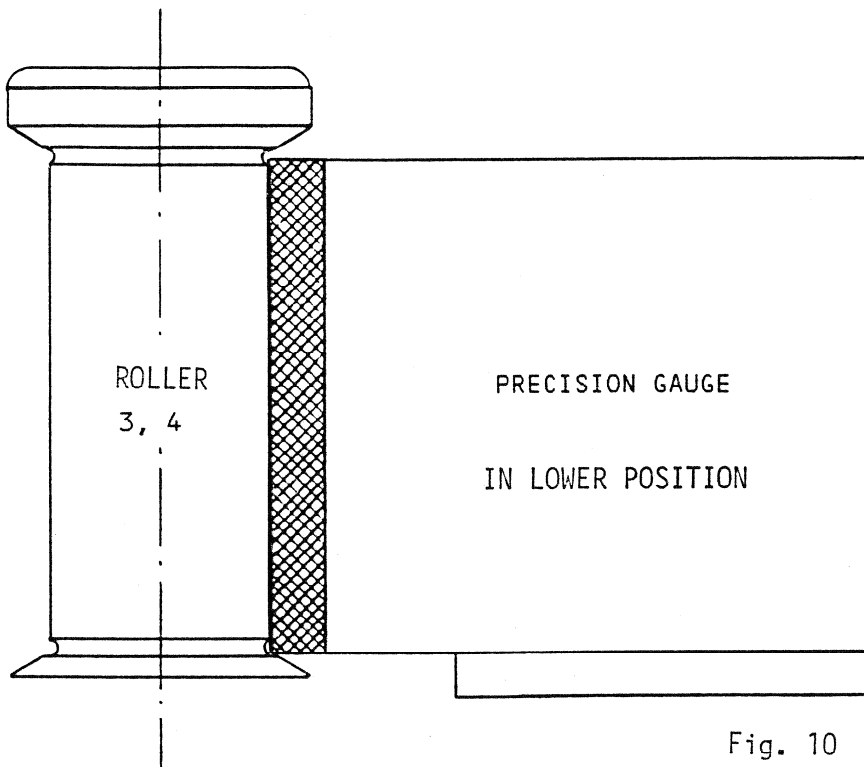


Fig. 10

6.2. Adjusting Roller Height

Step 1

Adjustment of rollers 1, 5 and 6. Axial alignment of these rollers is achieved by fitting or removing spacer discs.

See Fig. 11, Pos. 5 for Roller 5

See Fig. 12, Pos. 8 for Roller 1 and 6.

In most cases it is not necessary to adjust these rollers.

Prior to fitting the spacer discs it is advisable to measure their thickness with a micrometer.

Sorting the discs in this way, will be of great help in arriving quickly at the correct roller alignment.

- Spacer disc 0,1 mm 1.010.058.23
- Spacer disc 0,12 mm 1.010.059.23
- Spacer disc 0,15 mm 1.010.060.23
- Spacer disc 0,18 mm 1.010.061.23

Roller height must be checked again each time after their height adjustment has been altered. See chapter 6.1 Step 1.

