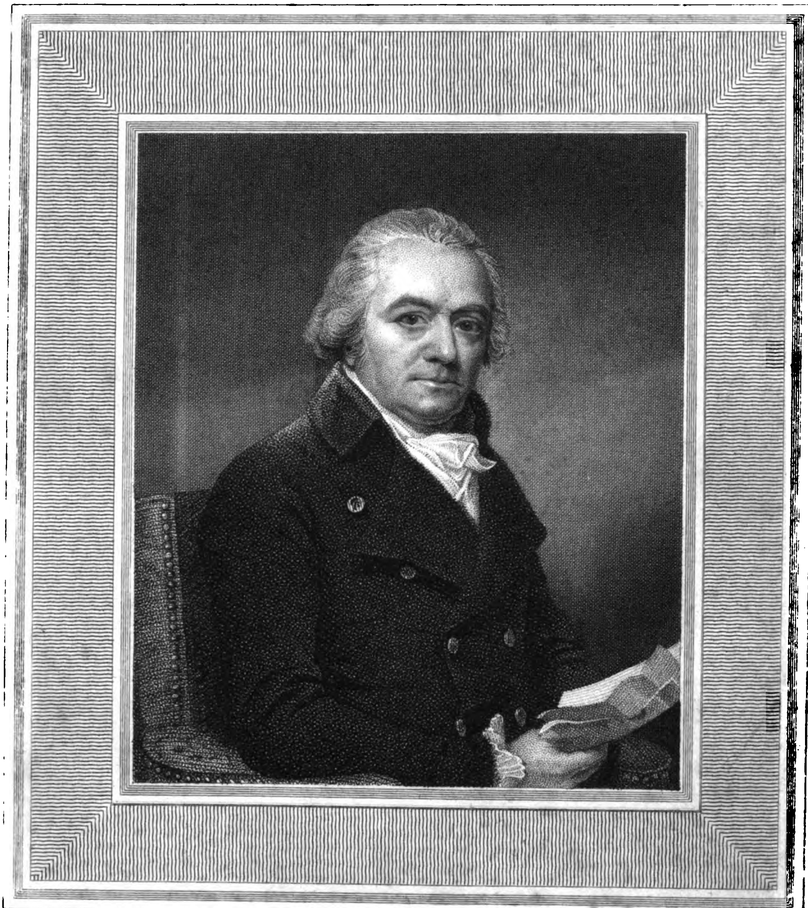
BAVERSTOCK ON BREWING.



Muller pinx 1790. Sid^y Hall sculp.

JAMES BAVERSTOCK,

Born 11 June 1741. Died 16th Dec 1815.

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TREATISES

ON

BREWING,

BY

THE LATE JAMES BAVERSTOCK, ESQ.

WITH NOTES, AND AN INTRODUCTION

CONTAINING A

BIOGRAPHICAL SKETCH OF THE AUTHOR,

AND

TWO PAPERS ON SPECIFIC GRAVITY,

INCLUDING

AN ACCOUNT OF THE VARIOUS HYDROSTATICAL INSTRUMENTS WHICH HAVE BEEN USED IN THE BREWERY;

AND

ON MALTING;

BY J. H. BAVERSTOCK, F.S.A.

LONDON:

PRINTED FOR G. & W. B. WHITTAKER, AVE-MARIA-LANE.

MDCCCXXIV.

LONDON:
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TO

THE SOCIETY FOR THE ENCOURAGEMENT OF ARTS, MANUFACTURES, AND COMMERCE.

My Lords and Gentlemen,

It is now nearly forty years, since my father published and dedicated to your valuable Institution, his Hydrometrical Observations and Experiments in the Brewery; at which time, he had for sixteen years used an hydrostatical instrument so constantly in his own practice, as on no one occasion, to vend a single cask of beer, the specific gravity of which had not been previously ascertained, and brought to a regular standard.

In the following biographical sketch, I have endeavoured to shew, and I trust with success, that he was the first to discover and to promulgate the method of applying the hydrometer to the purposes of the brewery—and I have related the ridicule he experienced from some, and the opposition he met with from others, (among whom, was Martin, its inventor and maker,) to its introduction; but time has shewn the value of the discovery, and the instrument, which has been gradually improved in its construction, is is now more or less used, in almost every public brewhouse in the kingdom. Indeed it has at length attracted the attention of the legislature, for the Act of 1 and 2 Geo. IV. cap. 22, contemplates the use of it in levying the Excise duties on beer, and Mr. Bate

of the Poultry, under the direction of the Board of Excise, has been employed to construct an instrument for the use of their officers.

The extensive mathematical and philosophical knowledge of this gentleman, and the accuracy with which all his instruments are finished, are well known; and in securing his attention to the subject, the Board could not have made a more judicious selection, and he has at length succeeded in producing an instrument (for which he has obtained a patent) on an entirely new construction, the principle of which is by very far the most mathematically correct, and the nearest to perfection of any saccharometer or hydrometer that has yet been published.

The rapid advances which chemistry has made in the last forty years, and the use of accurately-constructed thermometers and hydrometers, have been the means of introducing a regular system in brewing, which has shewn that the process is a science, depending for its success upon certain and invariable principles, and that it is not a mere mechanical operation, performable by any menial and illiterate person whom it may be convenient to employ in it. And it is, in consequence, beginning to rank as high among the arts and scientific manufactures, as the enormous duties which it pays entitles it to do among the revenues of the kingdom.

Much clamour has been raised against the supposed monopoly of the great capitalists in the concern, and it has been charged against them, that possessing such monopoly, they compel their customers to purchase, at an extravagant price, any trash that they may

think fit to supply them with. I pass by the ridiculous and unnatural supposition, that a brewer who has any regard for his reputation will purposely make a bad article, or, if he could be so blind to his own interest, that he could force persons to drink what they dislike, and at an unreasonable price, and shall tell the persons so ready to advance such charges, that it is only in London, and within a certain distance of it, that the public brewers exist in any number—that in 1807, the common brewers throughout the kingdom, and including London, did not exceed fourteen hundred—whilst the *brewing publicans* amounted to the amazing number of nearly twenty-four thousand, very few of whom were in London.

The chief part of the supply therefore, of the kingdom, is not produced by the common brewers, but by victuallers brewing their own beer; hence, the unfairness of the charge of monopoly—and if it be admitted that brewing is a science, requiring chemical and mathematical knowledge, it will not be denied, I think, that the reputable public brewers are more likely to possess the necessary qualifications for conducting the process fairly and successfully, than persons who are generally uneducated, and from their habits of life, unequal to any application to scientific pursuits.

With such persons, brewing must be wholly a matter of chance, in which success, when it happens, is blazoned forth in high colours, and disappointment (which if they were candid they would confess they most commonly experience,) is strictly concealed from their customers.

In situations where there are no large brewhouses, the importance of the concern in a commercial point of view, is little known or thought of. The vast capitals employed in buildings, in utensils, in machinery, in casks, in stock, and in book debts*, render a London brewery a pursuit of the first consequence; and if to this we add the enormous sums which it pays to the Excise directly and indirectly, it may be safely asserted, that no commercial undertaking is of more value to the Government and to the revenue, than the brewery.

In proof of this, the twelve principal porter, and the six first ale brewers in London, in the year ending 5th July, 1823, paid to the Excise for direct duties on strong beer only, the almost incredible sum of £706,038, 17*s*. 8*d*. exclusive of the direct duties on table beer; and on malt and hops, which of course the brewer also pays, though indirectly, in the purchase of those commodities, and which amount to as much more, making altogether the immense sum of a million and a half of money, paid to the revenue by eighteen houses only, a fact unparralled I presume, in any other business or country in the world.

A speculation of such magnitude necessarily requires considerable property to enable persons to embark in it, and property usually gives influence and power to its possessors, which may sometimes, per-

* I purposely omit public houses, which form no part of the *essential* capital of a brewery; if a brewer possesses a large fortune, it is of course more advantageous to him, to invest a part of it in the purchase of public houses, than in buying land or keeping it in the funds.

haps, be injudiciously used. The aspersions, therefore, which have been cast upon the brewery, ought, if there be any foundation for them, to attach to the individuals who have occasioned them, and not to the concern in general.

The best work on brewing and malting which has appeared, is unquestionably the Scotch Report, which was ordered by the House of Commons to be printed 6th June, 1806, and was occasioned by the following circumstances.

An opinion having been long entertained that Scotch barley and bigg were very inferior compared with English barley for the purposes of brewing and distilling, the duties charged on beer and on spirits made in Scotland, were considerably less than on the same articles manufactured in England. The late improvements in the agriculture of North Britain, and in consequence, in the quality of the grain produced, excited the English distillers to complain to the Lords of the Treasury "that they were undersold in their own market (London) by their competitors in Scotland," and that "the necessity of such a distinction in the duties no longer existed." Considerable debate having thus arisen on the question, and the Scotch distillers continuing to insist on the great inferiority of their own grain, it appeared to the Government that a decision between the two parties would be more justly formed by a scientific investigation of the relative qualities of the several sorts of grain in question. And for this purpose three gentlemen of distinguished abilities, *viz.*, Dr. Hope, Professor of chemistry, Dr. Coventry, Professor of agriculture in the University of

Edinburgh, and Dr. Thomson, Lecturer in chemistry in that city, were selected and recommended by the Board of Excise in Scotland, to the Lords of the Treasury in London, to make the researches.

The length of time which was necessarily occupied in the numerous experiments, together with the laborious attention paid to the minutest points under all the constantly-recurring variations in processes of such intricacy, by men so eminently qualified to form right conclusions from all the incidents, render their report of their experiments highly valuable to all who are interested in such inquiries.

