Results on known samples of pure calcium carbonate are as follows:

Weight of $CaCO_3$ taken. Grams.	Weight of $CaCO_3$ recovered. Grams.
0.5003	0.4998
0.4997	0.4993
0.5012	0.5007
0.8472	0.8465
1.0037	1.0026

ON A SYSTEM OF INDEXING CHEMICAL LITERATURE; ADOPTED BY THE CLASSIFICATION DIVISION OF THE U. S. PATENT OFFICE.[1]

BY EDWIN A. HILL.

Received May 12, 1900.

IN the following paper I will endeavor to describe the system of indexing or digesting chemical literature and patents, now in use in the Classification Division of the United States Patent Office. This division was organized about a year ago to perfect the existing classification of United States patents. Under our laws, no valid patent can be granted for any new process, composition of matter, or chemical body, described in any printed publication prior to the inventor's discovery thereof, or more than two years prior to the date of his application for such patent; and, among other things, this division is now preparing an index or digest of literature and patents relating to chemical bodies and processes, for the use of the office in making its examinations of pending applications.

The system adopted is in the nature of a reference index rather than a classification, and is one elaborated by myself, some five or more years since for another purpose, and on which we have been at work since last summer. I may add that our work was well advanced before my attention was called to the fact that there are great similarities between this system and that of Richter.

Generally speaking, in any comparison of digests or indexes that system may be considered best which, in the simplest, most certain, and most direct manner, puts the inquirer in possession of the desired information.

[1] Read before the Washington Section of the American Chemical Society, May 10, 1900.

If chemical bodies each had but one instead of many names, and if, in chemical literature, one never met with bodies as yet unchristened, then undoubtedly, the dictionary plan, pure and simple, in which the names of bodies were alphabetically arranged and the references to literature and patents were collected under their proper titles, would answer every requirement, and would be, in fact, the only proper system to use.

Practically however, most bodies known to chemists have more than one name, many have several, and the names approved in prior decades are generally not the names in highest repute to-day; nor is it likely that the names now in use will in all, or even in most cases, remain those approved in future years.

Where a chemical compound has several names, were it possible to decide now (which perhaps might be done) which one of them was, on good scientific grounds, the most appropriate in view of present knowledge, and further (which, of course, could not be done), could one be assured that such name would remain the approved name for all future time, such title could, without hesitation, be now adopted as the indexing title, under which all references to literature or patents could be entered, and all other titles and names cross-referenced into it; but, while this might be done now in certain cases, who can guarantee that all the names approved to-day shall retain that approbation as our knowledge of chemical constitution is increased?

Evidently the dictionary plan, unmodified, is not the best, and some better system must be devised not open to these objections.

It would seem that the kind and number of the component atoms of a chemical compound are its most unvarying characteristics, and are subject only to the errors of chemical analysis; and that therefore, these must form the most stable basis for any general scheme for the indexing or digesting of chemical literature; and this conclusion appears to have been independently reached by others than myself; as, for example, by Richter in his recent and former work, and by Jacobsen and Stelzner, following Richter in the index numbers of *Berichte* for 1898 and 1899. We differ chiefly in the methods by which this principle receives practical application.

The simplest, most certain, and most direct system would be to recast the empirical formulas of the compounds, writing

the atoms in the alphabetical order of their chemical symbols, and to then arrange the formulas on an alphabetical basis. For example, take the bodies

$$(CH_3)_2C_2H_2(NO_2)_2,\ (CH_3)_2CHNO_2,\ KH_3C_2O_4,\ CH_3Cl,\ Cu(AsO_2)_2.$$

Rewriting them as above, and arranging them alphabetically, we have

$$As_2CuO_4,\ CClH_3,\ CCl_4,\ C_2H_3KO_4,\ C_3H_7NO_2,\ C_4H_8N_2O_4.$$

It should be noted, however, that the compounds containing C and H, and broadly included in the domain of organic chemistry, constitute so large and important a class that we are fully justified in departing slightly from the alphabetical arrangement of chemical symbols, in order to thereby bring more closely together in the index bodies more or less closely related.

Generally speaking, an attempt to combine a dictionary or digest with a classification will be disastrous. We cannot sit on two stools at once, we will surely fall between them; and too much classification grafted on the dictionary or digest idea will give what is neither a good digest nor a good classification.

Classification, as applied to chemical compounds, should be supplementary to, and independent of, a mere digest or reference index.

In practice, therefore, I have modified the purely alphabetical scheme, and have adopted the following general rule for indexing:

Reject the water of crystallization, and rewrite the empirical formula in the alphabetical order of the chemical symbols, except that in carbon compounds write C first and H second; follow this rewritten formula with the constitutional formula, when given, adding the water of crystallization, if any, but arrange the titles alphabetically by the rewritten formula.

