

Section on Historical Pharmacy

Papers Presented at the Sixty-First Annual Convention

THE TABLET INDUSTRY—ITS EVOLUTION AND PRESENT STATUS—THE COMPOSITION OF TABLETS AND METHODS OF ANALYSIS.¹

L. F. KEBLER, PH. C., M. D.²

INTRODUCTION.

It is commonly estimated that from one-fourth to one-third of all the medications in the United States are administered in the form of tablets. Considering the comparatively recent origin of the medicinal tablet, there must be unusual reasons for such a phenomenal growth of the industry. Some of the chief merits claimed for this form of medication, are accuracy, elegance, economy, stability, portability, concentration, rapid solubility, absence of alcohol, comparative safety to the consumer, and convenience for the dispensing physician. If it be correct that machinery, appliances, and manual skill have reached a stage of development whereby it is possible to produce tablets having even a part of such a host of virtues, it would seem reasonable to expect that a very large portion of those found upon the market, should possess the composition claimed for them. It was, therefore, but natural that they should be carefully investigated by the Drug Division. A large number of assorted uncoated tablets, purchased directly and indirectly from manufacturers, were examined. The result did not thoroughly corroborate the general view as to uniformity of composition. Various manufacturers were invited to explain the shortcomings. In some instances they were traced to carelessness on the part of the tablet-machine operator, and in others to ignorance of fundamental conditions, loose methods, uncontrolled conditions, chemical, mechanical, and others, which may all be summed up as a failure to realize the necessity of carefully controlling all steps from the selection of the initial ingredients used in the manufacture of the tablet, to the final chemical examination of the finished product. All these, however, did not yet seem to explain the conditions found in some goods known to be prepared under careful control.

In order to obtain first-hand and full information of the industry, the literature on the subject was fully reviewed, laboratory methods, mechanical, supervisory, and analytical, and other elements were carefully studied throughout the United States. Numerous samples were collected and analyzed. This paper, which embodies the results of this work, covers uncoated tablets only.

¹ The historical portion was read before the Historical Section, and the remainder before the Scientific Section of the American Pharmaceutical Association meeting, held at Nashville in 1918.

² Chief, Drug Division, Bureau of Chemistry, U. S. Department of Agriculture.

HISTORICAL REVIEW OF THE INDUSTRY.

A review of the history of tablet making shows that the two general methods of manufacture, compression and molding, have had somewhat different lines of evolution. In the first method the powdered medicament was given form and compactness by subjecting it to compression in a suitable hand or power press without the addition of any foreign substance to give adhesiveness or bulk, and only substances adapted for compression in this way were employed. Gradually, however, as tablets grew in favor as a mode of administering medicines, it became desirable to compress other drugs, and it was then found necessary to add excipients, to give the ingredients sufficient bulk or adhesiveness, so that at present, while some compressed tablets contain medicaments only, most of those upon the market contain both medicaments and excipients.

In preparing molded tablets, the active drug is usually first mixed with sugar or milk, the mixture made into a suitable mass with liquid, and the paste pressed into molds from which it is subsequently ejected in the form of tablets. Tablets made in this way are usually designated as tablet triturates, but the distinction between them and the compressed tablets, in so far as it depends upon the method of manufacture, has been gradually disappearing, and the tendency is still in that direction.

From this it will readily be seen that there is at present but little real difference between the two processes so far as the essential details are concerned. Some form of adhesive, excipient or lubricant, and some degree of pressure must be used in both cases. These two processes, as well as the resulting products, such as compressed tablets, molded tablets, tablet triturates, hypodermic tablets, dispensary tablets, dosimetric tablets, veterinary tablets, ophthalmic tablets, tablet saturates, etc., will be considered in detail in the following pages.

COMPRESSED TABLETS.

Joseph R. Wood, in his book on tablet manufacture,³ gives the following footnote:

"Stamps have been found in England which have been shown to have been used by the Romans to stamp remedies for producing clearness of vision, or for doing away with dimness of sight. The object aimed at by the medicament was specified in the stamp. It is noteworthy that the stamps so far discovered were designed for remedies for ocular diseases. The preparations were hardened with gum or some viscid substance and were thus ready to be liquefied at any time. Thus our supposedly very modern device of triturates or compressed tablets is only a revival of an ancient Roman custom."—(*American Medicine*.)

Careful search on the part of the author and of the publisher of "American Medicine" failed to locate this statement. Its authenticity could not, therefore, be verified. Lozenges, troches, and pastilles, however, are referred to by a number of early writers.⁴

³ Tablet Manufacture, Its History, Pharmacy and Practice, 1906, p. 9.

⁴ Hippocrates (460-375 B. C.), Liber prior de morbis mulierum, Mauricio Cordaeo, Rhemo, interprete et explicatore, Karisii, 1585, pp. 198, 286.

Celsus, A. Cornelius (lived first century, A. D.), De Medicina, Alex. Lee's translation of Targa's edition, 1831, Lib. v, Cap. xvii, p. 14; Cap. xx, p. 35.

Cordi, Valerii, Dispensatorium, sive Pharmacorum, Conficiendorum Ratio. Lugduni Patavorum, ex-officina, Joannis Maire, 1651, pp. 253-279, 515.

Dispensatory of the Royal College of Physicians, London, 8rd ed., 1751, H. Pemberton, M. D., pp. 818-822.

Dispensatorium Pharmaceuticum Universale, etc., Daniele Wilhelmo Trillero, 1764, pp. 791-808.

There is no question that the molding of medicaments was in vogue many years before William Brockedon was granted English Patent No. 9977, December 8, 1843, under the title of "Shaping Pills, Lozenges and Black Lead by Pressure in Dies," and it is equally certain that this invention was the beginning of a great industry. On account of its historical value those portions of the patent and its accompanying illustrations dealing with medicated compressions are here given:

"To all to whom these presents shall come, I, William Brockedon, of Devonshire Street, Queen Square, in the County of Middlesex, Gentleman, send greeting.

"Whereas, Her present most Excellent Majesty Queen Victoria, by Her Letters Patent under the Great Seal of Great Britain, bearing date at Westminster, the eighth day of December, in the seventh year of Her reign, did, for Herself, Her heirs and successors, give and grant unto me, the said William Brockedon, Her special license, full power, sole privilege and authority, that I, the said William Brockedon, my exors, admors, and assigns, or such others as I, the said William Brockedon, my exors, admors, or assigns, should at any time agree with, and no others, from time to time and at all time during the term of years therein expressed, should and lawfully might make, use, exercise and vend, within England, Wales, and the town of Berwick-upon-Tweed, and in the Islands of Jersey, Guernsey, Alderney, Sark and Man, and in all Her said Majesty's Colonies and Plantations abroad, my invention of "Improvements in the Manufacture of Pills and Medicated Lozenges, and in Preparing or Treating Black Lead"; in which said Letters Patent is contained a proviso, that I, the said William Brockedon, shall cause a particular description of the nature of my said invention, and in what manner the same is to be performed, to be inrolled in Her said Majesty's High Court of Chancery within six calendar months next and immediately after the date of the said in part recited Letters Patent, as in and by the same, reference being thereunto had, will more fully and at large appear."

* * * * *

"It is well known that in making pills, and also medicated lozenges, as heretofore practised, the proper materials are mixed with a suitable liquid into a state of stiff paste, which is divided and shaped and allowed to dry, and it is well known that in some cases the gum and other materials, used as adhesive matter for keeping pills and lozenges in form, when the same are mixed by means of fluids, interfere with and prejudice the desired action of the matters employed in making up or preparing pills and lozenges, and these gums and adhesive matters are rendered necessary by the use of fluids for getting the matters into a condition to be shaped. * * * * *

DESCRIPTION.

"Figure 1 shows the section of suitable dies for making pills, and similar dies will be used when making medicated lozenges, but the same would be formed into suitable figures to produce lozenges of the shapes and sizes desired. *a* is the punch of the dies, the lower end being concave; this punch is to be worked by means of a fly press, or by other convenient means. *b* and *c* form the two parts of the lower die. The parts *a*, *b* and *c*, are of steel; and it will be seen that the part *c'* of the lower part *c* of the lower die rises into the part *b* of the lower die, and the part *c'* is sunk to correspond with the punch *a*. It is important that in using the matters in a state of powder or dust, that the successive quantities put into the dies should be (as nearly as may be) of the same weight, and, in order to save the trouble of weighing, I have devised a measuring instrument, which being forced into the prepared powder or dust will take up at each time a regulated measure thereof, and then deposit the same into the lower die. Figures 2 and 3 show two sections of this instrument; in one case the instrument is shown as having just been filled, and in the other figure the instrument is shown as having been emptied. *d* is the handle, which is fixed into the tube *e* by means

of a set screw *d'*, or by other convenient means, and according as the handle *d* is less or more into the tube *e*, so will the quantity measured by the instrument be more or less. *f* is another tube, which is closed at its lower end; this tube slides freely within the tube *e* and *g* is another tube which slides over the outer surface of the tube *e*; and the tubes *f* and *g* are fixed together by the screw *h*, which passes through a slot formed in the tube *e*, which slot allows the tube *f, g* to slide up and down, the end of the handle *d* determining the extent of such sliding. When the tube *c* projects beyond the tubes *f* and *g*, as is shown in Figure 2, it is pressed into the powder or dust, by which the end becomes full, taking care that in repeatedly filling the same the dust or powder from which the successive quantities are taken is not beaten down or compressed so as to cause the measure to make a materially greater quantity at one time than another. The measure of powder or dust being thus taken up, is to be deposited into the lower die, *b, c*, by moving the handle upwards whilst holding the outer tube, *g*, the pill is then to be finished by causing the punch or upper die *d* to descend into the die, and thus, by one or more blows, to consolidate the powder or dust. The upper die *a*, and also the part *b* of the lower die, is then to be raised up, when the pill may be removed. I have not thought it necessary to show dies for making different shaped medicated lozenges, as a workman acquainted with the making of similar dies for other purposes will readily make the proper punch and lower die to produce the proper size and shape of lozenges desired. It will be proper here to remark that this invention, when making pills, is particularly applicable when using matters readily soluble in the stomach, such as deliquescent salts used medicinally, the carbonates, tartrates and nitrates of soda and potash, and other matters, according to the judgment of the medical man, and the invention is also applicable when less soluble matters are used combined with others readily soluble in the stomach.