Dr. Thomson has since written an article on brewing for the Supplement to the "Encyclopedia Britannica," and there is a good article on the subject in Dr. Brewster's "Edinburgh Encyclopedia."

To you as the Patrons of the Arts, Manufactures, and Commerce, of these Kingdoms, I take the liberty of dedicating the following pages on a subject so consonant to the object of your excellent Society, expressing my hope that my humble attempt to excite attention to its importance, may not be altogether ineffectual, and soliciting your indulgence to its defects.

I have the honour to be,

With the most profound respect,

My Lords and Gentlemen,

Your most obedient humble Servant,

J. H. Baverstock.

Newport, Monmouthshire,
25th Nov, 1823.

INTRODUCTION,

CONTAINING

A BIOGRAPHICAL SKETCH

OF

THE AUTHOR.

INTRODUCTION.

JAMES BAVERSTOCK. the writer of the following pamphlets, was born at Alton, in Hampshire, on the 10th of June, 1741.

In the year 1763, he joined his father at Alton, who was at that time engaged in the brewery there, and who shortly after built the brewhouse in Turk Street.

Having met with Combrune's "Theory and Practice of Brewing," published in 1762, he purchased a thermometer which he was forced to conceal and to use by stealth, his father objecting vehemently to such "experimental innovations."

About the year 1768, he procured an hydrometer from Mr. Benjamin Martin of Fleet Street, who had advertised it as "useful in discovering the strength of beer, ale, wine and

worts," and in *January*, 1770, he put into the hands of that gentleman a manuscript containing the particulars of some experiments which he had made with it; but although Martin was the constructor, and, I believe, the inventor of the instrument, and had advertised it as beforementioned, *he could not be prevailed on to believe that it could ever be introduced into the brewery with any effect*; for having made his experiments on different sorts of *beers* instead of on unfermented worts, he found himself so bewildered and in such a labyrinth, that he had abandoned the pursuit, and did not, perhaps, choose to admit his error.

Unsuccessful with Mr. Martin, our Author afterwards procured an introduction to Mr. Whitbread, the founder of the celebrated brewery in Chiswell Street, who treated the matter as lightly as Martin had done, observing that he had got a large and successful trade without ever having used such an instrument, and he put an end to the conference by saying, "go home, young man, attend to your business

"and do not engage in such visionary pursuits."

Independently, therefore, of the prejudice of custom, which of itself generally operates against the introduction of any scientific improvement, the hydrometer had to contend with the most powerful obstacles; its use in the brewery being at that time denied by the inventor of the instrument, and treated as a chimerical theory by the principal brewer in London: but that it has successfully overcome all opposition since the first publication of the "Hydrometrical Observations" is proved by its being more or less used at the present day in most of the breweries in the kingdom; while this fact affords indisputable testimony in favour of our Author's judgment in this particular, and of his scientific and practical knowledge in the art of brewing *.

It was natural, however that such impedi-

* Since this edition has been preparing for the press, the legislature has passed an act, by which it appears that it is in contemplation to charge the duty on beer according to the specific gravity of the worts.

ments should be discouraging to him, and he had made up his mind to "return home" and to content himself with using the instrument in his daily practice in his own brewery, his experiments having convinced him of its immense value, too clearly to permit him to abandon it. Chance, however, introduced him to Mr. Thrale, then a highly eminent brewer in, and M.P., for Southwark.

This gentleman duly appreciating the value of the subject, entered into it with all the warmth it deserved, and signed the following declaration in the manuscript before alluded to, as having been shewn to Mr. Martin, expressive of his opinion of the utility of the instrument:

"Understanding by Mr. Baverstock that "Mr. Martin has objected that the mean value "of two worts is not ascertainable by the use "of figures, to such a degree of accuracy and "precision, as is requisite to make the hydro-"meter useful to the brewer; Mr. Baverstock "has this morning in my presence made some

"trials of the instrument on different worts, "each of which discovered such a different "density as was to be expected according to "the various mashes; and on mixing two equal "quantities of worts, the hydrometer disco- "vered to a digit, the exact density which the "medium value of the two amounted to by the "use of figures. And I furthermore give it as "my opinion, that the hydrometer is an instru- "ment of great use to the brewer in various "parts of his business.

"H. THRALE.

"*Southwark*,
"2d Feb. 1770."

During his intercourse with Mr. Thrale our author frequently met the celebrated Dr. S. Johnson, who sometimes was present at their experiments, on which occasions he always expressed himself highly gratified and pleased therewith, as tending to render that a scientific and philosophical pursuit, which had hitherto been considered a mere practical operation, requiring neither superior skill nor judgment.

Notwithstanding the numerous engagements which his parliamentary duties as representative of Southwark must necessarily have occasioned him, Mr. Thrale appears to have closely superintended the operations in his brewhouse, and to have attended, minutely, to the making up his lengths himself; consequently, his opinion and his reception of, were the more flattering to, our Author, with whom he continued to correspond, and to whom he presented an hydrometer which he directed Martin to make in silver, for the purpose *.

In 1773 the subject of this memoir formed a connexion with Mr. John Dowden, at Alton, under the firm of Baverstock and Dowden, which continued until the year 1786, when he left Alton for Windsor, having entered into an engagement with Messrs. John and Richard Ramsbottom of that place.

Here he had the management of the brewing department of a trade, which consisted at that time of no more than about 11,000 barrels per

* Some of Mr. Thrale's letters are inserted in the Appendix.

annum, but which increased annually until 1801, when he left it, and when it had reached to upwards of 30,000 barrels.

About the year 1796, the Windsor Brewery began to send ale to London, where it soon acquired a celebrity equal to their utmost expectations, and which has continued unabated during a period of seven-and-twenty years *.

* Mr. Emly a late scientific and judicious brewer at Salisbury, in a letter which he published in 1807, containing answers to some questions put to him by the collector of excise, relative to the different methods of malting, writes thus of the Windsor ale.

"But as speaking of our own article might have the appearance of egotism, I shall mention the Windsor ale, an article well known in London. This ale was introduced, and is still brewed, according to the practice of Mr. Baverstock, now of Alton, who is highly and very justly celebrated as a practical brewer. That gentleman has more than once told me, in speaking of the 'Ware' practice" (of malting,) "that he could find no malts from any other parts of the kingdom, that so well answered his purpose. Mr. Baverstock is in several instances a competitor with us in trade; but I have no hesitation in acknowledging that I have never yet seen malt-liquor from any house in the kingdom, which has discovered more evident marks of science in its manufacture, or that has exceeded the best Windsor ale in flavour and transparency.'

In 1785 he published his "Hydrometrical Observations and Experiments in the Brewery," and dedicated it to the Society of Arts. Upon which occasion he received the following letter from their Secretary, Dr. Samuel More.

Adelphi, May 19th, 1785.

Dear Sir,

I had the pleasure of laying before the Society for the encouragement of Arts, Manufactures and Commerce, at the meeting last night, your Treatise entitled "Hydrometrical Observations and Experiments in the Brewery;" and to read to them your polite dedication.

A Work calculated to improve so capital a branch of business as the brewery could not fail of meeting with the approbation of the Society; and I am directed to return you their thanks for this instance of your regard, and to assure you that the copy of the work which you have been pleased to present to them, is directed to be carefully preserved.

I have the honour of subscribing myself,

Sir,

Your most obedient, and most humble servant,

SAM. MORE,

Mr. Baverstock. *Secretary.*

This little treatise, which is, in fact, the manuscript which was shewn to Martin fifteen

years before, was no sooner published than the writer of it had a host of correspondents, chiefly brewers, with some West India planters, all seeking farther information on the subject; the letters of some of these are printed in the Appendix.

In 1801 the term of his partnership at Windsor having expired, he returned to Alton and resumed his brewery there, which he had leased to Mrs. Dowden, the widow of his former partner, and leaving his eldest son Thomas to succeed him in the firm of Ramsbottoms and Baverstock, at Windsor. In 1807 he printed the "Short Address to the Public on the Prejudices against the Brewery," which was distributed among his friends and customers, but not before published for sale.

In 1808 he wrote the letters in Cobbett's Register, which produced a very able reply from a gentleman at Malton, who signed himself CANDIDUS, and a short controversial correspondence ensued which ended in Candidus's

communicating his own practice to our author seeking his advice and instruction *.

In 1811 he published his "Observations on the Prejudices against the Brewery," and in 1813, "Observations on the State of the Brewery, and on the Saccharine Quality of Malt." This last was written expressly for, and printed in the fourth number of Mr. Valpy's valuable work "the Pamphleteer," and was the last of his publications.

He married in 1769, Jane, the daughter (and heir of her mother, the first wife,) of the Rev. John Hinton, who during fifty-eight years, was Rector of Chawton, near Alton, by whom he had a numerous family, and he died in the seventy-fifth year of his age, at Southampton, whither he had retired from business for the benefit of his health, only a few months, on 26th December, 1815, leaving his wife and

* All the letters of this gentleman are now in my posession, but I do not conceive myself at liberty to publish them not having asked his permission to do so.

three only of his children surviving him; of whom Thomas, the eldest died at Windsor in the following May, whereupon his youngest and only surviving son, James Hinton, the writer of this memoir, left Alton and succeeded his brother in his partnership at Windsor.