The reason for disregarding water of crystallization may be illustrated as follows: the three bodies, Na_2SO_4 or anhydrous sodium sulphate, $Na_2SO_4 + 10H_2O$ or Glauber's salt, and the heptahydrated salt $Na_2SO_4 + 7H_2O$, are in this way all indexed under the same indexing formula Na_2O_4S, and are thereby brought closely together, as they should be, in one place in the digest. If on the other hand water of crystallization was taken

into account for indexing purposes, the corresponding indexing formulas would become Na_2O_4S, $H_{20}Na_2O_{14}S$, and $H_{14}Na_2O_{11}S$ respectively, and these three very closely related bodies would, in consequence, be widely separated in the digest, which result would, we think, be a very undesirable one.

Our index is being prepared on the card catalogue plan. The cards used are the regular Library Bureau standard card, No. 33, size $7\frac{1}{2}$ by $12\frac{1}{2}$ cm., or approximately 3 by 5 inches, without rulings except a single blue horizontal line, ruled $\frac{3}{8}$ of an inch below the top edge of the card.

The following is a sample set of cards as actually made out in a given instance, except in size.

ONE FORMULA CARD:

$C_{12}O_{18}Fe_2O_{12}$ or $(CH_3.CO_2)_6Fe_2$.

Ferric Acetate; Acetate of Iron; Klaproth's Iron Tincture; Tinctura Ferri Acetatis; Iron Tincture, Klaproth's.

See A Treatise on Chemistry. By H. E. Roscoe and C. Schorlemmer, Vol. 3, Organic Chemistry, Part I, Page 505.

ONE POLYMER OR MULTIPLE FORMULA CARD:

$C_6H_9FeO_6$ Polymer Class 2.

See $C_{12}H_{18}Fe_2O_{12}$ or $(C_6H_9FeO_6)_2$
Ferric Acetate.

TWO CLASSIFICATION CARDS:

Acetates

Ferric.
See $C_{12}H_{18}Fe_2O_{12}$ or $(CH_3.CO_2)_6Fe_2$.

Iron

Acetate of.
See $C_{12}H_{18}Fe_2O_{12}$ or $(CH_3.CO_2)_6Fe_2$.

FOUR SUBJECT-MATTER OR TITLE CARDS:

Ferric Acetate

See $C_{12}H_{18}Fe_2O_{12}$.

Klaproth's Iron Tincture

See $C_{12}H_{18}Fe_2O_{12}$.

Iron, Klaproth's Tincture of

See $C_{12}H_{18}Fe_2O_{12}$.

Tinctura Ferri Acetatis

See $C_{12}H_{18}Fe_2O_{12}$.

Considering first the formula card, it will be noted that in the formula the atoms are rearranged in the alphabetical order of their chemical symbols, except that in carbon compounds C comes first, and H second; and that, had there been water of crystallization in the formula, it would have been rejected. Then follows the constitutional formula, where the water of crystallization, if any, would appear. Thus had the body been cupric acetate, the first line of the formula card would have been

$$C_4H_6CuO_4 \quad \text{or} \quad Cu(C_2H_3O_2)_2 + H_2O.$$

Then follows under the blue ruling, all the names given for the body in question, and finally the reference, by volume and page, to the work indexed.

When a citation is to a patent instead of to a book or other printed work, the reference given will be about like this:

See U. S. Patent No. 319082 to Fahlberg, dated June 2, 1885.

The arrangement of these cards in the card index is strictly an alphabetical one. Thus, all cards reading C_1 take precedence of C_2, C_2 of C_3, etc., etc. In the series C_1, etc., the order of arrangement would be:

$CAgNO$; $CAgS$; CAg_2O_3; CBr; $CClHgN$; CCl_2O; CCl_4; $CCuN$; $CHAgO_2$; $CHBr$; $CHCl_2I$; $CHCl_3$; CH_2AgNO_3S; CH_2Cl_2; CH_2S; CH_3AsCl_2; CH_3Br; CH_3ClOP; CH_3F; CH_4; CH_5AsClO; CH_5ClN; $CH_6AlNO_8S_2$; CH_6ClN; C_2H_2; C_2H_3Ca-ClO_2; C_2H_4AgNO; C_2H_6As; $C_6H_4AgNO_2$; $C_9H_{12}O$; $C_{10}H_{15}Cl_2P$; $C_{22}H_{18}ClN_4O$; $C_{40}H_{52}N_4O_{12}S_2$; CdO_4S; $ClCu$; ClH_2Hg_2NO; DiN_3O_9; HKO_2S; $KMnO_4$; PCl_3; PCl_5, etc., etc.

