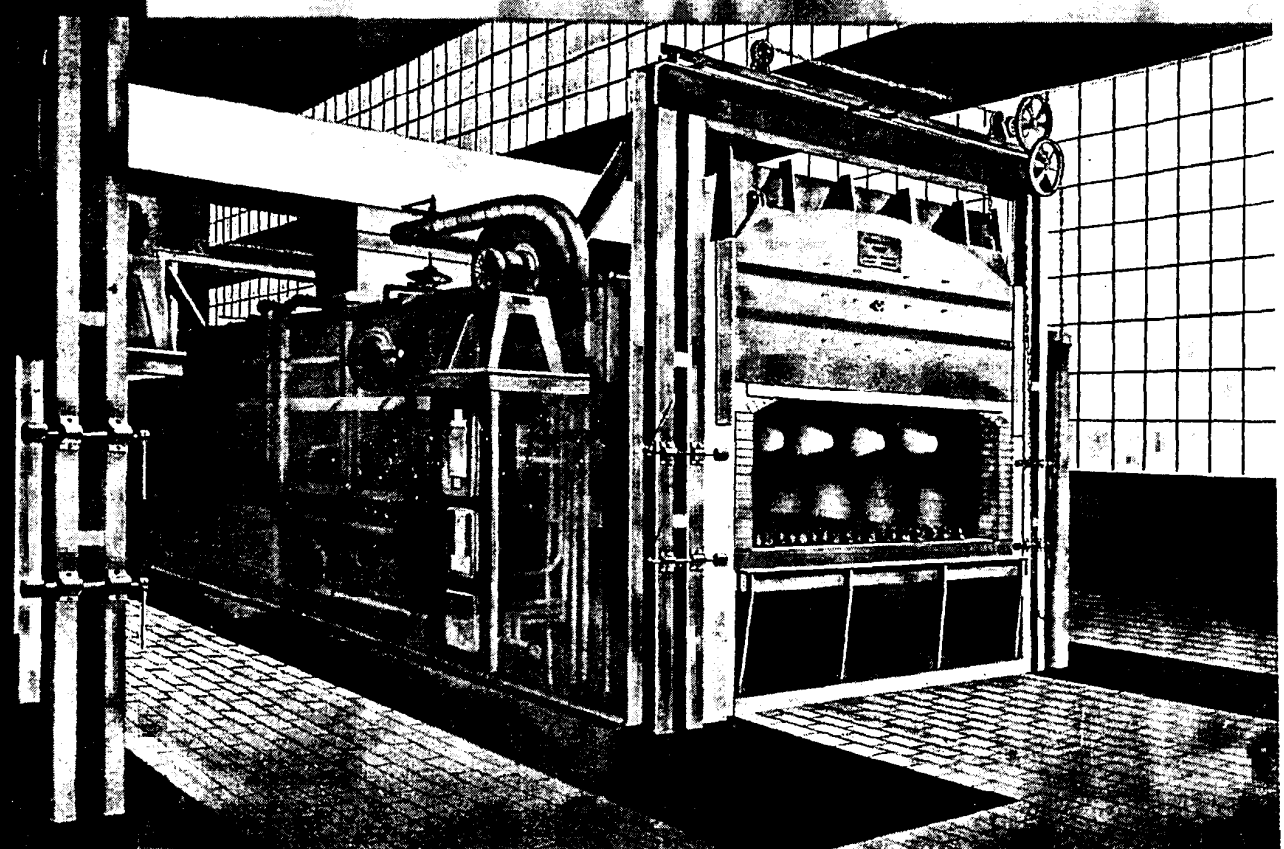
ARMSTRONG'S
INSULATING FIRE BRICK
AND
REFRACTORY CEMENTS



ARMSTRONG CORK COMPANY

INDUSTRIAL INSULATION DEPT. BUILDING MATERIALS DIVISION

LANCASTER, PENNSYLVANIA

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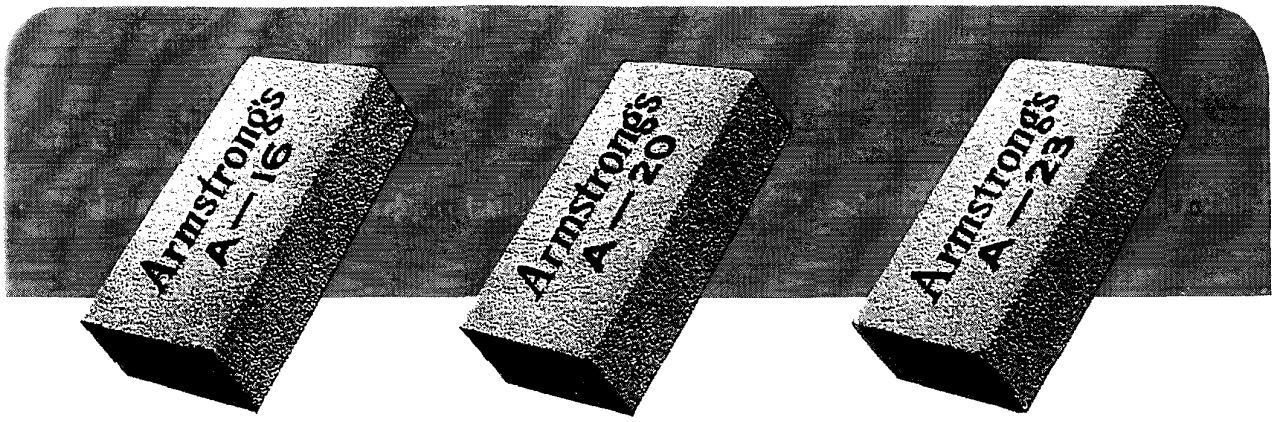
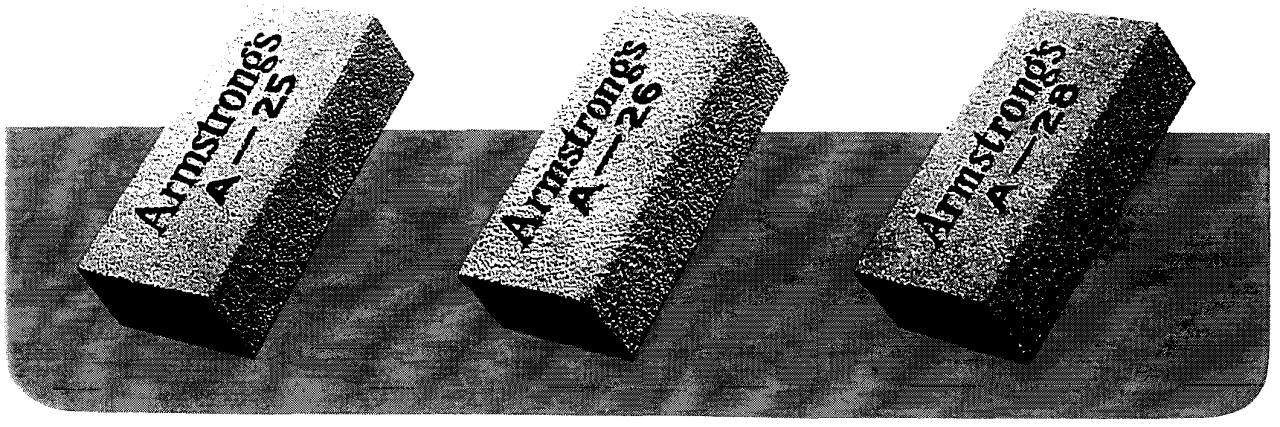


SIX TYPES OF ARMSTRONG'S INSULATING FIRE BRICK FOR TEMPERATURES FROM 1600° F. TO 2800° F.

Armstrong manufactures a complete line of insulating fire brick for temperatures from 1600° F. to 2800° F. These brick are used directly exposed as furnace linings or behind the refractory as back-up insulation. All types can be used directly exposed in equipment fired with gas, oil, electricity, or powdered fuel. However, insulating fire brick should not be used where they are exposed to molten metal and slags or severe mechanical abrasion. When these conditions prevail, insulating fire brick should be used as back-up insulation behind the refractory lining.

In the manufacture of Armstrong's Insulating Fire Brick, scientifically compounded mixtures of selected refractory clays and carefully sized cork dust are mixed together and molded. When the brick are fired, the cork particles burn out, producing a lightweight, porous structure composed of thousands of minute air spaces. These air spaces provide an effective barrier to the flow of heat through furnace construction.

The Armstrong Cork Company is one of the oldest and largest manufacturers of insulating fire brick in the United States. Since 1914, Armstrong has pioneered improvements in insulating fire brick, refractory cements, and other materials described in this booklet. Today, these materials are specified by leading furnace designers and builders because they have proved that they can be depended upon for consistently successful results.



HOW ARMSTRONG'S INSULATING FIRE BRICK IMPROVE FURNACE OPERATION

Armstrong's Insulating Fire Brick improve furnace operation as well as furnace design by:

1. Reducing fuel costs
2. Speeding production
3. Insuring more accurate temperature control
4. Simplifying furnace design
5. Reducing construction costs
6. Quieting furnace noises

Reduced Fuel Costs

Reduction of fuel costs by use of insulating fire brick is accomplished by the reduction of heat lost through furnace walls and by eliminating heat waste encountered in bringing heavy furnace structures up to operating temperature.

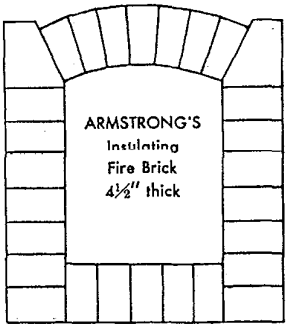
Heat losses through furnace walls often constitute a major portion of the total heat input required to maintain operating temperatures. Because of their low thermal conductivity, Armstrong's Insulating Fire Brick often save up to 80% of the heat ordinarily lost through uninsulated furnace wall construction.

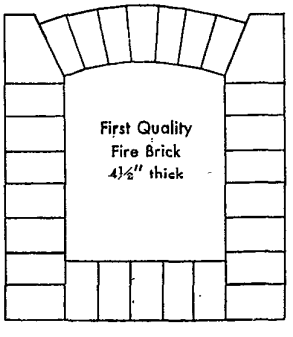
In bringing furnaces to operating temperatures, large quantities of heat are lost also through storage in furnace walls. The amount of heat thus lost is largely determined by refractory weight.

Light weight means low heat storage, and because of their light, porous structure, Armstrong's Insulating Fire Brick absorb little heat. Their use permits bringing the furnace to operating temperature rapidly because relatively small quantities of heat are absorbed by furnace walls. Furnaces built with Armstrong's Insulating Fire Brick may be brought to operating temperature in 80 to 90% less time than furnaces of heavy fire brick construction. Fuel costs are proportionately low.

Faster Production

Low heat storage capacity also permits more rapid cooling and heating cycles, which speed pro-





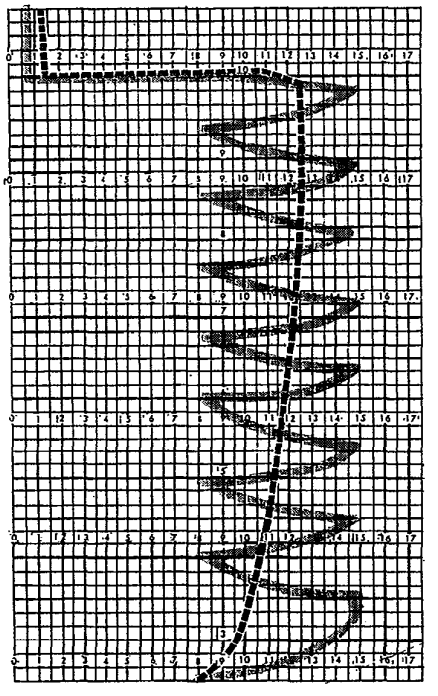
Shown are results of tests conducted by Armstrong's Research Laboratories on two small gas fired furnaces. One furnace was built of Armstrong's A-26 Insulating Fire Brick, 4½" thick. The other was identical, except that it was built of 4½" thick first quality fire brick. Comparisons were made of fuel consumption at identical temperatures and of time required to reach a temperature of 1200° F. with equal gas input.

GAS INPUT TO HOLD FURNACES AT 1200° F.