It is not the wish of the writer to trouble the reader with a recital of all the difficulties which he has had to contend with since his father's death. But he trusts that it may not be thought altogether unnecessary for him to state that an extent in aid was very unfairly obtained againts his father's estate, at the instance of a banking firm in London, in less than a fortnight after he was buried, and that the Alton Brewery was in consequence sold at a great loss in the October following, to a gentleman who having got possession of it, retained it for three years without completing the purchase, whilst the vendors were endeavouring to clear up some trifling defects in the title. That in October 1819, having obtained the command of a considerable sum of money, by compromising some law-suits in

which his mother had engaged for the recovery of some very extensive estates in Hampshire and other counties, to which she was heiress, he unfortunately withdrew himself from his partnership at Windsor and returned to Alton in the fond hope of being able to accomplish the settlement of his father's affairs, and voluntarily took upon himself all the incumbrances in which they were involved by the process before alluded to. He was, however, unfortunately disappointed; the undertaking proved too great for his means, and he failed in the attempt.

He hopes that he may be excused for this digression, but as the events are extensively known, his total silence on the subject might create surprise in some, and suspicion, perhaps, in others, who do not know him, that the circumstances could not be satisfactorily explained.

Having, since his father's death, been repeatedly asked for the Hydrometrical Observations, which have now been many years out of print, he has for some time past had it in con-

temptation to collect all the pamphlets and to print them in one volume, together with such manuscripts as he has found among his father's papers as relate to the brewery, and as may, according to his humble judgment, be interesting to the public, either professionally or otherwise.

With this view he has added some papers on malting, on specific gravities, and on the various kinds of hydrometers and saccharometers now in use, which are partly collected from his father's manuscripts, and partly original, and he flatters himself that they may be found to contain some matters not altogether unworthy notice.

He has carefully revised every sheet as it came from the press, and has occasionally added such notes as appeared to him to be required by the alteration of circumstances, which a period of nearly fifty years has necessarily occasioned.

In conclusion, he desires to add that respect to the memory of an honoured Parent is his principal motive for republishing his several

tracts on a subject in which he had placed his whole delight, and in which he was constantly and actively engaged for more than half a century.

The Hydrometrical Observations are favourably reviewed in the "Critical Review" of 1785, and they are quoted in the "Edinburgh Encyclopedia" article "Brewing," and by Dr. Shannon in his "Practical Treatise." Mr. Accum also in a little work published in 1820, entitled "A Treatise on the Art of Brewing," quotes from the "Observations" in the "Pamphleteer."

J. H. B.

POSTSCRIPT.

THAT my Father was the first person who used the hydrometer in the brewery, I have no doubt. He tells us in the year 1785, in the preface to the Hydrometrical Observations and Experiments, that he had *then* constantly used an instrument of this description for *sixteen years*, and the declaration of Mr. Thrale before noticed is dated 2d Feb. 1770, and the manuscript which my Father put into the hands of Martin in that year, contains some preliminary observations on the thermometer, which conclude thus: "what follows, relates to another "instrument called the hydrometer, which was "invented by Mr. B. Martin of Fleet-Street, for "the service of the distillery, *but which I have* "*never yet heard has been applied to any use in* "*the brewery. The ensuing examples will shew*

"*whether this is practicable or not.*" Then follow the hydrometrical experiments. This was written in 1769; Mr. Richardson did not publish his saccharometer until the year 1784, and in his treatise on the "Application and Use of the Saccharometer," he intimates that the only attempt which had been made to introduce an hydrostatical instrument into the brewery up to that time, was that by Martin, with his hydrometer. That Martin himself did not succeed we have already seen in the relation of what passed between him and my Father in *January* 1770. I will now quote what Mr. Richardson says of his communication with Martin, on the same subject; and if Mr. R. is correct in saying that there was no other attempt to introduce an hydrostatical apparatus into the brewery, then it follows, I think, that Martin's was the first instrument that was used in the brewery, and that my Father was the first person who discovered the mode of applying it; I quote Mr. Richardson's words:

"The only attempt, or rather profession to

"ascertain the strength of malt-liquors, within "my knowledge, was that of a late celebrated "philosopher, who, on publishing an hydro- "meter for assaying spirituous liquors, roundly "asserted in his treatise on that subject, that "it was useful in discovering the strength of "domestic liquors, such as beer, ale, punch, *&c.* "*&c.* (see Martin's Treatise on the Hydrometer.) "These are his words to the best of my recol- "lection, as I quote by memory. Unfortu- "nately, however, for the credit of his asser- "tion, after I had tried various sorts of malt- "liquor by it, and found their specific gravities "equally various and disproportioned to their "evident though undefined strength, I applied "to him for information on the method of "using his instrument, in order to attain these "ends, when he ingenuously signed his recan- "tation in reply, by acknowledging that he "knew of no instrument which would discover "the strength of malt-liquors." (See Richard- son's "Philosophical Principle of the Science of Brewing," p. 117.)

I wish Mr. R. had given us the date of this conversation with Martin, we should then have known which of the two, my Father or Mr. Richardson first conferred with that gentleman.

I have shewn by authentic dates, that my father used the hydrometer sixteen years before Mr. Richardson published his saccharometer; and that its use was unknown to the London brewers until my Father communicated it to Mr. Thrale, is, I think, quite clear, and amply proved by the reception he met with from Martin, from Mr. Whitbread, and by Mr. Thrale's declaration and letters.

J. H. B.

See also Sect. III. of "Observations on the Prejudices against the Brewery." p. 65.

CONTENTS.

HYDROMETRICAL

OBSERVATIONS AND EXPERIMENTS

IN THE BREWERY.

TO

THE SOCIETY FOR THE ENCOURAGEMENT OF ARTS MANUFACTURES, AND COMMERCE, LONDON.

My Lords and Gentlemen,

Humbly conceiving that the purport of the following sheets will be found to coincide with the views of your most respectable and laudable Institution; I beg leave, with all due deference, to inscribe them to the Society.

Notwithstanding the principal part of this work consists of examples, taken from actual practice in the brewery, it is presumed that the utility of hydrostatics, in contributing to the improvement of the arts and trades dependent on liquid extracts, is not confined to that branch; but that some hints may be hence derived, which may prove worthy the attention also of the malt-distiller and vinegar-maker.

Each of these respective employs being engaged in different processes on corn, hereby a relation is produced between the present subject and the important concern of agriculture. For by hydrostatics may be ascertained, to the utmost degree of precision and certainty, the value of every kind of grain; and hence the

exact superiority or inferiority between any corn of like species, the produce of different climates. Thus, we may be taught, how far the barley of Siberia exceeds in value the same kind of corn produced in England; or, in what degree the barley of one county in England is preferable to the same produce in any other county. Other examinations will, probably, tend to afford the like information respecting the intrinsic worth of different kinds of wheat: and the inquiries, in all the above cases, may be extended to the most useful instruction, by ascertaining the exact effects of different modes of husbandry, on both the grains here mentioned.

The business of sweets is, no less than the occupations dependent on corn, likely to be very materially benefited by the application of a hydrometer; as is attempted to be shewn in the following publication, in a section appropriated to that particular intent.

Submitting the whole to the perusal and attention of the Society, I am, with the greatest respect,

My Lords and Gentlemen,
Your most obedient and
very humble Servant,
J. BAVERSTOCK.

ALTON, HANTS, *May* 9, 1785.

PREFACE.

THE Author of the following Treatise having *now** used an hydrometer, during upwards of sixteen years, so constantly, as on no one occasion in all that time to vend a single cask of beer, without having previously ascertained the specific gravity of the worts, and brought them to a standard proportioned to the price of the beer, or to some standard determined on by considerations, varying with the yearly produce and price of the materials; it is presumed that it will not prove unacceptable to those who may be interested or engaged in the brewery, that the result of his observations should at length be made known.

He has the greatest reason to believe that he can render the information afforded by this instrument exceedingly useful to those who are employed in that business. It may not, therefore, be improper to assign the causes why it was not published sooner.

* Written in the year 1785.

So long ago as in January, 1770, he put in the hands of the late Mr. B. Martin, a manuscript, containing some observations and particulars of experiments, derived from the use of an hydrometer, which, about fifteen months before that time, had been purchased at his shop; which circumstance, indeed, led the author to consult him the first. When, notwithstanding what he had himself asserted in his Treatise, given with the instrument to the purchasers thereof, namely, "that it was useful in the discovery of the strength of beer, ale, wine, and worts," he was not, by any endeavours, to be prevailed on to acknowledge that such an instrument could, by any device or contrivance, be rendered of service to the brewery.

The fact was, that Mr. Martin had contrived this instrument for the service of the distillery only; and, so far as he had any conception of its application to the brewery, had tried his hydrometer in various kinds of *beer* and *ale*, instead of (as he should have done) in *worts* just boiled, and previous to fermentation: and the specific gravities of such beers and ales depending, in some measure, on the degree of their fermentation, and on their casual state of ripeness and clearness, at the times when these

experiments happened to be made, and not altogether on any other circumstances, he found himself so bewildered, that he gave the matter up.

His surprise, however, appeared to be very great, when he was first told the actual and very material differences in the gravities of a first, a second, and a third wort; a matter on which he seemed to have never once made any trials, notwithstanding he was the constructor of an instrument sufficiently capable of deciding thereon.

Unsuccessful with this gentleman, the author introduced himself to a late very eminent brewer*; who entered very warmly into the subject, and was so kind as to sign a declaration in the manuscript before-mentioned, expressive of his opinion of the utility of the instrument to the brewery †.

It would be tedious and uninteresting, to relate all the means which were used to prevail on this gentleman also to neglect the use of the instrument; suffice it to say, that they were of such a kind, that the author scorned to give himself the trouble to endeavour to

* Mr. Thrale.