The foregoing series will fully illustrate the method of arrangement.

The polymer or multiple formula cards perform the following function: There are many bodies which analysis shows to be composed of certain elements in certain proportions, but for which theory at present indicates a formula containing two, three, or more times as many atoms. Thus at one time the formula of ferric chloride was written $FeCl_3$, whereas it is now very often written Fe_2Cl_6, and such doubled and tripled formulas are very common.

In all cases where, in the formula as written, the exponents of

all the atoms have a common divisor, after the doubled, tripled, or other form as found is used for preparing the formula card, the formula is then reduced to its lowest terms by dividing the exponents by their greatest common divisor, and a polymer or multiple formula card, made out in the form shown by the foregoing sample ("Class 2," "Class 3," etc., on the polymer cards, indicates the common divisor). In this way the index is rendered independent of any changes in the formula consequent upon future changes of view with reference to constitutional formulas and other matters of theory.

A mere reference index or digest should in no way depend upon any theory subject to future changes with advancing knowledge. Classification, on the other hand, must necessarily depend on theory, and must change as knowledge is increased.

These polymer cards are sorted in with the regular formula cards to form part of the formula division of the index or digest. We may illustrate the function of these cards thus: suppose ferric chloride had been found in the literature under the formula Fe_2Cl_6, and so indexed, but no polymer card made out, and some one consulted the index under the formula $FeCl_3$; the reference, though in the digest, would not be found, but with the polymer card made out the inquirer by it would be referred to the card Fe_2Cl_6, where the required references would appear. All the remaining cards compose the subject-matter or title index, comprised first of the classification cards, second of the regular subject-matter or title cards, and third of any general topics that it may be thought advisable to include in the alphabetical division of the index.

These cards require but little explanation, except that the general statement should be made that all references to the literature or patents of chemical bodies are intended to be entered on the formula card, and all the other cards are merely used as cross references, referring the inquirer to the formula card for all required information.

Classification, it will be noted, is attempted only to a limited extent now, but will be carried out much more completely hereafter, by a supplementary scheme not yet fully perfected — independent of, though based on, the reference index.

The present scheme however, it will be observed, does inci-

dentally, bring together very many closely related carbon and other compounds, and arranges alphabetically, under such general titles as acids, alcohols, ethers, acetates, chlorides, etc., the specific bodies of the given class.

In practice, to use the digest, if the empirical formula of any compound is known, it must be rewritten by the rule already given, and at once is disclosed the definite place in the formula index where the desired references, if digested, will be found entered upon the formula card.

If on the other hand, one of the various names of the body is given, the subject-matter index is entered alphabetically, and a cross reference obtained to the rewritten formula with which the formula index is entered for the required information.

The question arises, as between this system and such a one as that adopted in the *Berichte*, which one of them is the best; that is, the most practical for the intended uses. It may be said generally that the Patent Office needs the index for exactly the same purpose as the scientific or practical chemist; *i. e.*, to obtain references to the literature concerning definite chemical bodies, where either the name or the chemical composition or both is given, so that the system best for the one use is probably also best for the other as well.

We consider our system to be preferable, certainly so at least for the patent office, and I may say that it was elaborated and adopted without any knowledge of the work of Richter as followed in the *Berichte* by Jacobsen and Stelzner.

In our system, the arrangement of the formulas is governed by the following general principles in the following order:

1st. The number of C atoms } in carbon compounds.
2nd. The number of H atoms }
3rd. The alphabetical arrangements of the symbols of the remaining elements (including H in other than carbon compounds).

Practically, in indexing, or in using the digest as an index, the only thing to be remembered is, that in carbon compounds C comes first and H second, and that otherwise the rearrangement of formulas and the arrangement of such formulas in the digest is always alphabetically by the symbols, instead of by the names of the component elements.

That the *Berichte* system is much more complex will be seen at once. Other things being equal, we deem that system which is simplest to be the best, provided it achieves a result of equal value. The ideal system, we think, produces the best result with the minimum of labor, both mental and physical.

In rewriting the empirical formula by the *Berichte* or Richter system, one must remember the following arbitrary established order of precedence of certain of the chemical symbols; *viz.*, C, H, O, N, Cl, Br, I, F, S, P, and this both in rewriting the formulas and in entering the table. One must also consider the number of carbon atoms in the compound, the number of different varieties of atoms, and various other things as well.

Thus for example, in the Richter system, the following are the principles which govern, in the order of their relative importance:

1st. The number of C atoms.

