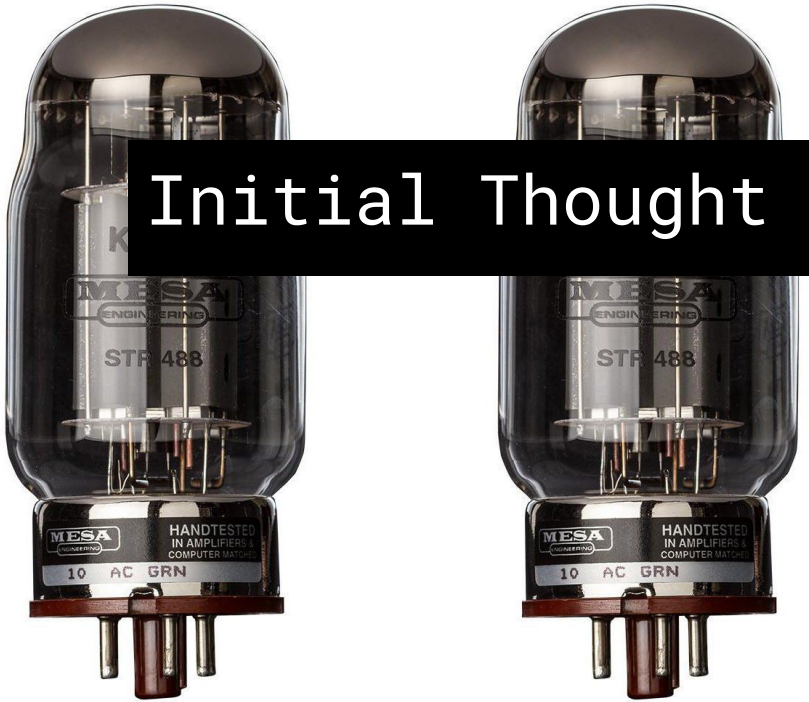
Woven Electronics

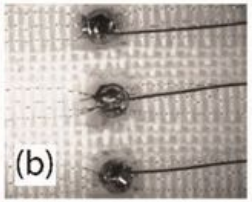
Pratheek Irvathur

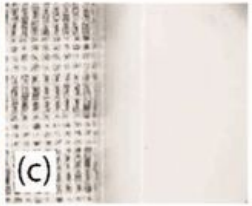
Initial Thought

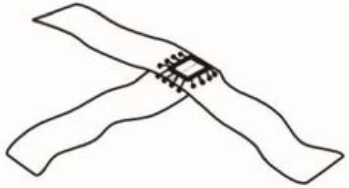


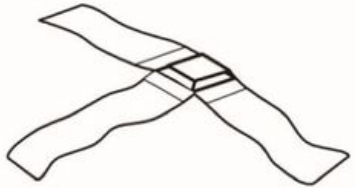
Dominant materials emerge alongside technological movements

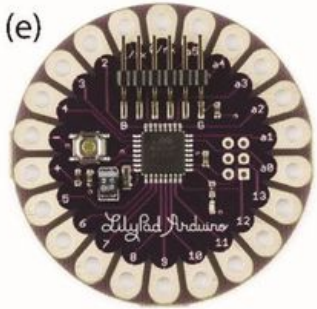
Current Scenario

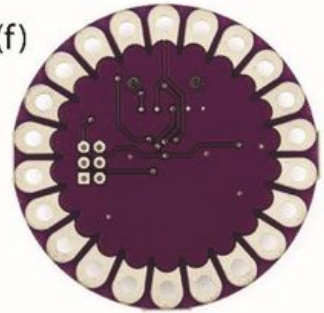




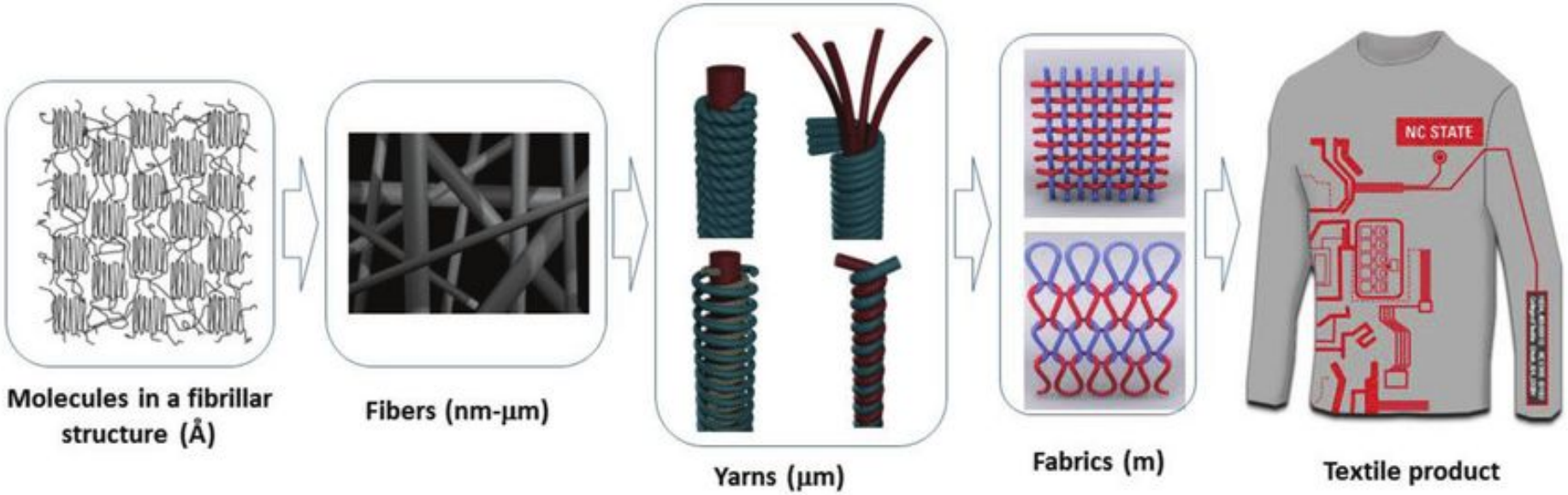








Points of Intervention



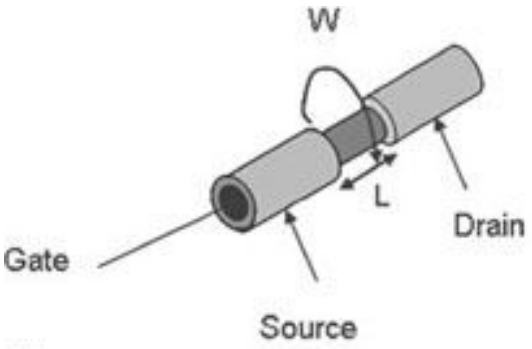
Concept Statement

Wearables that utilise computing and storage components, are often made of rigid materials that have been traditionally used for manufacturing electronic components. For a wearable that is textile based, the same rigid materials are utilised.

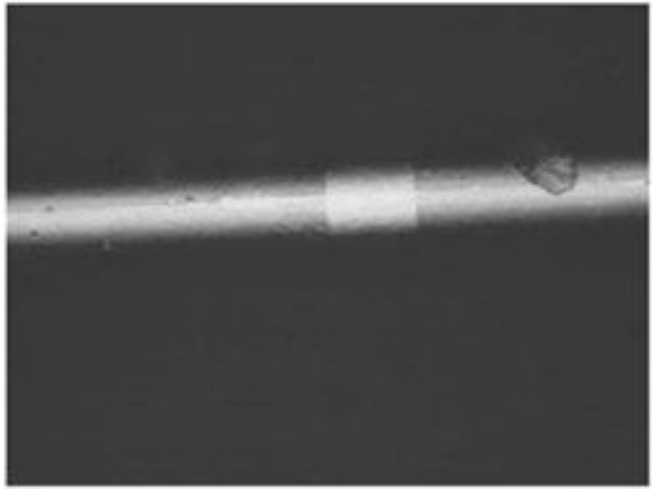
The project aims to create new material that is made using yarn and embedded materials from traditional electronics, to create flexible, non rigid materials that can be used to weave computing components.


Replace this...