"* * * * And I have found that the powder or dust of black lead may be rendered solid with more certainty by means of pressure in dies by withdrawing the air from the dies, and from the powder or dust of black lead therein, before operating by pressure, and such is the case in respect to making pills and medicated lozenges, but owing to the small quantities of matter operated on when making pills and lozenges, I have not in practice found it necessary to exhaust the air in these latter cases. * * * *"

"And I would state that I am aware that clay or brick earth has been formed into bricks, tiles, and other articles, by pressure in dies when in a state of dust or powder, and then burned in kilns, and patents have been granted for such means of making bricks, tiles, and other articles from brick earth or clay and burning; and I mention these manufactures in order to state that I do not claim the rendering powder generally into solid forms by pressure, and then subjecting the same to burning. But I do strictly confine my invention to the following improvements:

"First, I claim the mode of manufacturing pills and medicated lozenges by

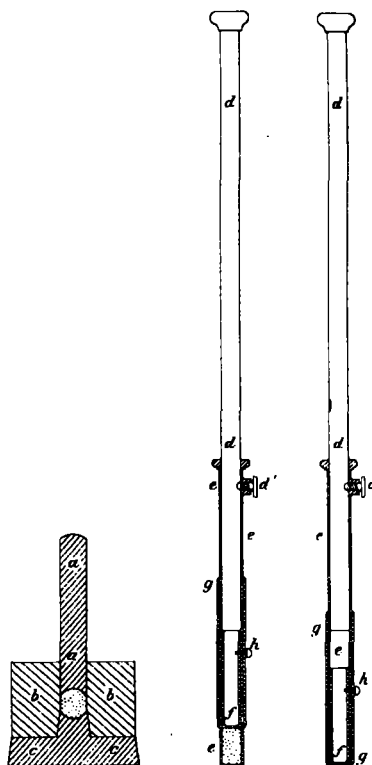


FIG. 1

FIG. 2

FIG. 3

causing the materials, when in a state of granulation, dust or powder, to be made into form and solidified by pressure in dies.

"Secondly, I claim the mode of preparing or treating black lead when in a state of powder, granulation, or dust, by pressure in dies, so as to solidify the same.

"In witness whereof, I, the said William Brockedon, have hereunto set my hand and seal, this eighth day of June, in the year of our Lord one thousand eight hundred and forty-four.

"WILLIAM (I. S.) BROCKEDON."

At an early date it was observed that pills made with adhesive material often interfered with and prejudiced the desired action. The underlying object of this invention was to compress medicinal agents in a state of granulation, dust, or powder without the use of gummy matter or other adhesive agents commonly employed in the manufacture of pills and lozenges. The goods made by this process were known for many years as "compressed pills." The patent was put into operation and the pills brought early to the attention of the pharmaceutical profession through the press, as is shown by the following extract⁵:

"We have received a specimen of bi-carbonate of potash compressed into the form of a pill by a process invented by Mr. Brockedon, and for which he has taken out a patent. We understand the process is applicable to the compression of a variety of other substances into a solid mass, without the intervention of gum or other adhesive material. Mr. Brockedon has promised to favour us with a detailed account of this process for publication in an early number."

This note shows that Brockedon put his invention into practical use, and subsequent data corroborate the fact that his goods were continuously on the market, both in England and America, for many years.

Mr. Charles Killgore, one of the pioneers in the manufacture of tablets in the United States, relates⁶ the following incident showing the early importation of "compressed pills" into the United States:

"'Compressed tablets' were commercially imported in 1854 by E. Milhau, a druggist of New York City, at the request of Commodore M. C. Perry, who first procured them in London. The commodore was very anxious to take some of these medicines with him on his trip to Japan. Mr. Milhau did not have this form of medicament in stock and was compelled to place the order abroad, which resulted in considerable delay. The day Commodore Perry received orders to report at Hampton Roads for his final instructions he called on Mr. Milhau and requested that he forward the compressed pills to him if they arrived in time to reach him before sailing. The goods were received in sufficient time to comply with his request."

One of the earliest American druggists to keep Brockedon's goods was Frederick Brown, as shown by the following letters to the writer:

"Philadelphia, Pa., January 8, 1913.

"L. F. Kebler, Chief Drug Division, U. S. Dept. of Agriculture, Washington, D. C.:

"Dear Sir—We were duly in receipt of your favor of December 27, 1912, and have endeavored to find out something definite as to the sale of compressed Potassium Bicarbonate and Sodium Bicarbonate Tablets.

"We regret that we are unable to give you definite information on the subject, as the retail branch of this business was sold in 1888, and we no longer have any

⁵ Pharm. J., 1844, 3; 554. A careful search of the files of the Pharmaceutical Journal failed to reveal a description of the promised process, and it seems likely that Mr. Brockedon never carried out his intention.

⁶ Private communication to the writer.

of the old records. Our treasurer, however, Mr. H. S. Robertson, began the drug business in 1860 with Frederick Brown, Sr., and he well remembers that Brockedon's Compressed Tablets were regularly in stock at that time, being quite actively in demand.

"Regretting that we are unable to give you any further information on the subject, we remain,

"Yours very truly,
(Sgd) "F. ZERBAN BROWN, President."

F. Newberry & Sons, in a letter to the "Chemist and Druggist," given in full further on, state that Brockedon's business was purchased by them in 1871, and they continued to sell his "compressed potass. and soda." Burroughs, Wellcome & Co., in a letter to the "Chemist and Druggist"⁷ write as follows:

"We notice the correspondence (24/27 A. C. S.) with regard to the use of the words 'Tabloids' and 'Tablets' as applied to compressed drugs. The word 'Tablets' was first applied by us to this class of drugs at the commencement of our business in 1878. This form of medication had hitherto been known in this country as 'compressed pills.'"

The following correspondence dealing with historical matters also throws light on the compressed drug industry in England about 1881⁸:

"To the Editor of 'The Chemist and Druggist':

"Sir—Have we in Great Britain any drug manufacturers with sufficient ingenuity to make little pellets or discs of such simple and useful substances as chlorate of potash, carbonate of soda, etc.? If there be such, how is it that a Yankee maker of these articles is permitted quietly, but none the less surely, to establish a monopoly of the 'compressed medicines,' as they are termed in this country?

"'Have you any of these American solid cakes of chlorate of potash?' is already becoming a stereotyped query from our customers. 'My doctor recommends them as so much superior to the lozenges.'

"We are not sure whether the articles in question are strictly a specialty of the wholesale druggist, or the lozenge-maker; but whichever it may be, it is clear that patriotic and selfish motives should combine to determine him to elbow out the intruder. * * * * *

"Bradford, November 5.

"M. ROGERSON & SON."

"To the Editor of 'The Chemist and Druggist'⁹

"Sir—We have observed the letter of your correspondents, Messrs. M. Rogerson & Son, in your last issue, and would point out that the idea of compressing pills or tablets, by whichever name they may be called, was originated by the late Professor Brockedon, the manufacturer of compressed Cumberland leads for lead pencils. He introduced, about twenty or more years since, Brockedon's compressed potass. and soda, which have ever since been on sale both in this country and America. In 1871 we purchased Professor Brockedon's interest in these preparations, and they are still well known at home and abroad. As to 'elbowing out the intruder' it may interest your correspondents to know that we have, since the introduction of the American compressed goods, remarked with satisfaction a steady increase in the demand for the Brockedon's already referred to, and the increase applies as well to foreign as to the home markets. The monopoly must, therefore, exist more in imagination than in reality. * * * * *

"London, November 29."

"F. NEWBERRY & SON.

⁷ Chem. & Drug., 1892, 40: 785.

⁸ Chem. & Drug., 1881, 23: 510.

⁹ Chem. & Drug., 1881, 23: 555

This correspondence shows that Yankee ingenuity and perseverance were making themselves felt in the tablet industry at that early date. The "American solid cakes of chlorate of potash" referred to in the first letter quoted were probably compressed tablets of chlorate of potash and borax, free from any excipient, which were marketed in the United States by John Wyeth & Brother, Philadelphia.¹⁰

The manufacture of "compressed pills" (tablets) in the United States was apparently begun by Jacob Dunton, a wholesale druggist in Philadelphia. He

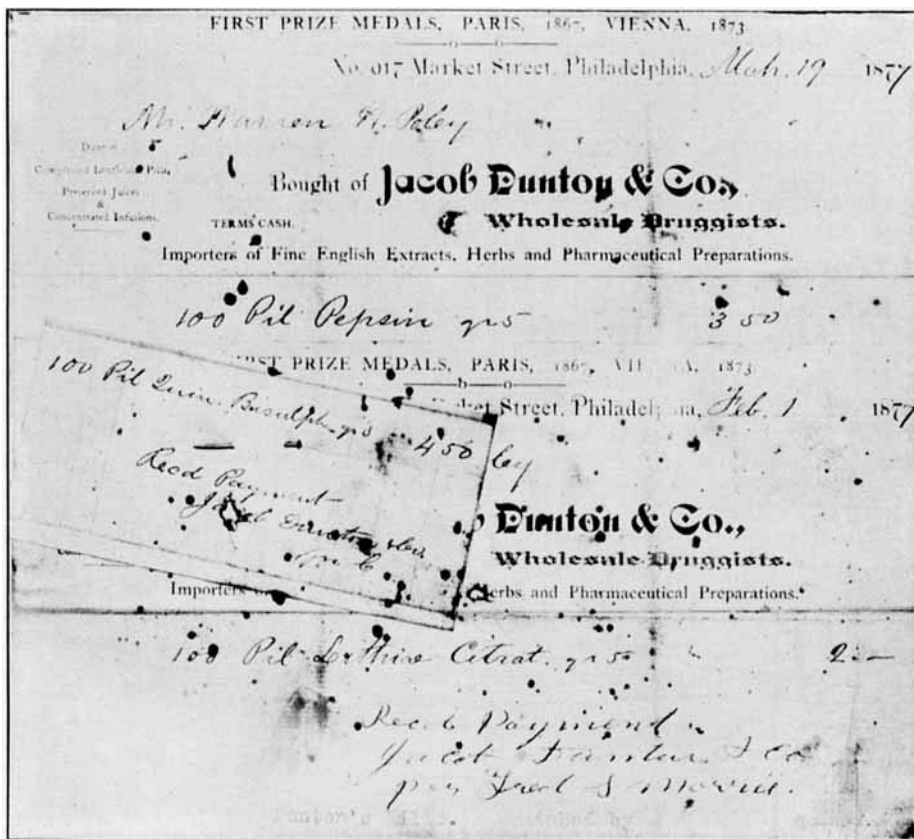


FIG. 4—Dunton's bills. (Furnished by M. Campbell, Philadelphia.)

was graduated from the Philadelphia College of Pharmacy in 1855. A letter from Dr. L. A. Edwards begins thus, "Washington, D. C., August 13th, 1862. My dear Pill-driver et Phot." It would seem that Dunton made "compressed pills" at this early date when they were actually compressed by driving. It is reported that Dunton supplied the United States Government "compressed pills" during the early sixties, but the records are inconclusive. A bill against the United States dated October 3, 1861, includes pills, but the kind of pills is left open. According to the copy of another bill, "compressed lenticular pills" formed a part of Dunton's business as early as 1867, when he was awarded a

¹⁰ New Remedies, April, 1870, p. 2, cover, vol. 8.

