entirely eliminated where the current flows in the same manner.

Briefly, the principle of this alternator is as follows: If a coil is magnetized by direct current and the magnetic circuit of the same is closed through a moving part which continually varies the air gap, the flux will vary correspondingly, and an alternating electric motor force will be introduced in the magnetizing coil. In its simplest form the device is inoperative because the alternating voltage is short-circuited upon the direct-current exciter. It is, therefore, necessary to use at least two coils connected in such a way that the alternating voltages are induced in opposition in reference to the direct current. This leads to two types of connections. In one the same wire is used for the flow of excitation and the alternating current, the exciting circuit flowing through the two coils in series and the alternating circuit through the same coils in multiple. In the other type of connection different wires are used, the exciting circuit always employing two exciting coils in series so as to eliminate the resulting induced voltage, whereas the alternating-current winding can be connected either in series or in multiple. This type of machine has the characteristics that the coil pitch of the winding has no definite relation to the frequency. The winding may cover either one or as many poles as is desired. The frequency is produced simply by the relation of the teeth of the stationary and rotating members.

The first model of this type that was tried was the telephone relay, which was demonstrated experimentally. It had a winding where each coil comprised one tooth. Subsequently the same machine was rewound so as to employ coils comprising several teeth, the magnetic structure being otherwise the same (see Figs. 5 and 7). The voltage in this type of generator being produced by fluctuations in the strength of the magnetic flux, it is essential that the carrier of the flux on the moving member should also be laminated; and this fact constitutes the limitation of the usefulness of this type of machine.

So far it has not been possible to employ speeds greater than two thirds of the speeds used by a type of alternator with solid steel rotor, and even then with a lower factor of safety. The advantage that might be claimed for the same is the indefinite ratio between the winding pitch and the frequency, which makes it possible to use larger slots than may be used in the purely inductor type of alternator. However, with the improved winding of the inductor alternator described above, using two thirds as many slots as the number of poles, the advantage is minimized. Whatever may be the usefulness of the high-frequency alternator with laminated rotor for special purposes, there is no doubt that the solid steel rotor is better adapted for producing extremely high frequencies; and efforts are being made to find a method to control high-frequency currents of greater intensity than those which can be handled by a carbon transmitter, even if water-cooling is resorted to for increasing its capacity to a maximum. Some experiments in fact have been made with a high-frequency amplifier, which give promise of the same advantages as the use of the microphone in the exciting circuit, as described above; but yet make it possible to use an alternator with solid steel rotor.

Classification of Igneous Rocks*

By H. Warth, D.Sc.

In the method described below I have based the partition of rocks into classes not upon individual bases, but upon the respective sums of bases of equal valency, as determined from molecular percentages. We call these sums respectively T, D and M (tri-, di- and monovalent). One thousand rocks were selected from the current literature and their molecular percentages calculated in the usual manner. A dichotomous division was then carried out. We first calculate the mean value or constant of D for the whole of the rocks. We then separate all the rocks into a set "a" which have a value of D smaller than the mean 17.83, and a set "b" which have a value of D larger than 17.83. Each of these sets we then divided once more according to the respective averages of another constant, obtaining "a a," "a b," "b a," "b b," as shown graphically by blank and shaded rectangles (pigeon holes) in diagram No. 1. The following are six constants which were used in succession:

D, T + D, T + D + M, D + M, T + M, M.

They yield us 2⁶, equal to 64 sets or groups of rocks, and the rocks of each group are of closely similar molecular composition. Herewith will be found a table showing the mean values of T, D and M of each group, also the respective mean totals of acid constituents A, which sum up to 100.0 with the other three values.

Diagram No. 2 represents these results graphically. We have abscissæ equal to the numbers of rocks, and ordinates equal to T, D and M, while A follows above the latter and extends up to a horizontal line which falls beyond the paper. A striking feature of diagram

*Slightly abridged from the *Proceedings of the Birmingham Natural History Society*.