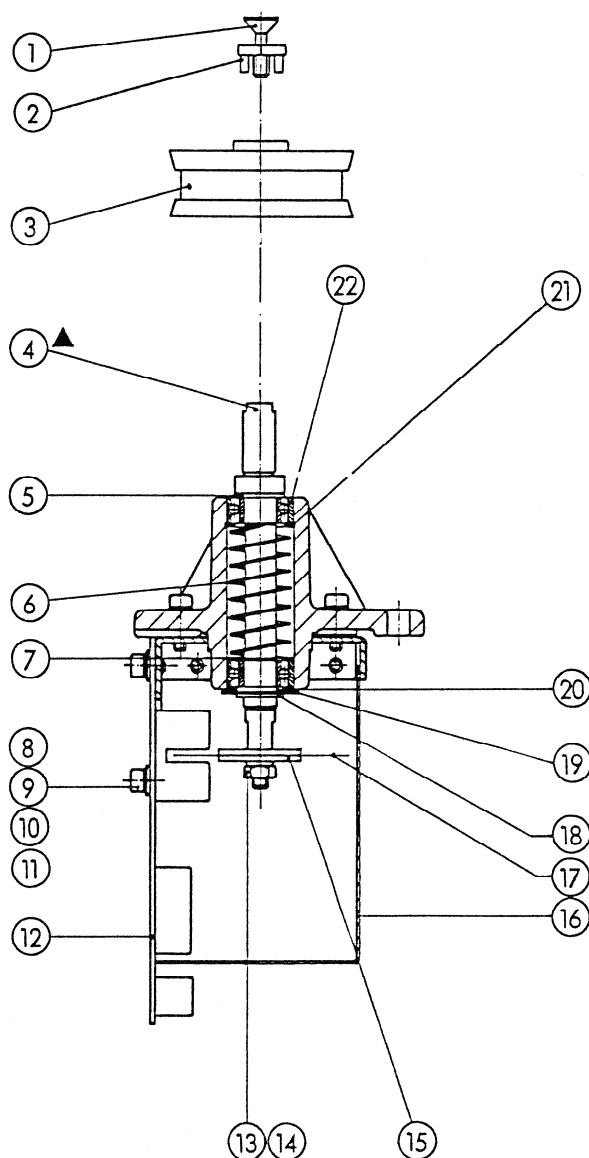


Fig. 11

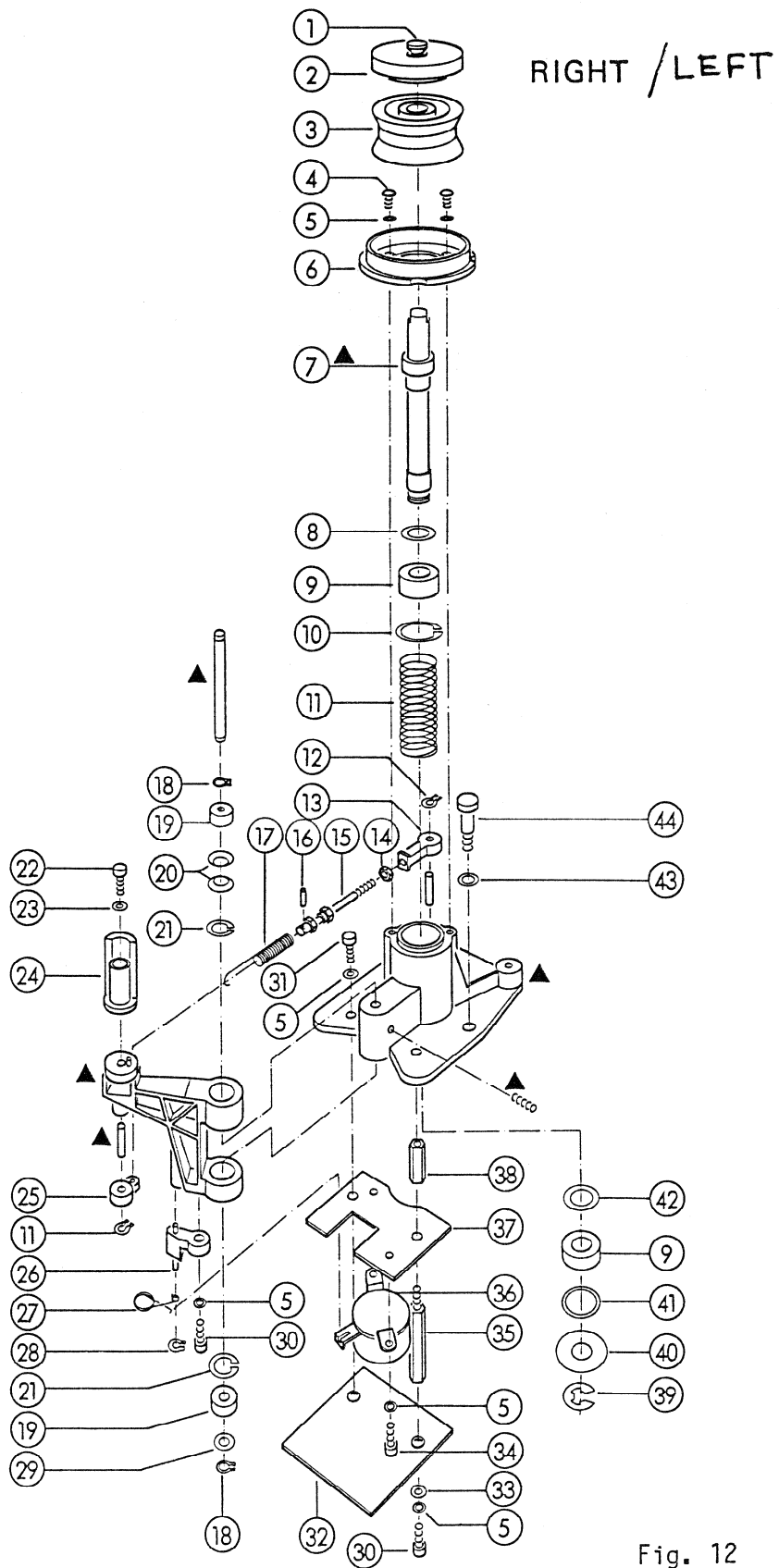


Fig. 12

6.2. Adjusting Roller Height

Step 2

Adjusting roller 2. Axial alignment of this roller is achieved by fitting or removing spacer discs. See Fig. 13, Pos. 14

Prior to fitting the spacer discs it is advisable to measure their thickness with a micrometer. Sorting the discs in this way will be of great help in arriving quickly at the correct roller alignment.

- Spacer disc 0,1 mm 1.010.058.23
- Spacer disc 0,12 mm 1.010.059.23
- Spacer disc 0,15 mm 1.010.060.23
- Spacer disc 0,18 mm 1.010.061.23

Roller height must be checked again each time after its height has been altered. See chapter 6.1 Step 2.