† See the Declaration, signed by Mr. Thrale, in the Introduction.

counteract them. Some of the hydrometers intended for him proved very defective: and thus the author was induced to decline all thoughts of making the matter public at that time; contenting himself with applying the instrument daily in his own practice, and finding, from every succeeding year's experience, still additional proofs of its extreme usefulness, as well in respect to profit by the just directions it has afforded in the purchasing of malt and barley, as also by its acting as the index to the process of brewing, in shewing the different effects of varying heats and operations.

It will, undoubtedly, be suspected and said, that the cause why the gentleman above alluded to, or the people he employed, rejected the instrument in question, might be, the total incompetency of Martin's hydrometer in *principle*, rather than merely to the inaccuracy or defectiveness of the workmanship.

It is readily granted, that much better instruments have been made, since that time, by Quin and others. But this superiority consists *only* in the workmanship, and in the strength of the instruments. The form* of each kind

* It is to be noted, that we are here speaking of *hydrometers*. The hydrostatical balance differs from such in form: although not, in respect to fluids, in application.

of them is the same; nor is there any distinction among them, provided they are equally well finished, save in the scale or sum of their indications; of which we shall speak in another place. Martin's hydrometer ever was, it may be asserted from long experience, as *capable* of perfection as any other; and it appears to be self-evident, that *any* instrument which serves to shew the comparative specific gravity which one wort bears to another, with the precise, or very nearly the precise superiority of each such wort to water, in different situations, (whether such an instrument may or may not be sufficiently nice to satisfy the inquiries of philosophy,) may be, and is, so great are the differences between the worts, fully competent to the practical purposes and pursuits of the brewery; in which, a small variation, as far as five, or even more, in a thousand, can never be an object worth notice.

It has been already observed, that the hydrometer acts as the index to the process of brewing, by shewing the different effects of varying heats and operations. It is not hereby meant that the hydrometer will inform the brewer whether his process is just, to the obtaining transparency, proper flavour, and the preservative principles; which, abstracted from more

immediate views of profit, are the properties mostly to be wished for in beer. But only that the hydrometer indicates to the brewer the precise quantity of valuable matter, obtained from any given quantity of malt.

If, therefore, the brewer could by any contrivance, such as the taking unusual care and pains in the mixing a certain parcel of malt to the amount of his consumption during several distinct brewings, make the whole exactly similar in quality; whatever difference then appeared, in the total amount of the specific gravity of the worts of each such brewing, must be imputed to a difference in the heats of the water applied in the respective mashes, or to some other variations in the process. And, thus, by the hydrometer is discovered a rule for establishing the best process, to the obtaining the greatest possible quantity of valuable matter, from any certain number of quarters of malt.

The other properties of early transparency, similarity of flavour, and due preservation, are to be obtained by proper regulations of the heats of the water used in the respective mashes, and of the heat of the worts under the action of fermentation. All which heats rest on the brewer's judgment; being obtainable to the utmost degree of exactness and precision, by

the use of another and better known instrument, the thermometer.

But to return to the hydrometer. If the constant use of this instrument were to become universal in the brewery, the event would be, the distinguishing which farmer produces the best barley, and which maltster sells the best malt. The real value of which, or the precise difference between different lots or parcels of them, may, by an hydrostatical apparatus, be discovered to such exactness, as to a five-hundredth part of the whole, if such exactness should be required. The author has frequently found such differences as from five to ten, and fifteen per cent., in the goodness of malt made from barley, even of the same season; and a still greater disproportion, so much as twenty and twenty-five per cent. in malts made from barleys the produce of different years; which is surely such important information, afforded by this instrument, as of itself to prove the extreme utility derivable from the continued application of it. And, if this information were to become general, it could be injurious only to such farmers as may be negligent, and to such maltsters as may be so unjust as to injure the quality of their malt, in their endeavours to obtain an unreasonable increase of quantity.

The author has only to observe farther, on the following sheets, that they are intended chiefly for the use and assistance of such persons in the brewery, as may not yet have seen, or, perhaps, ever heard, that there is such an instrument as the hydrometer. This view, or intention, will account for his being more particular, on some occasions, than may by others be thought necessary or proper. But the majority of readers will, he trusts, make allowances for that particularity, which can have no other object than their information and service *.

* It can not be too strongly impressed on the mind of the reader, that this was written in the years 1784-5, before the use of an hydrostatical instrument was known in the brewery.—J. H. B.

CONTENTS.

HYDROMETRICAL OBSERVATIONS
AND
EXPERIMENTS IN THE BREWERY.

Section I. *On the Hydrometer and the Hydrostatical Balance.*

The Hydrometer is an instrument adapted to ascertain the specific gravity of all fluids, from the most dense solutions, down to common water, and from water to alcohol, or the highest rectified spirit. And as the weight of some fluids, and the lightness of others, are, generally speaking, the most decisive proofs of their respective values; it follows, that a judicious use and application of this instrument must be of very great service to all those who are interested in forming and vending liquid extracts, of whatever denominations.

In many parts of the process of brewing, the hydrometer will be found to be such a guide, as to merit the most earnest attention. And, indeed, although the operator should proceed in the most rational method hitherto known or

practised, and regulate his heats by the direction of a thermometer, yet he cannot have the satisfaction of knowing what quantity of valuable or fermentable matter he has obtained, but by means of this other, most useful, instrument.

But the hydrometer is not intended to answer the purposes of gratifying curiosity *only*. A few examples of real experiments will serve to evince that the instrument is applicable to some other, and more important, ends in the brewery, as well in regard to actual profit, as to the credit and reputation of the art, by the assistance which it affords towards reducing the practice to rules, formed on sure and scientific principles.

Before we proceed to give these examples, it may not be improper to take some notice of another instrument, serving to determine the weight, or specific gravity, of fluids, called the Hydrostatical Balance, which, it must be acknowledged, is, in its application, as effectual for the purpose it was intended to serve, as any other contrivance of the kind is or can be, notwithstanding hydrometers are of later invention.

But the apparatus of the hydrostatical balance is so complicated and troublesome, and so much time is required to make an observa-

tion with it, that these considerations are sufficient to determine the preference in favour of the hydrometer; which is remarkably convenient, and expeditious in its application, and as well adapted to ascertain the gravities of different fluids, although not at all suited to find those of coins and other solids, as is the balance *.

These remarks being premised, we now proceed to shew, experimentally, the use and application of the instrument.

Section II. *Application of the Hydrometer in examining different Waters.*

In making observations on the gravity of liquors, due regard must be had to the heat of the subject.

If the liquor be either very hot, or very cold, a difference will be found, accordingly,

* Mr. Bate, an eminent philosophical instrument maker in the Poultry, now constructs an instrument, which he calls a Gravimeter, and which is in form similar to the hydrometer. Mr. Bate finishes these instruments with such great nicety, that, for taking the specific gravity of fluids, *lighter than water*, as also of coins and other small solids, not exceeding 300 grains in weight, they are extremely sensible, and nearly as useful as expensive balances.—J. H. B.

in the weight of the very same fluid. For this reason it is requisite that we should have a standard of heat for all our experiments. The most proper for the purpose appears to be a temperate warmth, or the point 55 degrees on Fahrenheit's thermometer. If the liquor exceeds this degree in heat, the gravity of it will be lessened; and, on the contrary, if the liquor be colder than 55 degrees, its weight will be proportionably increased.

We will begin with water; a subject of no small importance to the brewer; whom it behoves to be well acquainted with that which he uses, and to choose such as is soft and thin; properties which are indicated by its lightness.

Taking the jar*, intended for the use of the

* This jar is an appendage to the instrument, and delivered with it from the maker. It is usually of glass, or tin. But the brewer, who uses an hydrometer constantly, will find it necessary to have three of them, and they will be more convenient, as being more stout, if made of copper. Tin is much more liable to be bruised, and cannot perhaps be kept so securely soldered as copper, which is a consideration of great consequence, seeing that there is almost daily occasion to immerse these jars in water, for the more expeditiously bringing the worts to an examinable temperature. And, unless the jars are perfectly close, the water might, in some degree, communicate with the wort, to the destruction of the accuracy of the observation.

hydrometer, we filled it nearly to the top, with clean rain-water, and putting the bulb of a thermometer into the water, we found the temperature of it to be 48 degrees. As this was not warm enough for a just experiment, we dipped the jar, about three-fourths of its length, into some water which was hotter, for a minute, or until we found, by the thermometer, that the heat of the subject was 55 degrees. Having obtained this point, we proceeded to put the instrument, with the water-weight screwed on at the bottom, into the water, our subject*. The value of this weight is to be estimated as 1000.

But the water would not quite support the instrument, while this weight was on; and the hydrometer sunk to the bottom. We, therefore, took the water-weight off; and, in its stead, screwed on the weight used for the examination of spirits; which weight, compared with the

* The instrument here spoken of is the original hydrometer of Martin, the only one then made; the indications of which may be translated into the language of Richardson's saccharometer, with tolerable accuracy, by dividing them (after having deducted the weight of the water,) by 20. This will be more fully explained in the paper on the various kinds of hydrometers and saccharometers used in the Brewery.—J. H. B.

water-weight of 1000, may be estimated as 600; and, placing in the cup, at the top of the instrument, several other weights, to the amount, altogether, of 390 more, the stem of the hydrometer now sunk to eight of the divisions, which are ten in number, marked on it. Not content with its standing thus, as not being yet, perhaps, perfectly assured of the truth of the actual specific gravity of this water, by means of a slight touch with a finger, on the top of the stem, we depressed the instrument four or five divisions lower; but, on its re-ascending, after the removal of this pressure, it, in a few moments, settled at its first number of divisions, 8. The sum of all these weights, therefore, is as follows:

Proof-spirit weight - - - - - -	600
Weights in the cup - - - - - -	390
Divisions on the stem - - - - -	8
Weight of rain-water as - - -	998

In order to find how far rain-water is, in levity, preferable to that which is used in our brew-house, we filled the jar with some of this last; and, concluding that this would be found to be somewhat heavier, we took off the spirit-weight, and put on the water-weight 1000. Then bringing this to the due temperature, or 55 degrees of heat, we placed the hydrometer in

it, and found the stem to stand at two of the divisions, and that the weight of the water from our pump is

Water weight - - - - - - - - -	1000
Divisions on the stem - - - - - - -	2
Weight of the brew-house water - -	1002

By these two observations it appears that the water used in our brew-house is denser than rain-water by .004, or 4 parts in a thousand; and accordingly we are hereby taught that rain-water, if it was obtainable in a sufficient quantity for our use, would be, in this proportion, more beneficial.