2nd. The number of different kinds of atoms other than C.

3rd. The arbitrary arrangement of ten of the component elements in the following order; *viz.*, C, H, O, N, Cl, Br, I, F, S, P, all taking precedence over the remaining elements.

4th. The arrangement of all other component elements in the alphabetical order of their chemical symbols.

5th. The arrangement of chlorides, bromides, amides, anilides of carbon acids, acetyl and benzoyl derivatives, oximes, phenylhydrazones, etc., under the formulas of their corresponding bases.

6th. The arrangement in general, of salts, either under the formulas of their bases, or of their acids.

7th. The arrangement of salts of quarternary ammonia bases under the formulas of their corresponding hydroxides.

By way of comparison, I have taken from the pages of the *Berichte* index a number of bodies, with the formulas written and arranged as there shown, and have rewritten and rearranged them on our own classification division plan.

FORMULAS TAKEN FROM THE BERICHTE INDEX.

Pages refer to *Berichte*, No. 19, of 1899.

C_1: CO_2; CCl_4; CS_2; CHN — p. 3448.
$CHCl_3$; $CHBr_3$; CH_2O — p. 3449.
CH_2N_4; CH_2I_2; CH_3N_5; CH_3Br; CH_4O_3; CH_5N; $COCl_2$; $CNBr$; CHO_2Cl; $CHNS$ — p. 3450.
$CO_4N_2Br_2$; CHO_4N_2Br — p. 3451.

C_2: C_2H_2; C_2Cl_6; C_2HN_3 — p. 3452.
$C_2Cl_6Hg_6$; $C_2I_2Hg_2$ — p. 3453.

C_2: C_2HOCl_3; $C_2H_2O_3N_4$; $C_2H_2N_3Cl$; $C_2H_3O_2Cl_3$; $C_2H_3O_2Br$ — p. 3454.
$C_2H_4O_2S_2$; $C_2H_4N_2Cl_2$; $C_2H_5O_2N$; $C_2H_5N_2Cl_3$; $C_2H_6O_3S$; C_2H_6NBr — p. 3455.
$C_2HO_2Cl_3Hg_3$; C_3H_6; C_3H_6O — p. 3456.

C_3: $C_3HO_2N_5$; C_3H_3OBr; C_3H_5OCl; C_3H_5OBr — p. 3459.
$C_3H_6O_2S$; $C_3H_6N_2S$ — p. 3460.
C_3H_9ON; C_3H_9NS; $C_3H_{12}ON_2$; $C_3H_5O_2N_3S$; C_3H_6ONBr — p. 3461.

C_4: C_4H_4O; $C_4H_{12}N_2$; $C_4N_2Hg_4$; $C_4H_2O_4N_2$ — p. 3464.

C_4: $C_4H_{13}ON$; $C_4H_7ON_3S$ — p. 3466.
C_5H_{12}; $C_5H_4O_2$ — p. 3466.

C_5: $C_5H_{11}N$; $C_5H_{14}N_2$; $C_5HN_4Cl_3$ — p. 3470.
$C_5H_2O_3Cl_4$, p. 3471.
$C_5H_{15}O_2N$; $C_5H_2ON_4Cl_2$ — p. 3471.

C_6H_6; C_6H_{14}; C_6Cl_6; $C_6H_2O_6$ — p. 3474.
$C_6H_2O_2$, p. 3475.

C_6: $C_6H_6N_4$; $C_6H_6Cl_6$ — p. 3476.
C_6H_6S; $C_6H_{15}P$; $C_6H_3OCl_3$ — p. 3480.
$C_6H_3NCl_4$; $C_6H_{20}O_2As_2$; $C_6H_2ONBr_3$ — p. 3489.
$C_6H_{14}O_2NBr$; $C_6H_5OCl_2SP$ — p. 3491.

In the foregoing arrangement, the formulas are given in the same order as in the *Berichte*, other formulas which come in between these being omitted; and in the following table these formulas are rewritten and rearranged on the plan which we have adopted, a few formulas not found in the *Berichte* index being added to illustrate the application of our scheme to inorganic bodies.

FORMULAS REWRITTEN AND ARRANGED ON THE PLAN ADOPTED BY THE CLASSIFICATION DIVISION, U. S. PATENT OFFICE.

The rewritten formula is in our digest generally followed by the empirical or constitutional formula as usually written by chemists, but from lack of space I have omitted the constitutional formula in many cases in the following table:

C_0 Not in *Berichte* Index.