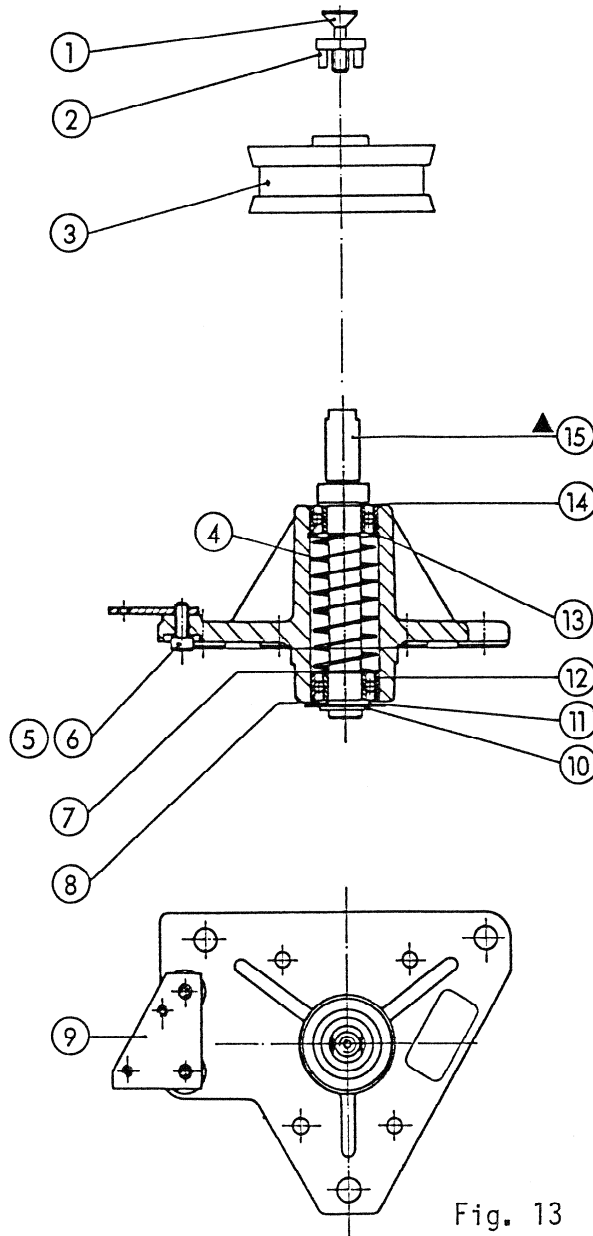


Fig. 13

6.2. Adjusting Roller Height

Step 3

Adjusting rollers 3 and 4. These rollers have first to be set to a reference height before further alignments can be performed. Exact axial alignment is then achieved by fitting or removing spacer discs.

- Remove the tape drive-assembly. Loosen the set screws A (Fig. 14) and adjust to a distance B for 1,6 mm by using a feeler gauge C (Fig. 14). Reinstall the assembly.
- Check roller height as per chapter 6.1 Step 3. In most cases the rollers will be positioned too low which is actually desirable. By fitting or removing spacer discs, the correct roller height must now be determined. Install spacer discs firstly directly underneath the rollers as Fig. 15 shows (experimental stage), once the correct height is determined install the spacer discs in the position Fig. 16 shows i.e between shaft and top ballbearing.
- Check tape motion in the shuttle mode (See chapter 5.1 Step 1). the tape should run nearly perfect. If it tends to run downwards in shuttle forward, correction is possible by raising roller 3 by 0,02 mm approx. If the tape tends to run upwards in shuttle reverse, correction is possible by raising roller 4 by 0,02 mm approx.