The result of these two experiments suggests to us, likewise, a conclusion, as highly probable, that the maker of the instrument, used on the present occasion, purposely adjusted it to sink to its due point, (*viz.*, ⊖ within the top of the stem,) in Thames or in New River water, rather than in rain-water. In which intention there could be no impropriety; seeing what immense use is daily made of those two waters, in various chemical and commercial operations; and viewing, also, the impracticability of procuring, with certainty, a sufficient quantity of rain-water for any such purposes; whatever desire there might be to use the one, in pre-

ference to the other. If, therefore, this conclusion should be admitted, our observation will stand thus; *viz.:*

Rain-water - - - - - - - -	998
Thames, or New River - -	1000
Water from brew-house well -	1002

Section III. *Use of the Hydrometer in discovering the value of Hops.*

It has long been an important view, among those who profess to brew on rational and scientific principles, to find out a method of proving, to a certain degree of accuracy, the intrinsic value of the hops employed; and thereby to distinguish, with all imaginable precision, the smallest differences between hops of different samples or plantations; as well as between the growth of even the same plantations, in different years or seasons.

For this purpose, it has been recommended to boil a certain weight of hops in a given quantity of water; on the supposition that the application of a thermometer to this infusion, while it is boiling, will enable us to judge of the quality of the hops, by the increased number of degrees to which the thermometer then

rises, from the known heat of boiling water, or 212 degrees. But this is, in our opinion, a rule by no means sufficiently accurate. The hydrometer may be certainly brought to answer the purpose much more effectually.

The first attempts which we made on this subject, were directed to the first extract or wort; of which we endeavoured to find the value, or specific gravity, previously to its going into the copper, to be boiled with the allowed quantity of hops. Could we have succeeded in this endeavour, the addition, occasioned by any given quantity of hops, would be shewn by the additional density of boiled wort, compared with the same wort while raw and unmixed with the hops; a due allowance being made for the evaporation during the action of boiling.

But the difference between the first and last parts of the same wort, while running from the mash-tun to the under-back, we found to be such, as to render it impracticable to obtain a just or equal sample of the whole; which is not to be done, until such wort is rendered uniform by some more strong motion or agitation than that which can be occasioned by its merely running down from the mash-tun to the under-back. Nor do we think, from the frequent

trials we have made, that any dependence is to be placed on the application of the instrument to the wort from the taps, or in the under-back, even when the whole is down *.

We therefore determined to take another method, and to try what would be the effect on our instrument, occasioned by boiling a given weight of hops in a given measure or quantity of water. Accordingly, we procured a copper pot, which was well tinned within, and provided with a close cover, capable of containing three pints of water; into which vessel we put an exact quart of water from our pump, which we placed on the fire until it became boiling. The instant that it began to boil, we took it off, and put into the water (still in our three-pint measure) two ounces of the hops, the value of

* A much-valued friend of mine, who has studied the subject with a degree of application surpassed by no one, and whom I have no hesitation in pronouncing to be a most scientific brewer, places great reliance on the samples of his worts from his under-back. Every opinion of this gentleman on the subject is of sterling value; but, as far as my own experience extends, I am compelled, though with much reluctance, to differ from him on this point, and to assent to the assertion in the text, that no dependance is to be placed on the application of the instrument to the worts from the taps.—J. H. B.

which we wished to ascertain. When these two ounces of hops were so fully saturated as to be quite covered by the water, we again put the whole on the fire, until it boiled. Then fixing the cover on very closely, so that none of the liquor could escape, we let it continue to boil exactly ten minutes by a watch. As soon as the boiling was thus finished, we strained the whole, through a fine hair sieve, into a clean tin pan. Then taking a sufficient quantity to fill the jar so high as to admit the whole length of the hydrometer, we proceeded to find the specific gravity of this extract.

So soon as this, after standing a moderate time in the jar, appeared somewhat cool to the finger, we applied the thermometer, and found that our subject was at 64 degrees of heat. We, therefore, placed the jar, about three-fourths of its length, in a vessel of cold water, from the pump, until the contents were sunk in heat to 55 degrees; and now putting the instrument, with the water-weight screwed on, into the decoction, and adding the two small weights marked 40, and 10, in the cup, we found the stem of the hydrometer to fix at the fifth division.

The value of the hops, then, is thus discovered:

Water-weight - - - - - -	1000
Weight in the cup - - - - -	40
Do. do. - - - - - - -	10
Divisions on the stem - - -	5
	1055
Deduct weight of water - -	1002
Value of the hops, or increased density in the water occasioned by the hops - - - - - -	53

In order to prove the accuracy of the experiment, we repeated it. But in this the nicest skill and care are absolutely necessary. If we deviate, though in the smallest degree, in any one part of the process, a difference will be found.

An enumeration of those particulars which require great caution, will appear to be a repeated description of the whole process. But still, since the hydrometer cannot shew the comparative value of one sample of hops to another, with that degree of accuracy and precision which is necessary, unless great diligence and nicety are observed, whatever tends to direct us in the performance of the experiment cannot be unserviceable.

First, then, we must take care that the cop-

per pot into which the water is put, be very clean; and that not the least portion of any other fluid, or matter, be joined to that water which is intended for the experiment.

Secondly, We must be particularly exact in the quantity of water and of hops; taking great care that the weight of the one, and the measure of the other, be precisely the same, for one and every subsequent experiment; and, to this end, the measure, weight, and scales should be preserved for, and used in, this single purpose.

Thirdly, We must diligently observe the water; so as to remove it from the fire at the first moment that it boils, previously to adding the hops. For the action of boiling, by expelling the air out of the water, renders this last so much heavier in proportion to the time it is suffered to boil, that a difference would be found in the density of the decoction, proportionable to the increased density of the water, before the hops are added to it.

Fourthly, Much the same reason may be assigned, for a diligent observation of the time when the *infusion* first boils.

Fifthly, Not less is the necessity of confining all the water, during the time allowed for the

boiling, by putting the cover on very tight, so that none can fly out at the top; for, as we find that simple water is considerably lighter than our infusion, it follows, that the specific gravity of this last will be in proportion to the greater or less quantity of water; supposing the quality and quantity of the hops to be the same.

It may not be unnecessary to observe here, that the quantity of any fluid, to serve for a subject for the hydrometer, makes not the least difference, as to the gravity of it, when it is in the jar; provided there is sufficient to suspend the ball, and cover the stem of the instrument. The hydrometer being formed on such principles, that it is not the *quantity* of the liquor *in the jar*, which adds to or diminishes the apparent specific gravity thereof—but the more or less dense quality of the subject; which suffers the hydrometer to occupy such a space only in the liquor, as is proportioned to the density of the fluid, when compared to the power given to the instrument by the proper and due addition of weights in the cup, at the top of the hydrometer.

Section IV. *Use of the foregoing Experiment.*

Having given these directions for the performance of our experiment on hops, we shall now proceed to shew the use and application of it; and endeavour to convert it to such purposes as, it is conceived, must be of great service, in directing and informing the brewer what quantity of hops, of a certain quality, (thus ascertained,) will be sufficient to answer any required purpose.

Suppose 112lb. of these hops, the value whereof is as 53, to be, on due proof, a sufficient quantity to preserve a brewing or guyle of beer, for a length of time suitable to the brewer's demand and intentions.

It is required to know what quantity must be used, in order to answer the same purpose, of another growth or parcel of hops, the value whereof, subtracting the gravity of the water, is as 56?

Rule. Multiply the value of the first sample, 53, by the number of pounds, 112, and divide the product by the value of the other growth or sample, 56.

Work - - - - - 53
112
106
583
56)5936(106 pounds
56
336

Thus we find, that 106 pounds of the hops of this last sample are equivalent in use to 112 pounds of the other.

Suppose, on the other hand, the value of another sample should be no more than 48, what quantity of that growth will be required to answer the same purpose?

Work - - - - $\left\{\begin{matrix}53\\112\end{matrix}\right\}$ as before.
pounds.
48)5936(123,66
113
176
320
320

Answer 123,66, or say 124 pounds of this sample equivalent to 112 pounds of the first, or to 106 pounds of the second sample.

It is presumed that the use of these experiments, and the advantages which might be obtained from a frequency of them, if made with due precision, and exactly minuted and noted,

must be obvious to every one. Generally speaking, an opportunity might be obtained to prove a sample of hops, or to examine a choice of samples, by our instrument, previous to an absolute purchase of them. In this case, it might happen, also, that an equal or higher price might be demanded for the lot, the value of which we have found to be only 48, than for the lot of the value of 56.

But whatever prices may be fixed, the brewer has hereby an opportunity of ascertaining the precise quantity of unctuous (which is the preservative) matter, and of determining accordingly on the price, to great advantage. It is true, there is another property in hops, of great consideration, which is wholly out of the reach of any instrument, and that is flavour; which is still, however, open to the usual mode of discrimination, and therefore what we assert is, that if it should be found that our sample 56 is equivalent *in flavour* to the lot or sample 48, —the former is, on the whole, preferable to the latter, in the same proportion that five pounds and twelve shillings are preferable to four pounds and sixteen shillings.