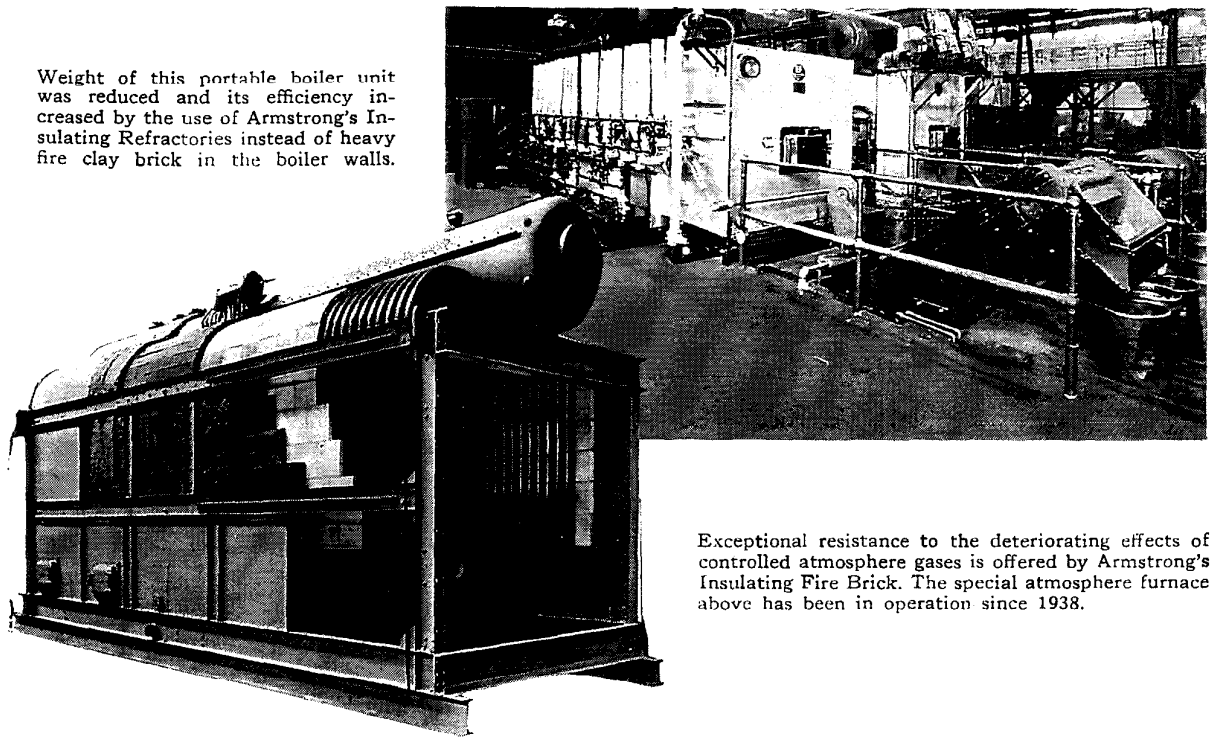
Insulating Fire Brick Construction	First Quality Fire Brick Construction
75 Cubic Ft. per hour	**180 Cubic Ft. per hour**

HEAT UP TIME WITH GAS INPUT OF 200 CUBIC FT. PER HOUR
(see curves at right)

Insulating Fire Brick Construction	**50 minutes to reach 1500° F. Cooled and heated 8 times in 7 hours, 25 minutes.**
First Quality Fire Brick Construction	**7 hours, 35 minutes to reach 1210° F.**



Weight of this portable boiler unit was reduced and its efficiency increased by the use of Armstrong's Insulating Refractories instead of heavy fire clay brick in the boiler walls.



Exceptional resistance to the deteriorating effects of controlled atmosphere gases is offered by Armstrong's Insulating Fire Brick. The special atmosphere furnace above has been in operation since 1938.

duction especially in batch or intermittent type operation. Additional time and cost savings are possible in heat treating shops because the need for a furnace operator to come in hours ahead of time to bring the furnaces to operating temperature is eliminated.

The combination of reduced heat losses and efficient furnace cycles possible with insulating fire brick construction results in substantial operating economies. An excellent return on the investment is consequently realized.

More Accurate Temperature Control

More accurate temperature control also is possible with Armstrong's Insulating Fire Brick. By drastically reducing heat loss, these brick help maintain even temperatures in all parts of the furnace, thus preventing temperature variations and fluctuation during processing. This results in a more uniform heat treatment, less scrap, and a finished product of finer quality.

Simplified Furnace Design

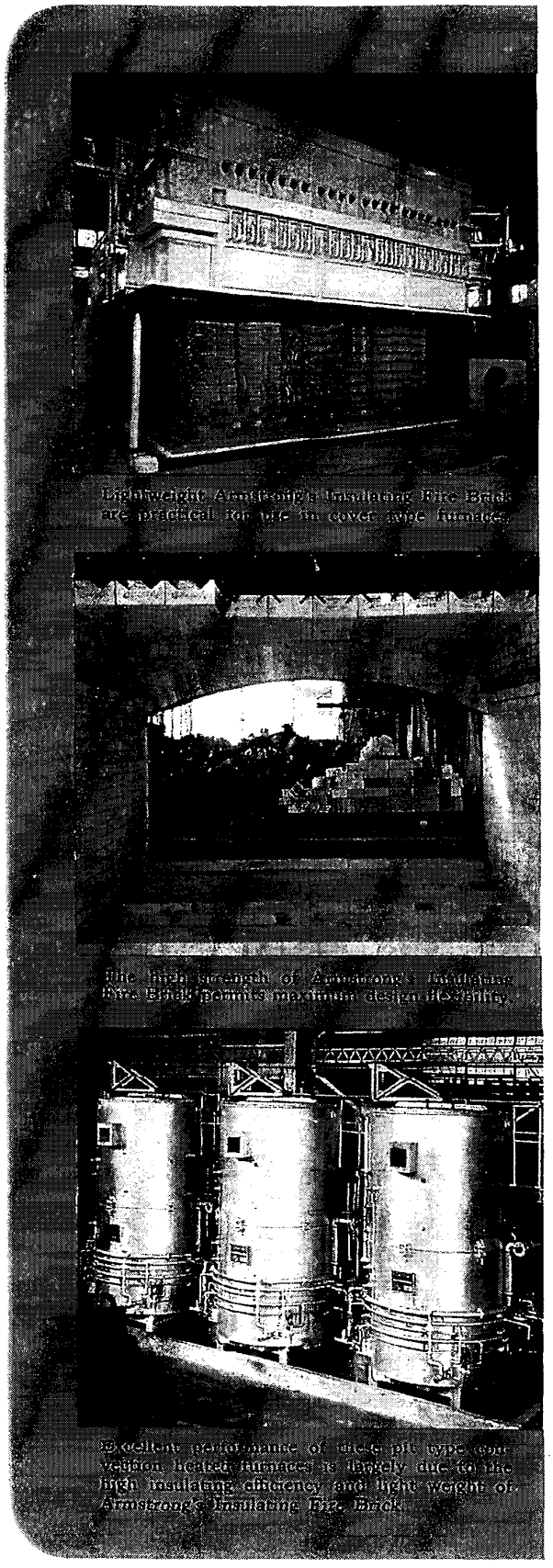
Armstrong's Insulating Fire Brick simplify furnace design by permitting thinner walls and lighter weight construction. Because of the high insulating value of these brick, a 4½" thick insulating fire brick wall will provide as effective insulation as a wall 13½" to 18" thick constructed of fire clay brick. These thinner walls allow for substantial space savings, important in crowded areas. They also permit larger hearth areas for the same outside dimensions. And thin, lightweight walls provide additional savings by reducing the over-all weight of furnace construction. This factor minimizes the need for heavy structural steel and reduces the cost of foundations and footings.

Reduced Construction Costs

Furnace construction costs are also reduced because Armstrong's Insulating Fire Brick are easy to handle. They weigh from 1.75 to 2.75 pounds, compared with 7.5 pounds for standard fire brick. And because of their accurate sizing and great strength, these brick lay up with a minimum of effort. They're easily cut and shaped on the job with a saw or rasp, thus reducing bricklaying time.

Quieter Furnace Operation

Porous insulating fire brick are ideal sound absorbers, too, having a noise reduction coefficient comparable to commonly used acoustical materials. Furnace roar and burner noises are drastically reduced, thus permitting the placement of furnaces without regard to noise nuisance.



Lightweight Armstrong's Insulating Fire Brick are practical for use in cover type furnaces.

The high strength of Armstrong's Insulating Fire Brick permits maximum design flexibility.

Excellent performance of these pit type convection heated furnaces is largely due to the high insulating efficiency and light weight of Armstrong's Insulating Fire Brick.

PRINCIPAL CHARACTERISTICS OF ARMSTRONG'S INSULATING FIRE BRICK

Armstrong's Insulating Fire Brick are manufactured with all the essential physical characteristics in careful balance to provide high thermal efficiency, longer furnace life, and lower installation costs.

The excellent service qualities of insulating fire brick in which all the physical characteristics are precision balanced have been proved in thirty-three years of manufacturing and field experience and by countless successful installations.

Low Conductivity

The fundamental purpose of an insulating refractory is to reduce heat loss. Low thermal conductivity, therefore, is one of the important requirements. The low conductivity of Armstrong's Insulating Fire Brick is due to thousands of minute air spaces resulting from the burning out of tiny cork particles in the manufacturing process. The use of cork burn-out, an exclusive Armstrong feature, results in the greatest insulating value with the highest possible strength and other vital service characteristics.

High Strength

High strength contributes greatly to the life of an insulating refractory in service. It provides for more dependable furnace operation and low maintenance costs. The high strength and exceptional general ruggedness of Armstrong's Insulating Fire Brick result from the cork burn-out. Cork does not reduce the plasticity or bonding quality of refractory clays in the wet mix, permitting the use of the most desirable combination of clays.

Because of the high strength of these brick, they offer great resistance to wear and to erosion by high velocity gasses and flame impingement. High strength also eliminates dusting and flaking on furnace wares and permits sound suspended arch and wall construction.

Resistance to Spalling and Shrinkage

The ability of an insulating fire brick to stand up in direct exposure depends largely on its resistance to spalling and shrinkage.

The uniform porous structure, the absence of laminations, and the elimination of internal strains due to controlled combustion of cork during manufacture produce brick with exceptionally high resistance to spalling. And Armstrong's Insulating

Fire Brick are fired in modern tunnel kilns at or above the temperatures for which they are recommended. This carefully controlled firing process assures uniformly low shrinkage in all types.

Light Weight

Armstrong's Insulating Fire Brick are formulated and manufactured to offer the lightest possible weight without undue sacrifice in strength. They are light enough to absorb little heat, yet strong enough to offer resistance to mechanical abrasion and accidental bumping, provide good load bearing, and resist breaking and cracking from furnace stresses during heating and cooling.

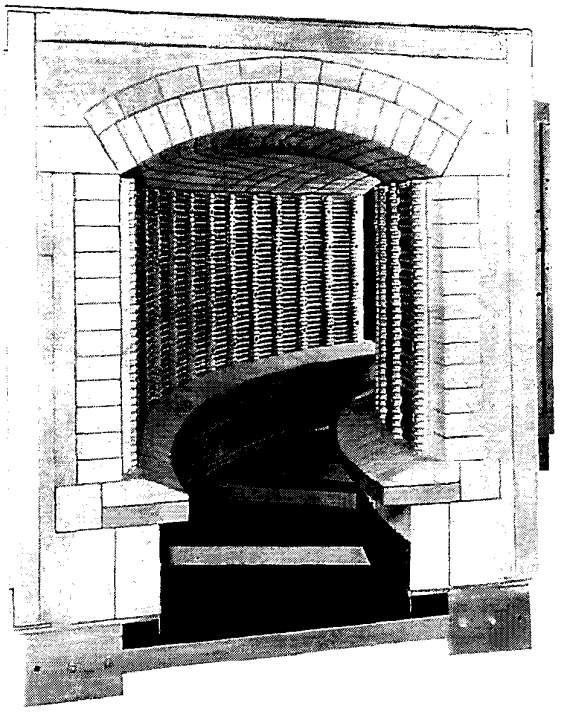
Uniformity and Texture

The uniform texture of Armstrong's Insulating Fire Brick makes possible easy machining and fabrication at the factory or on the job. Their porous structure and fine-grained composition provide for an excellent mortar bond, and the surface is a tough base which takes dense refractory cement wash coats. All brick are made slightly oversize and then accurately machined to specified dimensions with a maximum allowable tolerance of .035". This accurate sizing assures heat tight joints even if the insulation is laid up dry and permits an extremely thin joint of cement to be used.