AgCl
$AgMnO_4$
$AlH_4NO_8S_2$ or $NH_4Al(SO_4)_2 + 12H_2O$
AsH_2KO_4 or KH_2AsO_4
$AuCl_4K$ or $KAuCl_4$
$BNaO_2$ or $NaBO_2$
BaN_2O_6 or $Ba(NO_3)_2$
Br_2OSe or $SeOBr_2$
Br_2Zn or $ZnBr_2$

C_1

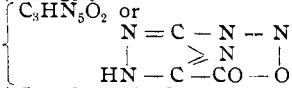
H_0: CBrN or Br CN; $CBr_2N_2O_4$ or $C(NO_2)_2Br_2$; CCl_2O or $COCl_2$; CCl_4

H_1: $CHBrN_2O_4$ or $CHBr(NO_2)_2$; $CHBr_3$; $CHClO_2$ or COCl.OH; $CHCl_3$; CHN or HCN; CHNS or CN.SH

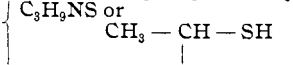
C$_1$
- H$_2$: CH_2I_2; CH_2N_4; CH_2O or COH_2
- H$_3$: CH_3Br; CH_3N_5
- H$_4$: CH_4O_3
- H$_5$: CH_5N or $NH_2(CH_3)$
- H$_6$: CO_2; CS_2

C$_2$
- H$_0$: C_2Cl_6; $C_2Cl_6Hg_6$ or $C_2Hg_6Cl_6$
- H$_1$: $C_2HCl_3Hg_3O_2$ or $CHg_3Cl_3CO_2H$; C_2HCl_3O or $CCl_3.CHO$; C_2HN_3
- H$_2$: C_2H_2; $C_2H_2ClN_3$; $C_2H_2N_4O_8$ or $C_2H_2(NO_2)_4$
- H$_3$: $C_2H_3BrO_2$; $C_2H_3Cl_3O_2$ or $CCl_3.CH(OH)_2$
- H$_4$: $C_2H_4Cl_2N_2$ or $(CH_2Cl)_2N_2$; $C_3H_4O_7S_2$ or $CHO.CH(SO_3H)_2$
- H$_5$: $C_2H_5Cl_3N_2$; $C_2H_5NO_2$ or $C_2H_5NO_2$
- H$_6$: C_2H_6BrN or $N(CH_3)_2Br$; $C_2H_6O_3S$ or $C_2H_5(SO_3H)$
- H$_0$: $C_2Hg_2I_2$

C$_3$
- H$_1$: $C_3HN_5O_2$ or

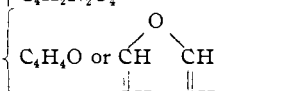


- H$_2$: C_3H_2O or $CHO.C_2H$
- H$_3$: C_3H_3BrO
- H$_5$: C_3H_5BrO; C_3H_5ClO; $C_3H_5N_3O_2S$
- H$_6$: C_3H_6 or $CH_3.CH.CH_2$; C_3H_6BrNO or $N.CO.C_2H_5.HBr$; $C_3H_6N_2S$
- H$_9$: C_3H_9NO or $OH.CH_2.CH_2.NH.CH_3$; C_3H_9NS or



- H$_{12}$: $C_3H_{12}N_2O$ or $OH(CH_3)_3N.NH_2$

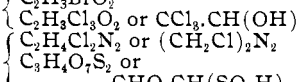
C$_4$
- H$_2$: $C_4H_2N_2O_4$
- H$_4$: C_4H_4O or



- H$_7$: $C_4H_7N_3OS$
- H$_{12}$: $C_4H_{12}N_2$ or $(CH_3)_2N.N(CH_3)_2$
- H$_{13}$: $C_4H_{13}NO$ or $N(CH_3)_4OH$; $C_4Hg_4N_2$

C$_5$
- H$_1$: $C_5HCl_3N_4$
- H$_2$: $C_5H_2Cl_2N_4O$; $C_5H_2Cl_4O_3$
- H$_4$: $C_5H_4O_2$
- H$_{11}$: $C_5H_{11}N$
- H$_{12}$: C_5H_{12} or $CH_3(CH_2)_3CH_3$
- H$_{14}$: $C_5H_{14}N_2$
- H$_{15}$: $C_5H_{15}NO_2$ or $N(CH_3)_3(C_2H_4.OH)OH$

C$_6$
- H$_0$: C_6Cl_6
- H$_2$: $C_6H_2Br_2NO$; $C_6H_2O_6$
- H$_3$: $C_6H_3Cl_3O$ or $C_6H_2Cl_3(OH)$; $C_6H_3Cl_4N$ or $C_6H.Cl_4NH_2$
- H$_5$: $C_6H_5Cl_2OPS$ or $SP(OC_6H_5)Cl_2$
- H$_6$: C_6H_6; $C_6H_6Cl_6$; $C_6H_6N_4$ or