Paris prize, but it could not be determined whether the pills were included or not. It is interesting to note from this bill that \$3.50 was charged for 100 pepsin tablets in 1877. There appears to be nothing in Dunton's private effects to throw any light on the time of his beginning pill compression. There is available, however, the complainant's record¹¹ of a litigation, which contains valuable data. On page 8 appears the following:

"Q. Give the date of your (Dunton's) first experiment in this matter, and your employing Mr. Murset.

"A. Some time in the winter of 1863 and 1864; by winter I mean the fall months and the early spring, say March; that was during my stay in the city; I was out of town most of the time from May until November."

On page 5:

"Q. Were you (Murset, a mathematical instrument maker) ever employed by Mr. Jacob Dunton to make a machine similar to that drawing, and if yea, state at what time.

"A. Yes, sir; it was in March, 1864; the beginning of March."

On page 10:

"Q. When did you (Dunton) first put upon the market these compressed pills?

"A. In the fall, of 1869."

On page 20:

"Q. I understand from your deposition that you did not put any pills on the market between 1864 and 1869; now I wish to know how many pills you made in that period, and what use you put them to.

"A. Several thousand. I made them up for stock to sell from.

"Q. Do you mean that you made them to put upon the market, but that you did not put them on the market?

"A. I do. The greater portion of these thousand were made in 1869; the latter part of 1869.

"Q. And with what machine were they made?

"A. The second and third spoken of; the second and third machines modified after the machine of 1864."

On page 19:

"Q. Then I understand you (Dunton) now that the lever and the screw and the eccentric were in 1869 adopted and applied by you for compressing the pill or powder?

"A. They were; not on the same machine, however; on different machines.

* * * * *

"Q. I wish to know how soon after 1864 you (Dunton) in any respect modified the machine represented in this Rough Sketch No. 2, and I wish to know at the same time of what the modifications consisted.

"A. I modified the machine described in Rough Sketch No. 2, within two or three years after 1864. The modification in this first machine, modified after the machine of 1864, was by the application of a screw to give power, and the addition of an eccentric to eject the lower plunger or lower die, to eject the pill."

On page 22:

"Q. How many varieties of compressed pills did you (Dunton) make in 1869?

"A. Over three hundred."

On page 21:

"Q. I understand you (Dunton) that you have stated that down to 1876 you had made between two million and three million pills; what machine were they made with?

¹¹ Jacob Dunton vs. Bennett L. Smedley, U. S. Cir. Ct., Eastern Dist. of Penn., in Equity, No. 88, April Session, 1879.

"A. Two and three machines, numbers 2 and 3 spoken of above, and similar machines."

"Q. And none of them were made on the machine patented to you in your patent No. 17490, as I understand you?"

"A. No pills were made for sale on machine patented No. 174790."

This testimony clearly shows that Dunton as early as 1864 had a machine constructed for compressing tablets. It also shows that the machine was modified from time to time and that a patent for one of the machines was applied for and granted March 14, 1876.¹² The apparatus is shown in Figure 5.

The following description of the machine is quoted from the patent:

"This invention relates to an improved machine for making pills by compression; and it consists in a movable or detachable compression-chamber or powder-receptacle, in combination with two movable dies having concaved ends, the upper one of which forms the plunger, and the lower one of which is made short, and is adapted to be driven through a hole in a base piece together with the pill.

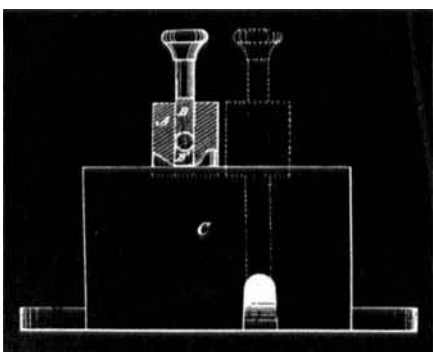


FIG. 5—Dunton's pill machine.
Patented March 14, 1876. (Patent
No. 174,790).

"The invention also consists in the construction of the base-piece, which is provided with a hole terminating in a laterally-discharging curved chute, by which the pill and lower die are driven out of the chamber into a convenient position; and it also further consists in the combination, with the powder-receptacle, of the base-piece, provided with guides, which permit the powder-receptacle to be shifted from its position for compressing to its position above the hole for dis-

charging the pill without displacement, and without the delicate adjustment which would be otherwise required.

"In the drawing, A represents the powder-receptacle, which constitutes also the compression-chamber. This receptacle is perforated vertically and longitudinally with a hole, in which are accurately fitted the dies, B B', of which B constitutes the plunger, through which the application of power is made to effect the compression. Both these dies are movable and entirely detachable, and have their adjacent ends concaved, so as to give sphericity to the pills compressed between them. The lower die, B', is made short, and is designed to be driven out with the pill through a hole, in the base piece, C."

It will be observed that this apparatus is very similar to that of Brockedon's compressor. It will be noted furthermore that nothing appears in this patent which would indicate the use of either a lever, screw, eccentric motion or foot-power, instead of hand-power, attachment to lever.

Dunton was apparently the first to secure a process¹³ patent for the preparation of materials to be used in the manufacture of tablets. This patent embodies some of the fundamental principles governing at present. He had noticed that in compressing materials containing the natural moisture of the air the cohesion of the particles was frequently insufficient to produce stability of form. He also observed that the adhesion between the material and the dies and punches was often greater than the cohesion of the particles. The invention con-

¹² U. S. Patent No. 174,790, dated March 14, 1876.

¹³ U. S. Patent No. 168,240, dated Sept. 28, 1875.

sists, first, in drying the material to be compressed in order to expel the natural moisture, thus increasing the cohesion, and, second, in lubricating the die or mold. On account of its historical importance and in order that certain features may be more readily available, portions of the patent are copied herewith:

* * * * *

"In carrying out my invention the powdered materials are first dried, preferably at a temperature of 90° Fahrenheit, so as to deprive them of the natural moisture absorbed from the air, which would have a tendency to decompose them or interfere with the compressibility or stability of compression.

"The materials are now in proper condition for compression and the cohesion of particles. In order to compress, however, such substances as sulphate of quinia, and other substances which leave a portion of themselves adhering to the mold after compression, which adherence prevents the formation and withdrawal of a successive pill of the same material in a perfect or merchantable condition, it becomes necessary to get rid of the adherence, and also to prepare the mold before another pill can be made. The ways which may be adopted are, first, after the pill is made, open the mold and brush out with a stiff brush as much as possible of the adhering particles, and then apply to the surface of the mold a thin film of oil, which takes or soaks up any portion of the particles which is left after brushing, and to get rid of the oil a pill of starch or other equivalent material is made, which absorbs the oil, and leaves the mold in a condition to make another pill of the original material; second, instead of lubricating the mold directly, a small portion of a liquid may be added to the powder (one percent being in some cases sufficient), which under pressure will ooze out at the surface of the pill, and act as a lubricant, so as to allow the pill to be removed from the mold without leaving any particles adhering to the mold, and leaving the latter in fit condition for the next pill."

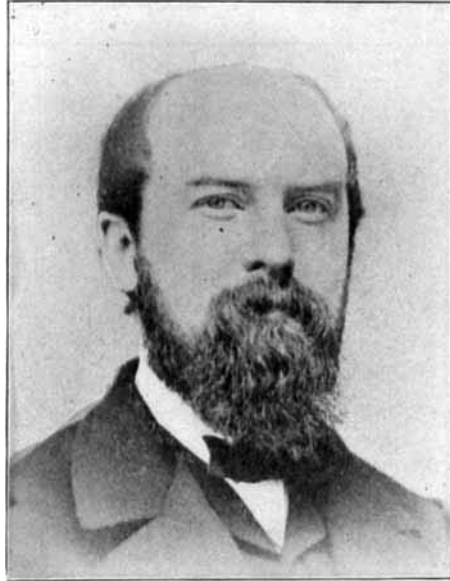


FIG. 6—Jacob Dunton.

* * * * *

"In lubricating the mold a portion of paraffin, oil or cacao, butter of cocoa, or other equivalent material may also be used, either alone or in solution in alcohol, benzine, or other volatile liquids, the object being to apply the least quantity that will produce the desired effect, and I may also use an oily or unctuous substance combined with an absorbent material or a material which is of itself both unctuous and absorbent, for cleaning and lubricating the molds."

* * * * *

"In manufacturing pills by compression, the herein-described method of drying the powders, before compression, at a temperature of about 90° Fahrenheit, with 24° absolute dryness (Mason's hygrometer) to prevent reaction upon the mold, and insure stability of cohesion, and lubricating the mold to prevent adhesion, and insure the removal of the pill integrally and perfect."

"Jacob Dunton.

Witnesses: "Lorenzo Westcott,

"Caspar S. Carmell."

The samples shown in Figure 7 were obtained from Professor Joseph P. Remington and Henry Blair, of Philadelphia. It will be observed that the name "compressed pills" was applied at that time, but the shape of the medication was that of the tablet as known at present. The exact date when these samples were put on the market could not be established, but the indications are that they are similar to, if not identical with, the tablets put on the market by Dunton in the seventies.

J. R. Wood¹⁴ states that John Wyeth and Brother, in conjunction with Henry Bower, succeeded in producing a "hand press" in 1872, which materially reduced

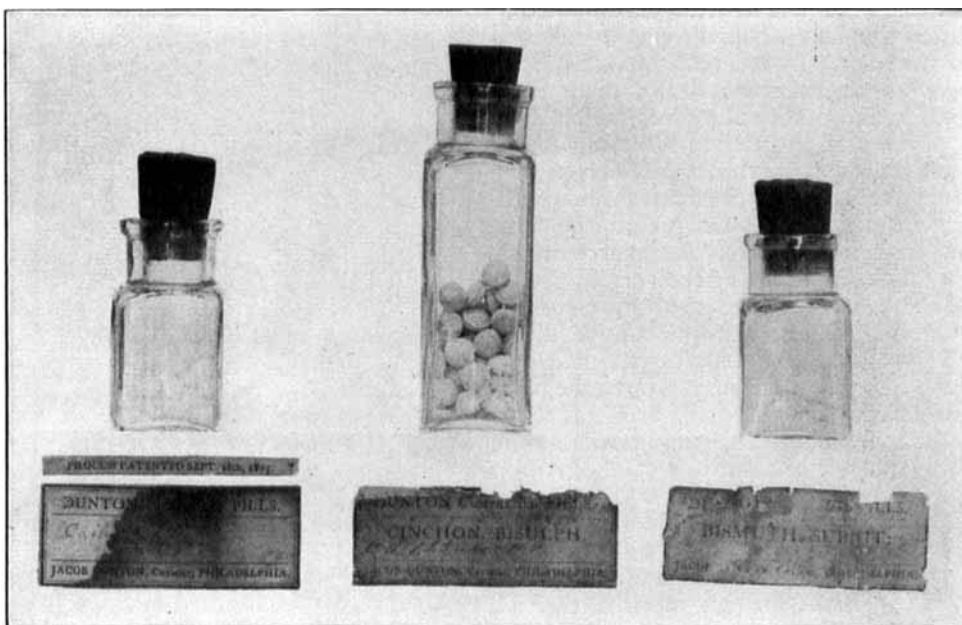


FIG. 7—Labels and bottles used by Dunton.

the cost of manufacturing tablets. This is corroborated by the following letter, except that the machine does not appear to have been a "hand press":

"Philadelphia, January 14, 1913.