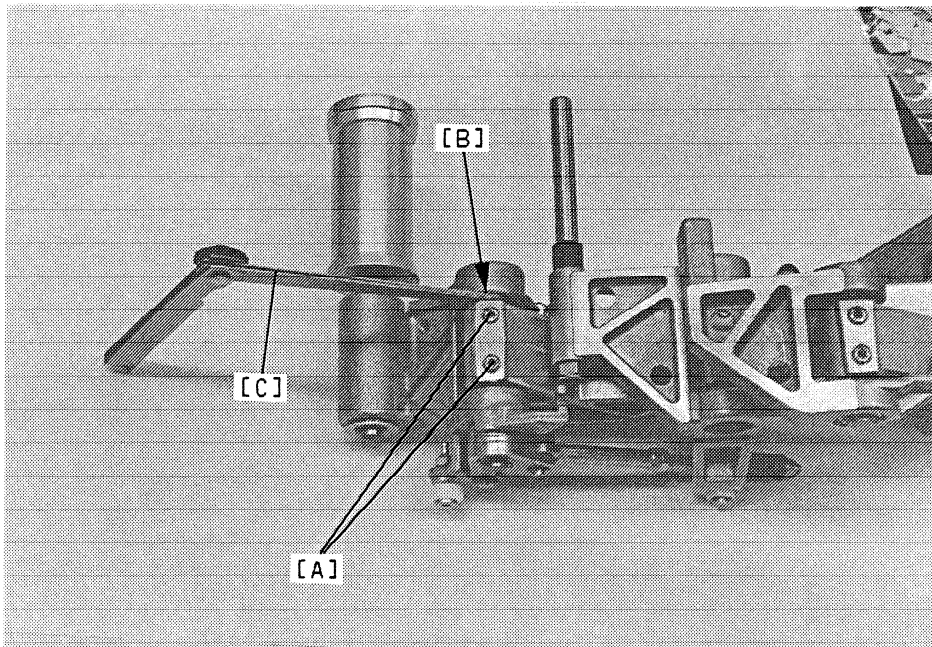


Fig. 14

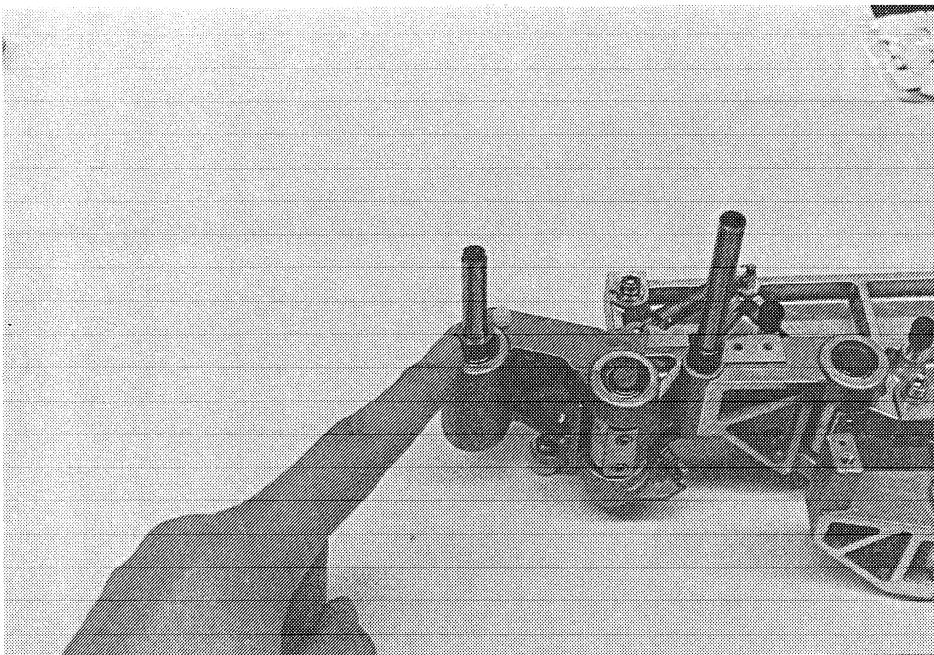


Fig. 15

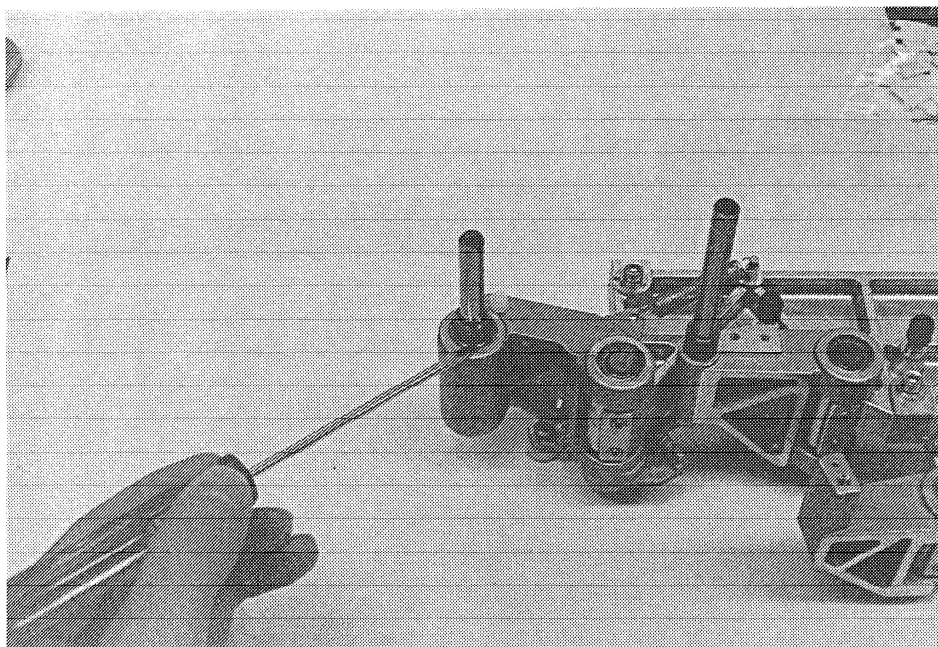


Fig. 16

7. Perpendicular Alignment of Pinch Roller

To stabilize the tape path, the pinch roller is fitted on a perpendicularly adjustable shaft. To achieve the desired effect by adjusting the pinch roller, rollers 1....6 must first be correctly aligned and the tape must travel perfectly across the heads in the shuttle mode (See chapter 5.1 Step 1).

Alignment Procedure

- Remove headblock and front cover plate.
- Reinstall headblock.
- Loosen the set screw A of the pinch roller shaft (use round-head hex screw-driver no. 2.5). See Fig. 17.
- Set pinch roller shaft to its normal position by using a 10 mm open end wrench. Turn the shaft so that the center punch mark B on the area where the wrench fits onto the shaft is in line with the set screw.
- Load recorder with tape and start in the play mode at 30 ips. Check tape tension as per section 3.3.8 of the A820 multichannel manual and chapter 4 of this SI.
- Observe tape motion across the heads. To the left of the capstan shaft gently push with one finger against the edge of the running tape in an upward and downward direction. See Fig. 2 and 3.
This results in an instability of the tape run causing the tape to run off in the initiated direction. With perfectly aligned tape guiding, the tape will return by itself and stabilize in the normal path when letting it run undisturbed again. In case of a misaligned pinch roller shaft, the tape will not return to its normal path.
- If the tape does not return into its normal path, the pinch roller shaft should be turned clockwise by 20 degree. See Fig. 18.
The behaviour of the running tape should now be checked again, and if it still does not return, the pinch roller shaft should be turned by an additional 20 degree. This procedure has to be repeated until the tape settles back and stabilizes itself in the normal tape path after it was pushed in either direction (up or down).
- In case the pinch roller shaft is turned by more than 180 degree, the reaction of the tape will change. Stability may either improve or it may deteriorate. Determine by experiment which direction of rotation of the pinch roller shaft results in the desired stability of the moving tape.