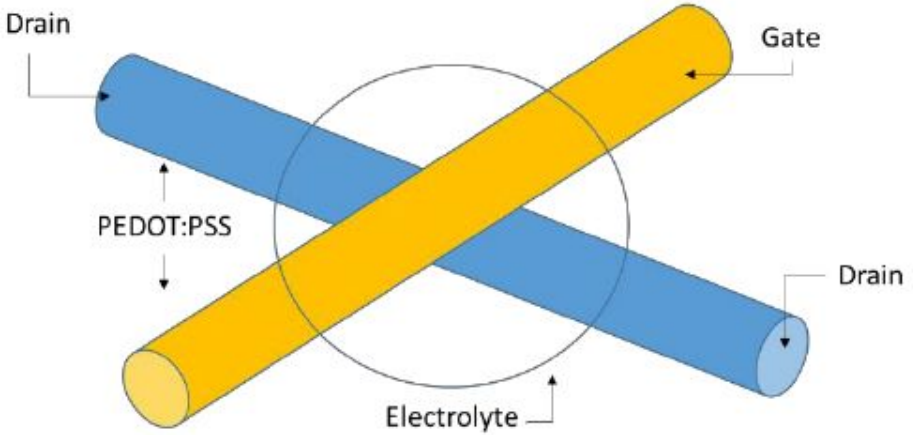

...With this



(a)



(b)

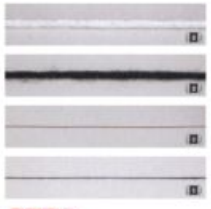


p/n junction on yarn

Knitted radio: Irene Posch

1 BLACK AND WHITE LOOSE FIT SWEATER

Drop-shoulder sweater with 2-color graphic pattern and loose fitting shape. Sized for Medium Unisex and shown in size Medium on front page.



FINISHED MEASUREMENTS

Stainless Steel in black (HT)
- 4 3½ oz/100g spools (each approx. 556 yds/509m) 0,15 diameter Enameled Copper Wire (CW)
- One pair size 4 U.S. (3.5mm) needles, OR SIZE TO OBTAIN GAUGE
- Stitch markers, stitch holders

GAUGES

- 28 sts and 36 rows = 4"/10 cm over chart 1 pat using size 4 (3.5mm) needles
- 27 sts and 34 rows = 4"/10 cm over chart 2 and 3 pats using size 4 (3.5mm) needles

TAKE TIME TO CHECK GAUGES.

BACK

With size 4 (3.5mm) needle and MC, cast on 162 sts.

Row 1 (RS) K1, *k1, p1; rep from * to last st, k1. Cont in k1, p1 rib as established for 22 rows more or until piece measures 2 ½ "/6.5 cm from beginning.

Beg chart

Note Chart is worked in St st (k on RS, p on WS), work CC and CW as one.

Row 1 (RS) With MC, k1 (salvage st), work 10-st chart rep 16 times, work to end of chart 1, with MC, k1 (salvage st).

Row 2 (WS) With MC, k1, work 10-st rep 16 times, with MC, k1.

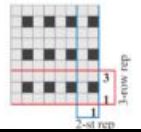
Cont. to work chart 1 in this way through row 10, then rep rpws 1 - 10, working salvage sts in MC in garter st (k every row) Work even for 119 rows, pm, work even for 112 rows.

Neck shaping

Next row (RS) K65 in pat, place center 32 sts in st holder, join 2nd balls of MC, CC, CW, k to end in pat.

Working both sides at once, bind off 2 sts from each neck edge every other row 5 times - 55 sts rem each side. Bind off 1 sts from each edge every other row 4 times - 50 sts stay. Work even for 10 rows.

CHART 2



white (CC)
black (MC and CW combined)

LEFT SLEEVE

With size 4 (3.5mm) needle and MC, cast on 94 sts.

Row 1 K1, *k1, p1; rep from * to last st, k1. Cont in k1, p1 rib as established for 16 rows more.

With CC, work in St st (k on RS, p on WS) for 3 rows

Beg chart

Note Chart is worked in St st (k on RS, p on WS), work MC and HT as one.

Row 1 With CC, k1, work st 0 of chart 2, work 2-st chart 47 times, work to end of chart, with CC, k1 (salvage st).

Cont to work chart 2 in this way through row 3, then rep rows 1 - 3, maintaining selvage sts in garter st. Cont in pats as established, working inc'd sts into chart 2 pat, inc 1 st each side every 5th row.

Work even for 163 rows, end with a WS row.

RIGHT SLEEVE

With size 4 (3.5mm) needle and MC, cast on 94 sts.

Row 1 K1, *k1, p1; rep from * to last st, k1. Cont in k1, p1 rib as established for 16 rows more.

With CC, work in St st (k on RS, p on WS) for 3 rows

Beg charts

Note Chart is worked in St st (k on RS, p on WS), work MC and HT as one.

Row 1 With CC, k1, work st 0 of chart 2, work 2-st chart 47 times, work to end of chart, with CC, k1 (salvage st). Cont to work chart 2 in this way through row 3, then rep rows 1 - 3, maintaining selvage sts in garter st.

Cont in pats as established, working inc'd sts into chart 2 pat, inc 1 st each side every 5th row. Work even for 36 rows.With CC, k1, work st 0 of chart 2, work 2-st chart 25 times. With CC, k1, work st 0 of chart 3, work 10st-chart 1 time. With CC, k1, work st 0 of chart 2, work 2-st chart 25 times.

Cont in pats as established, working inc'd sts into chart 2 pat, inc 1 st each side every 5th row. Work even for 126 rows. Work HT into CT in row 50 and row 74 - 125.

FINISHING

Block pieces lightly to measurements. Sew shoulder seams. Set in sleeves. Sew sleeve seams.

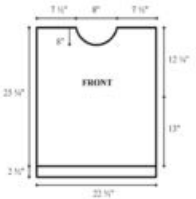
Neckband

With RS facing, beg at left shoulder, pick up k 16 sts along left front neck edge, pm, k32 sts from front neck holder, pm, pick up an k 16 sts along right front neck edge, k64 from back neck holder - 128 sts. Join and pm for beg of rnd.

Rnd 1 K1, * p1, k1; rep from * to end.

Rnd 2 (dec) [Work in rib as established to 1 st before marker, S2KP] twice, work in rib to end. Rep rnd 2 until neckband measures 1"/2.5 cm.

Bind off loosely in pat.



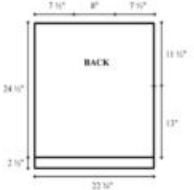
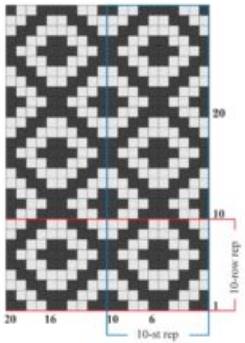
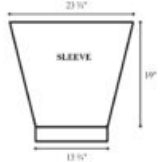


CHART 1



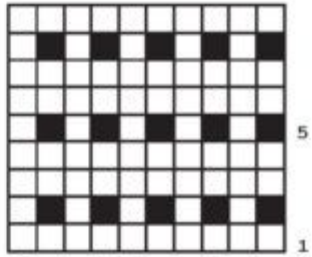


Color Key

white (CC)
black (MC and 2 strings of CW)

A resistor is a device that has a designed resistance to the passage of an electric current.

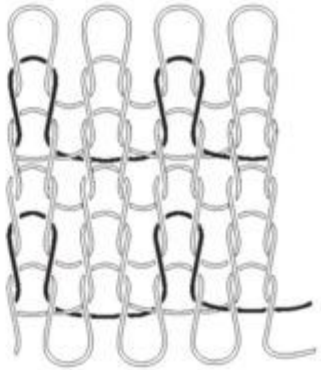
Resistors can be knitted out of wool and core-spun yarn with a resistive stainless steel core. The pattern makes sure that the wool functions as an insulator so that the resistive yarn does not create short-circuit throughout the patch.



Colour Key

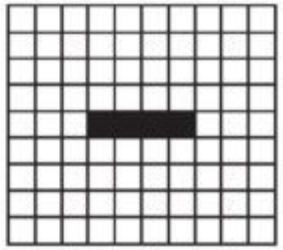
wool

spun stainless steel awool)



A coil is formed when a conductor is wound around a core. When electricity is passed through a coil, it generates a magnetic field.