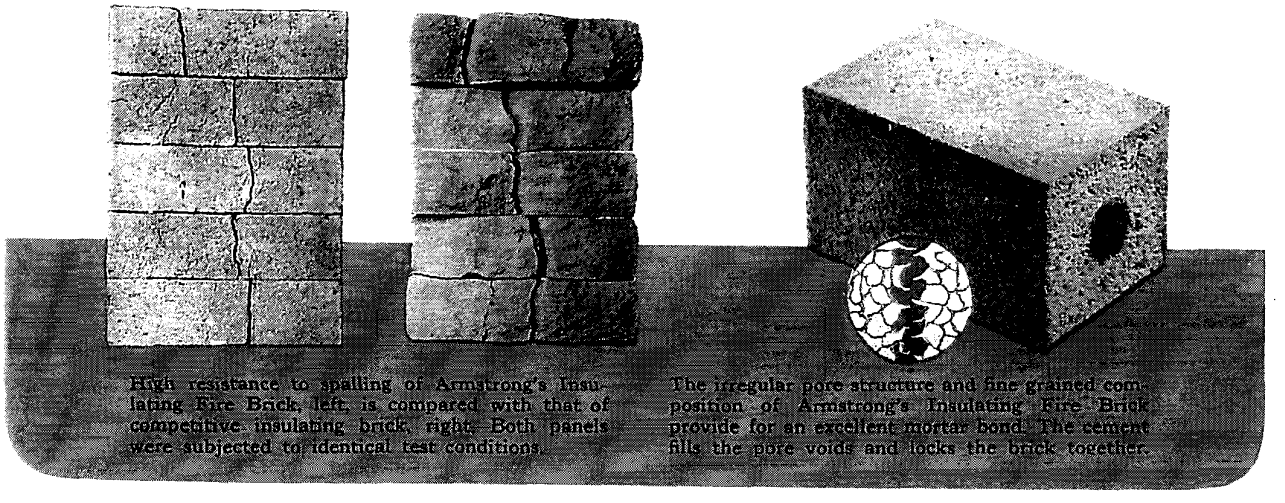
Pyrochemical Stability

Armstrong's Insulating Fire Brick offer resistance to chemical attack or chemical reaction at high temperatures. Normal furnace atmospheres and controlled special atmospheres encountered in metal processing furnaces do not cause disintegration or deterioration of Armstrong's Insulating Fire Brick. They have been used successfully in sulphur burning furnaces, phosphate furnaces, magnesium furnaces, and electrolytic cells and reactor chamber linings in the petroleum and chemical industries.

When insulating fire brick are being considered for service involving exposure to chemical atmospheres or solutions, it is recommended that Armstrong's engineers be consulted to determine the suitability of the brick for the application.



Accurately sized Armstrong's Insulating Fire Brick provide for neat appearance in factory-built furnace units. High strength of these brick permits shipping without damage.

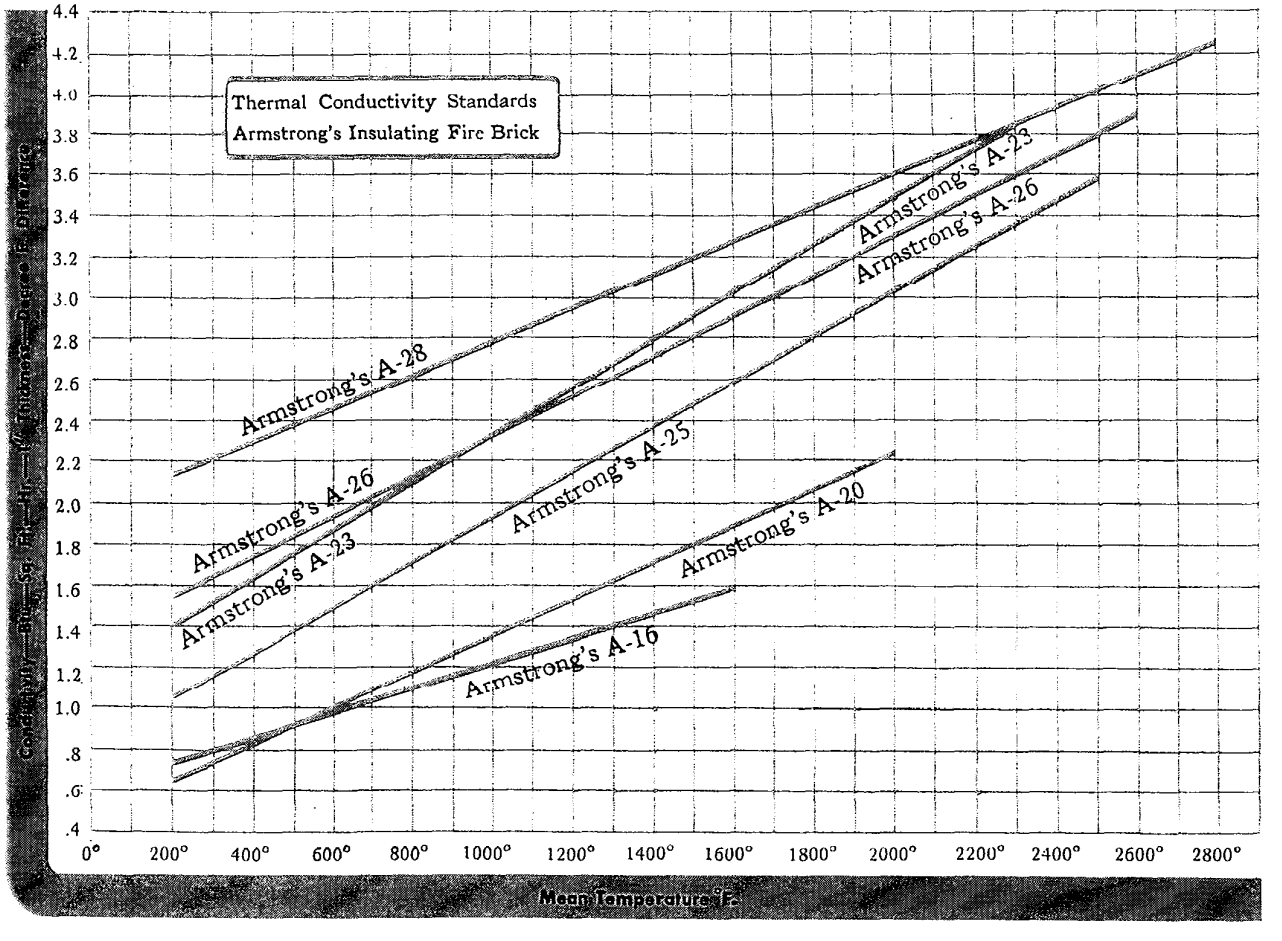


High resistance to spalling of Armstrong's Insulating Fire Brick, left, is compared with that of competitive insulating brick, right. Both panels were subjected to identical test conditions.

The irregular pore structure and fine grained composition of Armstrong's Insulating Fire Brick provide for an excellent mortar bond. The cement fills the pore voids and locks the brick together.

PHYSICAL PROPERTIES OF ARMSTRONG'S INSULATING FIRE BRICK

Type	A-16	A-20	A-23	A-25	A-26	A-28
Maximum hot face temperature	1600° F.	2000° F.	2300° F.	2500° F.	2600° F.	2800° F.
Flexural Strength (Lbs. sq. in.)	120	70	210	105	225	
Test Method: A.S.T.M. C93-39T.						
Compressive Strength, minimum (Lbs./sq. in.)	175	175	430	250	325	234
Test Method: A.S.T.M. C93-39T.						
P. C. E. No., minimum	7	29	31	29	33	36
Test Method: A.S.T.M. C24-35.						
Corresponding Softening Point	2282° F.	2939° F.	3056° F.	2984° F.	3173° F.	3290° F.
Weight per 9-inch straight. Lbs. maximum	1.85	1.90	2.75	2.35	2.80	3.25
Weight, lbs. per cut. ft. maximum	31.6	32.4	47.0	40.2	47.8	55.15
Spalling Loss—Average per cent	0.25	3.0	5.0	9.0	5.0	15.0
See page 7.						
Shrinkage, Linear change per cent at maximum hot face temperatures (maximum)	0.5	1.10	1.75	2.00	2.00	2.00
Test Method: A.S.T.M. C93-39T, for 24-hour period.						
Conductivity, Btu. per sq. ft. per hr. per in. thickness at max. mean temperature 400° F.	.890	.846	1.620	1.253	1.753	2.292
1200° F.	1.362	1.532	2.543	2.140	2.532	2.945
Test Method: Guarded Hot Plate Method.						



GUIDE FOR APPLICATION OF ARMSTRONG'S INSULATING FIRE BRICK

Type of Brick	A-16 1600° F.	A-20 2000° F.	A-25 2500° F.	A-23 2300° F.	A-26 2600° F.	A-28 2800° F.
METAL WORKING INDUSTRIES						
Blast Furnace Mains	B	B	B			
Blast Furnace Stoves	B	B	B			
Coke Ovens		B	B			
Core Drying Ovens	E					
Ducts, Flues, Mains	B	B & E	B	E	E	E
Forge Furnaces	B	B	B		E	E
Galvanizing Tanks	B	B		E		
Heating Furnaces						
Billet and Slab	B	B	B			
Plate	B	B	B		E	E
Rod	B			E	E	
Soaking Pit	B	B	B			
Soaking Pit Covers						E
Soaking Pit Dampers					E	
Heat Treating Furnaces						
Annealing	B & E	B & E	E	E		
Carburizing	B	E	E	E	E	
Drawing	B	E	E	E		
Hardening	B	E	E	E	E	
Malleablizing	B		E	E	E	
Normalizing	B	E	E	E		
Salt Bath	B	B	B			
Spheroidizing	B	E				
Stress Relieving	E	E				
Melting Furnaces						
Crucible Type			B			E
Electric			B			
Open Hearth	B	B	B			
Regenerators	B	B	B			
Recouperators	B	B	B			
Waste Heat Boilers	B	B			E	
CERAMICS AND GLASS						
Ceramic Kilns						
Periodic Kilns	B	B	B & E	E	E	E
Tunnel Kilns	B	B	B & E	E	E	E
Pottery Kilns	B	B	B & E	E	E	E
Experimental Furnaces	B & E	B & E	B & E	E	E	E
Enameling Furnaces	B	E	E	E	E	
Gas Producers	B	B	B			
Glass Annealing Lehrs	B & E	E				
Glass Bending Furnaces	B & E	E		E		
Glass Melting Tanks						
Crown			B			
Regenerators	B	B				
Uptakes		B	B			
Port Arch			B			
Forehearths		B				
Forehearths (above metal line)					E	
PETROLEUM INDUSTRY						
Air and Gas Heaters	B	B	E	E	E	
Oil Heaters and Stills	B	B	E	E	E	
Reactor Chambers	B	B	E	E	E	
CHEMICAL INDUSTRY						
Calcining Furnaces	B	B		B		
Sulfur Furnaces	B		B	E	E	
High Temp. Pressure Vessels	B	B & E	B & E	E	E	
POWER PLANTS						
Boilers						
Oil and Gas Fired	B	B & E	B	E	E	E
Coal Fired	B	B		E	E	
Waste Heat	B	B		E	E	E
Breaching and Ducts	B	B & E		E	E	
GENERAL						
Domestic Oil Burners		E	E	E	E	
Incinerators	B	B	B	E	E	
Stacks	B	B & E				

B—Used as Back-Up Insulation. E—Used directly exposed to furnace lining where temperature on brick does not exceed limits shown.