Molecular percentage					Chemical Composition													Rock Name	Locality
Current number GROUP	A 13-a	T a b b	D a a	M	SiO ₂	TiO ₂	P ₂ O ₅	Al ₂ O ₃	Fe ₂ O ₃	FeO	MgO	CaO	Na ₂ O	K ₂ O	H ₂ O	Sum			
228	77.8	7.7	7.3	7.2	72.5	—	—	11.5	2.1	—	2.7	1.8	3.4	5.2	.7	99.1	Porphyritic felsite	Arran	
229	76.7	9.8	6.7	6.8	71.9	—	—	15.6	—	2	2.3	2.4	3.3	4.9	1.4	99.9	Dacite (glassy)	Cherty, Kasbeck	
230	76.0	10.0	8.0	6.0	69.2	.4	—	14.3	2.1	2.3	1.3	3.2	3.3	3.5	.8	100.3	Tonalite	Meran	
231	76.0	9.9	8.2	5.9	68.9	—	—	14.7	.9	2.2	1.6	3.0	3.7	2.8	1.6	99.4	Porphyry	Bohulibi	
232	75.9	9.6	7.2	7.3	67.9	.9	.2	12.2	4.2	3.0	1.2	2.0	3.8	4.5	.7	100.5	Granite	Lovstakken	
233	75.7	9.7	8.6	6.0	68.5	—	—	14.7	.4	3.3	1.4	2.8	2.9	4.1	2.3	100.5	Rhyolite	Sweden	
234	75.6	10.3	7.1	7.0	66.6	—	—	15.1	.7	3.1	1.4	1.5	2.0	6.7	2.8	99.9	Porphyry	Münstertal	
235	75.5	8.6	9.0	6.9	69.4	.2	—	12.8	1.1	2.6	.7	4.7	3.1	5.2	.3	100.2	Granite	Madeira, S. Amer.	
236	74.7	9.7	8.7	6.9	64.6	.3	.1	13.6	1.2	1.2	.7	5.1	3.5	4.1	5.6	100.0	Quartz porphyry	Münster a/St.	
237	74.4	9.3	8.7	7.6	65.0	.5	.1	13.7	.4	2.2	.8	4.4	3.7	4.8	4.3	100.1	Quartz porphyry	Saar-Nabe	
238	74.3	11.1	7.4	7.2	65.7	.7	.3	15.3	2.5	1.6	1.6	2.7	3.6	4.6	.6	99.5	Quartz monzonite	Colorado	
239	74.1	11.8	6.8	7.3	65.9	.4	—	16.8	1.6	1.2	1.5	2.7	4.7	3.2	1.4	99.4	Porphyry	Montana	
240	73.7	12.7	5.6	8.0	65.6	.7	.2	18.7	1.3	1.3	1.0	2.3	5.6	3.7	.5	101.0	Plag. trachyte	E. Aar, Switz.	
241	73.4	10.8	7.3	8.5	67.4	—	.1	15.9	1.4	1.1	1.4	3.5	6.4	2.6	.1	99.9	Aug. soda syenite	Minnesota	