"Mr. L. F. Kebler, Chief, Div. of Drugs,
"U. S. Department of Agriculture, Bureau of Chemistry,
"Washington, D. C.

"Dear Sir: Your letter of the 27th ultimo was duly received and answer was delayed on account of absence of one of our principals and beg to herewith make reply and advise that the articles you have noted published under tablet manufacture and in the Medical Record are correct.

"We have no prepared data or printed matter on hand of tablet compressing machines; from our books we glean that in about 1872 we constructed the first rotary tablet machine in our own shop by our chief mechanic; this machine was what is styled a disc machine with several dies, and improvements were constantly added and machine perfected until we had some machines that had as many as 13 dies in rotating disc and some of these machines are still in use at the present time in our laboratory.

¹⁴ Tablet Manufacture... 1908, p. 11.

"We are also the originators of the compressed hypodermic tablets and compressed tablet triturates, also compressed medicinal lozenges; these three variations were introduced by us during a period of 1877 to 1880 and other combinations of compressed tablets followed quickly according to demands made upon us by the physicians and trade. Prior to 1877 the formulæ that were sold in tablet form were very few. They consisted of simple chemicals principally, such as potassium chlorate, ammonium chloride, etc., and after 1877 combinations followed. Physicians saw the convenience of this form of medication and at various times submitted different compound formulæ which were made into either tablets or compressed lozenges. After 1880, tablets having become quite popular, others entered into the manufacture of them, and various machines were invented and improved and are known as single and multiple die machines with shoe feeding devices; also different styles of rotary machines have been made since then.

"We trust this information will be helpful and regret we have no prepared data in detail that we can supply.

"Yours very truly,
(Sgd) "JOHN WYETH & BROTHER,
Incorporated. H."

The following extract from a letter written by Jacob Dunton shows that the manufacture of tablets in the United States was assuming a real trade interest:

"Philadelphia, Jany. 18th, 1876.

"I wish you would lend me a few of 'Wyeth's Compressed Quinine Pills.' I want to examine them. Some I purchased of them contained Cinchonine & I want to examine the lot they sent you.

* * * * *

(Sgd) "JACOB DUNTON."

In conjunction with this correspondence and the great improvements in mechanical apparatus used for compressing tablets, it is interesting to record the fact that there is still in use one of the old power tablet compressing machines made about thirty-five years ago. The exact age of the machine could not be determined, but Mr. Herman Wiph of John Wyeth & Brother, in whose establishment this machine is found, writes, April 29, 1913:

"Please find enclosed one front and one side view of the oldest power tablet compressing machine in existence, as far as I know; and still in use. I have personally been using it for the past 32 years, and it was in existence several years previous to my time. It is therefore about 35 years old, and may be even 40 years old. This machine is used on any size tablet from 1/16 inch to 3/4 inch in diameter, and the pressure can be regulated from the slightest to the most powerful. The material to be compressed is fed into the die, by hand, with German silver ladels or dippers of various sizes, according to the weight of the tablet. The tablet after being compressed is raised above the die level by one of the levers on the right side and is pushed off by the operator with the dipper. The other lever is used to throw the clutch for compressing, the machine making only one revolution, and is then stopped automatically by a brake, until the clutch lever is again thrown in. Only one tablet is compressed at a stroke."

This machine is similar to, if not identical with, the apparatus covered by United States patent, granted to Thomas J. Young in 1874.

Tablet making in Germany seems to have had its beginning in 1872, when Professor Rosenthal, of Erlangen, described his tablet compressor at a session

of the *Physicalisch-Medicinische Societät*.¹⁵ A translation of a part of the proceedings of the session is as follows:

"Prof. Rosenthal then exhibited an apparatus for the compression of medicinal substances in volume. This machine was originally intended for the administration of Koussou, but may be used for other medicaments also. It converts powdered drugs into small solid tablets, which may be easily swallowed. Ill-tasting

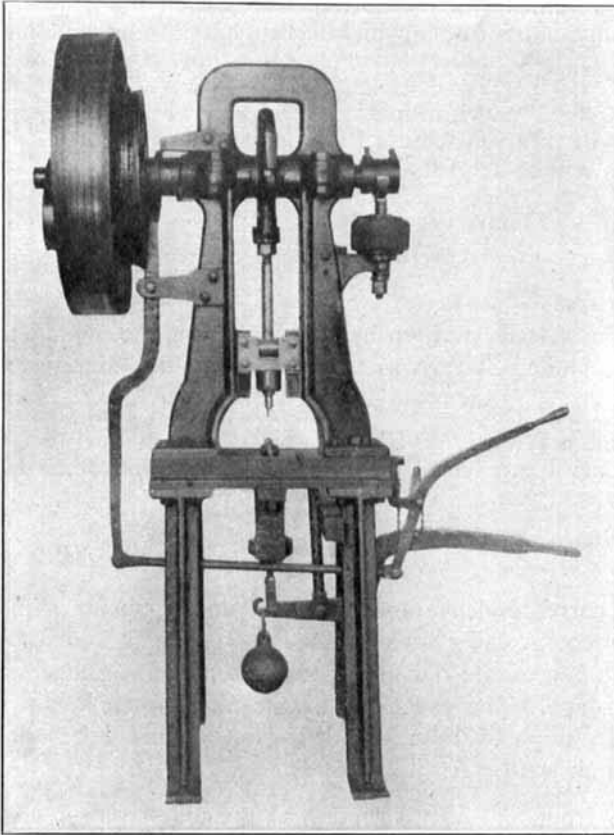


FIG. 8—Oldest known tablet machine still in operation. (Wyeth.)

drugs, in volume, or such as must possess exact dosage (*Dosierung*) are by this method made easy to take. The effectiveness of the medicament is in no way injured, as it disintegrates quickly in the stomach and reverts to its original state. This form of dosing has been tested with excellent results in various cases."

A fuller description of the invention was published in 1874.¹⁶ From this it appears that Rosenthal had no knowledge of Brockedon's invention, but believed his to be the first machine ever devised for the compression of drugs into tablet form. He says:

"Pills, powders and electuaries are still prepared and prescribed in essentially the same way as they were one hundred years ago. * * * Up to the present time

all previous methods have been insufficient to solve the problem of administering large doses of medicaments offensive to taste and smell, or both."

His method consisted in compressing drugs into tablet form without the addition of foreign matter, so that they might easily be swallowed without offense to taste or smell.

The machine consists of a screw press upon a rectangular stand which may be fastened securely to a work-table or counter with clamps or screws. The iron bed-plate supporting the press has a hole drilled through its center. A slide pierced to admit a ring for a handle can be used to close or open the hole in the bed-plate, by pulling it aside. Upon the bed-plate rests the hollow cylinder *d*,

¹⁵ *Sitzungsberichte d. Phys.-Med. Soc. zu Erlangen*, 1872, Heft 4 (Stzg vom 3 Juni), p. 70.

¹⁶ *Berl. Klin. Wochenschr.*, 1874, 11: 417.

and in this the powder is placed in the molds, *a*, *b* and *c* (Fig. 9.) When downward pressure is exerted by means of the screw, *e*, the loose powder is compressed into a tablet which, when removed from the cylinder, is ready for immediate use, or may be afterwards coated with gelatine. After the introduction of Rosenthal's machine, which was among the most advanced recorded at the time, the tablet became a recognized form of medication in Germany, but the home industry did not seem to keep pace with that of other countries, as is shown by the fact that English goods made such an impression upon the German public that manufacturers in Germany resorted to the scheme of using English labels to promote the sale of their goods.¹⁷

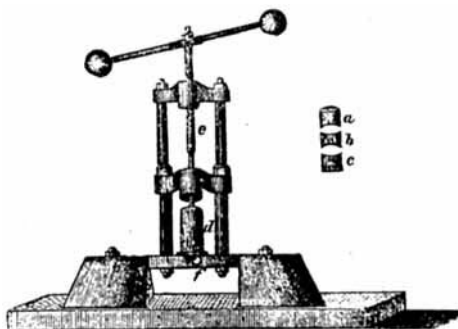


FIG. 9—Rosenthal press.

The tablet industry, like the coal-tar industry, had its origin in England.

Germany, having absorbed the greater part of the coal-tar industry, was reaching out for the tablet business, but not with very satisfactory results. Conditions in Germany were apparently not propitious for the best expansion of the industry, but at any rate, the center of activity was transferred to the United States, which country has held the supremacy for the last quarter of a century.

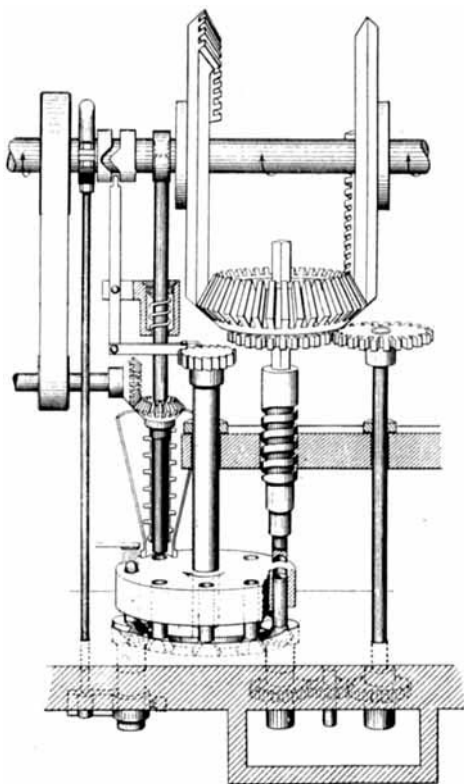


FIG. 10—J. A. McFerran's rotary machine,
U. S. Pat. 152,666, 1874.

Germany, having absorbed the greater part of the coal-tar industry, was reaching out for the tablet business, but not with very satisfactory results. Conditions in Germany were apparently not propitious for the best expansion of the industry, but at any rate, the center of activity was transferred to the United States, which country has held the supremacy for the last quarter of a century.

The first patent for an automatic "compressed pill" machine was issued to Dr. Joseph A. McFerran, of Philadelphia, in 1874.¹⁸ This was what is known as the intermittent rotating machine, and the idea was probably taken from the cartridge-filling machines which had been in use for a number of years. For some reason the invention did not find proper recognition and the inventor did not receive any material profits. The same year a patent was granted to Thomas J. Young, of Philadelphia,¹⁹ and assigned to Henry Bower, of the same place. This represents the earliest semi-automatic upright or vertical punch machine. In order to get the details of the

¹⁷ Chem. & Drug., 1888, 32: 712.

