SUBJECT MANUFACTURE OF CERAMIC INSULATORS - By Pressing

Formerly 13-10-3

A standardized process for manufacturing ceramic insulators, spacers, etc., from ceramic powder by the application of pressure and heat is herein given.

1. MATERIAL : C214 insulator preparation or any other material as specified for an I part.

2. EQUIPMENT REQUIREMENTS

a. Press such as Stokes Type R Tablet Press.
b. Die Sets designed with respect to type of pressing equipment, insulator design, compactibility of the ceramic material under a given pressure, and shrinkage of the material after firing. For compactibility and firing shrinkage of insulator material refer to Sec. 3.
c. "Hevi Duty" Electric Furnace, 140 V. 27 KW, or equivalent.
d. Alundum Slabs 1" thick and 6" x 18" or 3" x 18".
e. Tongs.
f. Hydrogen Furnaces such as RCA Model No. 780-F with automatic stoker operating at rate of 4"/min., and Model No. 780-J with stoker operating at rate of 1"/min.
g. Optical Pyrometer such as Pyro Optical Instrument Co. pyrometer (44-3-8).
h. Boats 8" long made of 1/16" sheet molybdenum and having flat bottom curved upward at one end.
i. Brush such as Devoe & Reynolds No. 3 artist's brush.
j. Micrometers with tungsten carbide tips, jaw openings 1" and 2".
k. Plug gauges of carboloy.
l. 1/8" strips of bakelite or equivalent material for separating rows of insulators on slabs.
m. Tool maker's microscope, preferably Zeiss.
n. Thickness, pin spacing, hole dia. and/or other gauges depending upon dimensions of insulators which require regular inspection.

3. COMPACTIBILITY AND SHRINKAGE OF INSULATOR MATERIAL

For making insulators, allowances for compactibility of ceramic powder, and insulator shrinkage, due to firing, must be made as follows:

a. Compactibility: Ratio of ceramic powder depth (die barrel length) to thickness of insulator after pressing - approx. 2.5 to 1.

** b. Shrinkage (Due to Firing):

Type Powder	Linear Shrinkage	Depth Shrinkage	Pressure
C200	6.0%	-	5,000 psi
C214	4.2%	2.44%	5,000 psi
C224	4.3%	2.5 %	5,000 psi
C234	4.3%	8.0 %	5,000 psi
C235	9.1%	12.0 %	10,000 psi
C240	5.0%	9.2 %	10,000 psi

Linear Shrinkage is with respect to dimensions parallel to faces.
Depth Shrinkage with respect to thickness of insulator.

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* CHANGE
** ADDITION

4. PROCEDURE (Cont'd)

A. Pressing Ceramic Material (Using Stokes Tablet Compressing Machine)

→ 1. Load *feed shoe with ceramic powder in quantities as required **maintaining level at least 1/2 full.

2. Using hand operated hydraulic pump, build up hydraulic pressure in pressure limiting device to 5000 psi. The reading on the gauge depends on area of spacer and will be different for different spacers.

3. Adjust die and upper and lower punches. The die must be flush with the table, otherwise the feed cup will scatter powder. The down stroke of the lower punch must be such as to provide a die cavity of a depth depending on specified compactibility of ceramic powder, Sec. 3-a. On the up stroke the lower punch should come exactly flush with die. If punch is too low the insulator will break and if too high the feed cup will strike the punch. When making insulators which are perforated at or near the center, set pins on rod which runs up thru a hole in lower plunger and lower punch flush with top of lower punch when in its highest position. Adjust stroke of upper punch so that travel of punch into die and resulting application of pressure will press insulators to required thickness.

4. All necessary adjustments having been made, press a few insulators by operating machine by hand, by turning flywheel with short steel bar provided for that purpose. Check insulator thickness and, if necessary, make further adjustments on machine. It may happen that insulators will run a little heavier when machine is later operated by power; consequently final adjustments for weight and thickness should be made after running off a few insulators.

5. Vary speed of machine to suit requirements, the best rate of production being less for large insulators than for small ones. At present it is considered desirable to press insulators at the following machine settings:

Insulators	Machine Setting No.	Insulators	Machine Setting No.
I82C	3	I266	18
I108B	8	I279	8
I157	8	I280	8
I194B	14	I282	2
I197L	5	I283	9
I259	3	I334	4

6. As insulators are ejected from die push them to side on table. They must not be allowed to drop into a receptacle, but must be carefully removed by hand.

→ 7. Using soft brush or an air blast remove ceramic particles from top plunger, die cavity walls, and bottom plunger top, about once every 20 insulators, to prevent pitting the surfaces. *Holes may be cleared with pin, using a mirror to view bottom of top plunger. Oil die parts, which have been removed from machine, to keep them from rusting. If die parts in a machine have stood idle for a week or longer they may be polished lightly with crocus cloth. During pressing operation no oil must be used on die parts which come in contact with ceramic powder.

NOTE : After pressing, insulators should be handled as little as possible to keep the surfaces clean and free from finger marks.