SECTION V. *Use of the Hydrometer in discovering the Value of Worts, and in ascertaining the mean Specific Gravity of two Worts.*

TRUSTING, therefore, that enough has been said to prove the utility of the instrument, so far as it may be applied to ascertain the intrinsic value of the two preceding subjects, water and hops, we shall now proceed to illustrate the uses of the hydrometer still farther, by employing it to discover the specific gravity, and thereby the strength and true value, of the different extracts, or worts.

In the country brewery, the length or quantity of beer is, most usually, formed by two worts for strong, and a third, or the last wort, for small. In the London, and in some large country breweries, this length, as it is termed, is most commonly made by uniting the three worts in one fermenting guyle. The rules, which we shall give for explaining the present design, will be founded on examples taken from the practice in both these instances.

We conclude that the copper, coolers, and every other vessel and utensil, employed during any part of the process of brewing, are kept

scrupulously clean. When the worts are duly and sufficiently boiled with the hops, they are, each in their turn, struck or drawn off from the copper, and running through a hair-cloth, or false bottom, they are thus strained from the hops, and pass regularly into the backs, there to lie in order to cool, previous to fermentation. The two worts, intended for one guyle of strong, must, so long as they remain in the backs, be kept separate and distinct from each other; which is very easily accomplished, provided the brew-house is constructed, and the coolers are fixed, pursuant to the modern convenient plan.

The worts having been so long in the coolers as to sink to a fermentable heat, or nearly thereto, we take the jars, appertaining to the instrument, and dipping them in the coolers, in such a gentle and careful manner as not to move any part of the sediment from the bottom thereof, we take out a sufficient quantity of each wort as a sample, for the experiment; and, bringing each to our standard temperature, or 55 degrees of heat by Fahrenheit's thermometer, we apply the hydrometer, (with the water-weight fixed on at the bottom,) and, placing such a number of additional weights at the top of our instrument, as each wort will bear respectively, we thereby discover the

precise density of each. For instance, to prove the first and strongest extract, or wort, we severally place on the top of the instrument the two weights marked 300 and 100; but, finding that the density of the wort still keeps the ball of the hydrometer suspended considerably above the surface of the liquor, we take off the weight 100, and in its stead place the weight 200. As this is not yet sufficient to sink the instrument, we add the small weight 40, and to this the weight 30. And the application of this last causes the hydrometer to sink to the bottom. We, therefore, remove the weight 30, and place 20 in its stead. And now the instrument, after moving gently up and down, fixes, but without touching the bottom; and examining the stem, we find that five of the divisions remain uncovered by the wort.

The sum of these weights, therefore, is as follows:

Water-weight - - - -	1000
Weight at the top of the stem -	300
Do. Do. - - -	200
Do. Do. - - -	40
Do. Do. - - -	20
Divisions on the stem - - -	5
	1565
Deduct for weight of water - -	1002
Specific gravity of the wort - -	563*

* See note in page 19.

Having thus found the weight of the first wort, we proceed by the same means to discover the value of the second.

We begin, accordingly, with placing on the stem the weight 300, and, finding that this power is nearly sufficient to sink the ball of the hydrometer, we add only the smallest weight 10, and then perceive the stem to fix, and three divisions to remain above the surface. The value of this wort, therefore, is

Water-weight - - - -	1000
Weight on the stem - - -	300
Do. - - - - - -	10
Divisions - - - - -	3
	1313
Deduct weight of water - - -	1002
Specific gravity of second wort -	311

The difference between these two worts appears to be 252, or as about 6 to 11, which is not a great way from two to one. The mean value of the two worts is readily discovered, provided the quantity of each is equal.

First wort - - - -	563
Second wort - - - -	311
	874
The medium - - - -	437

But if the quantity of either wort is greater or less than the other, still the mean value of the two is to be found very exactly. We will suppose these two worts to lie in two backs or coolers, the dimensions whereof are equal, but the depths of the worts different.

Taking the depth of the first wort to be 2.8 inches, and of the second to be 2.3 inches, what is the mean specific gravity?

RULE. Multiply the weight of the first wort 563 by its depth in the cooler, 2.8. Add the two products, and divide by both depths.

Work -	563	311
	2.8	2.3
	450.4	933
	1126	622
2.8	1576,4	715.3
2.3	715,3	

5.1) 2291.7(449 the mean gravity of these two worts*.
251
477
18

The same rule will lead us to the discovery

* This certainly is the mean gravity of the two worts; but the actual quantity in barrels and decimal parts, gives a far better factor than the depth in inches.—J. H. B.

of the mean value, when the quantity of the second exceeds that of the first.

As supposing the depths of each wort to be *vice versâ* ;

	563	311
	2.3	2.8
	1689	2488
	1126	622
2.3	12949	8708
2.8	8708	
5.1)	21657 (424	
	125	
	237	
	33	

is in this case the medium occasioned by the variation in the quantities, although the specific gravity of each wort, distinctly, is the same as in the former example.

This shews the necessity of attending scrupulously to the quantity of each wort, in forming our average, or mean. Since we find the difference in the two cases to be very nearly 6 *per centum*. The preceding rules for discovering the mean density of two worts, are founded on the presumption that the areas of each cooler are equal. But if it should happen otherwise, the medium may nevertheless be found with equal precision, by a proper use of figures. We will suppose the area of the first cooler to be 192 gallons, and

the second to be 175 gallons, the depth in each cooler, and the specific gravity of each wort to be the same as in the first of the two preceding examples; what is the medium value of the whole guyle, or brewing?

Rule. Reduce the contents of each cooler into barrels; multiply the weight of each wort by its number of barrels; add the two products, and divide by the contents in barrels in the whole guyle.

	Gal.	
Wort	192	175
	2.8	2.3
	153.6	525
	384	350
Gal.		
36	537.6(14.93	36)402.5(11.18
	177	42
	336	65
	180	290
	18	2

The question is now reduced to the following state:

Wort.	Barrels.	Sp. Gr.
First - - - - -	14.93	563
Second - - - -	11.18	311
Whole guyle - -	26.11	

Proceed thus :—

	563	311
	14.93	11.18
	1689	2488
	5067	311
	7882	3421
Value of 1st wort	8405.59	3476.98
Value of 2d wort	3476.98	
Divide by - 26.11)	11882.57 (455	the mean gravity of the whole guyle or brewing for strong.
	14385	
	13307	
	252	

The same rule will of course serve, supposing the depths to be changed.

In this case, the mean gravity will be found to be not quite 419. It is hoped that the preceding rules will not appear so troublesome and perplexing, as to occasion their being totally neglected, or to cause the instrument to be brought into disrepute. Nothing is more easily or more expeditiously disposed of, than questions depending on figures, when an habit is once obtained of recurring to figures frequently In the case before us, we have been fractionally exact; principally with a view to obviate any objections which might be urged against the accuracy of our instrument, or of our mode of applying it. But, in actual practice, this is

not strictly necessary. To exemplify this, let us, instead of 14.93 barrels of our first wort, take the quantity to be 15 barrels, (the difference being *not* three gallons in 540 gallons,) and, instead of 11.18 barrels of second wort, take the whole number 11 barrels, disregarding the fractions, amounting to 6.5, or 6 gallons and a half. In this situation, the question becomes exceedingly simple, and answerable by very few figures.

	563		311
	15		11
Barrels.			
15	8445		3421
11	3421		
26)	11866	(456	the mean gravity.
	146		
	166		
	10		

Here we find a difference of 1 only in 456, which is surely not worthy the least notice, in any person's practice.

SECTION VI. *Application of the Hydrometer, in discovering the mean Specific Gravity of three Worts, and in forming Standard Gravities, with either two or more Worts.*

THE preceding examples are founded on a supposition, that the two first worts are intended to form one guyle, or quantity of strong beer; and that a third wort is afterwards obtained from the same grist, or mashing of the malt, of a quality serving for small-beer. This third wort, when put in estimation with the two former, will be found to be in quantity about equal to either one of them; and in quality, as 100, or 120, by our instrument.

In small breweries it may happen, that the demand for table-beer may be in this proportion, *viz.*, one of small to two of strong. In such cases, the former mode of brewing is suitable and advantageous, as providing a proper supply of both strong and small, constantly and regularly. But in larger breweries, generally speaking, the case is very different. Where a very great quantity of strong-beer is demanded, the providing of table-beer is left to those who may find it to be worth their while to make a distinct business or employ of brewing this

sort. Or, if in large breweries it is found necessary or convenient to produce any small-beer, the proportion to the quantity of strong is usually very little.

Where, therefore, a brewery is established on this plan, the quantity of malt mashed at each time is very large; the first extract or wort very dense and rich, and the succeeding two worts, as well as the first, preferable in quality to the extracts produced from smaller mashes. The water being proportionally more abundant in those brewings where it is intended to make strong-beer of two worts, and small of one, than in the brewings we now purpose to treat of; in which the three worts are intended to form one guyle or quantity, of one quality or strength, for strong-beer.

Suppose that from the quantity of malt wetted, and of hops boiled with the extracts, the produce should prove to be,

Barrels.	Wort.	Gra.
42.5	first at	626
44.7	second	364
42.8	third	155
130.0		

What is the mean value or specific gravity of the three worts?

Multiplying the gravity of each wort by its respective quantity, and dividing the aggregate sum by the whole number of barrels, 130, the quotient, 380.8, or say 381, will shew the mean specific gravity of this guyle.