HEAT LOSS AND HEAT STORAGE FOR VARIOUS

WALL STRUCTURE (INCHES OF THICKNESS)			HOT FACE TEMPERATURES											
ARMSTRONG'S INSULATING FIRE BRICK, FIRE CLAY BRICK, AND COMBINATIONS			1000° F.		1200° F		1400° F.		1600° F.		1800° F.		2000° F.	
			Heat Loss	Heat Storage	Heat Loss	Heat Storage	Heat Loss	Heat Storage	Heat Loss	Heat Storage	Heat Loss	Heat Storage	Heat Loss	Heat Storage
4½"														
A-16			186	1363	240	1693	300	2027	364	2375				
A-20			186	1409	248	1753	316	2104	392	2467	474	2840	566	3211
A-23			326	2147	424	2658	533	3182	651	3721	776	4273	918	4830
A-25			265	1788	348	2186	441	2666	545	3125	655	3576	779	4061
A-26			341	2196	438	2712	545	3244	660	3789	783	4350	915	4908
A-28			418	2608	528	3223	649	3850	776	4491	912	5126	1053	5798
FB			971	6830	1260	8370	1577	9999	1917	11607	2290	13273	2687	14903
4½"	2½"	*A-16; A-20, etc.												
FB	16	*	254	10471	328	13039	410	15730	496	18462	589	21213		
FB	20		253	10504	330	13064	418	15734	516	18430	621	21147	736	23920
FB	25		327	10382	426	12855	535	15495	655	18157	785	20843	926	23596
A-20	16		126	2303	166	2904	209	3530	257	4186	309	4853	367	5557
A-23	16		170	3577	221	4459	276	5403	336	6348	401	7345	471	8354
A-26	20		168	3683	219	4571	275	5505	336	6443	403	7423	475	8411
A-28	20		184	4329	237	5378	295	6440	360	7535	427	8634	500	9759
A-28	25		222	4219	285	5233	353	6277	426	7311	504	8422	589	9522
FB	FB		678	9990	873	12341	1085	14703	1314	17119	1560	19589	1823	22130
9"														
A-16			96	2635	124	3260	154	3904	187	4575				
A-20			96	2702	127	3348	162	4014	201	4708	243	5394	289	6126
A-23			171	4041	222	5025	278	6014	339	7050	406	8075	477	9161
A-25			138	3408	180	4216	228	5086	281	5932	339	6833	401	7753
A-26			180	4118	231	5119	286	6133	345	7179	409	8213	477	9318
A-28			224	4892	283	6044	344	7224	410	8441	480	9694	553	10940
FB			549	12487	704	15367	873	18415	1054	21466	1248	24508	1456	27681
4½"	4½"													
FB	A-16		162	11393	209	14184	260	17106	315	20066				
FB	A-20		161	11426	211	14210	268	17113	330	20064	399	23029	475	26083
FB	A-25		216	11510	282	14318	355	17170	435	20128	522	23196	616	26251
A-20	A-16		99	2935	129	3694	163	4494	199	5323	239	6165	283	7031
A-23	A-16		123	4318	159	5391	200	6522	242	7682	289	8846	339	10080
A-23	A-20		121	4175	158	5434	201	6554	247	7699	298	8849	353	10031
A-26	A-16		124	4389	160	5476	199	6608	241	7769	286	8933	334	10136
A-26	A-20		122	4440	159	5506	200	6637	245	7777	295	8933	348	10115
A-28	A-20		129	5128	168	6361	211	7614	257	8907	307	10245	361	11534
A-28	A-25		164	5124	211	6356	263	7605	319	8902	380	10196	443	11540
9"	4½"													
FB	A-16		143	20495	185	25545	230	30706	278	36041	329	41570		
FB	A-20		141	20572	185	25556	234	30670	287	35959	345	41439	408	46894
FB	A-25		183	20067	238	24981	298	30007	364	35037	436	40537	512	45908
A-23	A-16		92	6790	120	8517	149	10294	182	12144	216	14014	254	15941
A-25	A-16		83	5664	108	7126	136	8635	166	10223	199	11820	234	13520
A-26	A-16		94	6926	120	8670	149	10450	181	12305	214	14176	250	16111
A-26	A-20		91	7024	118	8743	148	10513	181	12339	216	14179	254	16066
A-28	A-16		103	8237	131	10222	161	12265	193	14410	227	16626	264	18839
A-28	A-20		100	8334	129	10286	160	12370	194	14433	230	16616	269	18770
FB			385	17893	492	22049	608	26483	732	30921	865	35312	1006	39962
9"	9"													
FB	A-25		112	22787	146	28364	183	34035	224	39916	268	45971	317	51614
FB	A-20		82	22716	108	28256	137	34018	169	39896	203	45775	241	51334
FB	A-16		83	22634	107	28212	133	33985	162	39879				
FB	A-25	A-16	97	23288	125	29068	157	35032	191	41169	227	47315	266	53630
FB			298	13143	380	28686	468	34301	563	40090	664	46052	772	51929
18"		4½"												
FB		A-25	142	35378	183	43853	228	52903	273	61853	329	71334	385	80822
FB		A-20	114	36997	149	46017	187	55215	228	64750	273	74327	321	84160
FB		A-16	117	36786	150	45889	186	55228	225	64913	266	74640	311	84957
FB	A-25	A-16	90	32266	116	40204	145	48496	176	56970	210	65451	246	74211
FB			243	28384	309	35094	381	41902	457	49100	539	56395	626	63645

Heat Loss shown in Btu's per sq. ft. per hour. Heat Storage Capacity shown in Btu's per sq. ft.

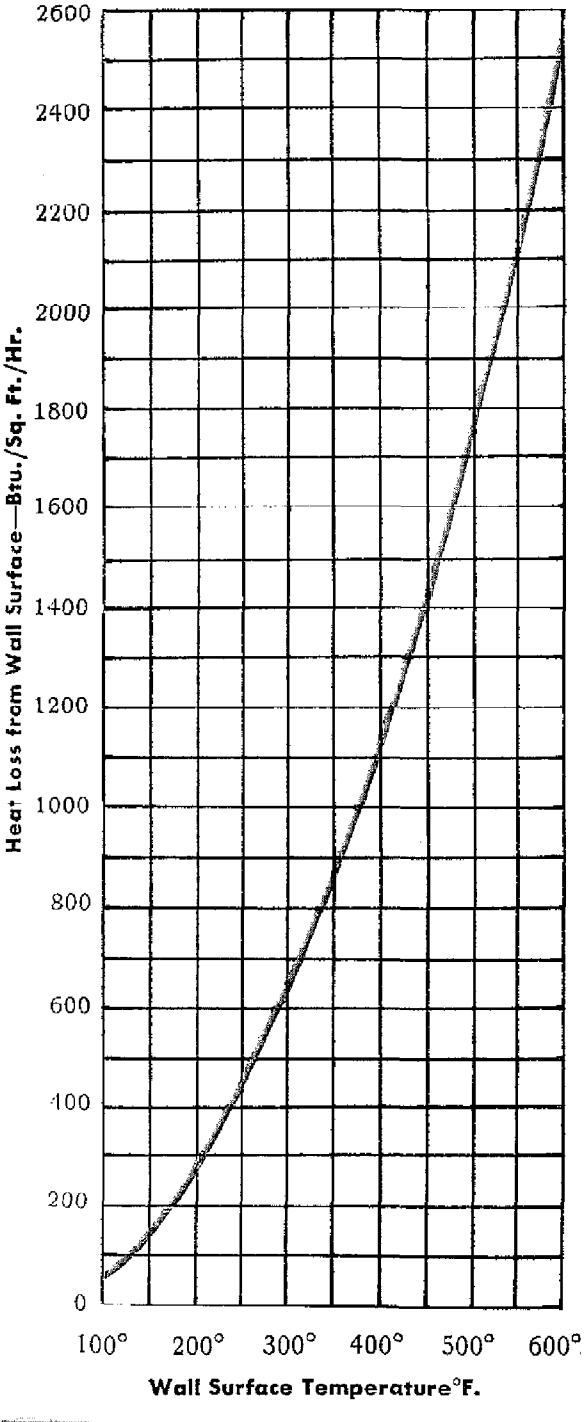
FURNACE TEMPERATURES

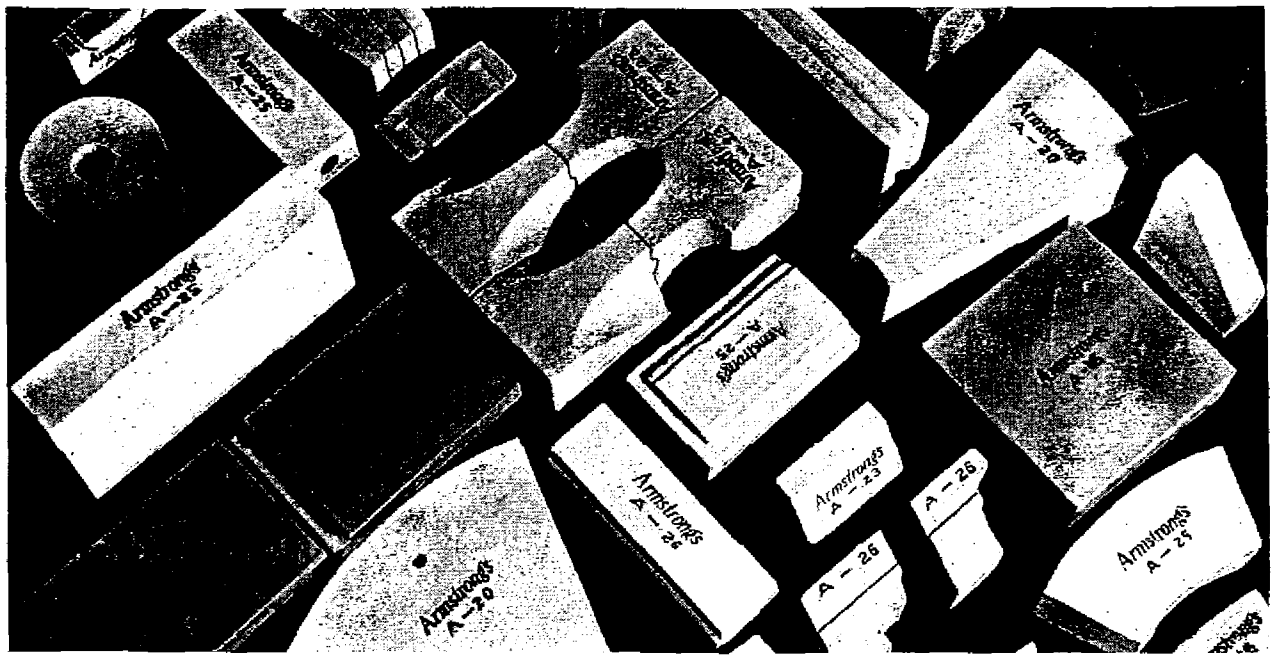
HOT FACE TEMPERATURES

2200° F.		2400° F.		2600° F.		2800° F.	
Heat Loss	Heat Storage	Heat Loss	Heat Storage	Heat Loss	Heat Storage	Heat Loss	Heat Storage
1065	5416						
912	4538	1051	5044				
1056	5499	1206	6083	1364	6675		
1202	6463	1358	7138	1526	7826	1697	8528
3109	16622	3559	18304	4038	19943	4539	21675
859	26793						
1078	26409	1239	29206	1410	32058	1591	34956
545	9389						
551	9395	634	10429	722	11449		
577	10913	663	12050	750	13209	842	14393
677	10619	773	11768	871	12876	976	14070
2104	24626	2400	27174	2715	29756	3044	32391
553	10237						
469	8672	541	9610				
549	10412	626	11530	706	12662		
630	12262	711	13556	795	14830	883	16174
1678	30845	1911	34052	2156	37325	2416	40641
553	29197						
718	29306	826	32405	941	35696	1063	38807
412	11251						
405	11335	467	12530	532	13761		
419	12910	481	14261	546	15645		
512	12906	585	14260	663	15614	744	17046
476	52281	547	58039				
595	51232	682	56870	776	62415	874	68205
294	17936						
272	15168	313	16938				
288	18087	329	20070	372	22072		
294	18017	338	19933	385	21901		
303	21029	343	23379				
310	20932	354	23130	401	25380	450	27639
1157	44566	1315	49268	1481	54032	1657	58931
368	58128	423	64299	481	70844	543	76991
282	58010						
308	60138	353	66564				
885	57936	1005	64325	1132	70337	1265	76730
445	90243	509	100211	577	110051	649	119641
372	94267	427	104205	486	114387	548	124725
357	94956						
284	83212	324	92124				
718	71340	815	78936	917	86692	1024	94545

Outside Wall Surface Temperatures

Outside wall surface temperatures may be estimated from this curve, using the heat loss figures shown in chart at left. For example: 4½" A-16 wall at 1400° F. shows a heat loss of 300 Btu per sq. ft. per hr. The curve below indicates that the outside surface temperature of the furnace wall is 200° F.