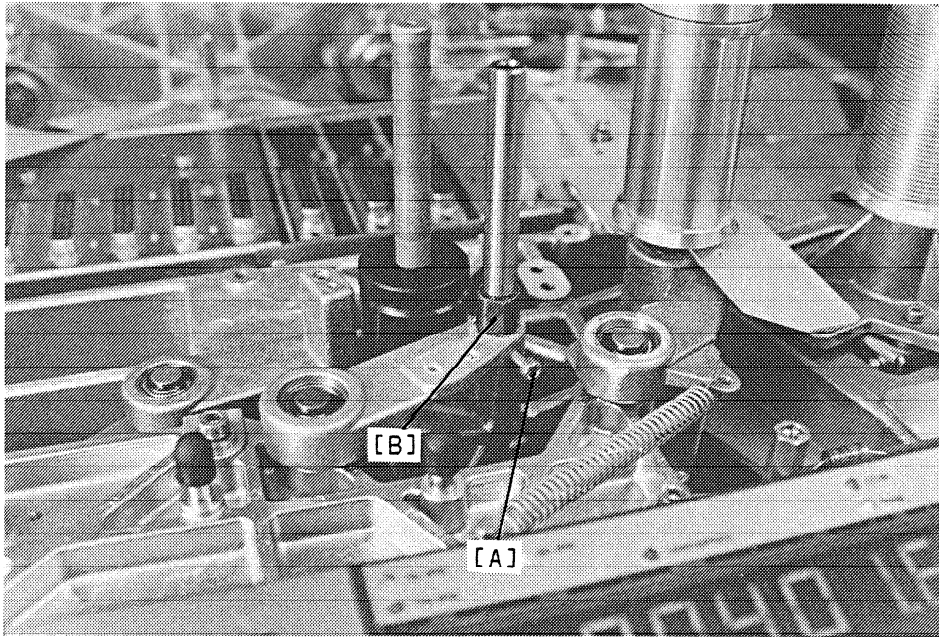


Fig. 17

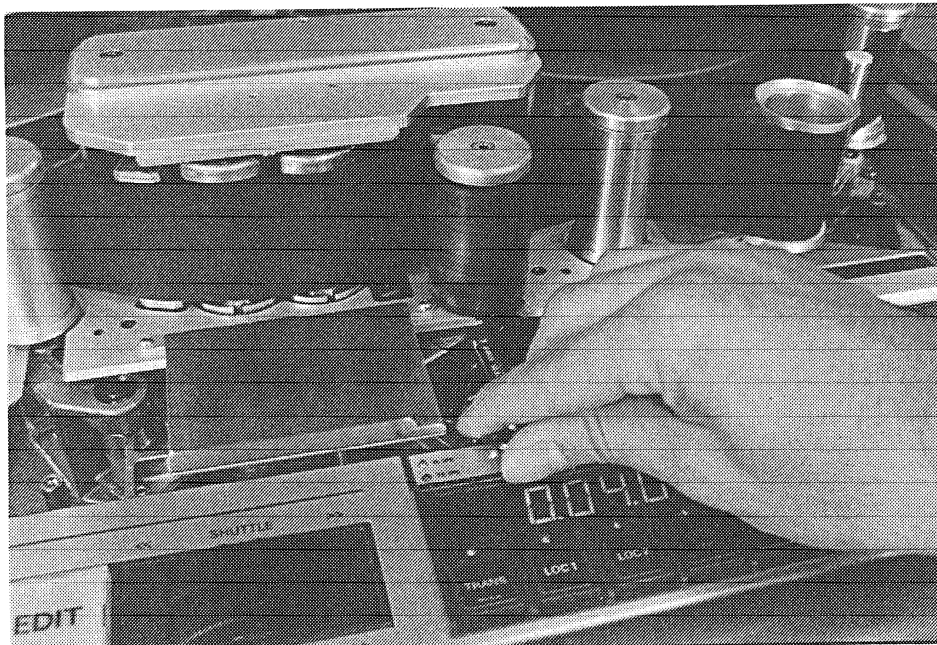


Fig. 18

will show up as periodic changes in level.

REPRODUCE:

Press the "NRS TONE" button and set the meters to the PEAK mode.

Play the Dolby Noise section of the tape. Both the "tape" and the "ref." sections of the Dolby Noise should be at the same level. If this is not the case adjust the "NRS LEVEL" until the "ref." section of the noise is at the same level as that of the "tape" section. This may be done by ear or by using the meters as above.

3. Instructions for the use of Dolby A-type noise reduction and Dolby Spectral Recording modules with STUDER A820 Multitrack machines and the following combination of software versions:

TD software 14/10/87
 Master software 10/10/87
 Audio software 14/10/87
 VU-panel software (X-Panel) 41/87
 Parallel channel remote IF (X-Panel) 41/87

DEFAULT SETTING:

NR SYSTEM Functions 054/055	Indication of the LC display on the meter bridge:	
	VU metering mode	PEAK metering mode
Dolby A	+0.0 VU	-6 dB
Dolby SR	+0.0 VU	-6 dB
Telcom	+6.0 VU	0 dB

Note 1: The TELCOM system is related to peak recording level. The DOLBY systems are related to operating level.

Note 2: Channels with activated NR system will switch automatically from REPRO to INPUT at drop-in, and back to REPRO at drop-out. It is possible, however, to select REPRO manually during recording.

Note 3: In "NRS TONE" and "NRS ALIGN" modes, the NR system will automatically switch to "BYPASS" for alignment and measuring purposes.

Note 4: The function AUTO ALIGN is not implemented yet.

The following instructions are intended to clarify the alignment and use of Dolby Laboratories Cat. Nos 22 A-type and 280 SR modules when fitted in STUDER A820 MCH recorders. These instructions are intended for audio software release dated 11/09/87. Future software revisions for the A820 MCH will provide both automatic and more comprehensive manual alignment facilities than are currently available.