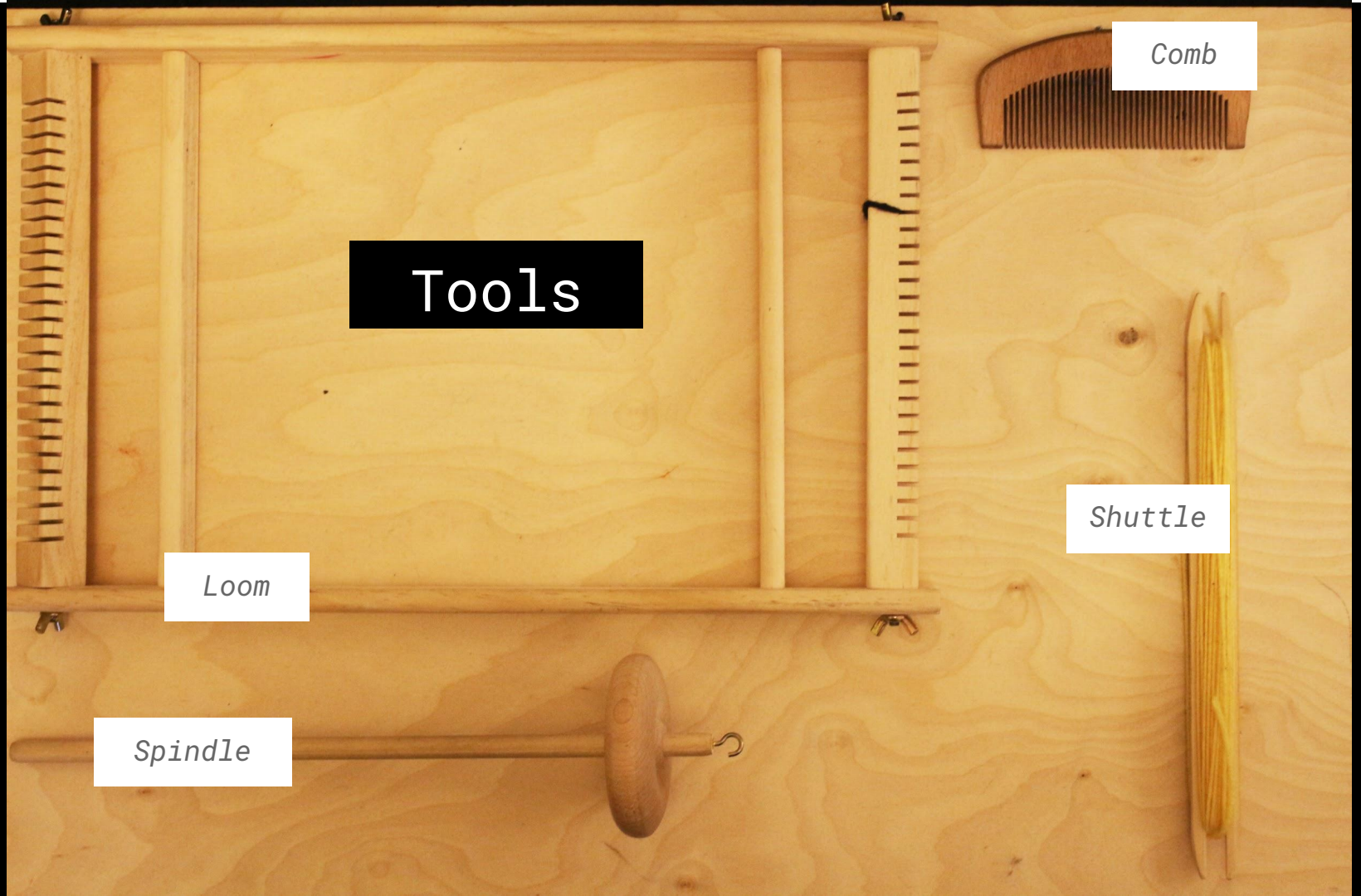
Knitted coils can be created by making a number of plain stitches using a single strand of insulated copper wire.