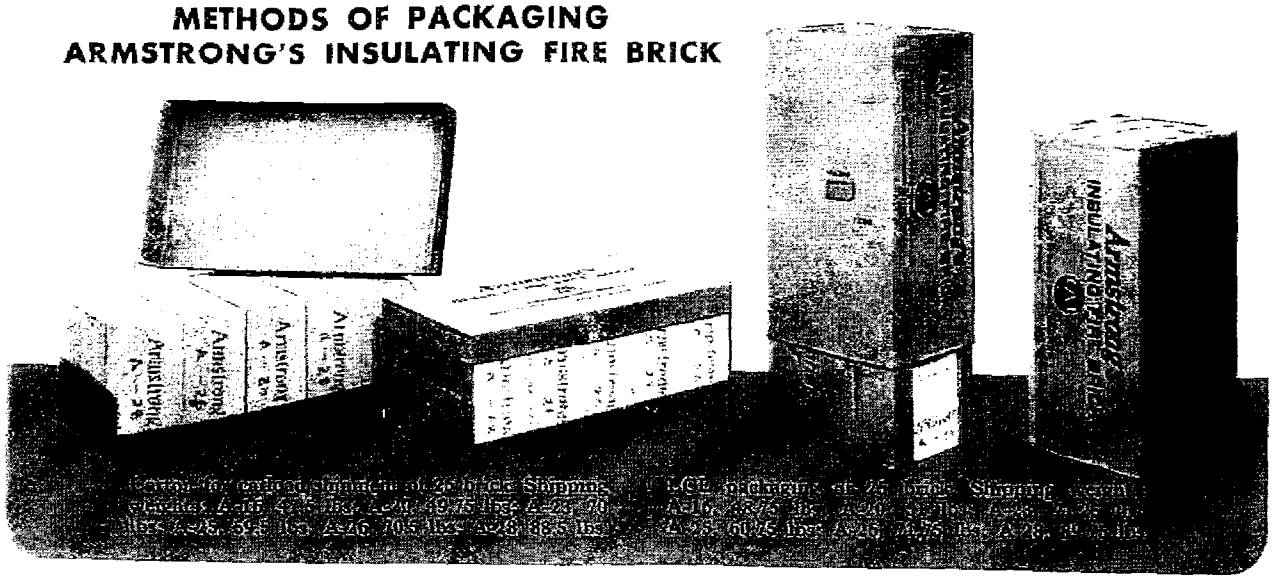


SPECIAL SHAPES MADE TO YOUR SPECIFICATIONS

To meet the demand for special shapes made to customers' specifications, Armstrong has established a plant department where custom-built shapes are manufactured. Special shapes can be made to specification in any of the six type bricks in the Armstrong Line. These shapes are machined from rectangular pieces having the three greatest dimensions of the finished piece. To meet unusual requirements, an assortment of rough stock is maintained at the factory so that quick service on almost any shape can be provided. On orders for unusual sizes, additional time for molding, drying, and firing is required.

The high strength and fine-grained structure of Armstrong's Insulating Refractories, combined with the care taken in machining special shapes, result in finished pieces having clean sharp edges, square corners, and extremely accurate dimensions.

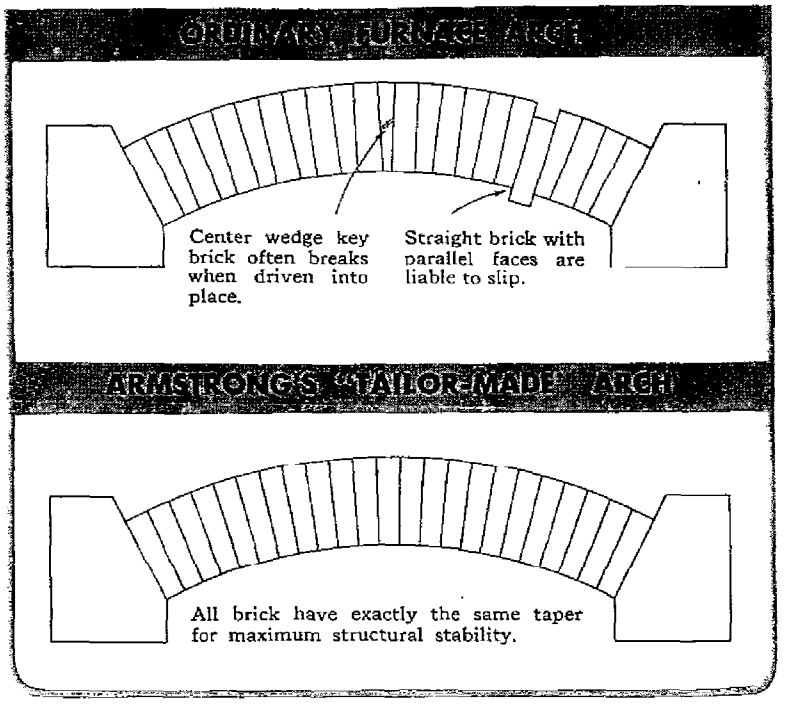
METHODS OF PACKAGING ARMSTRONG'S INSULATING FIRE BRICK



ARMSTRONG'S "TAILOR-MADE" ARCHES

Armstrong's "Tailor-made" arches lay up faster and are stronger because each insulating fire brick is cut to the same size and taper. This feature provides a more positive keying action with a maximum of structural stability that cannot be obtained when straight and standard arch or wedge brick are combined to form the arch.

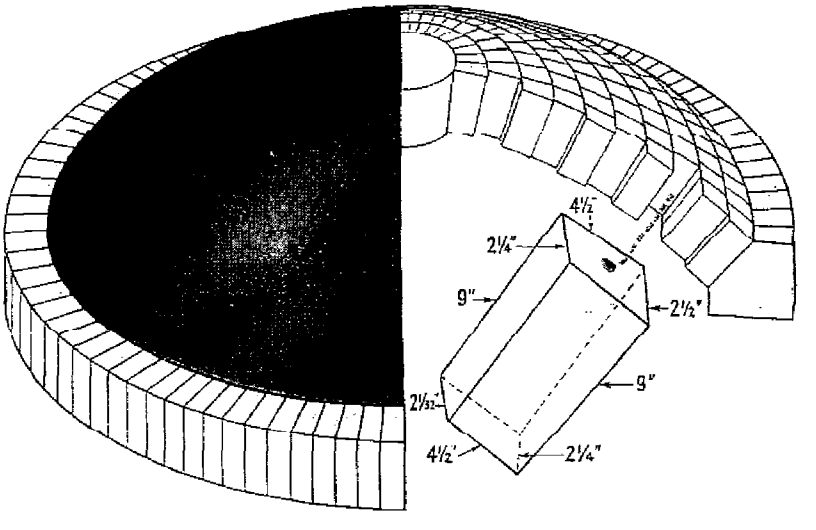
When ordering Armstrong's "Tailor-made" arches, simply state the span, rise, thickness, and length of the arch. The brick are precision machined at the factory for perfect fit. In addition, the large ends of tapered brick are marked with a colored dot to save bricklaying time and to avoid errors. "Tailor-made" arches are available in all six types of Armstrong's Brick at standard arch or wedge brick prices.



ARMSTRONG'S "TAILOR-MADE" DOMES

"Tailor-made" domes simplify furnace design and provide for maximum strength and structural stability. In addition, installation costs can be reduced as much as 25% because these domes are pre-assembled at the factory before shipment, and each course is carefully marked for quick identification on the job. Cartons in which the brick are shipped are also marked so that bricklaying can be done rapidly and economically. Because the brick are cut from standard stock sizes, this custom work can be done promptly and the brick, if damaged, can be replaced at relatively small cost. Armstrong engineers will design the entire dome for you without extra charge.

"Tailor-made" domes are available in all six types of Armstrong's Insulating Fire Brick.

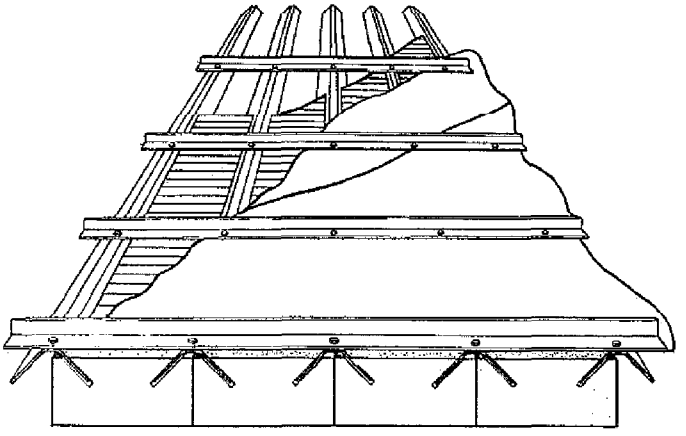


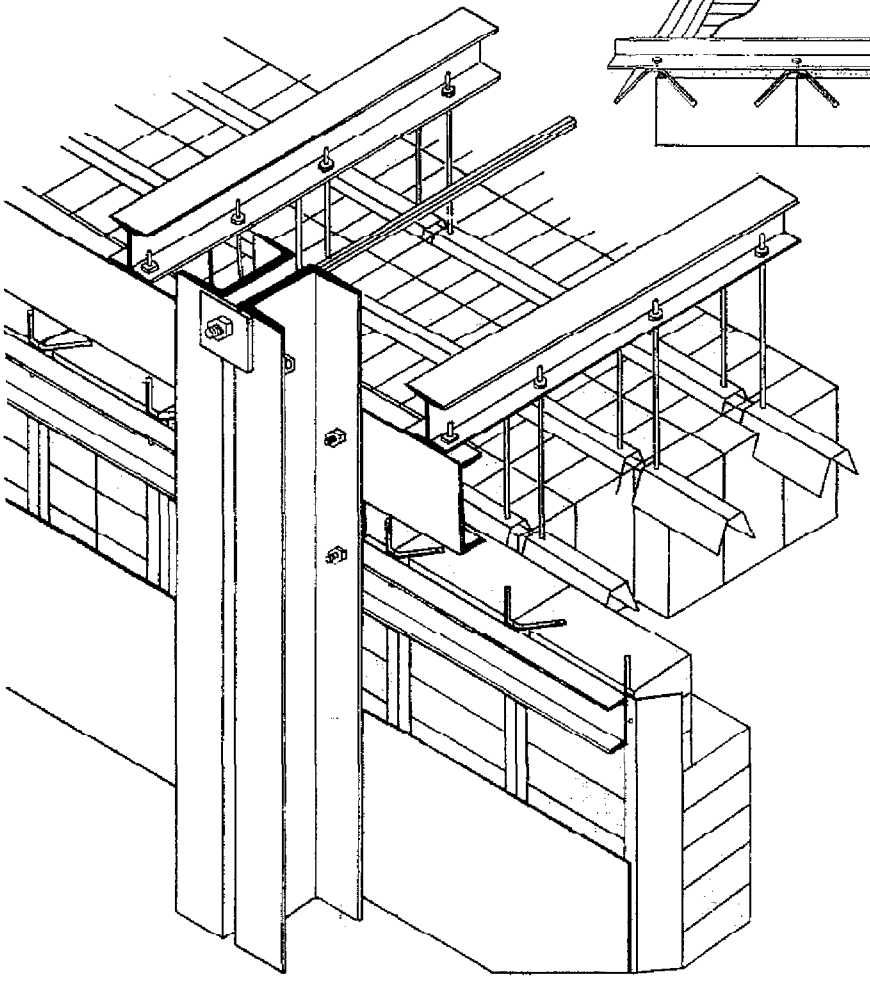
SUSPENDED ARCH AND WALL CONSTRUCTION

Suspended arches and walls offer distinct advantages to furnace builders and designers. They make possible the practical construction of wide span flat arches and permit erection of thin, lightweight walls of high thermal efficiency and structural stability. The use of insulating fire brick in suspended construction reduces over-all weight by eliminating the need for heavy steel members, thus reducing foundation costs. It also provides positive means for supporting brickwork in applications where equipment design demands thin walls of high efficiency

Armstrong offers insulating fire brick shapes for flat arches and suspended walls of many types in addition to the typical ones illustrated on this page. All are extremely simple in design and are planned for fast, low-cost erection. A minimum of shapes is employed, and all shapes are factory cut from standard Armstrong's Insulating Fire Brick, making it unnecessary for the average user to stock special shapes for repair work.

Armstrong's Insulating Fire Brick are accurately machined with square edges and corners that assure heat tight joints. Brick fabricated for suspended construction are available in all six types of Armstrong's Insulating Fire Brick. Their high strength, hot or cold, their accurate sizing, and their exceptional resistance to spalling make them ideally suited for this type of construction.





TYPICAL SUSPENDED CONSTRUCTION DETAILS

Detail above shows typical method of applying Armstrong's Insulating Fire Brick on the inside of a metal casing such as a duct, breeching, or furnace shell. Brick are accurately cut at the factory to fit the butterfly angles.

Detail at left illustrates suspended arch and wall application to furnace construction. Ease of fabrication at the factory or on the job permits use of standard shapes that are convenient to stock. Costly special shapes are unnecessary.

If you have a problem involving the use of suspended arch or wall construction, there is a trained sales engineer in a nearby Armstrong office who will be glad to help you solve it.

ARMSTRONG'S REFRACTORY CEMENTS

ARMSTRONG'S C199 CEMENT

Armstrong's C199 Cement is a newly developed air setting refractory mortar for laying and facing all types of insulating fire brick and all types of fire clay brick, including super-duty brick. C199 Cement offers excellent workability and meets every essential engineering requirement.