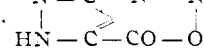


$C_6H_6O_2$ or $C_6H_4(OH)_2$; C_6H_6S or $C_6H_5.SH$
- H$_{14}$: C_6H_{14} or $(CH_3)_2CH.CH(CH_3)_2$; $C_6H_{14}Br$
- H$_{15}$: $C_6H_{15}P$ or $P(C_2H_5)_3$
- H$_{20}$: $C_6H_{20}As_2O_2$ or $(CH_3)_3(OH)As_2OH(CH_3)_3$

Not in Beilstein's Index.
- Cl: ClO_3; Cl_2Ni or $NiCl_2$; CoS
- Cr: CrO_4Pb or $PbCrO_4$; $Cr_2K_2O_{16}S_4$ or $Cr_2(SO_4)_3K_2SO_4+24H_2O$; CuN_2O_6 or $Cu(NO_3)_2$; $FeKO_8S_2$ or $FeK(SO_4)_2$
- C$_0$
- H: HK_2 or K_2H; H_2MoO_4; H_3N or NH_3; $HgNO_3$; IKO_3 or KIO_3; $K_2NiO_8S_2$ or $NiSO_4+K_2SO_4+6H_2O$; MoO_4Pb or $PbMoO_4$; Na_2O_3Si or Na_2SiO_3
- O: OPb or PbO; O_2Pd or PdO_2; O_3Te or TeO_3; SSi or SiS

As a practical test of the two systems, take the six following bodies; rewrite them first by our system and find them in our table; then rewrite them by the *Berichte* rules and find them in the *Berichte* table; and the demonstration of the superior simplicity of our system will be complete. The bodies are:

1. ..... $SP(OC_6H_5)Cl_2$
2. ..... $C_6H_2Cl_2(OH)$
3. ..... $CHg_3Cl_3CO_2H$
4. ..... CN.SH
5. ..... $N.CO.C_2H_5.HBr$
6. .....



This comparison speaks louder than words, and I think most chemists will agree with me that our system affords to the inquirer, with the minimum of technical knowledge, the maximum of information, in the surest manner, and with the minimum of mental and physical labor, and without the danger that a future change in theory will mislead the future user of it. In other words, the use of the digest is as far as possible independent of all theory, and founded only on unchanging facts.

Let me here call attention to the point that in the *Berichte* system the formulas of very many large classes of bodies, such as salts, amides, anilides of acids, etc., etc., have no representation in the index. Their formulas do not appear in it at all; but only their names, which are classified under the different formulas of some related body; so that in a given case, unless one remembers all these various classes of excepted bodies, if forgetting any of these things he rewrites the formula, and enters the *Berichte* digest or index with it, thus rewritten, he finds none of the matter indexed. He must first remember that the body sought is not indexed under its own, but under some different formula of a body more or less closely related to it; that is, that the body belongs in some one of these many excepted classes, and then, after determining under what base or acid it will be found, he must enter the table with the rewritten formula, not of the body itself, but of the given base acid or other body to which it is now supposed to be related, although advancing knowledge may hereafter prove this view as to supposed relationship to be erroneous.

Moreover, in the case of a body of which the number and kind of the component atoms are known, but as to the constitution of which little or nothing is known, while the body may be correctly entered in the *Berichte* index under the formula of some base or acid or other supposedly related body, it would evidently never be found, because not knowing its constitution, we do not know the base or acid under which it is indexed, and so would not find it in the table.

In our system, every chemical body indexed is represented in the digest or table by its rewritten empirical formula. No bodies are indexed as subheads under the formulas of other compounds. The indexing, and conversely, the finding of the body in the index, is rendered absolutely independent of any theories of constitution whatever, and made to depend solely on the kind and number of the component atoms, arranged alphabetically by their symbols, except that in carbon compounds, C comes first and H second. Nothing can be more simple.

No serious attempt is made, however, to make the system, which is merely intended to be a reference index, at once a classification, and also an index as well; that is, classification is not pushed beyond the point where it begins to encroach on the digest idea; and any such attempt, I believe, will surely fail to fully fulfil either function in the highest degree. In a good index, the classification idea must be kept subordinate. Hence, it follows that from our point of view, the *Berichte* system, as a mere digest or index, as well as that of Richter and all other similar systems, is inferior to ours in the points indicated; while as systems of classification, they can not but be inferior to such as are founded on proper lines. Such systems can be worked out without being hampered by the digest or dictionary idea, and which important work — classification proper as distinguished from a mere digest or index — we hope to be able to take up at some future time, on a comprehensive scale, as supplementary to the present work in hand.