Colour Key

wool

enamelled copper wire


Tools
Comb
Shuttle
Loom
Spindle

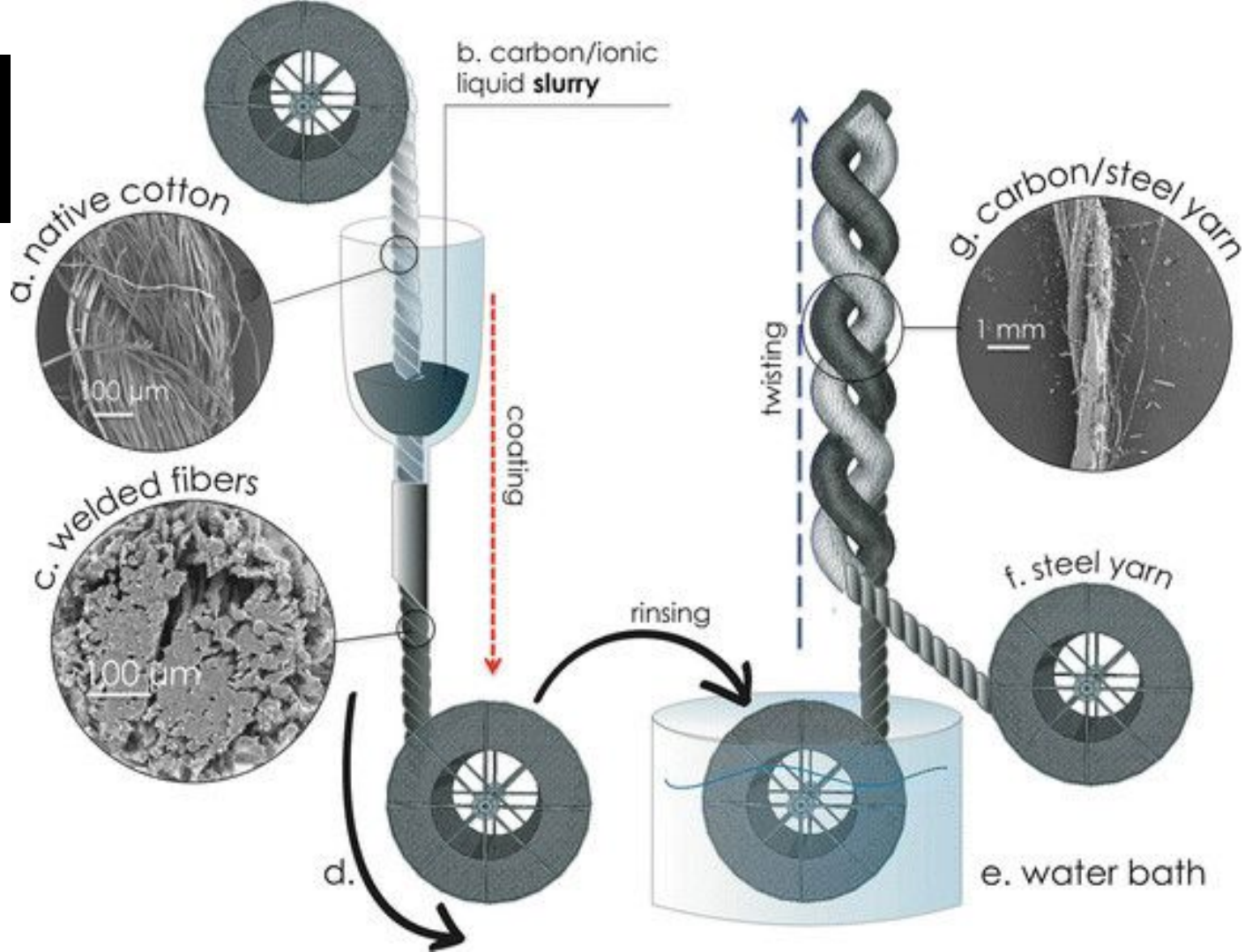
Carbon

Fibre

Yarn

Swatches

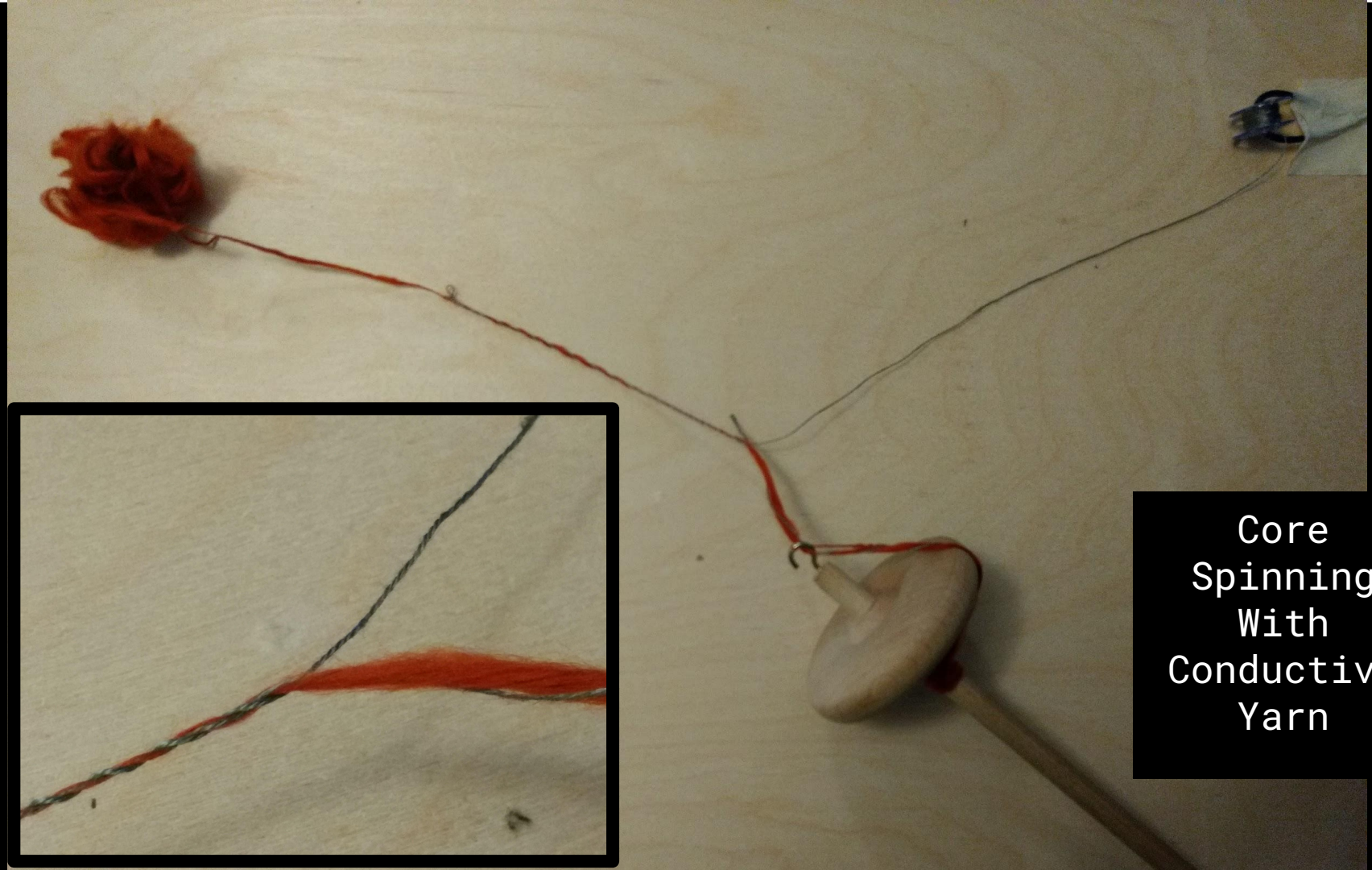
Industrial Natural Fiber Welding



Fibre Treatment

Combed cotton fibres are suspended in an activated carbon slurry

Spinning Into Yarn

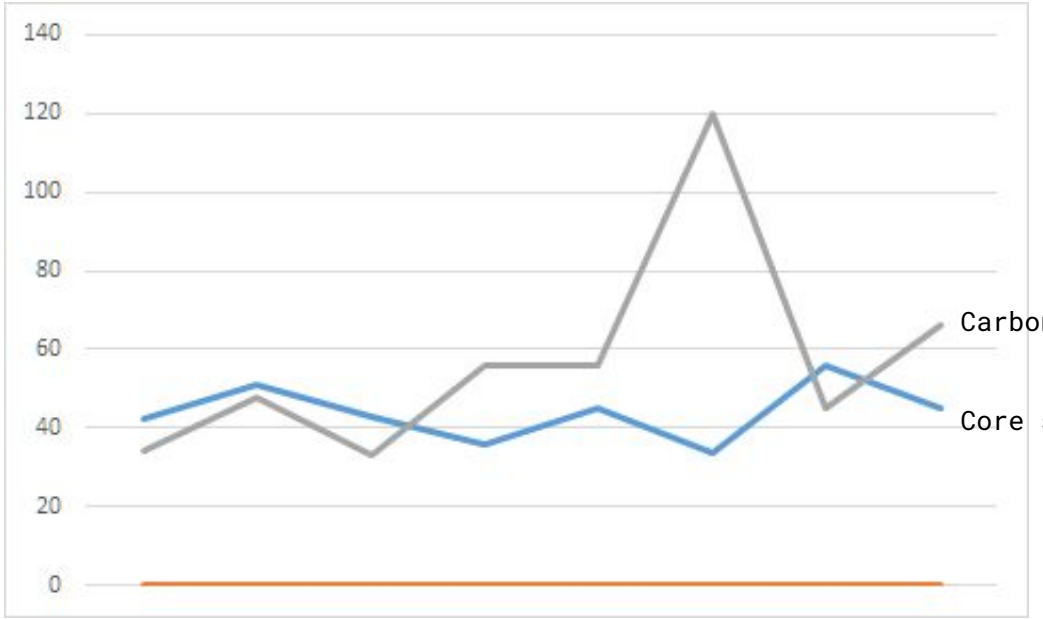


Core Spinning With Conductive Yarn