The NR interface circuitry of the A820 MCH contains two digitally controlled gain stages, one before the NR module and one after. The machine software sets the gain of these stages in such a way that the overall gain of the NR system (see Note 1) is always unity. The advantage of such an arrangement is that the program levels are inde-

pendent of the setting of the NR system. The disadvantage is that any changes to the "NRS LEVEL" are not reflected by changes on either the machine or the console meters. The current settings of the "NRS LEVEL" may only be viewed or changed by using the LC display on the meter bridge.

Note 1:

Other than any gain intentionally introduced by the NR process. The Dolby A-type system for example has a gain of $-1/2$ dB in record mode and $+1/2$ dB in play mode at Dolby Level. Such gain differences will be apparent if tones are measured when the NR is switched on and may cause confusion. When recording with noise reduction switched on the signal "off tape" will be encoded, giving the impression of a level difference between INPUT and REPRO. On reproduce, however, once the signal has been decoded the level will be the same as the original INPUT signal. The same effect can be seen when the noise reduction unit is external to the tape machine, except that on the tape machine both INPUT and REPRO signals are encoded, giving a difference between the console and tape machine meters.

- Using Cat. No. 22 A-type modules:
Set functions No. 053 to "METERING VU", No. 054 to "NRS DOLBY", and No. 055 to "DOLBY A".

RECORD:

- Dolby Level = 0 VU:

This is the most frequently used alignment method. Set "NR TONE UNCAL CH 1-XY" to +0.0 VU on the LCD:

- Press "NRS ALIGN"; the "UNCAL MODE" is either ON or OFF, depending on if the NR system has to be aligned for all channels (UNCAL MODE = OFF), or for individual channels (UNCAL MODE = ON).
- Press "MANUAL ALIGN".
- Set for +0.0 VU with the "PARAM UP/PARAM DOWN" buttons.
- Press "STORE" if the level is reached.

The tape machine should be aligned with noise reduction switched off. To double check this if you are unsure, press the "NRS TONE" button and record a section of tone on blank tape. The tone should read 0 VU when played back (either with the "NRS TONE" button still pressed or NR switched off).

- Dolby Level does not match 0 VU:

Example: 0 VU corresponds to a flux level of 320 nWb/m and Dolby Level corresponds to 200 nWb/m. Playing a 200 nWb/m test tape on a machine which has been aligned for 320 nWb/m would give a reading of -4 VU.

Set "NR TONE UNCAL CH 1-XY" to -4.0 VU on the LCD:

- Press "NRS ALIGN"; the "UNCAL MODE" is either ON or OFF, depending on if the NR system has to be aligned for all channels (UNCAL MODE = OFF), or for individual channels (UNCAL MODE = ON).
- Press "MANUAL ALIGN".
- Set for -4.0 VU with the "PARAM UP/PARAM DOWN" buttons.
- Press "STORE" if the level is reached.

Again if you are unsure, press the "NRS TONE" button and record a section of tone on blank tape. The tone should read -4 VU when played back (either with the "NRS TONE" button still pressed or NR switched off).

REPRODUCE:

- Dolby Level = 0 VU:

With the "NRS TONE" button pressed, Dolby Tone reproduced from tape should read 0 VU. If this is the case then all is well. Check also that the "NRS TONE UNCAL CH 1-XY" or the "NR TONE CAL" is set to +0 VU.

Set "NR TONE UNCAL CH 1-XY" to +0.0 VU on the LCD:

- Press "NRS ALIGN"; the "UNCAL MODE" is either ON or OFF, depending on if the NR system has to be aligned for all channels (UNCAL MODE = OFF), or for individual channels (UNCAL MODE = ON).
- Press "MANUAL ALIGN".
- Set for +0.0 VU with the "PARAM UP/PARAM DOWN" buttons.
- Press "STORE" if the level is reached.

If Dolby Tone from tape does not read 0 VU then there are two possible solutions:

A Check that the "NRS TONE UNCAL CH 1-XY" or the "NR TONE CAL" is set to +0 VU.

Use the AUTO ALIGN features of the tape machine whilst playing the Dolby Tone section of the tape to reset all reproduce gains so that the Dolby Tone reads 0 VU for all tracks. This method is probably best used when the tones are close to 0 VU, i.e. errors are probably due to small misalignments when the tape was recorded.

B If the level is very different from 0 VU i.e. is due to a different standard being used during the recording, then it may be better, rather than re-setting the reproduce level, to change the "NRS LEVEL" as follows:

- Play the Dolby Tone section of the tape and note the level, e.g. -4 VU.
- Press "NRS ALIGN"; the "UNCAL MODE" is either ON or OFF, depending on if the NR system has to be aligned for all channels (UNCAL MODE = OFF), or for individual channels (UNCAL MODE = ON).
- Press "MANUAL ALIGN".
- Set for -4.0 VU with the "PARAM UP/PARAM DOWN" buttons.
- Press "STORE" if the level is reached.

- Dolby Level does not match 0 VU:

If your Dolby Level is other than 0 VU (e.g. -4 VU) Dolby Tone should read your Dolby Level when played back with either the "NRS TONE" button pressed or noise reduction switched off. If this is not the case use procedure B above to realign.

■ Using Cat. No. 280 Spectral Recording modules:

Set functions No. 054 to "NRS DOLBY", and No. 055 to "DOLBY SR".

The alignment of SR differs from A-type in two aspects. Firstly, the alignment signal is pink noise rather than the familiar Dolby Tone. This noise signal known as "Dolby Noise" has short "gaps" in it every two seconds, similar to the warble in Dolby Tone.