It would be manifestly unfair, however, in this comparison of systems, to overlook the fact that both in the field covered, and in the intended use, the two systems are not exactly the same. Richter's system is designed for and applied solely to the bodies of organic chemistry for the use of specialists in that branch

familiar with its classification. Ours covers the entire domain of chemical research, both inorganic and organic, and is for the general inquirer. From a classification standpoint, the order of preference — C, H, O, N, Cl, Br, I, F, S, P — is justified in organic chemistry; but in inorganic chemistry it has no justification, and would lead to awkward and unfamiliar formulas, with no compensating advantages.

When a general reference index to all bodies, both organic and inorganic, is under consideration, if an order of preference is to be established, one will have to adopt different orders in the organic and inorganic domains, or else do as we have done — that is, establish no order of preference whatever, with the one exception of giving C and H preference in that order in carbon compounds so as to thereby effect a differentiation of organic from inorganic bodies.

Moreover, Richter's system is more adapted to the needs of those who are studying bodies as a class and to whom classification is of greater importance; while our system is specially adapted to the needs and requirements of those who are merely searching for references to the literature of specific chemical bodies — particularly those bodies the empirical formulas of which are known, but as to the constitution of which little if any information is at hand.

The approval of our system, therefore, does not necessarily imply that it is a criticism of or shall supersede that of Richter. Because of these differences in the field covered and in the intended use, the two systems have really no serious quarrel; and where ours is applied to organic bodies, the Richter formula could also be given on the cards prepared on our system to facilitate reference to the *Berichte*, and the Richter Lexicon, with its 75,000 titles of organic compounds.

In conclusion, there arises the question of how far the system described in this paper is adapted to the needs of chemists generally as a universal scheme for the indexing or digesting of chemical literature. That it fully meets the needs of the Patent Office we have no doubt, and for myself, I can not see why the needs of the practical and scientific chemist are not about the same as ours.

The object of a dictionary of chemistry, a reference index, or

a digest system, such as those contained in the German *Berichte* and similar works, and the *Abstracts* of the Chemical Society, is to furnish to the chemical inquirer, in the best and quickest way, digested information and references to the latest literature on any given chemical body, process, or general chemical topic. Our system directly covers, very fully, and in, we believe, the best and quickest way, the inquiry as to the chemical body, and incidentally, the inquiry as to any specific chemical process, since every such process has for its aim the production of a specific chemical body, and hence the literature relating to such process will, of course, be digested under the formula of the resulting product.

An index or digest of general chemical topics, or processes of a general nature not specially adapted to the production of a specific body, but to many bodies more or less closely related, can not, of course, be included in any mere formula scheme, which can only represent specific bodies, but must come into some general or dictionary plan based on names or titles, and such references of this class as it might seem desirable to include in a general scheme of chemical indexing, would easily work in with the alphabetical arrangement of chemical names provided for in the system we have adopted.

Probably the most natural objection which the practical chemist would make to the adoption of the system of indexing by rewritten formulas as one of the component parts of a general scheme for chemical indexing, would be that to rewrite or rearrange the chemical symbols in the accepted formula on a purely alphabetical basis, would appear to offend the chemical sense, and do violence to the long-established usage of chemists in writing such formulas with the component elements or radicals arranged in an order depending largely on their relative, positive, or negative qualities, using these terms in their broadest chemical meaning.

In answer to this objection, it should be noted that if this really be a valid objection, it applies just as fully to the system used by Richter in the earlier editions of his "Lexicon" and adopted and approved in the *Berichte* Indexes and other publications as to ours; and it can be urged with equal force against the monumental work of Richter, just published, which is an

enlarged edition of his earlier work. So that, with such backing as Richter and the *Berichte*, it would seem as if the objection was not as valid as might at first appear.

Moreover, in our system it is an unvarying rule that the rearranged formula is never used or written, whether on cards or elsewhere, without being immediately followed by the empirical or constitutional formulas, so far as the same are known or inferred; so that an objection which might have force, were nothing but the rewritten formulas given in the digest or on the index cards, loses its force when the ordinary formula, so familiar to the chemist, is always an invariable accompaniment of the new and unfamiliar indexing formulas.

As soon as the idea is fully grasped that the rewritten formula is merely an arbitrary arrangement, in the nature of a position indicator, determining position in a mere reference index to literature and nothing more, the chemical sense will be no longer offended. The justification for its use lies in the fact that such a formula unerringly indicates one, and one only, definite and specific place in the index where we are to look for all references, with a certainty that no other character, name, or title of the body can afford. With other systems we are somewhat uncertain where to look for our information; — with this system all uncertainty at once disappears.