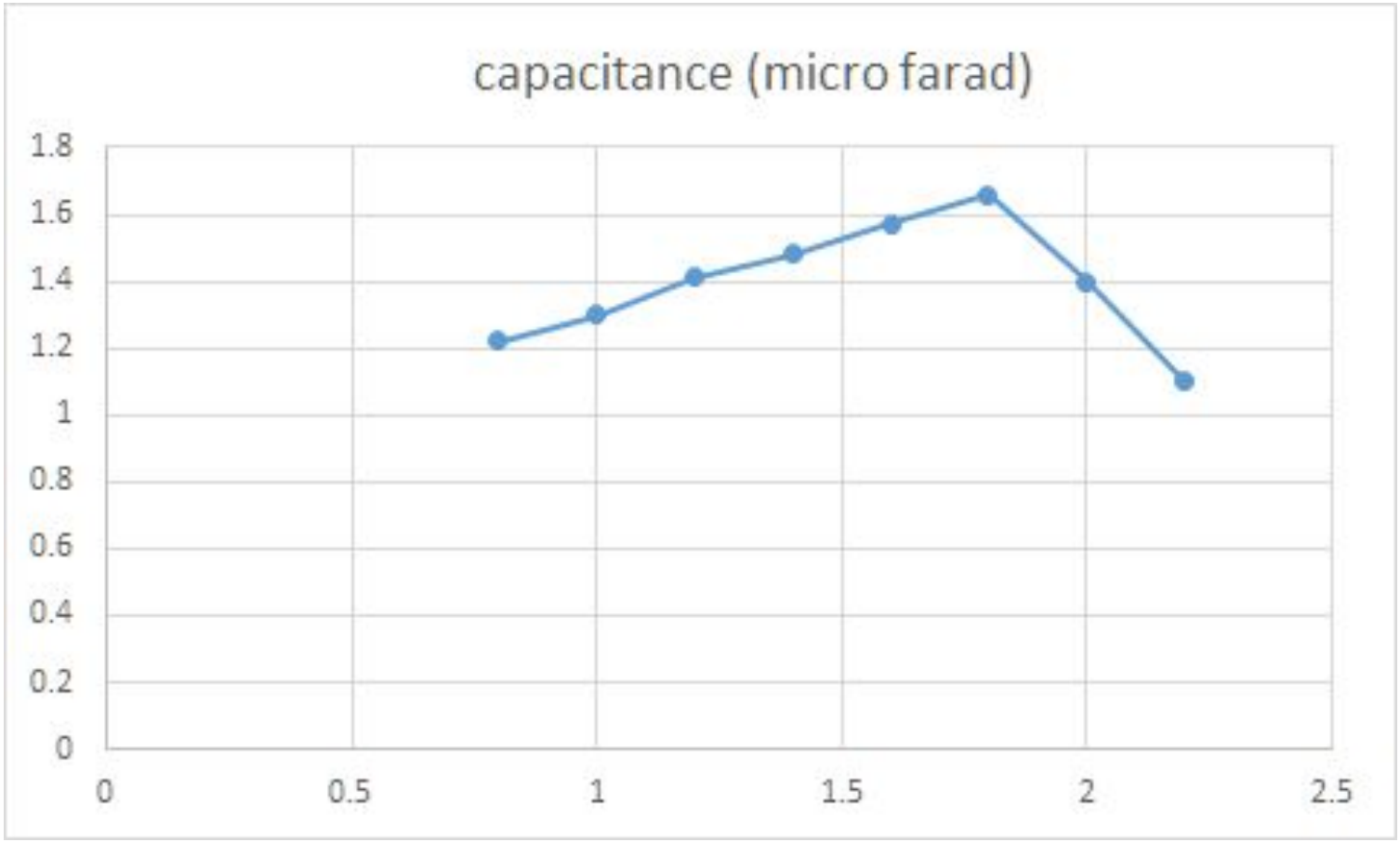

Spun Yarn
VARIABLE
RESISTANCE
#3


CARBON DUST #2 RESISTIVE
CARBON SLUG #1 RESISTIVE
VARIABLE DOPING #3 VARIABLE RESISTANCE
CLADDING #4 CAPACITIVE

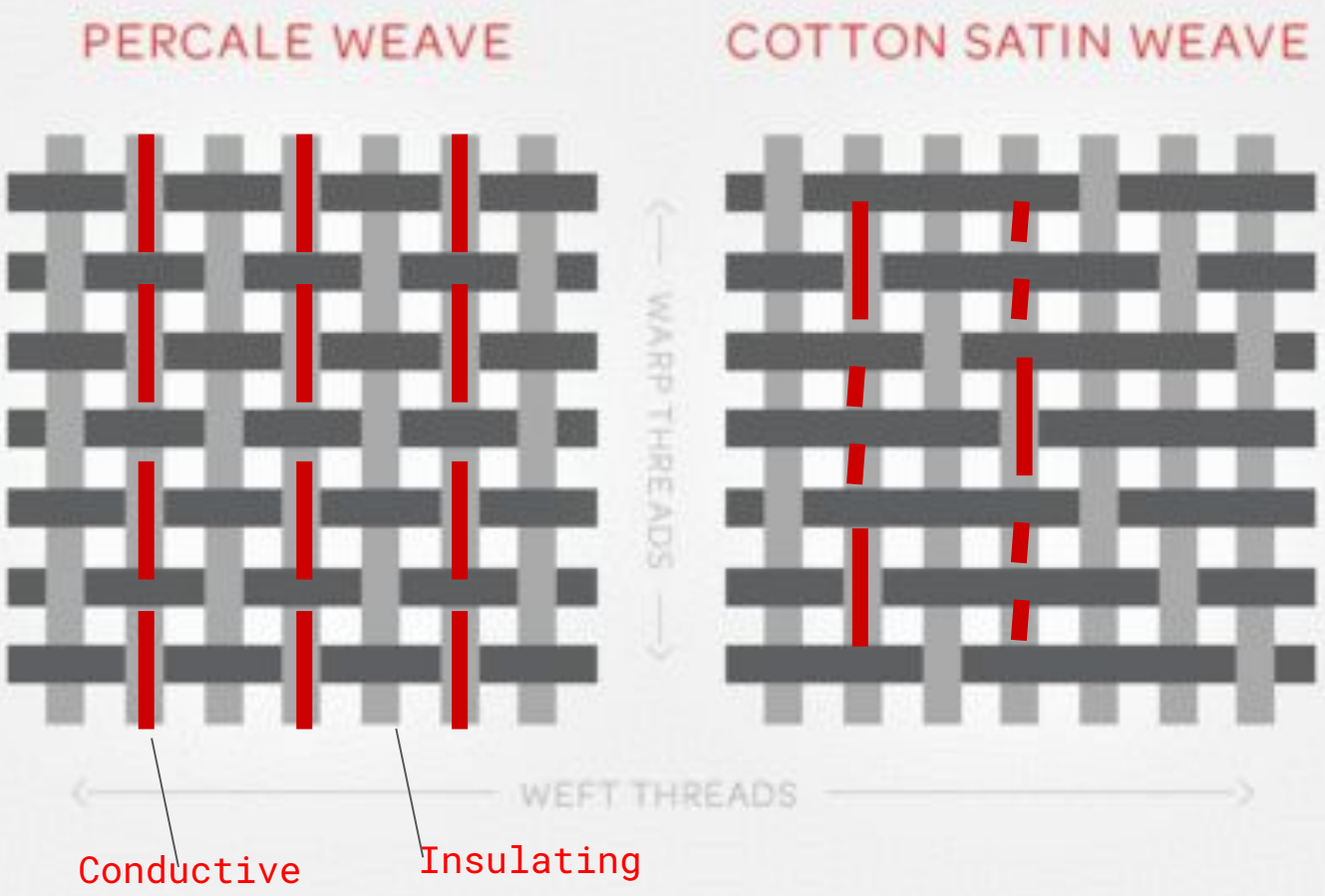
Resistance (ohms)



Sample no.

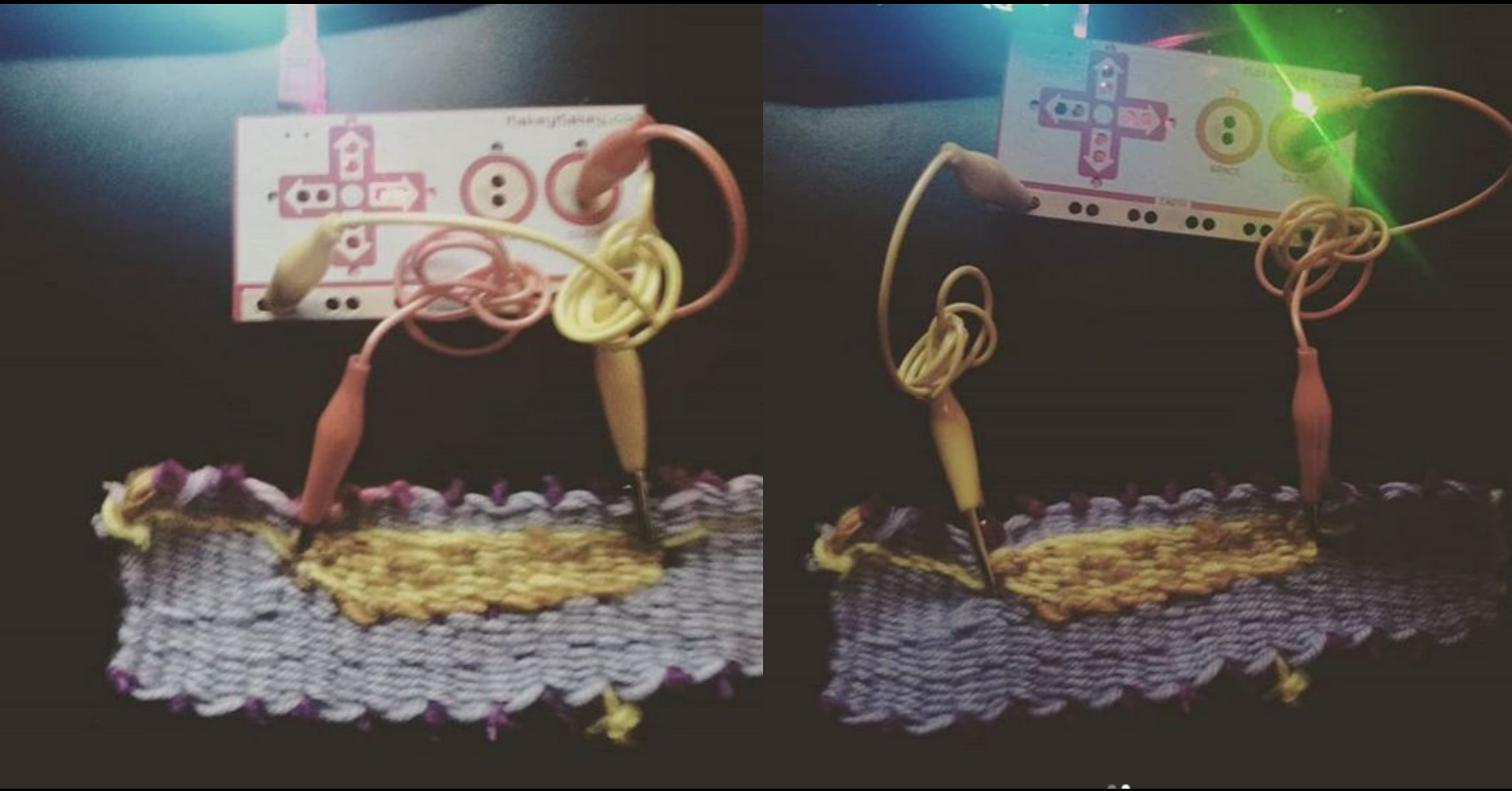

capacitance (micro farad)
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
0.5
1
1.5
2
2.5