Secondly, Dolby Noise serves not only as a level reference but also can be used to check frequency response as well. To facilitate frequency response checks all SR processors include a facility known as "Auto Compare". Auto Compare works as follows: In RECORD, the module

will output the following sequence: 4 seconds of noise from the tape followed by four seconds of noise from the internal generator. This sequence shows up audibly any level or response errors in the recorder including any Dolby Level misalignment. The "tape" section of the noise has a 20 ms gap after 2 seconds; the "ref." section from the internal generator is continuous. Lights on the front of each Cat. No. 280 indicate which signal is being heard at any time.

On the rear of each Cat No 280 is a frame configuration switch used to configure the auto compare system as appropriate for different types of interface. The switch is labeled "360", "361", and "M" for use with Dolby Laboratories models 360, 361, and M series. For use in the STUDER A820 MCH the switch should be set to the "360" position.

On any of the units manufactured by Dolby Laboratories the meter gain of the unit is changed so that when the Dolby Tone button is pressed the meter will read on the Dolby Level dot for noise recorded 15 dB below Dolby Level. This feature is not implemented in this version of the A820 software; so, for a Dolby Level of 0 VU, Dolby Noise will read -15 dB. Reading pink noise accurately can be problematic on some types of meter. The A820 MCH VU-meter display used in its high resolution mode shows several dBs of fluctuation with Dolby Noise. We therefore recommend that for checking the level of Dolby Noise you should use the "PEAK" mode (Function No. 053, "METERING VU/PEAK"). Noise corresponding to a Dolby Level of 0 VU (-6 dB peak) will read -15 dB peak.

RECORD:

- Dolby Level = 0 VU (Dolby Noise at -15 dB peak):
 - Set the "NR TONE UNCAL CH 1-XY" on the LCD to +0.0 VU if VU metering mode is switched on, or to -6 dB if PEAK metering mode is switched on:
 - Press "NRS ALIGN"; the "UNCAL MODE" is either ON or OFF, depending on if the NR system has to be aligned for all channels (UNCAL MODE = OFF), or for individual channels (UNCAL MODE = ON).
 - Press "MANUAL ALIGN".
 - Set for +0.0 VU (in VU metering mode), or -6 dB (in PEAK metering mode), resp., with the "PARAM UP/PARAM DOWN" buttons.
 - Press "STORE" if the level is reached.
 - When Dolby Noise is recorded on tape it will be at a level of -15 dB peak.
- Dolby Level does not match 0 VU:
 - Example: 0 VU corresponds to a flux level of 320 nWb/m and Dolby Level corresponds to 200 nWb/m. Playing a 200 nWb/m test tape on a machine which has been aligned for 320 nWb/m would give a reading of -4 VU.
 - Set the "NR TONE UNCAL CH 1-XY" to -4 VU:
 - Press "NRS ALIGN"; the "UNCAL MODE" is either ON or OFF, depending on if the NR system has to be aligned for all channels (UNCAL MODE = OFF), or for individual channels (UNCAL MODE = ON).
 - Press "MANUAL ALIGN".
 - Set to -4.0 VU (in VU metering mode), or to -10.0 dB (in PEAK metering mode), resp., with the

"PARAM UP/PARAM DOWN" buttons.

- Press "STORE" if the level is reached.
- Press the "NRS TONE" button and record a section of Dolby Noise on blank tape. The noise should read 4 dB below -15 dB, i.e. -19 dB when played back (with NR switched off).

In either of the above cases you can check the level of the Dolby Noise on tape by pressing the "NRS ALIGN" and "NRS TONE" buttons ("AUTO COMPARE" mode) during reproduction of the Dolby Noise and "soloing" each monitor channel in turn. Both the "tape" and "ref." sections of Dolby Noise should be at the same level. The recorder meters will also alternate between "tape" and "ref.". Differences between the two will show up as periodic changes in level. Set for minimum difference for each channel.

REPRODUCE:

Press the "NRS ALIGN" and "NRS TONE" buttons ("AUTO COMPARE" mode) and set the meters to the PEAK mode. Play the Dolby Noise section of the tape. Both the "tape" and the "ref." sections of the Dolby Noise should be at the same level. If this is not the case adjust the "NRS LEVEL" until the "ref." section of the noise is at the same level as that of the "tape" section. This may be done by ear or by using the meters as above. Set for minimum difference for each channel.

POS. 1 - 10 LOCATED IN ELECTR. RACK LEFT TO RIGHT	DATE	COMPATIBLE COMBINATION	COMPATIBLE COMBINATION	COMPATIBLE COMBINATION	COMPATIBLE COMBINATION
	SERIAL NO:	April 87	May 87	Aug. 87	Oct. 87
		1000-1023	1000-	1000-	1000-
		1	2	3	4
1 Spooling Motor Driver	1.820.759	84	84	84	84
2 Capstan Control Unit	1.820.764	23 Software 1.820.994.22 36/86	24 Software 1.820.994.23 17/87	24 Software 1.820.994.23 17/87	24 Software 1.820.994.23 17/87
3 Capstan Interface	1.820.727	00	00	00	00
4 T.D. Periphery Ctrl.	1.820.762	81	81	81	81
5 T.D. Counter Timer	1.820.761	81	81	81	82
6 Spooling Motor Control	1.820.822	00	00	00	00
7 MP-Unit T.D. Control	1.820.781	00/Software 3.4.87	00/Software 5.5.87	00/Software 10.7.87	00/Software 14.10.87
8 T.D. Serial IF	1.820.763	81	81	81	81
9 Master Serial IF	1.820.753	00	00	00	00
10 MP-Unit Master	1.820.784	00/Software 2.4.87	00/Software 26.5.87	00/Software 24.7.87	00/Software 10.10.87
11 Serial Remote Controller	1.810.751	82	82	82	82
12 SMPTE/EBU Interface	1.820.751	--	21 Software 1.820.998.21 10/87	21 Software 1.820.998.21 10/87	21 Software 1.820.998.21 10/87
13 Master To Audio Interface	1.820.756	00	00	00	00
14 Communications Controller	1.820.718	00	00	00	00
15 MP-Unit Audio	1.820.782	00/Software 4.4.87	00/Software 26.5.87	00/Software 6.7.87	00/Software 14.10.87
16 Generator Unit	1.820.725	00/81	00/81	00/81	00/81
17 External NRS Controller	1.820.816	00	00	00	00
18 Multichannel Bus Driver	1.820.723	00	00	00	00