14 rocks																			
Mean	75.3	10.1	7.6	7.0	67.8	.3	.1	14.6	1.4	1.8	1.4	3.0	3.8	4.3	1.6	100.0			
GROUP 14-a a b b a b																			
242	78.2	7.9	3.8	10.1	70.3	—	—	6.3	9.2	1.4	.9	.8	7.7	2.5	.8	100.0	Pantellerite	Pantellaria	
243	76.7	6.5	6.6	10.2	70.6	.1	—	8.6	2.5	6.3	.1	.6	6.8	4.5	.1	100.2	Rhyolitic obsidian	Br. E. Africa	
244	76.2	9.3	4.8	9.7	68.8	—	—	11.3	4.9	4.3	.1	.5	6.1	4.4	.1	100.5	Liparite (4 and 5)	Somali Desert	
245	75.7	8.2	6.5	9.6	69.1	—	—	10.5	3.6	6.4	.1	.4	6.2	4.3	—	100.6	Pantellerite	Ouache, E. Africa	
246	75.5	9.4	5.1	10.0	67.5	—	—	9.7	7.4	2.2	.8	1.5	7.2	2.9	1.0	100.1	Pantellerite	Pantellaria	
247	75.4	10.7	3.8	10.1	66.2	.2	—	14.2	3.1	1.7	.5	1.2	5.0	6.3	1.3	99.7	Granite	River Aar	
248	75.4	6.1	7.5	11.0	68.8	—	—	5.9	5.8	5.3	.1	2.1	7.5	4.3	—	100.0	Pantellerite	Pantellaria	
249	74.9	11.2	3.8	10.1	68.7	.3	—	17.1	.9	.4	.4	2.3	7.0	3.8	.6	101.5	Red granite	Osteroe, Norway	
250	74.5	11.4	4.3	9.8	67.2	—	—	17.2	.8	—	—	3.6	4.7	6.7	—	100.3	Garnet granulite	Mexico	
251	73.3	11.9	4.7	10.1	65.4	—	—	17.1	1.7	1.1	.4	2.5	4.8	6.9	1.8	101.7	Syenite	Monzoni	
252	72.6	9.5	6.3	11.6	64.0	.8	—	10.4	6.3	4.2	.3	1.5	7.6	4.6	.2	100.0	Phonol. obsidian	Br. E. Africa	
253	72.3	10.3	8.2	9.2	66.7	—	—	15.8	.7	.3	2.1	3.9	7.1	2.4	1.0	100.0	Dacite	Sumatra	
254	72.2	10.4	7.7	9.9	63.0	—	—	13.4	3.5	5.3	.6	1.3	5.5	5.2	2.8	100.5	Quartz syenite	Fourche Mts.	
13 rocks																			
Mean	74.8	9.5	5.6	10.1	67.4	.1	—	12.1	3.9	3.0	.5	1.7	6.4	4.5	.7	100.4			