Weaving


PERCALE WEAVE
COTTON SATIN WEAVE
WARP THREADS
WEFT THREADS
Conductive
Insulating

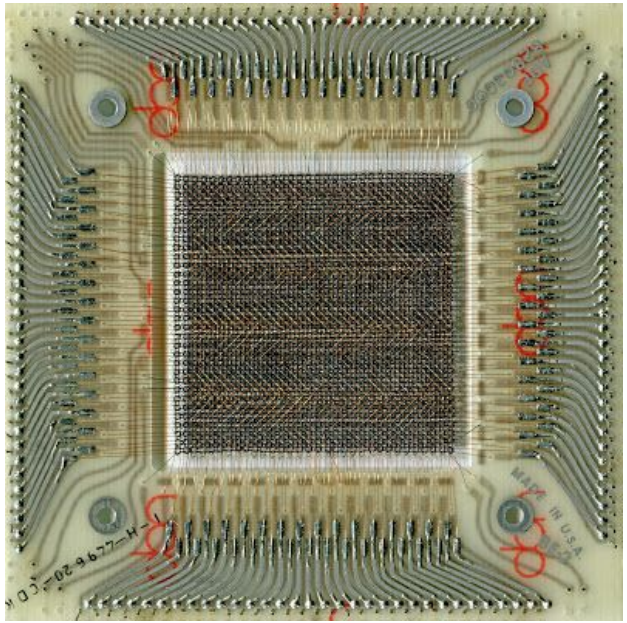
Weaving


Diode Patch

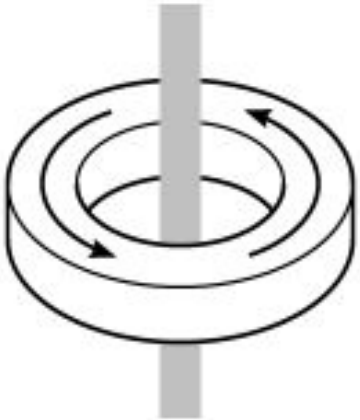



Transistor

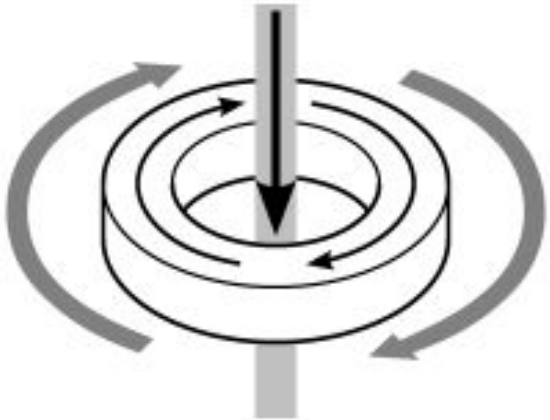
Core Rope Memory



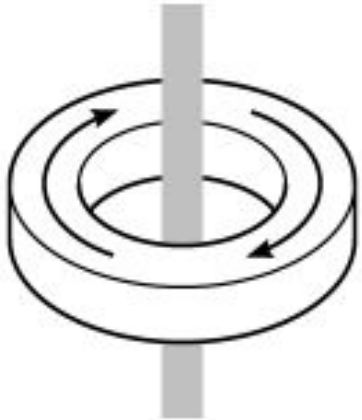
The core is magnetised anti-clockwise, and therefore holds the bit 1. No current flows through the wire.