¹⁸ U. S. Pat. No. 152666, dated Jun. 30, 1874, appln. filed Jun. 18, 1874.

¹⁹ U. S. Pat. No. 156398, dated Oct. 27, 1874, appln. filed Oct. 8, 1874.

machines it is best to consult the patents themselves. The illustrations and brief descriptions are intended to give only a general idea.

Briefly, McFerran's patent consists of an intermittent rotary disc, with eight dies, an automatic feed, an upper and lower punch and a brush for removing the pills. The upper punch is raised and lowered by means of two beveled cog-wheels with a part of the teeth cut away and a spiral on the punch. The upper and lower punches are reciprocatingly rotated in order to overcome sticking.

Young's machine consists of two punches and a die. The upper punch is raised and lowered by means of an eccentric wheel, and the lower punch is raised

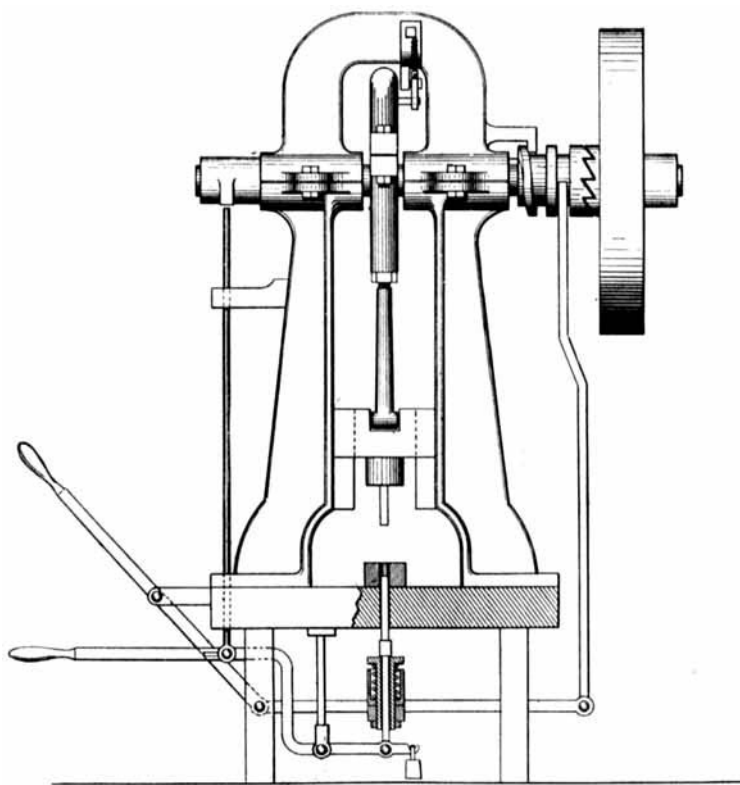


FIG. 11—I. J. Young's vertical machine. U. S. Pat. 156,398, 1874.

by a *cam* on a shaft, transmitting power through a rod and lever, and is lowered by a weight. The press is set in motion by a lever and is automatically stopped at the completion of one revolution. Feeding must be done by hand.

Joseph P. Remington, of Philadelphia, in 1875, described a simple piece of apparatus of the Brockedon type whereby the retail druggist could manufacture his own compressed medicines called for on prescription.²⁰ The method of operation can be readily learned by referring to the original communication.

This apparatus was improved by the inventor in 1876.²¹ The vertical machine alluded to was improved in 1877 by Thomas J. Young²² and this improve-

²⁰ Proc. Am. Pharm. Assoc., 1875, 23: 620.

²¹ Am. J. Pharm., 1876, 48: 97.

²² U. S. Pat. No. 189005, dated Mar. 27, 1877, appln. filed Mar. 9, 1877.

ment was assigned to Henry Bower. In 1879 Jabez H. Gill, of Philadelphia, was granted a patent²³ for an improved "compressed pill" machine, which he assigned to Henry Bower. Two years later the same inventor was granted another patent²⁴ which was assigned to John Wyeth & Brother.

It should be noted that there appears to have been some affiliation between Mr. Bower and John Wyeth & Brother. In fact, the latter at some time acquired the entire tablet interests of Mr. Bower. Patents were also issued to Charles Killgore in 1882 and 1883,²⁵ and to J. T. and C. T. Jones in 1882.²⁶ From this time forward inventions in tablet machinery were numerous. The most familiar names in the industry are C. L. Jensen, F. S. Hereth, C. A. Tatum, E. C. Clark, Arthur Colton, E. V. Pechin, E. L. Richards, E. D. Dühring, J. F. Buckley, and A. M. Hance. A list of the patents for tablet machines consulted is given in the bibliography at the end of this paper.

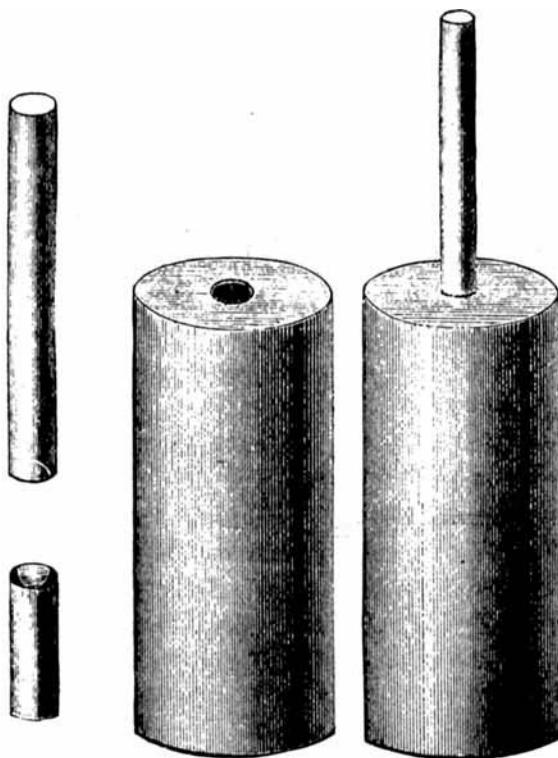


FIG. 12—Remington pill press.

TABLET TRITURATES (MOLDED TABLETS), SOLUBLE TABLETS, AND TABLET SATURATES.

The homeopathic profession²⁷ had for years been using triturations and medications in the form of pellets, saturated with suitable medicinal agents. Efforts had been made from time to time to bring the several professions of medicine closer together on the subject of medication. In 1877 Dr. H. G. Piffard read a paper²⁸ before the New York Academy of Medicine on "The Use of Certain Triturations," in which he called attention to some of the advantages of triturations. He gave the homeopathic profession credit for their development, but did not think any one should enjoy a monopoly of their use. Some of the triturations mentioned he had "compressed into convenient doses." This article appears to represent Piffard's contribution on the subject of tablet triturates, but it clearly shows that he was the first to have recorded the fact that he had

²³ U. S. Pat. 215452, dated May 20, 1879, appln. filed Mar. 28, 1879.

²⁴ U. S. Pat. 251678, dated Dec. 27, 1881, appln. filed Dec. 7, 1881.

²⁵ U. S. Pat. No. 260578, dated Jul. 4, 1882, appln. filed Nov. 16, 1881; U. S. Pat. No. 276828, dated May 1, 1883, appln. filed Aug. 22, 1882.

²⁶ U. S. Pat. 256573, dated Apr. 18, 1882, appln. filed Dec. 9, 1881.

²⁷ Hahnemann, *Organon*, 4th ed., 1829, p. 298 (foot-note to paragraph 283). *Id.* 1st Am. ed. from the 4th German ed., 1886, pp. 144 and 207. U. S. Homeopathic Pharmacopœia, 1st ed., 1878.

²⁸ *Med. Rec.*, 1877, 12: 766.

“compressed into convenient doses” triturations, and had brought them to the attention of the medical profession.

Dr. R. M. Fuller,²⁹ in speaking of Dr. Piffard’s work, says:

“Dr. Piffard has found that a plate three millimetres in thickness, containing holes six millimetres in diameter, will produce tablets of about one decigramme in weight, while a plate four millimetres in thickness, with holes eight millimetres in diameter will produce tablets of about two decigrammes in weight.”

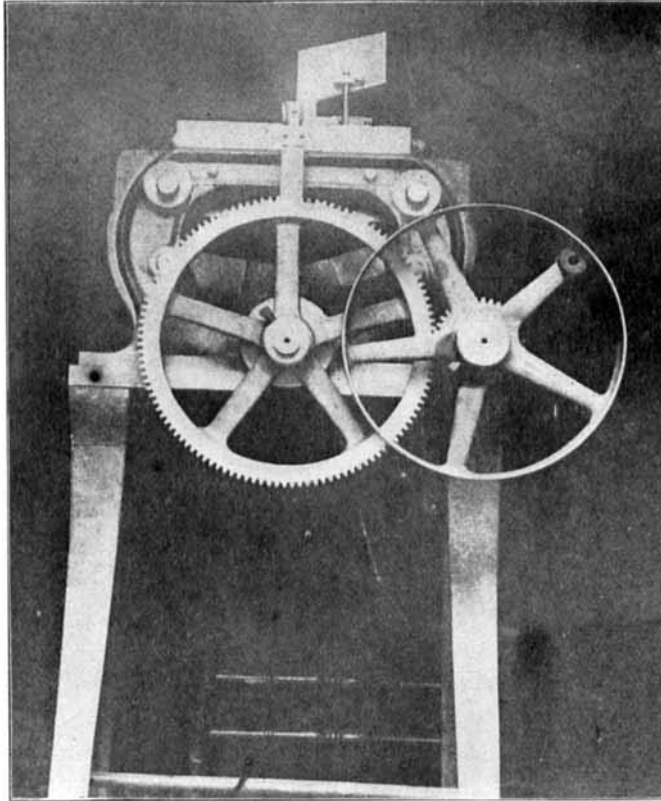


FIG. 13—Killgore machine. Patented in 1883.

Dr. Robert M. Fuller is, however, undoubtedly the originator of tablet triturates and the moving spirit in placing the industry on a substantial basis.

In 1878 his first contribution, entitled “Dose Dispensing Simplified, an Easy, Economical, and Accurate Method of Dispensing Medicines in a Compact and Palatable Form,” appeared.³⁰ In this paper he described “soluble tablets,” “tablet triturates,” and “tablet saturates.” “Soluble tablets,” as made by him, consisted simply of certain medicines made into a soluble paste with the aid of sugar of milk and alcohol or water, and molded into form. In some instances, however, he found it necessary to employ a more effective excipient than sugar of milk. His purpose was to prepare a tablet readily soluble or disintegrable

²⁹ *Med. Rec.*, 1878, 13: 185.