4. PROCEDURE (Cont'd)

A. Pressing (Cont'd)

8. Insulator perforating pins are subject to the most rapid wear and will therefore have to be replaced sooner than any other die part. Check pin for size after forming designated number of each of the following:

800	of	I82	500	of	I248
11,000		I157	3,200		I266
11,000		I194	5,000		I279
10,000		I197	800		I282
800		I208	11,000		I283
500		I247	800		I334A
			4,000		I334B
			800		I334C

Since walls of die cavity wear more near bottom end of die than near upper or open end, it is necessary that inside of die be stoned to remove constriction formed at the section of least wear. With die cavity smaller at top than at bottom the insulator will buckle as it is pushed thru upper part of die.

B. Firing : Insulators must be firedfirst in air and then in hydrogen, the schedule for firing in hydrogen depending on the composition of insulator material.

a. Firing in Air (to remove the organic binder)

1. Brush insulators with soft brush to remove any powder which may be on surfaces, then stack insulators on alundum slabs in piles of 12-20, the number of stacks and their arrangement depending on size and shape of insulators. By means of 1/8" width bakelite strips separate rows approx. 1/8" to allow escape of combustion gases during air firing.

→ 2. Place alundum slabs, loaded with insulators, into *"Hevi-Duty" furnace.

3. Fire <u>large insulators</u> at 220°C for 7 hours, and then at 1050°C, for 4 hrs. Pull switch and cool to at least 400°C. before removing slabs and insulators.

4. Fire <u>small insulators</u> at 220°C for 4 hours, and then at 1050°C. for 2 hours. Pull switch and allow furnace to cool to at least 400°C. before removing slabs and insulators.

CAUTION : After firing insulators in air they must not be touched with bare hands. To handle fired insulators wear clean cotton gloves or use suitable tweezers with wood inserts.

4. PROCEDURE (Cont'd)

B. Firing In Hydrogen (Schedules for firing air fired insulators in hydrogen)

→ SCHEDULE NO. 1. Used for firing pressed *33-C-214 insulators and extruded
→ *33-C-222 insulators.

1. Carefully lay insulators singly on flat bottom of a boat having a clean surface.
2. During operation of furnace (Mod. No. 780-F) for firing insulators use:

→ *12 1/2 cu.ft. humidified hydrogen/hr. in tube (Humidifier at room Temp)
5 cu.ft. dry (line gas) " " " case

3. Fire insulators at a temperature necessary to shrink them to specified
→ fired sizes, using a stoking speed of *4"/min. This temperature will
→ be approx. *1500°-1580°C, depending on size and shape of insulators.

NOTES:
a. All linear shrinkage takes place during final firing. In case of insulators made, as herein specified of 33-C-214 material, this shrinkage is 4.2%. If insulators are piled on each other during final firing, they will warp and be non-uniform in hardness and strength. If fired insulators show some discoloration, it may be as a result of surface condition of boats or of a foreign material in or on insulators. If warping occurs during firing in hydrogen the insulators may be fired between molybdenum slabs (1/8" thick.)
→ using *1500°-1580°C as specified above. Each insulator should be covered with an individual molybdenum slab, but a common or single long slab of molybdenum may be used in bottom of boat to support insulators.
b. Do not refire insulators.
c. Wear clean cotton gloves or use suitable tweezers to handle insulators after they have been fired in hydrogen.

DO NOT TOUCH WITH BARE HANDS.

SCHEDULE NO. 2 - As used for firing pressed 33-C-200 insulators.

1. Load insulators, previously fired in air, into boat or on molybdenum plates, as described in Schedule 1.
2. During operation of furnace (Mod. No. 780-J) for firing insulators use:
15 cu.ft. humidified hydrogen/hr. in tube (Humidifier at room temp.)
15 cu.ft. (line gas) "
3. Using a stoking speed of 1"/min. fire insulators at 1300°-1320°C in front tube of furnace and at 1600°-1620°C in rear tube.

NOTE:
a. Insulators made from 33-C-200 material shrink 6% when fired as specified above.
b. Insulators may be refired.
c. Refer to Note c under Schedule 1.

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4. PROCEDURE (Cont'd)

C. Inspection

1. Visually inspect all (100%) fired insulators, rejecting insulators which are dirty, black, split or chipped about edges and holes.

2. Using a regular micrometer for checking outside dimensions and a toolmaker's micrometer microscope for checking dimensions which cannot be measured with an outside micrometer, check-inspect new types of fired insulators for thickness, length and width, hole diameters, distance between hole centers, and whether holes are otherwise centered as specified, in order to approve new dies and dimensions of insulators which are produced with them. After dimensions are approved initially, check 10% of insulators for essential dimensions using micrometer, pin hole gauges, pin spacing gauges, go and nogo gauges, etc., depending upon insulator. Some dimensions may even require 100% inspection or, after check inspection, during which a number of rejections are found, it may be advisable to check 100% of the insulators.

3. Complex insulators with narrow tolerances should be given a complete hole dimensional and spacing check after firing, by threading them over a pin gauge, the pin size, etc., of latter depending on design dimensions of insulators involved.

4. If specified, a go-nogo gauge should be used for checking insulators having close tolerances for thickness.

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NOTE: Insulator materials are abrasive, consequently, pins, slots, etc., of gauges should be checked frequently enough to avoid using gauges after they become undersize or oversize due to wear.

D. Correctly pressed C214 material should have an apparent porosity between 26 and 31%. For the determination of apparent porosity refer to 34-37-13B.

E. Storage:

Insulators, if not used immediately, should be kept in a covered container to keep them clean and free from dust and dirt.

ENGINEERING SECTION
STANDARDIZING

*** Test Strength deleted.

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