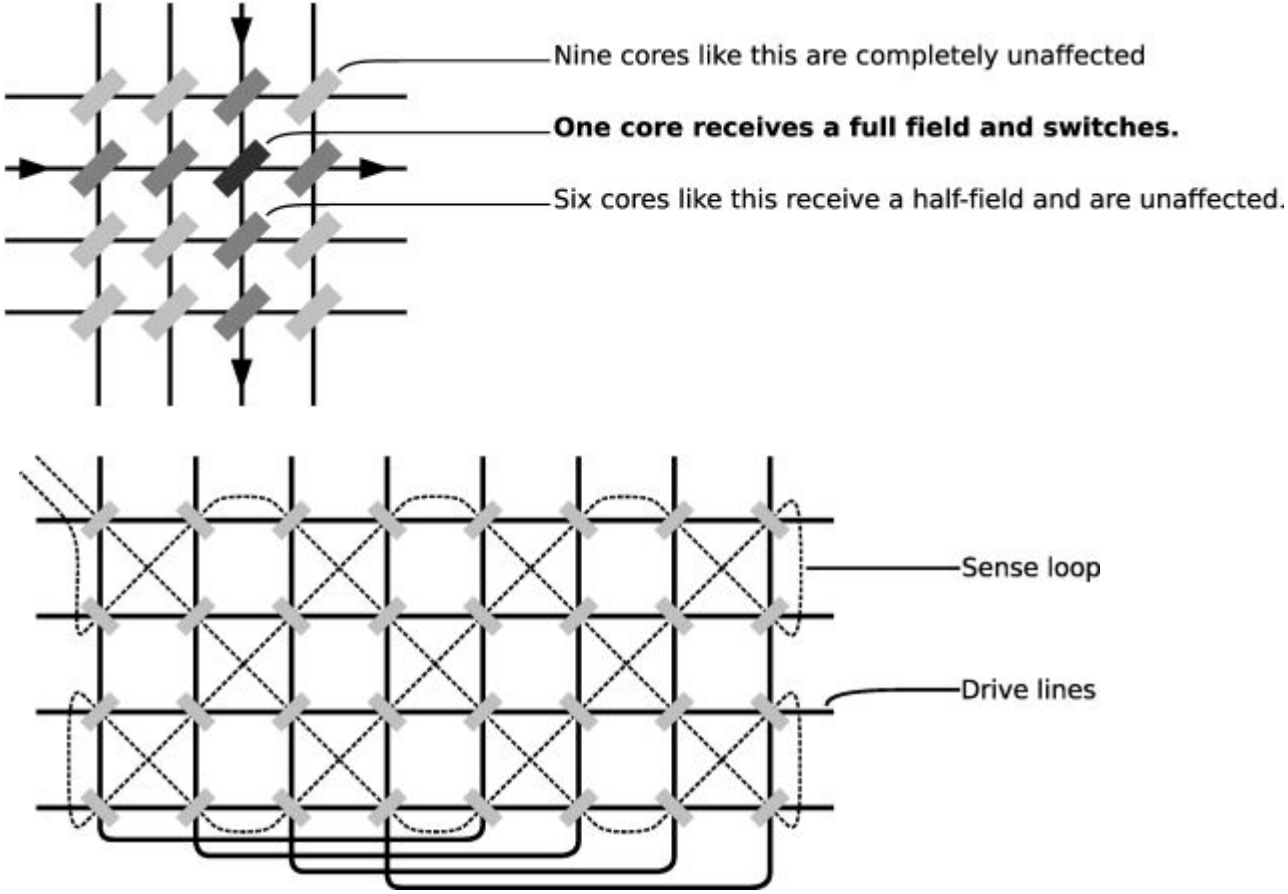


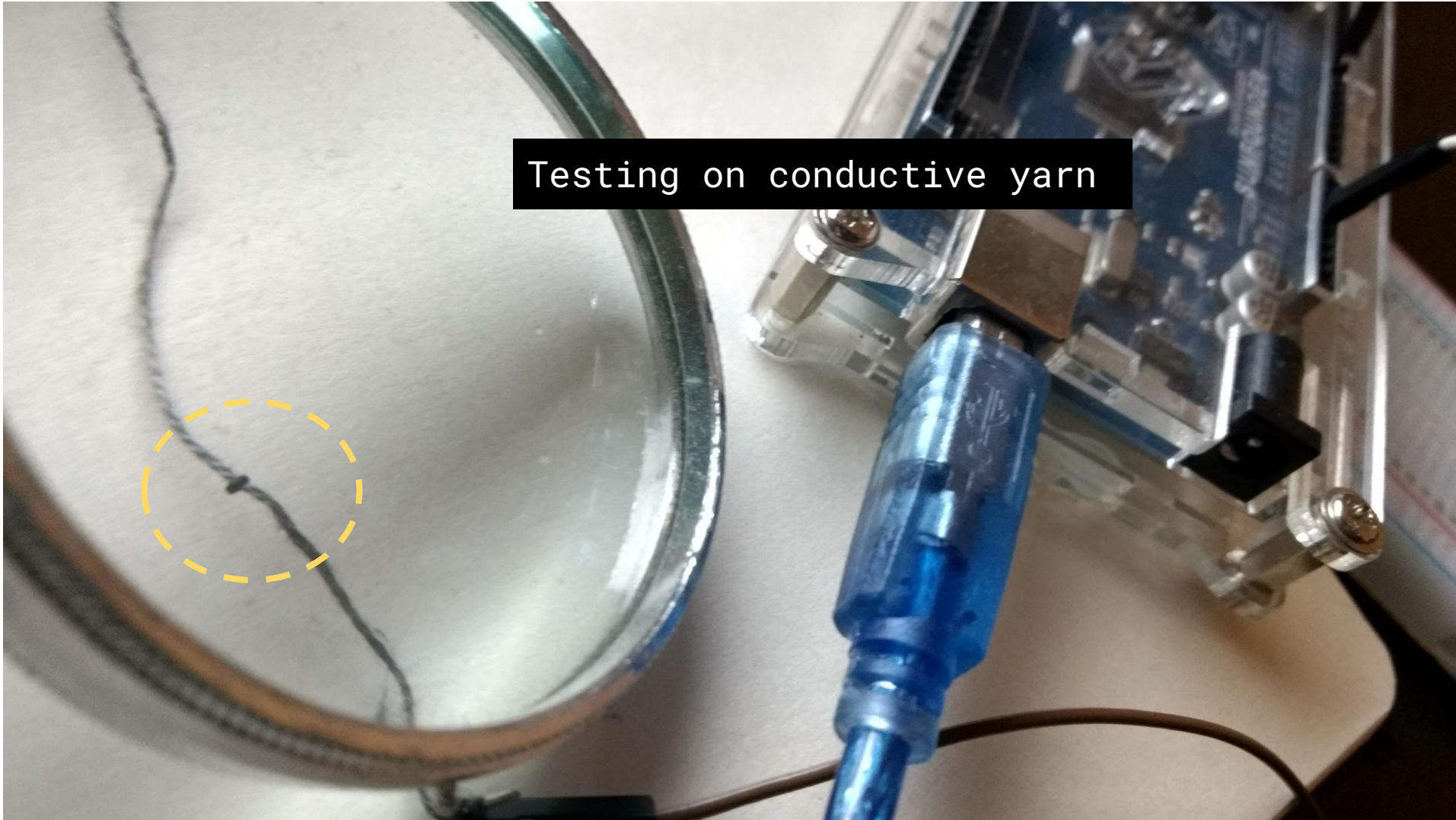
A large current is supplied, generating a strong magnetic field. This switches the core's magnetisation to clockwise.



When the current is turned off, the core remains magnetised clockwise, therefore now holding 0.

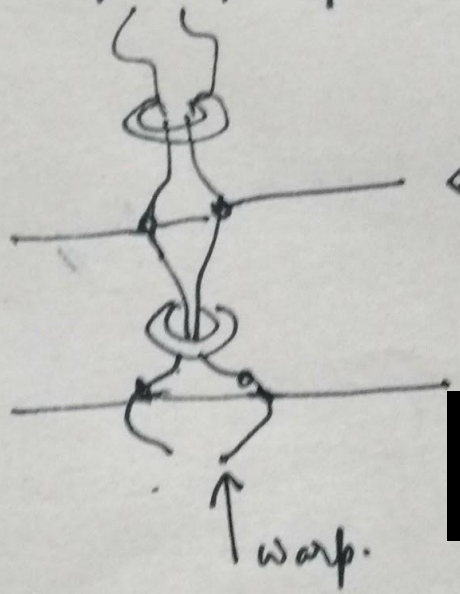


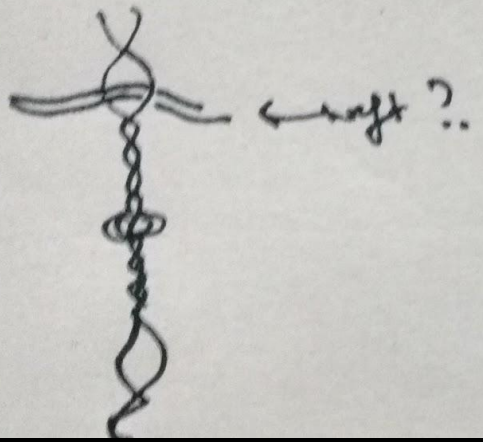

Nine cores like this are completely unaffected
One core receives a full field and switches.
Six cores like this receive a half-field and are unaffected.
Sense loop
Drive lines


Testing on conductive yarn

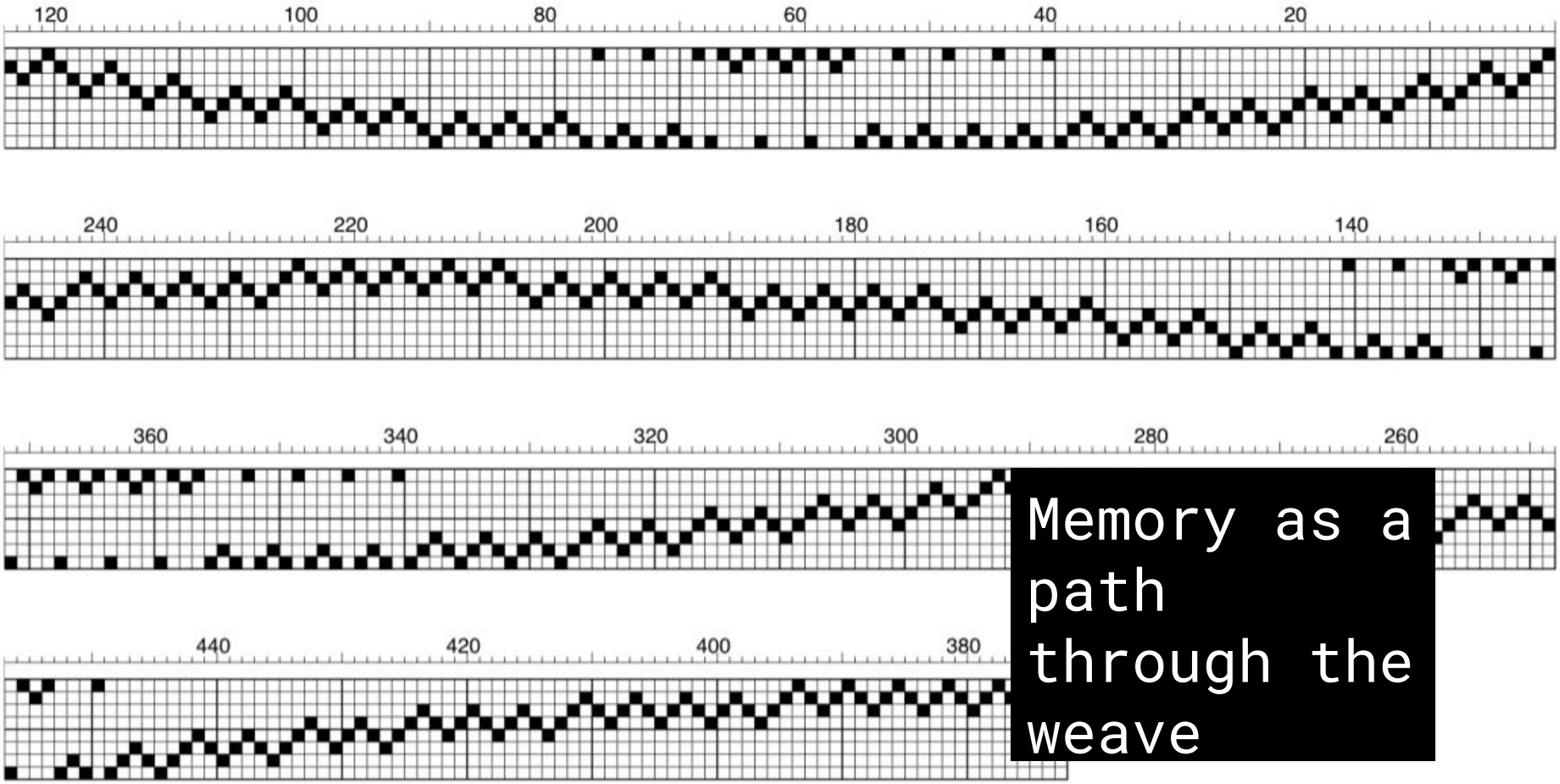
How does one bead the warp and weft through the cores?