Personally I should be glad to see a general scheme of indexing current chemical literature carried out at some future time for the benefit of American chemists, under the auspices, for instance, of the Smithsonian Institution, along these general lines which have been blocked out in our Classification Division, modified or improved perhaps by the combined wisdom and experience of the American Chemical Society.

For example, the Smithsonian Institution might publish an annual index to current chemical literature, divided into a formula division, arranged along some such lines as here suggested, and a subject-matter or title division, in which all names and subjects were alphabetically arranged, and the names of chemical bodies all cross-referenced into the formula index, all references to the literature of chemical bodies being collated under the unvarying formula of the body, and not under one of its various and varying names.

Such an index should cover the leading chemical periodicals —such works as *Berichte* and the *Abstracts* of the Chemical Society, and the more important chemical publications of the year.

The vast army of chemical workers in our universities, laboratories, and corporate and government offices and institutions, state and national, should be enlisted in the work, each willing worker assigned some special publication or portion of same, and be supplied with standard library bureau cards and general instructions; and the cards as prepared sent in to the central bureau established here in Washington, where, after being sorted into place in the receiving cabinets, and with proper editing, they would form the basis from which would be compiled the annual index volume.

These volumes would probably be less of a digest and more of an index than the present *Abstracts* of the Chemical Society or the *Berichte*, and would cover a somewhat different field than either.

Lastly, these annual volumes should be sold at cost price, so as to become a working tool in the hands of all the chemical workers of the country.

I may here briefly refer to a special development of this work now being carried out in our Patent Office Index. We have procured two copies each of the *Berichte* Indexes for 1898 and 1899. The separate titles in the formula portion of these indexes are in most cases small enough to be cut out and pasted on our standard indexing cards and still leave room enough at the top to rewrite the formula on our own plan. We are also considering the application of this system of cutting and pasting from two duplicate copies to the new Richter "Lexicon" with its 75,000 titles, and possibly to the four volumes of the last edition of Watts' "Dictionary," Thorpe's "Dictionary of Applied Chemistry," the yearly abstract volumes of the *Journal of the London Chemical Society*, and such other works of general reference as it may be found advisable.

But to return, in conclusion, to the idea of a central bureau at Washington, supervising the indexing of chemical literature, would not some such plan, properly matured, and carried out to a successful completion, be a work worthy of the great scien-

tific institution of the national capitol, founded expressly for the dissemination of useful knowledge, and be directly in line with their publication in past years, of the indexes to the literature of specific chemical bodies, which has so much redounded to their credit? It seems to me at least that it would be a work worthy of their best endeavor, and of whose great utility there could be no question whatever.

CAUSE OF THE LOSS IN WEIGHT OF COMMERCIAL PLATINUM, WHEN HEATED UNDER SOME CONDITIONS.

BY ROBERT W. HALL.

Received June 15, 1900.

THE fact that commercial platinum sometimes loses weight when heated has been frequently noticed and experiments made to determine the cause of the loss. This loss has been observed under at least seven conditions.

1. *When platinum is made the cathode for the spark from an induction coil.*—That platinum is dissipated under this condition, was observed by Plücker[1] and very fully described by him. A. W. Wright[2] and others studied the same phenomena. The platinum is dissipated alike in air, in vacuum, and in hydrogen, and the phenomena are regarded as purely physical or mechanical.

2. *When platinum is heated in a Bunsen gas flame, sufficiently, reducing to deposit some carbonaceous matter on the platinum.*—Rémont[3] obtained in this way, in thirty minutes, a deposit weighing 22 milligrams and containing 10 milligrams of platinum. Rémont made some experiments to show that this loss is not due to the heated carbonaceous matter alone. He attributed it to some constituent of the gas.

3. *When platinum is heated in the ordinary smokeless Bunsen flame.*—Some observers note a constant loss under these conditions. Wittstein[4] found such a loss and attributes it to osmium, which he found in the platinum scrap of that time. Stolba[5] found that a platinum crucible lost weight at the rate of 16 milligrams in twelve hours. Stolba remarks that while he

1 *Ann. Phys. Chem.*, 103, 90 (1858).
2 *Sill. J. Sci. and Arts*, January, 1877.
3 *Bull. Soc. Chim.*, **35**, 486 (1881).
4 Dingler's *poly. J.*, **179**, 299 (1866).
5 *Ibid.*, **198**, 177 (1870).