After what has been said on the method of finding the mean value of two worts, it is presumed that this single instance will be a sufficient direction to ascertain the mean of three worts.

A more important consideration arises from the premises; which is, the *application* of the information pointed out to us thus by our instrument. We shall, accordingly, endeavour to shew some of the advantages resulting to the brewer from a due attention to the material information here afforded, by adapting it to answer some desirable and advantageous ends, in the practical parts of his business.

The candid and fair trader cannot but enjoy a very pleasing reflection, when he finds that he has secured to himself the favour and good opinion of his customers.

For this purpose, it is incumbent on the brewer to use such means as a rational theory, confirmed by his own practice, teaches him are most likely to conduce to the improvement and perfection of his beer. But, as it is necessary,

as well for the credit of the brewer as of his product, that this last should, among other desirable properties, be of a sufficient strength to extend the sale of it; so must it be useless, with respect to the consumer, as well as a considerable loss to the brewer, in a deduction of his profits, that he should send out his beer of a quality superior to what is expected or desired by his customers. The position which we here mean to lay down, and which we presume cannot be controverted, is, that *supposing the extent and the degree of the fermentation to be the same, the strength of the beer, in a drinkable state, will be in an exact proportion to the specific gravity of the worts from whence such beer is formed.*

It is absolutely impossible here to fix on such a point of density as may be said to be a true value or standard for any sort of beer. All that can be said on this head is, that a few observations on different guyles will teach the brewer how to adapt the density of his worts to his own price and profits, as well as to the taste and expectations of the consumers.

These being different as the different local trades in this branch throughout the kingdom, we shall exemplify the means of attaining average standard gravities in two extremes, name-

ly, the London porter brewery, in which the length is very large, and the country pale-beer brewery, in which the quantity drawn from a given number of quarters of malt is proportionably much less.

It is to be observed, that we do not venture to give these examples as the actual standard in either case. All that we intend or propose, is to give such explanations as may serve to direct the practitioner to make up his own standard, in any instance which may occur; which standard, as has been observed before, varies with situation and price. Was the author to give here his own real specific gravities, it could be of no service to any one in another part of the kingdom.

We will suppose then, that after a proper variety of trials made, in regard to the palates of the consumers, a degree equal to 450 should prove to be a saleable density for strong-beer, or strong-ale at 40s. per barrel, and that 360 should be a satisfactory gravity for inferior beer; which, as it is charged with the same excise or duty, may perhaps be sold from 30s. to 34s. per barrel. We will, accordingly, call these points, or 450 in one instance, and 360 in the other, our standards of density. And now, in all our future brewings, we must add to the

value of our worts so often as they happen to be less than our standard, and reduce them when their mean specific gravity exceeds the standard *.

As the reduction must be performed by a greater quantity of smaller wort or beer, so the addition of gravity must be effected by a greater proportion of such wort or beer, as is considerably stronger than the mean of that which is deficient.

We shall give an example in each case, and shew that the quantity which may be required, either for addition or reduction, is discoverable with great ease, and to great precision, by the use of figures.

And first, in the instance of two worts intended to form one guyle of strong. Suppose we find the coolers to contain of worts, when sunk to a fermentable degree of heat, or very nearly thereto, 23 barrels of the gravity 558, and 23.5 barrels of the gravity 305. What method is to be taken to improve this guyle, (the mean gravity whereof will be found to be no more than 430,) so much as to bring it to our standard, 450?

* It must be remembered that this was written in the year 1769, and consequently has reference to the prices of that day.—J. H. B.

Either an additional quantity of first wort should be introduced during or subsequent to the fermentation, or else a certain portion of the second wort should be kept back, just as may be most convenient to the brewer's peculiar process, or to the construction of his office, and number of utensils. To know how much of the second wort should be reserved, the following rule will direct:—

1st. Find the difference between the intended standard, 450, and the gravity of the second wort, 305.

2d. Find the difference between the mean of the present brewing, 430, and the second wort, 305.

Multiply the length, 46.5 barrels, by the smallest difference, and divide that sum by the largest; the quotient shews what must be the quantity of the guyle; and the difference between this quantity and the length, 46.5 barrels, is the quantity of second wort to be reserved.

Work 450 required mean.
305 second wort.

1st dif. 145

Bar. 46.5
125

Bar. 125 2d difference.

430 present mean.
305 second wort.

145)5812.5(40.08

6.42 of the second wort to be reserved.

46.5

The guyle will then consist of 23 barrels, of 558 specific gravity, and 17.08 barrels, of 305 specific gravity.

To prove the rule and the work, see what will then be the mean:

558		305
23		17.08
12834		5209.40
	Add	12834
Divide by	40.08)	18043.40(450 the mean.

A question now follows, *viz.*, How this quantity of 6.42 barrels of wort, of 305 gravity, is to be disposed of, or what use is to be made of it?

It may be fermented by itself, and reserved as the means of reducing some future brewing, perhaps the operation of the very next day, which might be purposely performed with a less allowance of water, with a view to bearing such a proportion of inferior wort.

If, therefore, the produce of the next ensuing, or any future process, should prove to be 22.3 barrels of the gravity 604, and the like quantity of a gravity 336; the mean of such a guyle would be 470. Let us then see how much of our wort, of the gravity 305, not before

disposed of, these 44.6 barrels of 470 will bear, so as to leave the guyle of a value not less than 450.

Rule. Find the difference between the standard 450, and the reducing wort 305.

2dly. Find the difference between the mean of the present brewing 470, and the wort 305.

Then multiply the length 44.6 barrels by the largest difference, and divide by the smallest; the quotient shews what must be the quantity of the whole guyle; and the difference between this quantity, and the length 44.6 barrels, must be supplied from the reducing wort.

450 required mean.
305 reducing wort.
——
145

Bar.
44.6
165
——
2230
7136
——
Bar.
145)73590(50.75
44.6
——
6.15 of 305 gravity.

470 present mean.
305 reducing wort, or
—— beer
165

The guyle will then consist of 44.6 barrels, of 470 specific gravity, and of 6.15 of 305, which brings the mean to 450, as proved by the following work:

Bar.
44.6 × 470 = 20962
6.15 × 305 = 1875.75
50.75 divided in - 22837.75(450 the mean.

It is presumed that these two examples will suffice, in directing the brewer to form the standard specific gravities, with two worts. The addition of the improving or reducing wort may, as has been before observed, be made either in the fermenting ton, or by a due division of the whole quantity among the casks, according to their contents, when in the cellars*. This must be left to the brewer's own judgment, as depending on, and varying with, the particular circumstances of his trade, and conveniency of his utensils.

Indeed, it may be asserted, once for all, that to make any use of the instrument on any one occasion whatever, an habit of attention, no less than a perfect knowledge of the principles and practice of arithmetic is absolutely necessary.

But it may, at the same time, be said, that no part of this is difficult, or that at all events, the whole of it may be speedily obtained by due industry and application, accompanied with a moderate share of skill and ingenuity.

We shall now proceed to point out our method of forming standard gravities, with three worts.

* Supposing such wort to have been already fermented.

Suppose that from any given quantity of malt and hops, the produce in coolers, taking out samples of each, and bringing them to the temperature 55 degrees of heat, should be

	Bar.	Grav.
Wort 1.	39.5	622
2.	43.7	316
3.	45.8	118

The specific gravity of each wort being multiplied by its own quantity, and the sum of the whole being divided by the total number of barrels, 129, the mean density will be found to be 339.

Now, this being a quality not likely to prove perfectly satisfactory to those consumers who have been accustomed to malt-liquor, formed from worts of the density 360; so much of the third or lowest wort (of 118) must be kept back, as will serve to leave the remainder of the guyle at the standard 360. The quantity to be reserved is shewn by the rule before given, reversing the operation.

360 required gravity. 339 present mean.
118 third wort. 118 third wort.

1st. dif. 242 Bar. 129 221

242)28509(117.8 barrels at 360
11.2 ditto 118

129

The guyle will then consist of the following component parts, *viz.*:

39.5 barrels at		622	24569
43.7	ditto	316	13809
34.6	ditto	118	4082.8
117.8 which when divided in			- 42460.8 shews 360
With 11.2 barrels at 118 reserved.			

These 11.2 barrels of third wort are of a very suitable quality for small-beer. And, indeed, as almost every public brewery has some occasion for small-beer, a more convenient mode, to produce a supply, cannot perhaps be adopted than to make long lengths (as is the technical term) with a view to reserving just so much of the last wort, for small-beer, as may be found to be requisite to the bringing the two former worts to our standard, whatever that may be*.

To reduce the aggregate value of three worts, when their mean exceeds the standard determined on, either an additional quantity of inferior wort must be introduced, or a part of the strongest extract reserved. Taking, therefore, our example, page 42, as the subject of our operations, let it be required to say what

* If this method should not be approved of, less quantities of water in the second and third extracts of the future operations of the season will, of course, bring the three worts nearer to the standard.

quantity of wort, such as we last reserved, (of 118) must be added, or what quantity of the first extract of our present example (of 626) must be deducted, to reduce the mean of these three worts 381, to the standard 360.

360 381
118 118
— Bar. —
242 130 263
130
242)34190(141.28
130.
11.28 of 118 must be added.

The exact mean will be then found to be 360.

Or 626 626
360 381
— Bar. —
266 130 245
130
266)31850(119.73, or say 119 barrels $\frac{3}{4}$.

10.26 barrels, therefore, must be deducted from the first wort; the guyle will then consist of the following parts:

		Grav.
32.24	of first wort at	626
44.7	second	364
42.8	third	155

119.74 the mean whereof will be found to be 360.67.