L1	L2	M.	
0	1	0	→ use for read maybe?
1	0	0	
1	1	1	



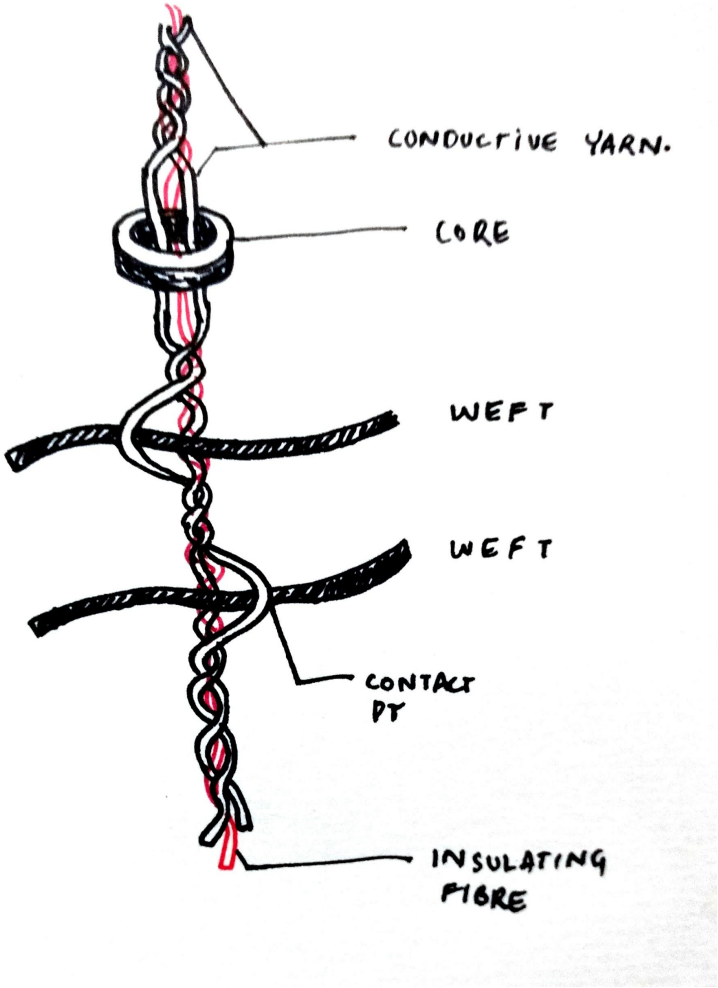


Memory Yarn



Memory as a path through the weave

8 bits

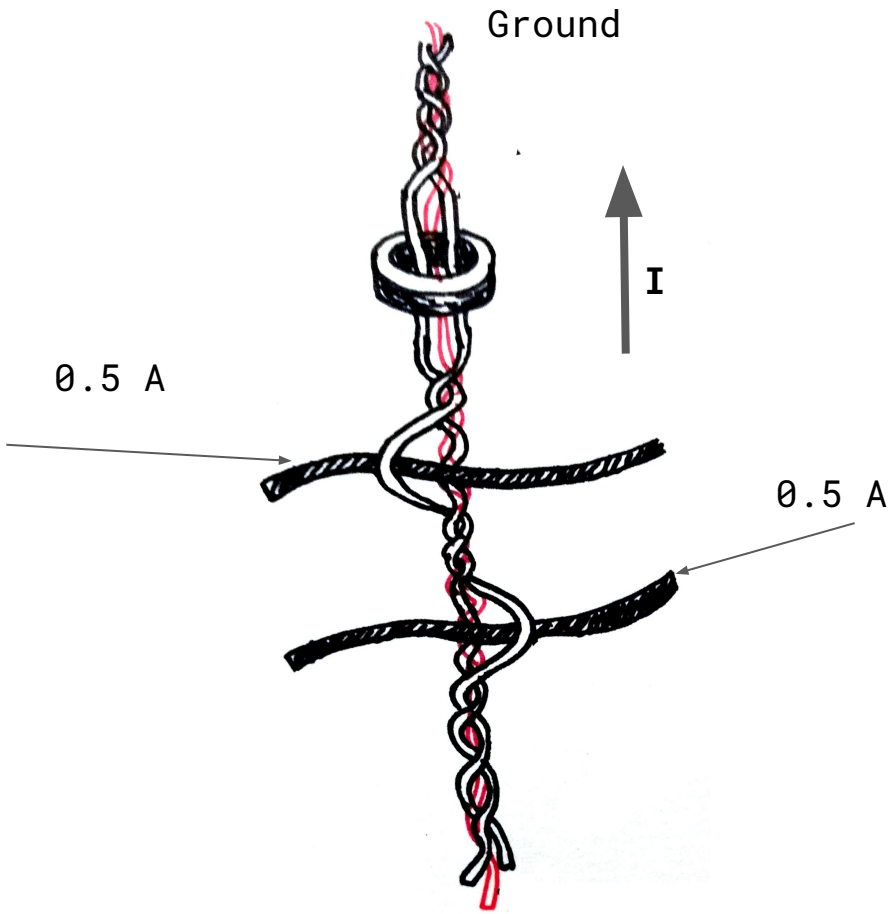


Final design

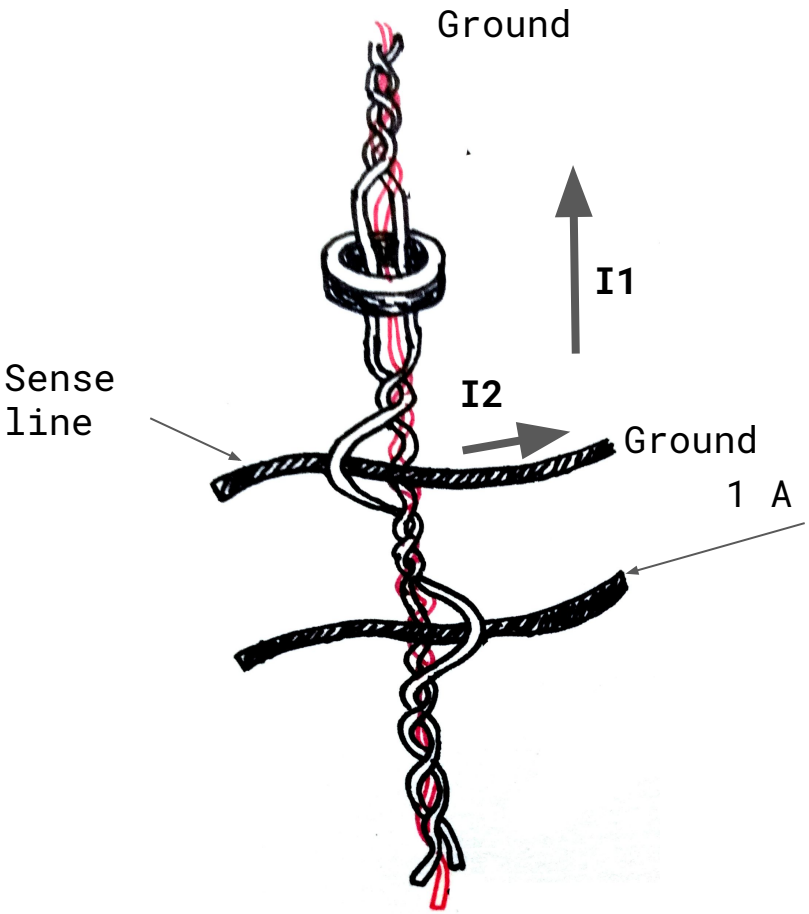
3 core plies ; 1 insulating, 2 conducting

Loops along yarn for passing the weft

Insulating fibres ensures one conduction point makes contact with weft at a crossover.



Write



Read

Future direction

- Weave a 128 bit swatch