		COMPATIBLE COMBINATION	COMPATIBLE COMBINATION	COMPATIBLE COMBINATION	COMPATIBLE COMBINATION
	DATE	April 87	May 87	Aug. 87	Oct. 87
	SERIAL NO:	1000-	1000-	1000-	1000-
		1	2	3	4
19 Bus Converter MCH	1.820.717	00	00	00	00
20 HF-Driver	1.820.813	00	00	00	00
21 Reproduce Amplifier HX Pro	1.820.811	00	00	00	00/81
22 Reproduce Amplifier	1.820.710	84	84	84	84
23 Switching + Metering Unit	1.820.716	00	00	00	00
		OR	OR	OR	OR
24 Internal NRS Controller	1.820.815	00	00	00	00
25 Line Amplifier Trafoless	1.820.715	81	81	81	81/82
		OR	OR	OR	
26 Line Amplifier	1.820.714	83	83	83	83
27 Basis Board NRS	1.820.809	00	00	00	00
28 Spolling Motor Drive Amplifier	1.820.875	00	00	00	00
29 Switching Stab. +/- 15 V	1.820.871	00	00	00	00/81
30 Switching Stabilizer + 5 V	1.820.872	00	00	00	00/81
31 Capstan Motor Drive Amp.	1.820.774	23	23	23	23
32 Parallel Remote Interface	1.820.738	81	81	81	81
33 Serial Remote Interface	1.820.729	<u>20</u> Software 1.820.999.20 13/85	<u>20</u> Software 1.820.999.20 13/85	<u>22</u> Software 1.820.999.22	<u>23</u> Software 1.820.999.23
34 Power Supply	1.820.350	00	00	00	00
35 MP-Unit VU-Panel	1.820.783	00/Software 31.3.87	00/Software 21.5.87	00/Software <u>26.6.87</u>	<u>21</u> Software 1.820.988.21 41/87
36 VU-Panel Central PCB	1.820.705	00	00	00	00

		COMPATIBLE COMBINATION	COMPATIBLE COMBINATION	COMPATIBLE COMBINATION	COMPATIBLE COMBINATION
	DATE	April 87	May 87	Aug. 87	Oct. 87
	SERIAL NO:	1000-	1000-	1000-	1000-
		1	2	3	4
=====					
37 Bargraph Board 8 CH	1.820.736	00	00	00	00
38 Channel Ctrl Key Board	1.820.708	00	00	00	00
39 Key Board Driver	1.820.709	00	00	00	00
40 Master Key Board Audio	1.820.817	00	00	00	00/81
41 Tape Tension Sensor 2" left/right	1.820.157/158	00/81	00/81	00/81	--
42 Tape Tension Sensor 1" + 2" left/right	1.820.387/388	--	--	--	00
43 Tape Tension Sensor 1" left/right	1.820.155/156	00/81	00/81	00/81	--
44 Tape Tension Sensor 1" ONLY left/right	1.820.385/386	--	--	--	FUTURE
45					
46					
47					
48 Autolocator Autolocator Driver PCB	21.328.240.00 1.328.232	--	--	<u>22</u> Software 1.328.999.22 29/87	<u>22</u> Software 1.328.999.22 29/87
49 Autolocator Autolocator Driver PCB	21.328.230.00 1.328.232	--	--	<u>22</u> Software 1.328.999.22 29/87	<u>22</u> Software 1.328.999.22 29/87
50 Aud. Rem. Ctrl. 8 CH MP-UNIT VU-Panel	21.328.501.00 1.820.783	--	<u>20</u> Software 1.820.988.20 22/87	<u>20</u> Software 1.820.988.20 22/87	<u>21</u> Software 1.820.988.21 41/87
51 Aud. Rem. Ctrl. 24 CH MP-UNIT VU-Panel	21.328.503.00 1.820.783	--	<u>20</u> Software 1.820.988.20 22/87	<u>20</u> Software 1.820.988.20 22/87	<u>21</u> Software 1.820.988.21 41/87
52 Paral. Channel IF MP-UNIT AUD. REM. IF	21.328.500.00 1.820.787	--	<u>20</u> Software 1.820.984.20 20/87	<u>21</u> Software 1.820.984.21 26/87	<u>22</u> Software 1.820.984.22 41/87
53 TLS 4000 Interface A820 MCH	1.812.134	--	<u>20</u> Software 1.812.968.20	--	<u>21</u> Software 1.812.968.21 42/87
54 TLS 4000 Synchronizer Board	1.812.106	--	<u>22</u> Software 1.812.910.22	<u>22</u> Software 1.812.910.22	<u>23</u> Software 1.812.910.23 40/87