Table Showing Names and Composition of Rocks of Groups 13 and 14.

Molecular percentage.					Chemical Composition													Rock Name	Locality
Current number Group	A 15-a	T a b b	D b a	M	SiO ₂	TiO ₂	P ₂ O ₅	Al ₂ O ₃	Fe ₂ O ₃	FeO	MgO	CaO	Na ₂ O	K ₂ O	H ₂ O	Sum			
255	74.8	11.5	1.7	12.0	66.5	.7	—	16.3	2.0	.4	.2	.8	7.5	5.5	.5	100.5	Lestiwirite	Lougental	
256	74.4	11.6	2.6	11.4	65.9	.5	—	16.0	2.6	1.8	.3	.3	7.4	4.7	.3	99.8	Alkali gneiss	Portugal	
257	74.1	11.8	2.8	11.3	66.1	—	—	16.5	2.3	1.6	.2	.8	6.8	5.5	.6	100.4	Riebeck. trachyte	Berkum	
258	73.5	13.0	2.4	11.1	64.3	—	—	17.5	3.1	1.3	.3	.6	7.3	4.3	1.0	99.7	Acinite trachyte	Montana	
259	72.7	13.8	1.7	11.8	63.7	—	—	17.9	4.3	.5	.1	.8	7.2	5.2	.8	100.5	Silvs bergite	Abyssinia	
260	72.1	11.5	4.9	11.5	63.8	.7	.2	17.4	.1	1.5	.9	1.7	6.7	6.0	.4	99.3	Pyrox. syenite	Knusamo, Finl.	
261	72.0	12.2	4.3	11.5	64.0	.6	—	17.9	1.0	2.3	.6	1.0	6.7	6.1	1.2	101.4	Nordmarkite	Tonsenaas	
262	71.2	13.3	4.2	11.3	62.2	—	.1	18.6	2.2	1.1	.7	1.6	7.6	3.9	1.6	99.5	Aemite trachyte	Montana	
263	70.8	14.0	4.0	11.2	60.1	1.0	—	18.8	2.9	.9	1.0	1.1	4.6	8.1	2.0	100.6	Trachyte	Cape Vert	
264	70.5	13.4	4.4	11.7	61.1	.3	—	18.8	2.0	3.1	.4	1.3	6.6	6.0	.8	100.0	Silvs bergite	Massachusetts	
265	70.4	14.5	3.7	11.4	60.1	1.2	.1	20.0	2.4	1.3	.8	.9	6.3	6.0	1.6	100.7	Foyaite	Arkansas	
266	70.2	13.6	4.6	11.6	60.6	.7	.2	18.3	2.9	2.7	.5	1.0	6.7	5.7	.7	99.9	Syenite porphyry	Massachusetts	
267	70.2	13.4	4.7	11.7	61.0	.5	—	18.5	2.1	.8	.9	1.9	7.3	4.8	3.1	101.3	Soda trachyte	Rhöngebirge	
268	69.2	13.8	5.4	12.6	59.7	—	.1	17.0	3.2	1.3	.8	2.3	8.4	4.2	2.5	99.6	Syenitic trachyte	Montana	
14 rocks Mean	71.8	12.9	3.7	11.6	62.7	.4	.1	17.8	2.4	1.5	.6	1.1	6.9	5.4	1.2	100.2			
Group	16-a	a b b	b b																
269	71.4	13.8	1.3	13.5	62.5	1.1	—	18.7	3.3	.5	.1	.5	11.8	.8	.7	100.0	Mariupolite	Sea of Azoff	
270	70.8	13.1	2.6	13.5	61.8	.1	—	19.2	.7	1.7	.5	.2	7.9	6.7	(1.5)	100.3	Pegmatite	Isles de Los	
271	69.1	13.8	3.3	13.8	57.6	.2	—	17.5	3.5	1.2	.2	1.4	5.8	9.2	3.2	99.9	Tinguaite	Montana	
272	69.1	14.5	2.8	13.6	58.6	.2	—	19.6	2.2	.6	.4	1.2	8.4	5.3	2.9	99.7	Phonolite	Colorado	
273	68.9	15.4	2.8	12.9	60.4	—	—	22.6	.4	2.3	.1	.3	8.5	4.8	.6	100.0	Elaeolite syenite	Maine	
274	68.5	15.0	1.8	14.7	58.5	—	—	20.3	2.4	.6	—	.9	9.5	5.2	2.6	100.0	Phonolite	Dakota	
275	68.5	15.3	1.3	14.9	59.5	(.2)	—	21.2	2.7	.5	.1	.5	10.7	3.9	(.7)	100.1	Alkali gneiss	Portugal	
276	68.3	15.4	2.1	14.2	57.8	—	—	18.7	5.8	.4	—	1.3	9.4	4.5	1.5	99.4	Tinguaite	Abyssinia	
277	68.1	14.1	3.4	14.4	57.9	—	—	19.1	2.5	—	1.1	1.2	6.6	9.2	2.4	100.0	Pumice	Krufter Ofen	
278	65.9	15.4	2.7	16.0	56.2	.3	.1	21.4	2.0	.7	.2	1.5	10.5	5.7	1.0	99.9	Phonolite	New Mexico	
279	65.7	14.9	3.4	16.0	54.9	.4	—	20.8	1.3	1.4	.4	1.0	9.0	7.3	2.6	99.7	Nephel aplite	Cabo Frio, Brazil	
11 rocks Mean	68.6	14.6	2.5	14.3	58.7	.2	—	19.9	2.4	.9	.3	.9	8.9	5.7	1.8	99.9			

to a large extent if the petrological name remained the same.