³⁰ *Med. Rec.*, N. Y., 1878, 13: 184.



FIG. 14—Robert M. Fuller.

"A Convenient Method of Dosage and Administration. The Process of making Tablets of Simple and Compound Powders, including Triturations, Hypodermics, etc."³¹ This contribution is an amplification of the work described four

in the mouth or in a spoonful of water. His "tablet triturates" consisted of triturations of metallic, mineral and vegetable matter, such as were discussed by Dr. Piffard in the paper referred to. These preparations were mixed into paste with alcohol or water, according to the adhesiveness required, and the paste molded into any size desired.

Tablet saturates are made by first molding sugar of milk into convenient form and saturating the blanks by immersing in the liquid to be used for medication, or dropping it upon them by means of a pipette. The term "tablet saturates" is now seldom used in practice. Dr. Fuller in the same article describes somewhat in detail the apparatus he used for the manufacture of soluble tablets, tablets triturates, and tablets saturates.

In 1882 the same investigator presented another paper before the New York Materia Medica Society, entitled

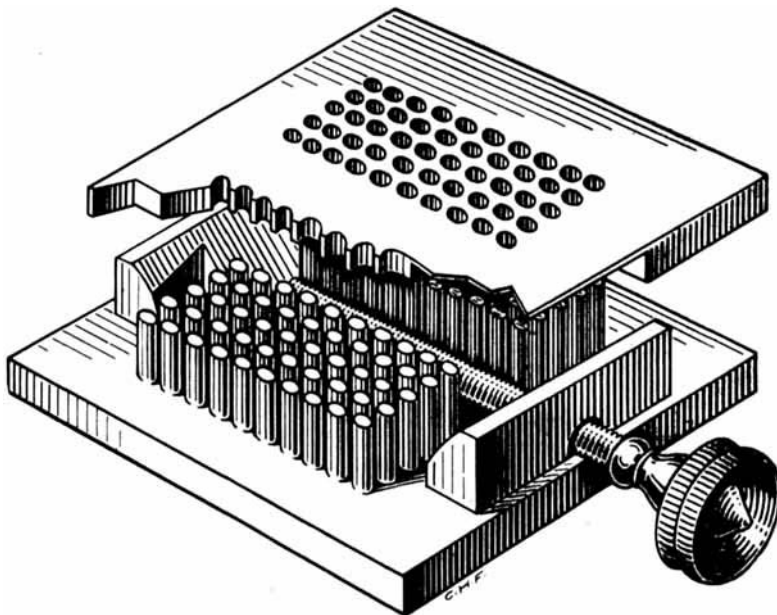


FIG. 15—Fuller's early mold.

³¹ Med. Rec., N. Y., 1882, 21: 811.

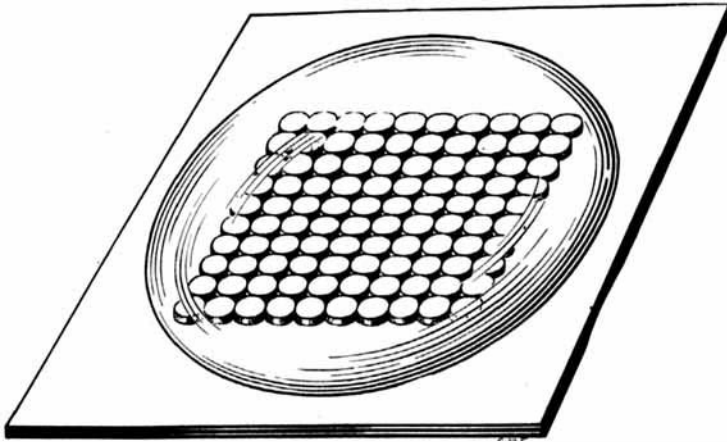


FIG. 16—Fuller's tablet saturate device.

years earlier. In it he gives another form of tablet mold, an illustration of which is given in Figure 17.

Dr. Fuller says in this article: "The idea of their adaptability for this purpose was the outgrowth of general laboratory practice in pharmacy and chemistry during 1861 to 1864. * * * * * The triturations were prepared in the manner elaborately and interestingly described in a text-book, used in connection with my earliest experiments, and entitled Mohr & Redwood's 'Practical Pharmacy,' and published in London in 1849. * * * * *" The method in question which assures the same accurate results as obtained by the process of compression, was the outcome of a long series of experiments made in this line

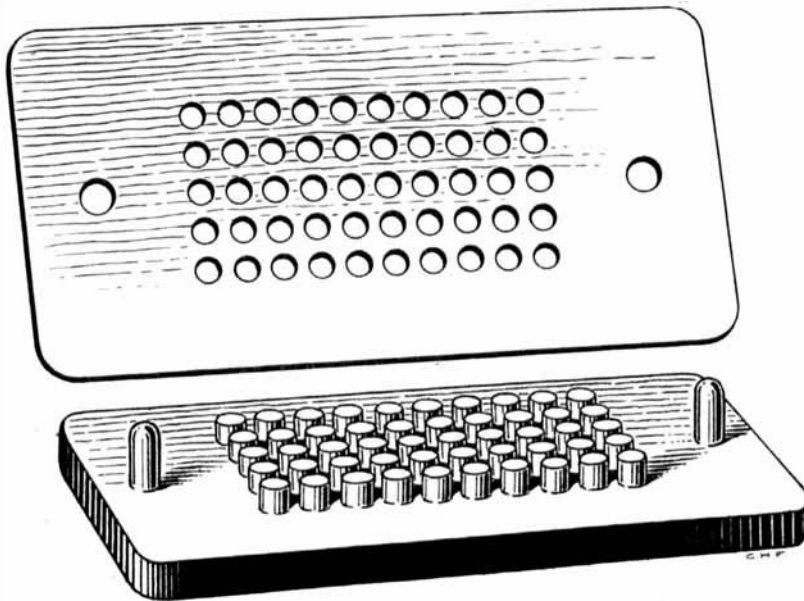


FIG. 17—Fuller's improved mold.

as early as 1861, before the system of compression was generally known or adopted in this country.

Dr. Fuller is fortunately still living and contributes the following letter, detailing briefly his early connection with the evolution of tablet triturates:

"Schenectady, N. Y., August 15, 1913.

"Dr. L. F. Kebler, Chief of Drug Division, Bureau of Chemistry,
Washington, D. C.:

"Dear Sir—Agreeable to your request of January 10th ult., and also further correspondence from Dr. Fraser and yourself, I am writing you a brief statement of my claim as the originator of the making of tablets in this country.

"Having received considerable printed matter from me and being familiar with the two papers prepared and read by me, the one under date of February 21, 1878, before the New York Academy of Medicine, and the other under date of February 23, 1882, before the Materia Medica Society, and also having at your command many articles and editorials with reference to my work along the line of the tablet industry, I feel sure that no detailed statement is necessary at this time.

"In the spring of 1861 I was employed in a drug store where I first began the practical work of making pills, subsequently called tablets. I subsequently took a full course in chemistry in the laboratory of Union College from 1861 to 1863.

"During all this time and for many years, I was greatly interested in the industry of making apparatus with which to find a convenient method of making compressed tablets and Tablet Triturates. At first, in 1861, the process for making porous pills was very simple and finally resulted in producing the 'Tablet Triturates' as now used as well as the compressed tablets.

"My work has been continued from that time—1861—with more or less interest, and while I am not inclined to be presumptuous, I might say that I was known as the 'Father of Tablet Triturates.'

"I was well acquainted with Dr. Piffard, but never knew that he made a claim as the discoverer of any tablet process. I well know that I first brought attention of the medical profession to the 'Tablet Triturates.' Dr. Piffard and I worked together long after I had invented the process. I have abundant proof among my private papers of the above facts but too much space would be required to go farther into details at present.

"Yours truly,

(Sgd) "ROBT. M. FULLER, M. D."

Numerous editorials and trade references are available to show Dr. Fuller's connection with the early evolution of this industry. The following editorial appears in "New Remedies"⁸²:

"Dr. Fuller's method of subdividing remedies (see page 69) so as to enable them to be administered in an agreeable form, and in uniform and adjustable strength, with the least expenditure of labor, appears to be a step in advance of previously-known pharmaceutical methods, and, like some other inventions of practical utility, surprises us by its simplicity, and makes us wonder why it was not suggested long ago. * * * *

"So far as we are able to judge from examination of Dr. Fuller's specimens, and from seeing his processes of manipulation, there is now little reason why they may not prove to be among the most successful of the methods yet proposed for the accurate subdivision of doses.

"Certain it is that Dr. Fuller is entitled to great credit for the persistency with which he has worked out the problem, and overcome its difficulties."

⁸² New Remedies, Vol. VII, 65, March, 1878.

In a circular published by Boericke & Tafel, April, 1878, appears the following:

"New Pharmaceutical Preparations, in Separate Doses, in a compact and palatable form. Soluble Tablets, Tablet Triturates, Pill and Tablet Saturates, made according to Dr. Robert M. Fuller's method as published in the Medical Record of March 9, 1878."

In a circular to the trade issued April 8, 1878, by Caswell, Hazard & Co., appears the following:

"Soluble Tablets, Tablet Triturates, Pill and Tablet Saturates, made according to Dr. Robert M. Fuller's method."

Fraser & Company, in a leaflet issued December 10, 1881, speak of "Tablet Triturates made according to method proposed by Dr. Robert M. Fuller."

The cut shown in Figure 18 was circularized to the trade in 1886.

A letter from Messrs. Boericke & Tafel, of Philadelphia, shows that the form of medication advocated by Dr. Fuller was put on the market soon after his contribution appeared in print. The letter is as follows:



FIG. 18—Package of tablet triturates.

"Philadelphia, January 7, 1913.

"Mr. L. F. Kebler, United States Dept. of Agriculture, Washington, D. C.:

"Dear Sir—We have endeavored to find some data in reference to the early history of the manufacture of tablets and find that we can give you very little information. We published from 1871 to 1885 a quarterly bulletin announcing anything new of interest to physicians in our school. In the May, 1878, issue we find an article on the use of certain triturations by Dr. Piffard taken from the December number of the Medical Record, which is no doubt the article you refer to. We find no mention made of the announcement of the manufacture of tablets until the August, 1879, number in which there is a statement made that we can now furnish tablet triturates giving prices, etc. The following statement was taken from the May, 1884, number:

"We have been subjected to some criticism for pushing these goods, and will take this opportunity to briefly state our position in the matter:

"In the December 1, 1877, number of the Medical Record, there appeared an article that had been read before the New York Academy of Medicine by Dr. Piffard, calling attention to the homeopathic triturations, and recommending the use of our first and second decimal triturations of a number of the active drugs, it being as-

serted that they were found to be more prompt and reliable than these same drugs when exhibited in the ordinary mode and form.