High Bonding Strength

C199 Cement joint is stronger than the average fire brick it bonds. This Armstrong cement takes a strong set at room temperatures and maintains its strength through its entire working range. It bonds the cooler portions of the wall as well as the exposed brickwork, assuring a uniformly strong bond throughout the entire structure.

Exacting specifications for an air setting cement call for a cold bonding strength of 200 pounds per square inch. The strength of C199 Cement is over three times this value.

High Refractoriness

In the formulation of Armstrong's C199 Cement, selected refractory clays combined with special bonding agents assure sufficient refractoriness to more than meet A. S. T. M., American Refractories Institute, Federal Government, and U. S. Navy specifications for super-duty mortar at 2910° F.



Laboratory tests prove high bonding strength of Armstrong's C199 Cement.

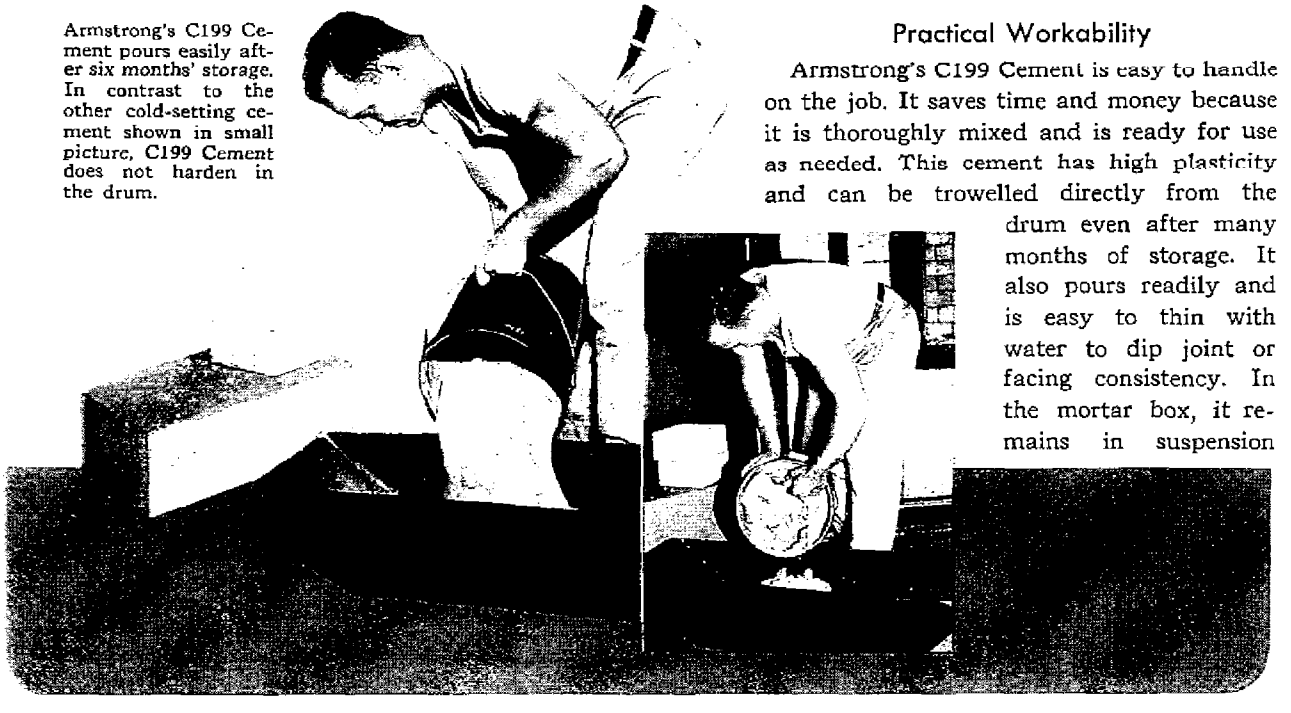
C199 Cement will not soften or run out of joints. It provides a tight, dense joint that will withstand abrasion, slagging, and spalling as effectively as the brick itself.

Low Shrinkage

Precision blending of the raw material particle size, plus a new Armstrong development that eliminates the usual bonding and plasticizing agents that cause shrinkage, results in a cement that will not shrink, crack, or crumble out of joints.

Practical Workability

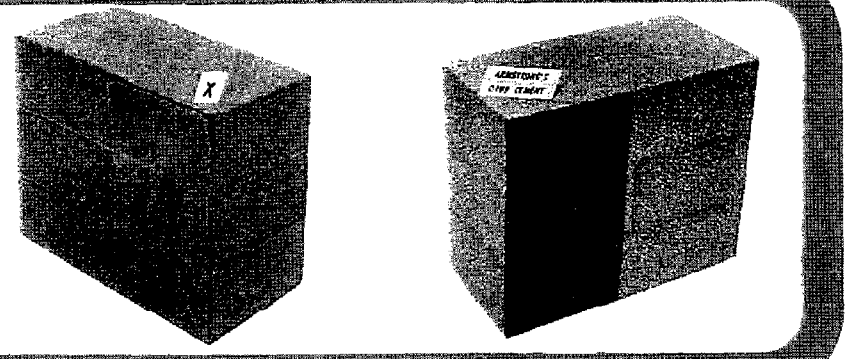
Armstrong's C199 Cement is easy to handle on the job. It saves time and money because it is thoroughly mixed and is ready for use as needed. This cement has high plasticity and can be trowelled directly from the drum even after many months of storage. It also pours readily and is easy to thin with water to dip joint or facing consistency. In the mortar box, it remains in suspension



Armstrong's C199 Cement pours easily after six months' storage. In contrast to the other cold-setting cement shown in small picture, C199 Cement does not harden in the drum.

Shrinkage of ordinary air setting refractory cement facing has torn surface of insulating fire brick on left after firing to 2000° F.

The unusually low shrinkage of C199 Cement prevents tearing of the insulating fire brick face. Also note the thin, tight joints possible with this cement.



even when thinned, and one mixing provides a uniform consistency of mortar.

The water retention test outlined in Technical Bulletin No. 60 of the American Refractories Institute specifies a water retention period of two minutes. The water retention period of Armstrong's C199 Cement far exceeds this specification. Thus good workability and strong, thin joints are assured, even with the most porous brick. Joints may be spread well ahead of the mason.

C199 Offers Substantial Savings

Open joints permit heat, slag, and furnace gases to attack the inner portion of the wall, materially shortening the service life of fire brick. Armstrong's C199 Cement provides a tight joint as effective as the brick itself and a strong bond that prevents brick from becoming loose in the wall. This means increased life for furnace linings, with reduced refractory and maintenance costs.

When you use C199 Cement, simplified inventories and minimum warehouse stocks are possible. It can be used with all types of clay or insulating fire brick, eliminating stocking several types of refractory cement.

Because this cement does not deteriorate in any way during storage, it can be purchased in quantity at substantial savings for use as needed.

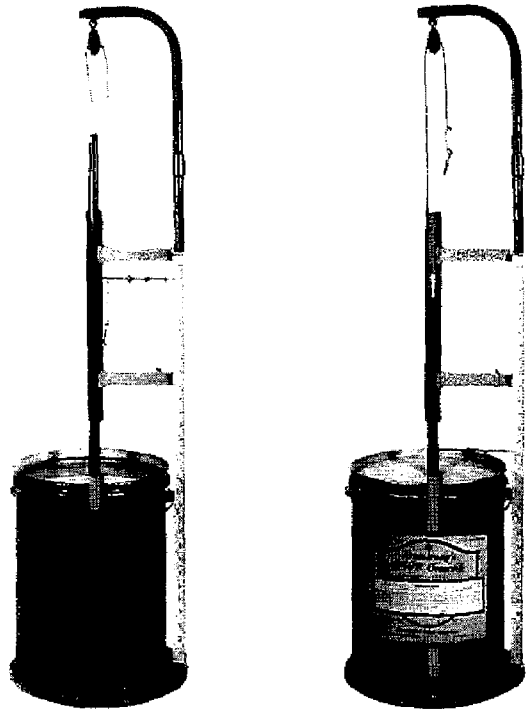
Use of C199 with Insulating Fire Brick

Armstrong's C199 Cement is unique in that it is ideally suited to laying insulating fire brick as well as fire clay brick. Many cements have shrinkage characteristics that cause them to tear the surface of insulating fire brick and disrupt the furnace lining. The low shrinkage of Armstrong's C199 Cement assures high bonding strength without tearing the surface of insulating fire brick.

C199 Protective Facing

Armstrong's C199 Cement may be applied by brush or spray gun as a protective facing on fire brick or insulating fire brick furnace linings. This coating will bond tightly to the brick surface, and, because of its low shrinkage and compatible expansion characteristics, it will not crack or peel away from face of fire clay or insulating brick.

Picture below shows the penetrometer test on a drum of ordinary cement after six months' storage. The rod has penetrated only 2 inches. But Armstrong's C199 Cement stays workable in the container after six months in storage as evidenced by the photo at right, showing rod penetration to the very bottom of the drum.



CHARACTERISTICS OF ARMSTRONG'S REFRACTORY CEMENTS

	ARMSTRONG'S C 199 CEMENT	ARMSTRONG'S No. 2500 CEMENT	ARMSTRONG'S No. 2600 CEMENT
	Wet, factory mixed, air setting cement	Dry, mixed on job, heat setting cements	
Cement used for	Laying and facing all types of insulating fire brick and all types of clay fire brick including super-duty brick	Laying all types of insulating fire brick and fire brick for service up to 2500° F.	Laying and facing A-23 and A-26 insulating fire brick and fire brick for service to 2600° F.
Packed in	Steel drums of 16, 50, 100, 200 lbs. net.	Bags of 100 lbs. net.	Bags of 100 lbs. net.
Weight per cu. ft. as shipped—lbs.	110 lbs.	70 lbs.	68 lbs.
Amount of water needed for dip joint consistency—gals. per 100 lbs. cement.	1 gal.	6½ gals.	3½ gals.
Amount of water needed for brushing consistency—gals. per 100 lbs. cement.	2 gals.	. . . .	6½ gals.
Lbs. cement needed for dip joint construction per 1000 insulating fire brick.			
A-16, A-20, A-25, A-23	250 to 300 lbs.	150 lbs.	
A-26, A-28	250 to 300 lbs.	. . .	200 lbs.
Lbs. cement needed per 1000 clay fire brick.			
Thick trowelled joints	350 to 400 lbs.		
Thin trowelled joints	300 to 350 lbs.		
Dipped joints	250 to 300 lbs.		
Lbs. cement needed for double brush coating one sq. ft. Armstrong's Insulating Fire Brick.			
A-16	0.5 lb.		
A-20, A-25, A-23, A-26	0.5 lb.		0.35 lb.
A-28	0.5 lb.		

ARMSTRONG'S HEAT SETTING CEMENTS

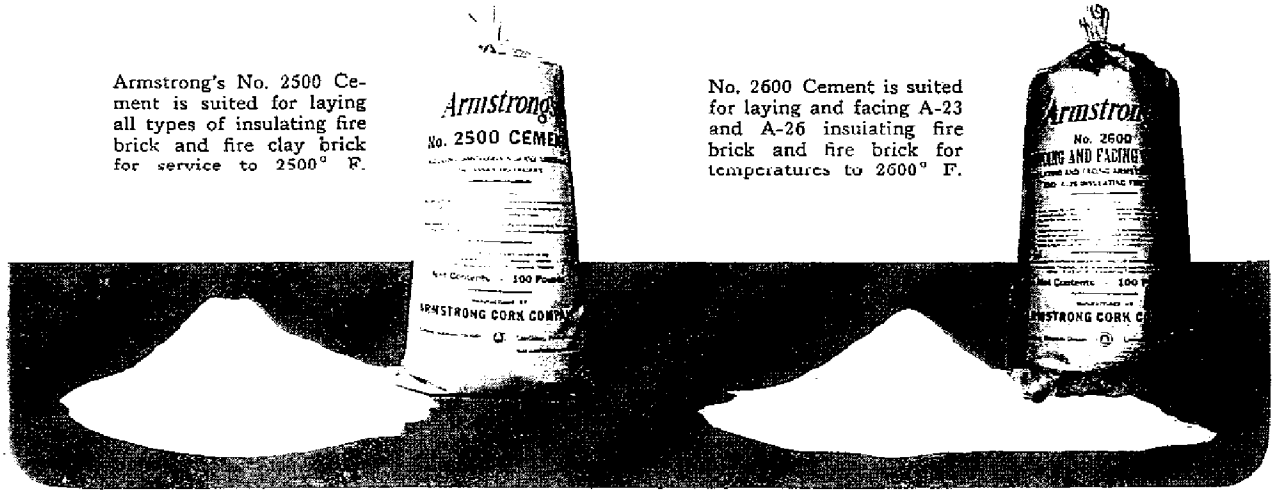
Armstrong's No. 2500 and No. 2600 Cements are dry cements composed of high-grade refractory clays and grog chemically and physically similar to the components of Armstrong's Insulating Fire Brick. This similarity provides shrinkage and expansion characteristics in the cements practically identical to the insulating fire brick with which their use is recommended. It also eliminates cracking, peeling, and crumbling out of joints.