It remains now to show how diagram No. 1 enables us to assign any rock to whatever group it belongs. We select for this purpose the following rock:

Phonolite trachyte, Hawaii. "Journal of Geology, 1904, p. 510. (Also Upsala Univ., p. 283.) Quantitative composition:—

SiO ₂	TiO ₂	P ₂ O ₅	Al ₂ O ₃	Fe ₂ O ₃	FeO	MnO	MgO	CaO	Na ₂ O	K ₂ O	H ₂ O	Cl	Total
62.19	.37	.14	17.43	1.65	2.64	.32	.50	.86	8.28	5.03	.53	.09	99.93

Molecular percentage:—

SiO ₂	TiO ₂	P ₂ O ₅	Al ₂ O ₃	Fe ₂ O ₃	FeO	MnO	MgO	CaO	Na ₂ O	K ₂ O	H ₂ O	Cl	Total
70.22	.51	.07	11.51	.70	2.49	.30	.8	1.04	9.07	5.51			100.00
A = 70.60	T = 12.21	D = 4.51	M = 12.68										100.00

The following six constants are used for partition:—

1	2	3	4	5	6
D	T+D	T+D+M	D+M	T+M	M
4.5	16.7	25.4	17.2	24.9	12.7

Number of group	Formula	Molecular percentage				Number of rocks
		A	T	D	M	
1	aaaaaa	85.2	8.4	3.1	3.3	18
2	aaaaab	84.3	8.3	1.9	5.5	18
3	aaaaba	82.0	9.8	1.9	6.3	24
4	aaabbb	82.5	8.9	1.0	7.6	21
5	aaabaa	80.8	8.5	5.1	5.6	16
6	aaabab	81.7	8.1	2.8	7.4	20
7	aaabba	80.4	9.5	2.5	7.6	27
8	aaabbb	79.7	9.1	2.3	8.9	14
9	aaabaa	78.1	10.2	6.1	5.6	16
10	aaabaab	77.7	10.4	4.8	7.1	22
11	aaababa	76.5	11.9	3.8	7.8	18
12	aaababb	76.2	11.5	2.3	10.0	13
13	aaabbaa	75.3	10.1	7.6	7.0	14
14	aaababb	74.8	9.5	5.6	10.1	13
15	aaabbbb	71.8	12.9	3.7	11.6	14
16	aaabbbb	68.6	14.6	2.5	14.3	11
17	aaabaaa	73.4	11.6	10.9	4.1	14
18	aaabaab	73.4	11.7	8.7	6.2	23
19	aaababa	71.4	14.0	7.5	7.1	15
20	aaababb	69.3	15.2	4.3	11.2	11
21	aaabaaa	69.6	11.7	13.3	5.4	30
22	aaababb	69.5	11.4	10.1	9.0	16
23	aaababa	68.8	12.7	10.2	8.3	11
24	aaabbbb	68.6	13.5	6.9	11.0	13
25	aaabaaa	66.2	14.1	14.9	4.8	19
26	aaababb	66.2	14.6	10.1	9.1	13
27	aaababa	65.6	15.4	7.3	11.7	19
28	aaababb	64.8	16.1	4.9	14.2	23
29	aaabaaa	64.9	13.2	16.9	5.0	22
30	aaababb	63.7	13.0	15.6	7.7	17
31	aaabbbb	61.6	15.3	13.7	9.4	13
32	aaabbbb	60.8	15.5	8.5	15.2	14