"In February, 1878, Dr. Robert M. Fuller read a paper before the same body, in which he referred to Dr. Piffard's address, and proposed as a convenient mode of dispensing these triturations, an invention of his, which he styled "Tablet Triturates," which consisted in forming of these triturations suitably sized tablets, each of which constituted a dose."

"The idea found much favor, and to supply the demand, we prepared a list

of our regulation triturations, of which any given trituration is made into tablets containing the usual dose of two grains.

"Later on,³³ tablets containing larger proportions of crude drugs were ordered by old-school physicians, and the trade assumed such proportions that we prepared the list, again published in this number, styling them 'Dosimetric Tablet Triturates,' in contradistinction to those of the regular homeopathic triturations.

"They are prepared according to Dr. Fuller's method with one difference, i. e., substituting glass plates for those of hard rubber, an obvious advantage, the increased cost of which has so far prevented others from following suit.

"Trusting that the above will help you in your investigations, we remain,

"Yours truly,

(Sgd) "BOERICKE & TAFEL."

Dr. Fuller is said to have laid the details of his investigation before Horatio N. Fraser, who at the time was in charge of the prescription department of a large New York pharmacy. It is also stated in literature that after a vain attempt to induce his employers to take up the industry, Fraser started the manufacture of molded tablets in a modest way in 1881. The records show that Caswell, Hazard & Co. were prepared to supply physicians with soluble tablets and tablet triturates, made according to the method of Dr. Fuller, as early as April 8, 1878. In a circular issued April 1, 1878, by Boericke and Tafel appears the following statement:

"Acting on Dr. Robert M. Fuller's valuable and eminently practical suggestions as set forth in his article above mentioned, we are engaged in getting ready a line of goods in conformity therewith * * *."

Dr. Fraser³⁴ in discussing these matters, says:

"I am glad you wrote me the letter about the circulars which seem contradictory, because it gives me a chance to say some things which I would not have bothered you with before, but which seem necessary under the circumstances.

* * * * *

"My fire, some years ago, destroyed all my papers and I had no copy of the circular, photograph of which you sent me, but I saw it in Dr. Fuller's office when I was in Schenectady and both recognize and remember it.

"While there I also saw a list of Wyeth & Bro. dated 1877, in which no mention was made of the word tablet that I could find. I also saw a Wyeth list which I think was dated 1883, and which spoke of tablets. This was the first Wyeth list I remember of seeing which did mention tablets.

"I notice that I mentioned Wyeth's *New Hypodermic* tablets in my circular of 1881—I suppose from this that they had put a hypodermic tablet on the market about that time but whether they called it 'Tablet' or not I do not know, but would infer as much from the language of my circular, though I may have had the word in my mind when writing the circular, and gave it the term, myself.

"I came to Caswell, Hazard & Co.'s store under the Fifth Avenue Hotel in 1876, from being a classmate of one of the Hazards in college. I worked there until just before the first of May, 1881, and during most of this period had charge of their prescription department, consequently was there during the time when tablets were introduced to the profession. I rented my first store May 1, 1881, and opened it about the last of July in the same year.

"I also recognize Caswell, Hazard & Co.'s circular. While I had been there continuously from 1876, I do not remember the date, but know it was about that time when they first made tablets. I cannot remember making any of them at

³³Boericke & Tafel's Bulletin of Homeopathic News, May, 1884.

³⁴Private letter to writer.

Caswell, Hazard & Co.'s store until just after Doctor Fuller's first paper was read, but W. F. Ford, who was head of the surgical instrument department of C. H. & Co., and another specialty manufacturer in the same factory building, must have been experimenting and working with the molds long before that, because they had them in shape to make fair tablets at the time the paper was published.

"W. F. Ford has been dead some years, but I have just had a conversation with Clarence Ford, his son, who worked in the C. H. & Co. surgical instrument department from 1875 to 1880. He says that, as well as he can remember, his father commenced to experiment with molds either in 1876 or 1877.

"Another indication that the date on the Caswell, Hazard circular is at least about right, is that Mr. Caswell of that firm had gone out of the concern a few months after I came with them. He started the firm of Caswell & Massey and was at that time in a dispute whether Caswell, Hazard & Co. had any right to that name, for the reason that he did not sell out his interest but took a *pro rata* amount of the stock and fixtures for his share.

"Caswell, Hazard & Co. lost the suit and changed their name to Hazard, Hazard & Co. after the decision of the court. I do not remember whether they were allowed to use the trade mark with the oldest name of the firm on (Hazard & Caswell) or not.

"My personal connection with tablets commenced, as I say in my letter of October 6, when I was a clerk in Caswell, Hazard & Co.'s (or Hazard, Hazard & Co.'s, as it was after the decision of the court), consequently my name should not figure in their history until I went into business with Mr. Fairchild in 1881.

"But having been most of the time from 1876 to 1881 at the head of Hazard, Hazard & Co.'s prescription department, I personally had something to do with their manufacture, because they made them in a very small way, as shown in your photograph of their circular dated 1878, the last paragraph of which says 'and will make special rates when 100 or upwards are ordered.'

"As well as I can recollect, it was just after Dr. Fuller read his paper on tablets that either Mr. Hazard or Dr. Fuller asked me to go up to the doctor's office on a special errand. While there he showed me what he had done and the details of the process that I might start making them at once for Caswell & Hazard Co.'s business. In the course of our conversation he said that he wished to have nothing to do with the trade end of the matter, and that he wanted to give the result of his work to the profession for their benefit without any returns or profit to him; and had made Mr. Hazard promise to have no secret about any of the formulas and to patent no part of the idea or processes. He also made me promise the same thing, and I, at least, have kept both the letter and spirit of that promise.

"At that time either he told me, or Mr. R. N. Hazard told me, that the doctor had talked to other firms about his idea but that none of them could see anything in the doctor's ideas, especially as they were complicated with his ethical restrictions.

"The Hazards made the tablets in a small way for some time and I could never induce them to go into their manufacture in what I thought was a business way.

"One of my principal reasons for leaving the Hazard employ was the idea that there was a future ahead for tablets, and my business was based on their manufacture and the idea that a druggist's success depended on what he did for and suggested to physicians.

* * * * *

"To sum up: I have no doubt but that Dr. Fuller should have the credit for precedence in the history of tablets; that either Caswell, Hazard & Co. or Boericke & Tafel made the first of them for the market, and all I had to do was the work of perfecting their manufacture, as was incumbent on me as the head of the prescription department of Caswell, Hazard & Co. at the time they

were introduced, and the faith I had in what they would do for the physician in the mechanical branch of medicine.

"I have done the best I know how to help you get at the history of Tablet Triturates."

As will readily be seen from the foregoing historical data, compressed tablets and tablet triturates, from which all other varieties originated, have had different lines of evolution. In point of time, however, the improvements proceeded almost simultaneously. Tablet triturates are either compressed³⁵ or molded. Their upper and lower surfaces are flat. In the case of compressed tablets the upper and lower surfaces may be either convex or flat. The three workers who stand out in the early history of the industry are Brockedon, Dunton and Fuller.

DEFINITIONS.

The term "tablet" has been applied to solid medicines of certain forms for several centuries. Samuel Johnson³⁶ gave the following definition for the term "tablet" and an illustration of its use:

"A medicine in a square form.

"It hath been anciently in use to wear tablets of arsenick, or preservatives, against the plague; as they draw the venom to them from the spirits.—Bacon."

The same definition will be found in the edition of 1819 and in the reprint of 1827.

M. Baumé³⁷ as early as 1762 devoted several pages (526-541) to the subject of "tablettes." He also gave a number of formulæ for preparing "tablettes," of which the following is representative:

Des tablettes altérantes, qui se font à la cuite du sucre.
Tablettes béchiques.

Sucre	lbj
Racines de Guimauve } aa.....	3 ij
Réglisse }	
Iris de Florence.....	3 j
Gomme adragant	3 ij
Opium préparé par digestion.....	gr. vj

The same author in the second edition of his book on "pharmacie" gave the following formula³⁸:

Tablettes antimoniales de Kunckel (lived 1630-1702).

Amandes douces pelées.....	5 j
Cannelle	3 ij
Petit Cardamome	3 ss
Antimoine crud préparé.....	3 ss
Sucre	5 vij

Kunckel died in 1702 which clearly shows that tablets as then known were made previous to that time. The term "tablet" was applied to a mixture of melted camphor and white wax in 1847.³⁹ Chlorate of potash tablets were re-

³⁵ So far as records show, Dr. Piffard was the first to have recorded the manufacture of compressed tablet triturates.

³⁶ A Dictionary of the English Language, 1st ed., 1755.

³⁷ Elemens de Pharmacie, 1762, 1st ed.

³⁸ Elemens de Pharmacie, 1769, 2d ed., p. 707.

³⁹ Pharm. J., 1847, 7: 47.

ferred to in the same journal as early as 1862.⁴⁰ Burroughs, Wellcome & Co. wrote as follows⁴¹:

"We registered the word "Tablets" in this connection as a trade-mark, and therefore regard it as our rightful property, also because we introduced the word here, and because it is in our opinion non-descriptive, and therefore eligible for use as a trade-mark. We still employ it on some of our goods. A 'Tablet' has never been described or considered as a substance having a round or oval surface, but rather as having a flat or squared surface. In the compressed form of medication the surface is rounded or curved. Some firms have, we presume, inadvertently used the word 'Tablets' in connection with compressed drugs."

According to the "British Trade Marks Journal" of February 28, 1883, page 115, a trade-mark, No. 31,235, was issued to this firm, but apparently not solely on the word "tablets." The trade mark is in the form of a rectangular figure with the word "tablets" impressed upon it. This is quite a different matter from claiming the exclusive right to the use of the word "tablets." Additional information upon this subject will be found in the "Chemist and Druggist."⁴²

The name "tablets" is sometimes restricted to tablet triturates,⁴³ but trade practice does not warrant such limitation. At present the designation "tablets" is a general term and cannot be said to mean any special kind of tablet.

Every indication tends to show that the term "compressed tablets" had its origin in the United States and that John Wyeth and Brother were the originators of the name.⁴⁴ Registered trade-marks No. 1001 and 1002 were issued to that firm on March 13, 1877, covering the term. The copy of a label found in the U. S. patent office records of one of the above numbered marks follows:

"Compressed Tablets of Chlorate of Potash for Hoarseness, Bronchial Irritations, Sore Throat, Ulcerations, Mercurial Salivation, Diphtheria, Croup, etc., etc.

"FOR SORE THROAT, HOARSENESS.

"Directions:—Adults should take one every hour or two until relieved, allowing it to dissolve slowly in the mouth. Children half of one as often.

"For offensive breath, no remedy will give more certain relief. Use one, two or three times a day.

"For diphtheria, croup and the more serious ailments, the physician should direct.

"JOHN WYETH AND BROTHER, PHILADELPHIA."

Dispensary tablets. A soluble form of medication of accurate composition, for the use of the pharmacist in preparing certain solutions, thus dispensing with the necessity of weighing.