No. 2500 and No. 2600 cements both provide an excellent bond of moderate strength. They do not possess strong bonding qualities at lower temperatures, but when exposed to furnace temperatures over 1800° F. a comparatively strong bond is developed. Because these cements do not develop a ceramic bond below 1800° F., they are well suited for laying up insulating fire brick as back up insulation, allowing the brick to be salvaged for reuse with little or no loss.

Armstrong's No. 2500 Cement is used as a mortar for laying all types of insulating fire brick for temperatures up to 2500° F. Armstrong's No. 2600 Cement contains an organic binder that makes it suitable for laying and facing A-23 and A-26 insulating fire brick in heavy duty applications directly exposed to furnace gases.

Armstrong's No. 2500 Cement is suited for laying all types of insulating fire brick and fire clay brick for service to 2500° F.

No. 2600 Cement is suited for laying and facing A-23 and A-26 insulating fire brick and fire brick for temperatures to 2600° F.



ARMSTRONG'S INGOT INSULATION

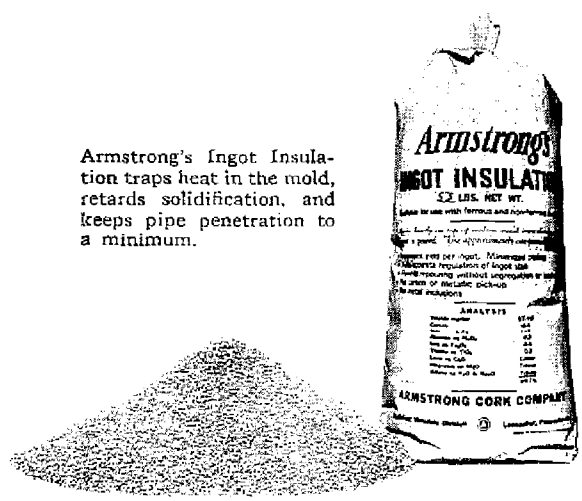
Armstrong's Ingot Insulation is used in steel mills to increase the yield of steel from the ingot by reducing piping. It is a highly efficient insulating material composed of carefully graded particles of cork coated with a film of special clay.

Armstrong's Ingot Insulation is applied to the top of the molten ingot after pouring. There the clay coating protects the cork from the terrific heat and permits the insulating properties of the cork particles to remain effective. The ingot insulation, by preventing rapid cooling, keeps the steel molten longer, allowing it to "feed" properly and fill the pipe as it forms. The use of Armstrong's Ingot Insulation reduces depth of pipe by 20% to 30%, thus reducing proportionally the amount of the ingot that must be cropped and scrapped.

Armstrong's Ingot Insulation lasts until the ingot has solidified. It is still intact and will float to the surface if the ingot is repoured, avoiding entrapment of non-metallic inclusions. The chemical composition of the ingot is not affected and there is no carbon pickup.

Ingot insulation is packed in 50-lb. bags for ease in shipping and handling.

Armstrong engineers will be glad to cooperate with you in conducting tests at your plant to demonstrate how substantial savings may be effected with Armstrong's Ingot Insulation.

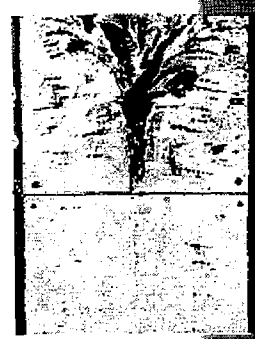


Armstrong's Ingot Insulation traps heat in the mold, retards solidification, and keeps pipe penetration to a minimum.

The photographs at the right are of cross sections cut through the center of four ingots from the same heat. The total volume of pipe is considerably less in the ingot insulated with Armstrong's Ingot Insulation.



Cross section of top of steel ingot insulated with sawdust.



No insulation used here. Photo of cross section shows deep pipe.



Cross section of steel ingot. Insulation used was not specified.



Armstrong's Ingot Insulation produces more useable steel.

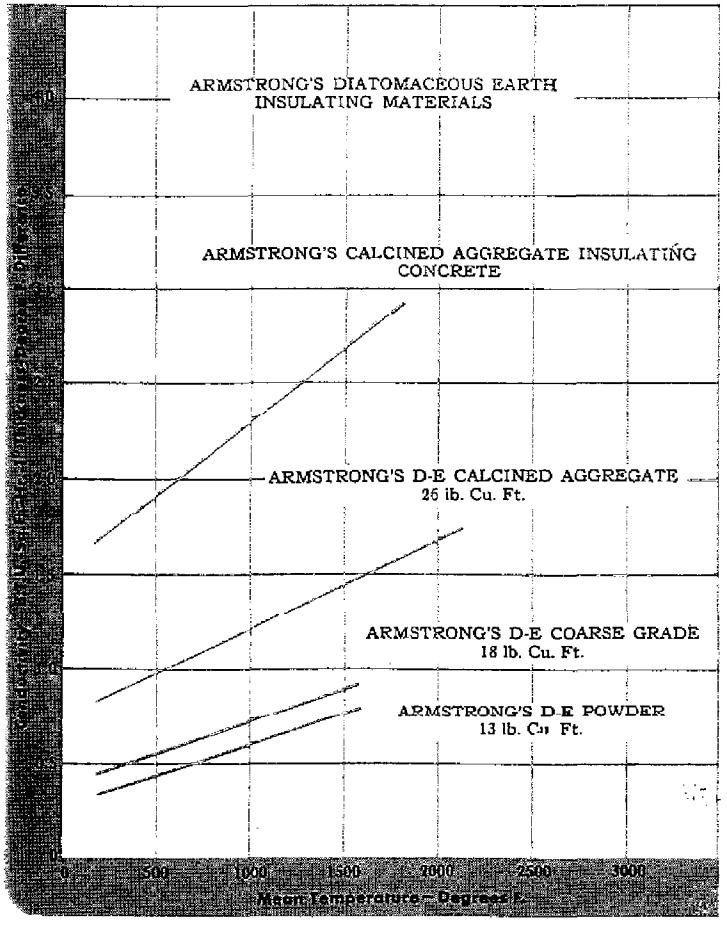
ARMSTRONG'S DIATOMACEOUS EARTH (D-E) INSULATING MATERIALS

Armstrong's Diatomaceous Earth Insulating Materials include D-E Powder, D-E Coarse Grade, and D-E Calcined Insulating Aggregate. All are highly efficient when used in conjunction with insulating fire brick. D-E Powders are used as fill type insulation, and D-E Calcined Aggregate is used in mixing insulating refractory concrete.

Armstrong's D-E Materials are produced from a deposit yielding a very pure grade of diatomaceous silica composed largely of spicular and elongated diatoms. Carefully controlled processing retains the original diatom structure. The high insulating efficiency and light weight of diatomaceous earth are both due to the exceptionally high percentage of minute air cells or voids. Seen under the microscope, Armstrong's D-E Insulating Materials resemble a jackstraw arrangement of diatoms. Between and around these particles are microscopic air cells—several million to the cubic inch—so minute that they efficiently retard the flow of heat.

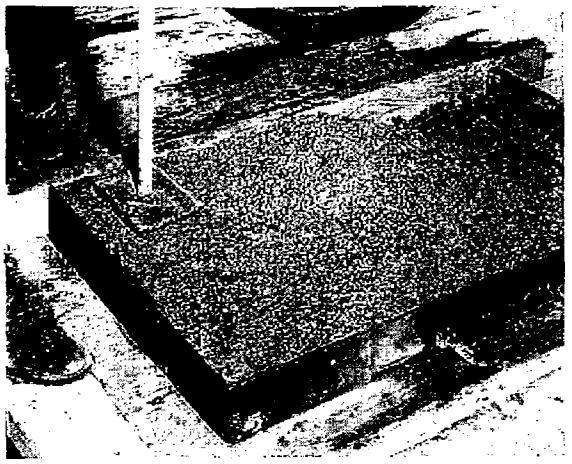
The high insulating efficiency of Armstrong's D-E Insulating Materials is illustrated by the conductivity curves shown below.

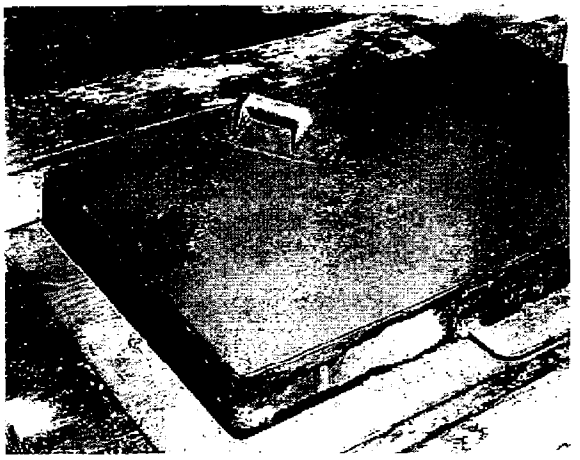
In considering the quality and value of diatomaceous earth, the weight per cubic foot is a deciding factor. The lighter the earth, the greater the insulating value per ton. Armstrong's D-E Insulating Materials are free from impurities and average 10% lighter in weight than earth from other deposits now available. In addition to their low conductivity and light weight, Armstrong's D-E Insulating Materials will not deteriorate or shrink under direct heat at the temperatures to which they will be exposed in service. These materials have a fusion point of approximately 2900° F. D-E powder and D-E coarse materials will withstand temperatures up to 1600° F. without shrinkage. Armstrong's D-E Calcined Insulating Aggregate is processed to withstand direct exposure to temperatures as high as 2100° F.



APPLICATION OF ARMSTRONG'S FILL-TYPE D-E INSULATING MATERIALS

D-E powder insulation and D-E coarse grade insulation find their principal application as "fill" type materials. D-E powder insulation is used where it can be tamped into place to the proper density. D-E coarse grade insulation is used where tamping is impractical and where it is necessary to pour the material into place. Both serve very effectively between a refractory lining and the steel shell of metal jacketed equipment. They are especially valuable in applications where insulating fire brick cannot be installed conveniently. Fill-type insulations find wide usage in boilers, hot blast stoves, vertical shaft lime kilns, bakers' ovens, and other furnace applications. D-E powder insulation is especially suited for use over the arches of tunnel kilns, round periodic kilns, and similar irregular surfaces.





INSULATING REFRACTORY CONCRETE MADE WITH ARMSTRONG'S D-E CALCINED AGGREGATE

Insulating refractory concrete is a lightweight monolithic insulation highly effective for service at temperatures up to 1800° F. It is convenient to use in a wide variety of applications. Since refractory concrete may be cast in place using simple forms in much the same manner as ordinary structural concrete, it offers great flexibility in design and low installation cost.

Typical applications for insulating refractory concrete are:

Furnace doors	Furnace car tops
Furnace bases	Stack linings
Protective slabs over concrete foundation.	Dampers and baffles
	Duct linings

Estimating Data: To provide for 1 cubic foot of insulating refractory concrete in place (based on a 4 to 1 mix by volume) estimate:

29 lbs. of D-E Calcined Aggregate

20 lbs. of Portland or Lumnite Cement

After drying, properly mixed Armstrong's D-E Insulating Refractory Concrete weighs approximately 49 lbs. per cubic foot. It has a cold crushing strength of approximately 1500 lbs. per sq. in.

	D-E Powder Insulation	D-E Coarse Grade Insulation	D-E Calcined Insulating Aggregate (Meets Federal and Navy Specifications)
Maximum temp. without shrinkage	1600° F.	1600° F.	2200° F.
Loose weight per cu. ft.	9-11 lbs.	16-18 lbs.	20-22 lbs.
Dry packed weight per cu. ft.	12-14 lbs.	18-21 lbs.	26-28 lbs.
Silica content	80-94%	80-94%	80-94%
Loss on ignition	6%	6%	0%
Moisture	4%	8%	0%
Screen analysis			
% Retained on 3 Mesh		0%	0%
6 Mesh		5-15%	30-53%
10 Mesh		18-40%	50-69%
20 Mesh		40-60%	66-82%
150 Mesh	No more than 6%		
Packaging: Multi-wall paper bags			
Approx. weight per bag	50 lbs.	50 lbs.	100 lbs.