Number of group	Formula	Molecular percentage				Number of rocks
		A	T	D	M	
33	baaaaa	63.0	12.6	21.0	3.4	16
34	baaaab	63.4	11.7	19.8	5.1	19
35	baaaba	59.7	15.6	20.2	4.5	13
36	baabbb	59.5	14.5	19.0	7.0	12
37	baabaa	59.2	10.5	26.5	3.8	17
38	baabab	59.7	9.7	25.2	5.4	15
39	baabba	58.8	12.6	24.0	4.6	15
40	baabbb	59.6	10.8	21.9	7.7	12
41	baabaaa	56.3	13.2	27.0	3.5	24
42	baabab	55.9	13.1	25.9	5.1	14
43	baababa	55.2	16.1	23.6	5.1	16
44	baababb	55.7	14.2	21.9	8.2	16
45	baabbaa	55.5	10.4	30.8	3.3	23
46	baababb	54.5	10.3	29.9	5.3	20
47	baabbbb	53.5	13.0	27.7	5.8	15
48	baabbbb	52.5	13.1	25.0	9.4	15
49	baabaaa	52.8	11.3	34.2	1.7	11
50	baabab	51.9	11.0	33.6	3.5	17
51	baababa	52.0	15.1	30.4	2.5	11
52	baababb	50.1	14.0	31.4	4.5	16
53	baabbaa	49.2	6.6	43.2	1.0	11
54	baababb	50.0	7.6	38.8	3.6	8
55	baabbbb	48.5	10.9	37.5	3.1	14
56	baabbbb	48.0	10.8	35.8	5.4	12
57	baabaaa	44.8	9.6	44.1	1.5	11
58	baabab	44.9	9.2	42.0	3.9	13
59	baababa	43.9	14.4	38.9	2.8	10
60	baababb	44.3	12.5	37.2	6.0	13
61	baabbaa	38.0	3.4	58.6	.0	14
62	baabbbb	39.7	4.4	54.8	1.1	7
63	baabbbb	41.0	7.4	50.0	1.6	10
64	baabbbb	41.5	7.7	46.1	4.7	8
Mean		64.22	11.60	17.83	6.35	

One Thousand Rocks Examined and Classified According to Their Contents of Trivalent (T) Divalent (D) and Monovalent (M) Bases.

No. 1.

Diagram of the Classification of Rocks According to Their Contents of Trivalent (T), Divalent (D) and Monovalent (M) Bases.

Diagram Showing the Number of Rocks (as Measured by Abscissae) Which Fall Into Each of the Sixty-four Groups, and Their Composition. This is a Graphic Representation of the Tables Adjoining.

With these constants at our disposal, diagram No. 1 enables us to determine the group in a very short time. We proceed from row to row ascertaining if our figure for D, T + D, etc., is smaller or larger than the figure on the diagram, in the former case giving the letter "a," in the second case "b." According to the letter "a" or "b" we successively move to the left to a blank rectangle (pigeon-hole) or to the right to a shaded rectangle. We thus arrive at the formula "a a b b b a," and our rock belongs to group 15. As our value of M happens to be very close to the respective constant 12.78 in the sixth row, the rock approaches the boundary of group 16.

According to the descending order of A in the table page 330 it falls between the rocks number 263 and 264, and we find it closely related to these neighbors.

In conclusion I may remark again on the ease with which a group for a rock is found by means of diagram No. 1. Once the molecular percentage has been obtained or calculated, it takes less than a minute to complete the operation. We notice that this resembles the simple method of finding a word in a dictionary. As we find a word by taking up in order one consecutive letter after the other in a dictionary, so we find our group by selecting either the letter "a" or the letter "b" six times in succession.

Rat-proof Buildings

THE recent elemental catastrophes—the cyclones in the Middle West, and the floods in that vast region watered by the Ohio—have destroyed many hundreds of buildings. Here, out of misfortune much good should come. A timely appeal for the rat-proofing of dwellings and other buildings at present existing, under construction or in contemplation comes from the United States Public Health Service. Those about to erect a new building or repair an old one, whether of frame, brick, rock, concrete or other construction, may learn from Dr. Simpson's paper what sanitary and economic benefits are to be derived from permanent rat-proofing; and measures to such ends should be demanded by prospective owners as a part of building contracts. The

rat is far too prolific to be exterminated by such agencies as traps, poisons, lethal gases and the like; these may reduce the numbers of the rodents, but if there is food within reach, the surviving rats will have more to eat proportionally, and procreation will be stimulated the more. Rat extermination can be effective only by separating that creature from its provenance. Dr. Simpson's paper appears to contain all necessary information to this end, so far as relates to buildings. Those already erected can be rat-proofed by the closure of all natural or accidental openings; by being remodeled with material impervious to rats; by the removal of structures which will give refuge to rats, and by the protection or removal of foods which rats will eat.—*Journal of the American Medical Association.*