Dosimetric tablets. A form of tablet triturates prepared to give accurate dosage used as early as 1884.

Hypodermic tablets. These are soluble tablets for hypodermic use for both human and veterinary purposes.

Molded tablets. This term covers any form of medication prepared in molds of the kind first brought forward by Dr. Fuller. The two sides are usually flat.

⁴⁰ Pharm. J., 1862, 22: 40.

⁴¹ Chem. and Drug., 1892, 40: 785.

⁴⁷ Chem. and Drug., 1890, 37: 581, 563, 603, 665, 695; 1892; 40: 785, 817, 849, 881.

⁴³ Remington, Practice of Pharmacy, 1907, 1199.

⁴⁴ Chem. and Drug., 1883, 25: 567.

It should be stated, however, that not all tablets with two flat surfaces, "block tablets," are molded.

Ophthalmic tablets are tablets containing medicinal agents for the use of oculists, and the filling of their prescriptions by druggists.

Proprietary tablets. This term is applied to proprietaries in tablet form.

Soluble tablets. A general designation applied to all forms of tablets soluble in water.

Tablet saturates. A form of medication introduced by Dr. Fuller but at present little used, as is shown by the following letter:

"Philadelphia, February 13, 1913.

"Mr. L. F. Kebler, United States Dept. of Agriculture, Washington, D. C.:

"Dear Sir—In reference to the use of tablet saturates would state that these are not much used by doctors. Our dilution and tincture tablets, of course, are practically tablet saturates only that the tincture and dilution are mixed in proper proportion with sugar of milk and then molded into tablets, whereas the tablet saturates are made by taking the blank sugar of milk tablets and merely saturating them with the tincture or dilution. The former, you will see, is a much more accurate preparation, as the exact amount of liquid can be added to the sugar of milk so that each tablet will contain a specified amount.

"Very truly yours,

(Sgd) "BOERICKE & TAFEL."

Tablet triturates. A term originally applied by Dr. Fuller to molded tablets. At present, however, it is indiscriminately applied to all tablets, soluble or insoluble, having two flat surfaces. They may be made by either molding or compression.

Veterinary tablets. This is a term applied to tablets used in veterinary practice.

MANUFACTURE.

INGREDIENTS.

Experience had shown in the time of Brockedon that pills as then made with adhesives often operated to the detriment of the patient. They became hard and indisintegrable for practical purposes. Brockedon conceived the idea of compressing drugs without the use of adhesives, thus eliminating this undesirable feature. So far as the records show he compressed soluble chemicals only, and his best known tablet was "soda and potash." "Chlorate of potash" tablets were best known and made in the United States. How long the practice of compressing soluble chemicals without adhesives prevailed is not known, but there is reason to believe that these adhesives began to be used in the early seventies. It is definitely known that Dr. Fuller used them in preparing tablets proposed by him in 1878.

Tablet triturates appear to have been specially devised for molding insoluble drugs into tablet form, and there are reasons for believing that Dunton did this long before, because he had acquired a reputation at this time for his "quinine tablets," as they were then known. There was no trouble in making tablet triturates as usually understood, but the compression of insoluble agents without adhesives presented numerous difficulties. Without these agents it was necessary to use undue pressure, thus making an extremely hard tablet, which might,

and even did, pass through the system intact, would be void of medicinal action, and might jeopardize the safety of the patient. Difficulties also arose because the tablets adhered to the various parts of the compressor. Dunton, in his process patent, provided for several forms of lubrication. The ideas he advanced are fundamental and are still basic in the industry. It is reported that the secret of Dunton's success in producing "pure tablets" without the use of adhesives or foreign material was due to the fact that he made each alternate tablet of chalk, which must be looked upon as a process of lubrication, or cleaning out the mold preparatory to another operation.

The situation in the early eighties was, therefore, that the compressed tablet industry would be restricted to the manufacture of tablets from chemicals soluble in water, which placed the industry in a very awkward position in view of the fact that tablet triturates, and soluble tablets, as molded by Dr. Fuller, were not confronted with this obstacle. The desideratum was now to prepare tablets containing insoluble ingredients which would readily disintegrate in the system in order to obtain medicinal effects. An agent was needed which would break up the tablets when moistened or placed in water. It is reported that numerous investigations were made and discoveries claimed, but nothing appears in the records. If anything was discovered and used it was kept a trade secret until 1887, when Charles Killgore applied for a patent. Mr. Killgore relates the circumstances leading up to the discovery as follows:

"In the spring of 1887 Mr. Fraser called upon me and stated that he had received complaints that the acetanilid combinations did not disintegrate readily when placed in water and I told him that I would make experiments and see if the objection could not be overcome. The criticism of Mr. Fraser recalled to me an experience I had in trying to make bi-carbonate of soda tablets in 1881. In order to get a nice, smooth tablet I had added enough potato starch to the soda to keep the tablet from sticking to the dies and by so doing obtained a beautiful looking tablet and of course thought my troubles were over, but, on examining them the next day I found they went to powder on being touched. They had been near a sink in the back room and absorbed enough moisture to swell the fecula of the starch and you might as well have tried to pick up a soap bubble. Based on this experience I then made a series of experiments with acetanilid combinations and found that starch in proper quantities would accomplish the disintegration of the tablets when they came into contact with moisture, and further experiments demonstrated that it would work with a large percentage of tablets that were used. In May, 1887, I filed an application for a process patent covering the addition of starch to dried materials before being compressed, for the purpose of disintegrating them in the presence of moisture. The application was rejected on the ground that starch was used in so many products. Up to this time it had not been used in compressed tablets, but since then has come into general use, as I made no secret of it."⁴⁵

Mr. Killgore's application, No. 238,375, which was filed May 16, 1887, is in part as follows:

"It is well known that the administration of medicines in the form of compressed tablets or pills, while having many advantages, has been open to disadvantage arising from the slowness with which the same dissolve in the stomach.

"The object of my present invention is to form compressed tablets or pills which, while possessing all of the advantages of those heretofore employed, are

⁴⁵ Private communication.

not attended by the disadvantage above referred to; in that when subjected to moisture they rapidly disintegrate. This result I accomplish by mixing with the ordinary ingredients constituting a compressed tablet or pill a percentage of starch which will so change the character of the compressed tablet or pill that the same will not be open to the objections heretofore existing.

* * * * *

"In making my improved compressed tablet or pill the same is prepared in the usual manner down to the point where the preparation is ready to be submitted to the action of the pressing machine. At this point I mix with the other ingredients a percentage of starch; and having done so, the mixture is subjected to the same operations as were heretofore employed for completion of the tablet or pill.

"Since the application of my improvement is not limited to tablets or pills of any particular constituents but may be generally applied, the percentage of starch to be preferably employed will vary in different cases. Some kinds of tablets or pills require a larger percentage of starch for obtaining the desired object than others. It will be sufficient for me to mention as an example, that in making compressed tablets or pills from bismuth, it will be found desirable to add about five percent of the starch. The starch being a substance which has substantially no injurious influences, of course an excess of it is not harmful.

"The tablet or pill resulting from my invention possesses, as far as I know, all of the qualities of those heretofore made excepting that when taken into the stomach it immediately disintegrates.

"I claim a compressed tablet or pill containing a substantial percentage of starch, for the purpose of facilitating disintegration, as set forth.

(Sgd) "CHARLES KILLGORE."

The rejection of the application is given in the following notation of the Patent Examiner on the application:

"The claim would not be patentable aside from novelty in view of the dec., *Tarr vs. Webb*, 2 O. G., 568.

"Starch is the most commonly used dividing agent. It enters into pills, tooth-powders, baking powders, and toilet powders generally. See Griffith's *Formulary*, p. 516, Br. Pat. No. 1630 of 1857, and *Tooth and Baking Powders* in the various *Encyclopædias*. Such having been compressed, there is neither novelty nor invention in applicant's procedure. See also Br. No. 202 of 1870. The application is rejected."

The reasons for disallowing the patent were general and, it must be said, not very convincing. The phenomenon observed was new and its application was undoubtedly novel. The discovery was a great triumph for the industry. From this time forward its growth was simply phenomenal. All conceivable solid drugs are now compressed into tablet form, and some fluids are also incorporated, often, however, with unsatisfactory results.

It seems hardly necessary to consider even briefly the various medicinal agents compressed. They may be found in simple or composite form in the general trade price-lists. It is, however, desirable to state somewhat in detail the excipients or adjuncts used in compressing them.

EXCIPIENTS.

The term excipient is applied to any substance other than the medicament used in the manufacture of, or which enters into the composition of, tablets or pills.

Excipients may, for convenience, be divided as follows: Liquids, adhesives, bases, disintegrators, absorbents, lubricants, and fillers.

LIQUIDS.

The liquids used consist essentially of water, ethyl and methyl alcohol, as well as mixtures of benzine and either of the alcohols. Their purpose is to facilitate granulation and to dissolve a small portion of the adhesive, thus increasing the adhesion or cohesion of the particles.

ADHESIVES.

These consist of cane sugar, milk sugar, acacia, tragacanth, glucose, gelatine, Irish moss, and dextrin. Cane and milk sugars are the most valuable and most commonly used. When they are properly employed no additional adhesive is necessary in many cases. Cane sugar is preferred by some on account of its greater solubility, while others prefer milk sugar because it makes a more porous and absorbent tablet. Cane sugar is used in the form of both powder and syrup. Acacia is employed in powder and mucilage form. The latter is more effective than the powder subsequently moistened. This adhesive must not be too freely used on account of its tendency to produce "insoluble tablets," or those which disintegrate with difficulty in the system. Tragacanth is seldom used except in cases where it is difficult or impossible to prepare sufficiently firm granulations by other means. Glucose, gelatine, dextrin, and flour are used only for certain mixtures. Gelatine in tablets is liable to become moldy, thus rendering the tablets unfit for use. Some, however, say that this criticism is unwarranted.

(To be continued.)

THE NEW AGE.

This is an age of social service. Never in all history has the world been so concerned in the welfare of "the other half"; never has there been such a strict inquiry into the life conditions of all peoples; and never has there been such concerted action to relieve suffering and social wrongs, as we see manifested so generally to-day. Surely the "millennium" is at hand. Well may we say with Riley:

"This world is a curious compound, with its honey and its gall,
With its tears and bitter crosses, but 'tis a good world after all.
And a good God must have made it—leastwise that is what I say,
When a hand is on your shoulder in a friendly sort o' way."

Everywhere the hand of social service is being laid upon the shoulder of the poor and unfortunate, the oppressed and the needy "in a friendly sort o' way." It is a great work and is enlisting the co-operation of all classes of people. The layman in his sphere, and the members of all professions are working side by side—each in his sphere—to bring about proper life conditions for all.—*Russell W. Bunting, D. D. S., in Lehn & Fink's Dentist's Diary.*