INSULATING REFRACTORY RESEARCH AT ARMSTRONG

Recognizing the importance of research in the development and improvement of insulating refractories and sundry materials, Armstrong Cork Company maintains in its laboratories a completely equipped Insulating Refractories Section.

Here well-trained men are constantly at work checking the quality of current products and searching for ways to improve them; developing new products in the insulating refractories field; and working toward the solution of problems encountered in the practical applications of insulations for high temperatures.

Armstrong's laboratory plays an important part in helping furnace manufacturers and users find the answers to their insulating refractory problems. The laboratory men work closely with Armstrong's sales engineers—enabling them to pass along to their customers the type of information that has proved invaluable in the solution of scores of furnace problems. If questions involving original research arise, Armstrong engineers refer them to the laboratory for solution.

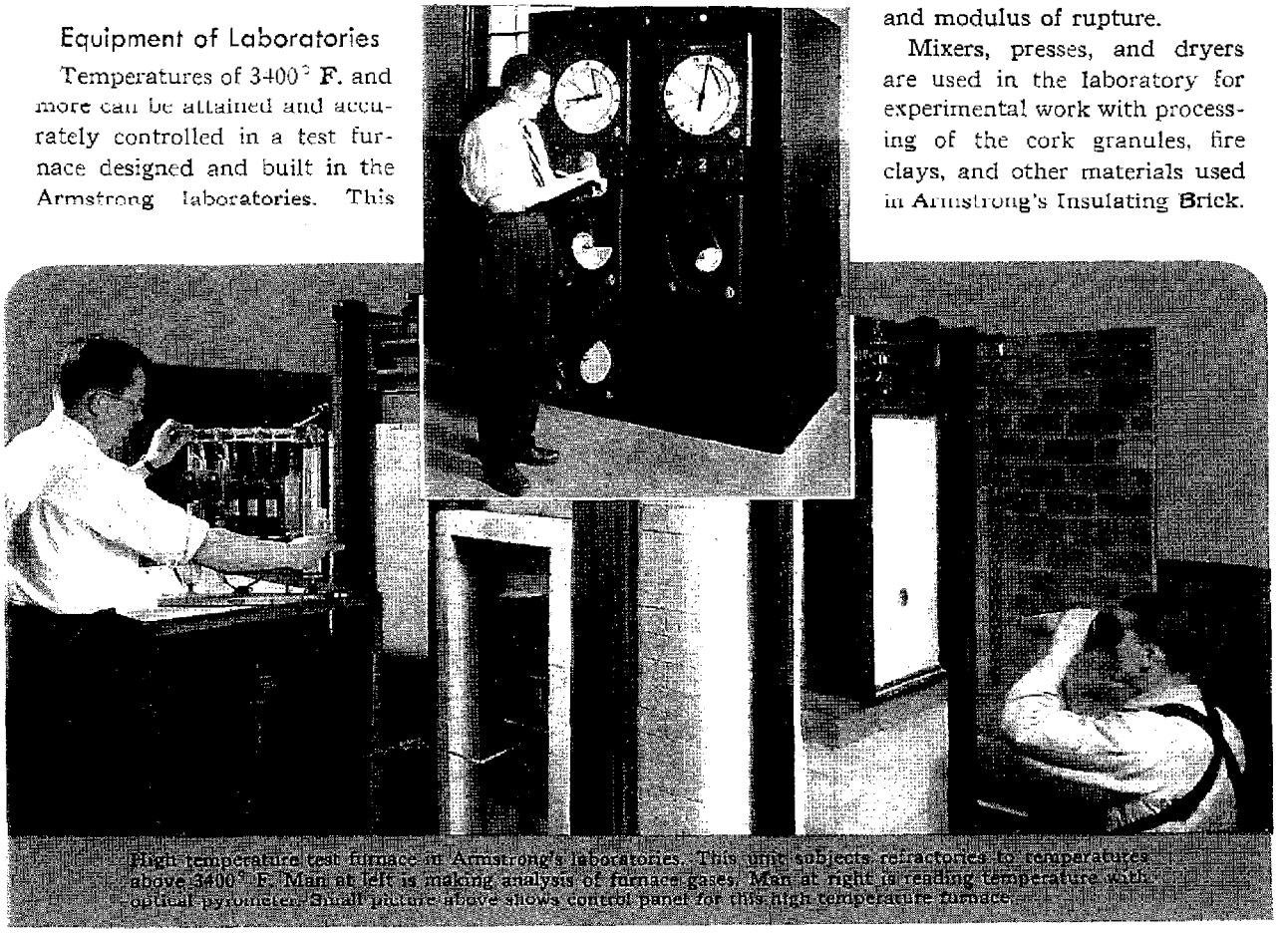
Equipment of Laboratories

Temperatures of 3400° F. and more can be attained and accurately controlled in a test furnace designed and built in the Armstrong laboratories. This furnace is used to test the physical and chemical reactions of insulating refractories under extreme temperatures. It is unique because it has completely automatic temperature and atmosphere controls. Two electronic indicating and recording potentiometers are employed, each operated by an individual time pattern transmitter unit which eliminates the human factor in timing and regulation. Complete gas analysis apparatus is also available for checking furnace atmosphere.

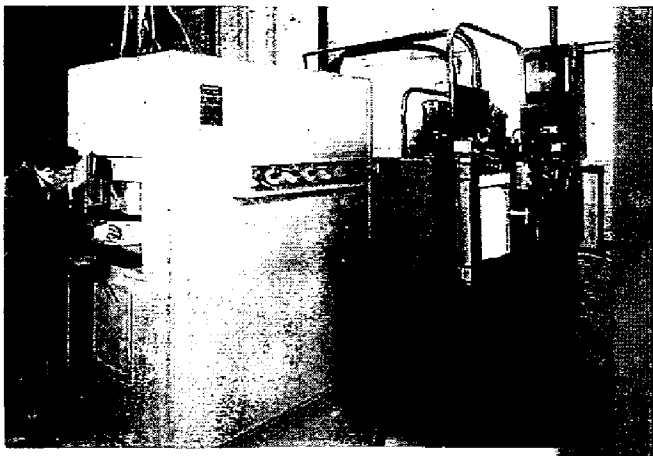
At somewhat lower temperatures, electric furnaces are used to investigate the effects of controlled atmospheres on insulating fire brick. Special furnaces are employed for testing spalling, shrinkage, and deformation under load at elevated temperatures. Another furnace is used for making PCE determinations.

Chemical analyses are made by conventional means and also by the spectroscope and the petrographic microscope. Physical testing is done by standard apparatus which determines thermal conductivity, cold crushing strength, and modulus of rupture.

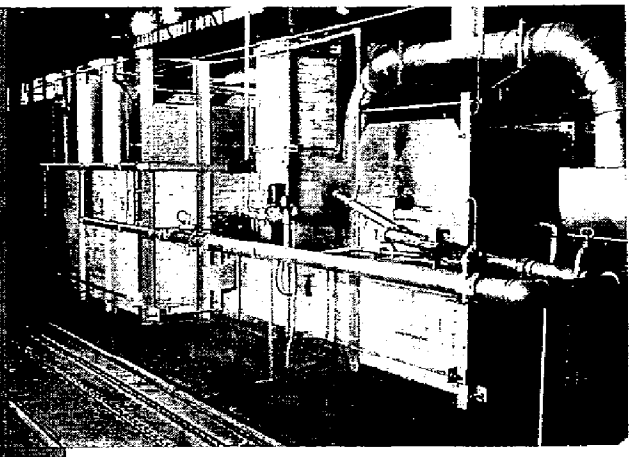
Mixers, presses, and dryers are used in the laboratory for experimental work with processing of the cork granules, fire clays, and other materials used in Armstrong's Insulating Brick.



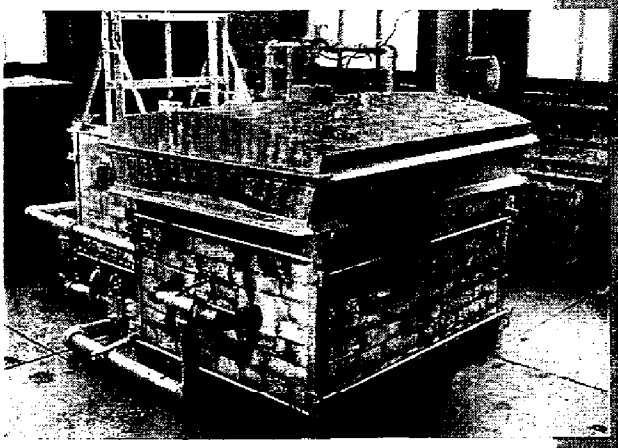
High temperature test furnace in Armstrong's laboratories. This unit subjects refractories to temperatures above 3400° F. Man at left is making analysis of furnace gases. Man at right is reading temperature with optical pyrometer. Small picture above shows control panel for this high temperature furnace.



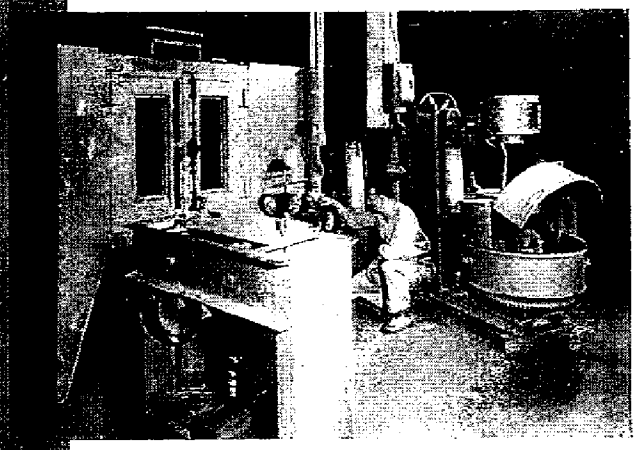
Information on the effects of special atmospheres on insulating fire brick gathered from detailed studies made in electric furnaces helps guide Armstrong's sales engineers in their recommendations.



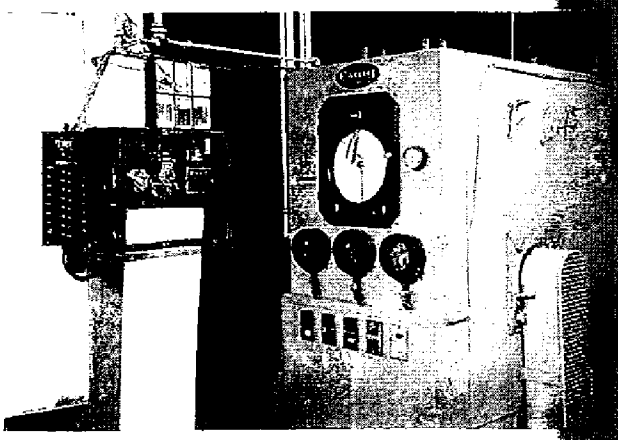
Intensive spalling tests which expose production and laboratory samples of insulating fire brick alternately to heat of furnace and blasts of cold air are conducted in the large furnace in foreground.



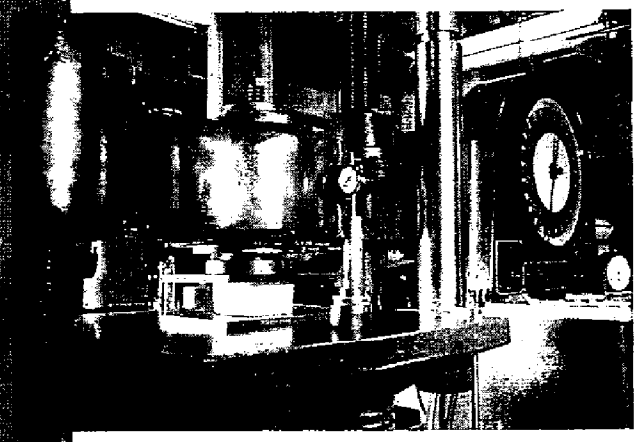
This small laboratory furnace is used for tests on ceramic raw materials used in insulating fire brick formulation. High temperature tests on various cements and other refractory products are also made.



Complete equipment for experimental brick-making is available to the trained technicians of Armstrong's Research Laboratories. The drier, press, and mixer above simulate results of actual production equipment.



Controlled humidity, temperature, and air velocity in the drier pictured above permit complete studies of the drying problems encountered in the manufacture of all types of insulating fire brick.



This universal testing machine provides for careful study of the strength characteristics of Armstrong's Insulating Fire Brick. It assures uniform and accurate control of this important physical property.



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