The inconvenience and trouble attending the disposal of the reserved wort may be urged, perhaps, as a strong objection to the whole of our system, by those who may entertain such an aversion to trouble of any kind, as to choose, on that account, to trust to chance, rather than by rule and method to obtain precision and certainty. It is to be expected, that all our recommendations of the instrument, as well as all our directions as to the application of it, will be wholly thrown away on this description of persons. In large and extensive breweries where the operations are daily, this trouble will be proportionally greater than in smaller trades.

But here it might be exceedingly well worth the proprietor's consideration, to appropriate a fermenting ton, of a size suitable to the occasion, for the purpose of receiving the surplus of worts, in either or any case. And, it might frequently happen, that thus the surplus of one day may serve to correct the deficiency of a former, or succeeding guyle.

But this is one of those circumstances which (as has been said before) must be left to the brewer's own determination and contrivance. Another and more forcible objection may be

made against that method of reduction, which governs our last example; namely, the reserving a part of the first extract; inasmuch as we thereby deprive the remainder of the guyle of a considerable portion of the most nutritious, most balsamic, and most highly-flavoured properties, both of the malt and hops. This, as we have said, is an objection truly forcible. And, therefore, the method should not be practised, without great necessity, which will seldom be found to occur, to an ingenious operator. At least, if it happens once in a season, from the unexpected richness and good quality of the malt, the intelligent brewer will take care to provide accordingly in future, or so long as he is using the malt of that season, and so far as he can judge of that value, by employing a greater abundance of water in the second and third extracts. For any thing farther on this part of our subject, we shall refer the reader to the remarks we have made on occasion of reserving 11.2 barrels of the third wort, in our example of improving the mean specific gravity of a guyle, page 52. Adding only thereto, that this is, in our judgment, the method of all others hitherto recommended for applying the instrument. the most

practicable, the most accurate, and the most beneficial*.

Section VII. *Use of the Hydrometer in discovering the precise Value of different Mashes, or Parcels of Malt.*

The hydrometer, by discovering the mean gravity of the worts, points out to us a method of ascertaining the whole value of the mash, or parcel of malt, employed in producing such worts; and thereby the exact value, to one penny or less, of each quarter composing such mash,

* Since this was written several methods have been proposed, and are practised, for reducing the mean density, when it exceeds the intended standard; almost any of which are preferable to that which is here suggested, namely, keeping back a portion of the first wort; but, we must bear in mind the length of time since this was written, and that our author lived to alter his practice very considerably in this respect. The best method of improving the density is by using a less portion of the third wort, whilst the best method of reducing it when it exceeds the acquired standard is, by adding a portion of a weaker beer from a former brewing, or of liquor to the worts before they are struck from the copper; but no general rules can be given; the intelligent brewer must use his own discretion, and practise that mode which local circumstances may point out to his judgment as the most proper for him.—J. H. B.

or whole grist. The method is, to reduce each quarter of malt to a certain produce of density, by dividing the whole sum or value of the mash, by the number of quarters used.

Suppose, that from 20 quarters of malt we should extract a guyle, containing 44.6 barrels of 425 specific gravity; what is the value of each quarter of malt, indicated by the sum of its density?

Rule. Multiply the gravity 425 by the number of barrels 44.6, and divide the product by the number of quarters of malt employed, 20.

425
44.6

2550
1700
1700

Divide by 20)1895.50 amount of the aggregate value of the whole grist.
947.75 density of each quarter.

Again. Suppose that from the same quantity of malt we should obtain a guyle of 45.4 barrels of 466 specific gravity; the density of each quarter will be then found to be as 1057.8. Now setting the price of the malt used in the latter example at 36 shillings per quarter, what price ought to be given for a quarter of that

malt, the sum of the density of which is only as 947.7? say

If 1057.8 — 36 — 947.7
36

56862
28431

s.
1057.8)34117.2(32.25

Thus we find that 32.25, or 32 shillings and three pence, is the precise value per quarter of one lot or parcel of malt, when put in estimation with the other sample, which was to be purchased at 36 shillings the quarter. The same rule will serve in all instances. And we can with confidence assert, that such a difference as we have here specified, is to be discovered almost every season, in malts apparently nearly equal in value, as judged of only by the usual and common modes of examination; and when, consequently, the difference in their prices is so trifling, as to bear no proportion to the difference in their intrinsic worth. Placing our two samples or parcels of malt in another point of view, and inverting the sums of their densities, we learn that 947.7 quarters of one quality are equal in the production of wort or valuable matter, to 1057.8 quarters of

the other, or that nine quarters of the one are as valuable as ten quarters of the other.

But, supposing that the two mashes or parcels of malt, which were employed to produce the two preceding guyles of this different density, were, nevertheless, taken from one and the same heap, or large parcel of malt.

We will go farther, and conclude that this whole heap of malt was made from a quantity of barley, the produce of one and the same farm; that the process observed in malting each different wetting and floor of this corn, was as nearly as possible the same; and furthermore, in order to render this whole parcel of malt perfectly equable, suppose that a proper number of persons were employed to screen and throw the whole to and fro, so often as to mix and unite the whole most intimately and uniformly.

In such a case, to what shall the brewer impute this material difference in the density of his worts, and the yield of his malt?

Is it not obvious, that he must have varied in his operations during some part or other of his process when brewing?

Will he not accordingly refer to the book where we conclude (if he acts prudently and rationally) each part of the process observed

in every day's brewing, is exactly and constantly noted and minuted?

Will he not there principally and most attentively examine what were the several degrees of heat at which his different quantities of water were turned out of the copper, for the mashes; what were the calculated heats of these mashes, and what the actual heat of each tap when running; and how far these calculated and actual heats differ?

Thus, though it must be by the use of a thermometer only, that we can *obtain* any required heat for the different mashes, (a part of the process of brewing, which is universally allowed to be of the utmost consequence,) yet is it manifest, that the hydrometer is the best *guide* to direct us in the discovery of this very capital and important desideratum, the most profitable degrees of heat for the mashes; by shewing, as we see, the different effects of different degrees of heat.

And surely we may hence very reasonably conclude, that by a due attention to the circumstances of different brewings, (we mean of such brewings as are regulated by a thermometer,) and by an observation of the different effects of varying operations, as ascertained by the hydrometer, the brewer may, in due time, hope to

arrive at such precision in his art, as will make him ample amends for any application or pains, which may be necessary.

Section VIII. *Of the different Kinds of Hydrometers.*

The preceding rules are formed on the scale of Mr. Martin's hydrometer; but they are just as applicable, and that with the greatest ease, to any other hydrostatical instrument.

This leads us to speak more particularly than hitherto, of the various kinds of hydrometers now made. Some of them, by their makers, claiming the merit of being single in utility, and condemning all the others as totally inefficient.

Whereas the fact is, that they are all or any one of them, provided they are well finished and perfect of their kind, fully competent to their proposed end. The principle of their operation not admitting of any considerable variation in their form; and the difference among them all consisting principally in the scale, or in the sum of their indications.

In the construction of this instrument, the first thing required to be done is to adjust it,

so as that it may sink to very nearly the top of its upper stem in rain-water, at a certain temperature of heat to be determined on by the maker. The whole length of this stem should be equal in estimation to the smallest of all the designed weights, and graduated in a certain number of divisions, amounting altogether to the difference in value between the lowest and the next increased weight. Suppose the lowest weight should be estimated as 10. The difference between the top and the bottom of the upper stem should be equal to this weight. The intermediate gradations on the stem will then serve to shew by due notations and divisions being made thereon, the* tenth parts of this smallest weight, as the addition of weights placed on the cup or top of the stem shews by the sum of such weights the whole value, or specific gravity of the subject.

When the instrument is so adjusted as to sink to the top of the stem in *rain-water*, every other water to which it may be applied will occasion it to rise by just so many divisions or

* By noting the distance between any two of the divisions where the instrument may fix, we are shewn the specific gravity of the subject to the *twentieth* part of the stem; if curiosity, or any other motive, should at any time induce us to be so exact.

tenth parts of the stem, as such water may be inferior to rain. And, as every other water *is* inferior to rain-water, hereby the local differences in water are found most precisely. Should it happen that any water should be so heavy as to require a farther power to sink the instrument to some part of the stem, the small weight before mentioned then serves to represent ten additional notations or divisions.

Having thus found the specific gravity of the water employed in brewing, and deducted the sum of its weight from the specific gravity of each wort respectively, the remainder shews, by the same scale, the density or specific gravity obtained in such wort or worts from the malt.

Now, whether this scale or sum is expressed by any fixed and definite term, as grains, ounces, or pounds; or whether it is pointed out to us by a simple number, without any other meaning than the relative proportion of 100 to 500, or to 1000, must be a matter of the most perfect insignificance to us. For, where can be the difference in the conclusion or inference, whether we say that the specific gravity of a wort, or the average of two or more worts, amounts to 25 ounces of fermentable matter; or whether the acquired density is indicated by

a certain number or sum, as 200, 300, 350, *&c. &c.?*

As a proof that the hydrometers made by various hands are, or may be rendered, equally serviceable, the author has occasionally used no less than five, all differing in their scales, but each of which he has, in a short time, with little trouble, and to great or fully sufficient exactness, reduced to one and the same sum of indication. He has for several years past used Quin's hydrometer; still noting the value or specific gravity of each wort, in the same terms, and by the sum which the same wort would cause Martin's instrument to express. The reason for which is nothing more than his having long been in the habit of determining the aggregate value of a given quantity of malt, by the scale of Martin's hydrometer. Which scale, as it is thereby become familiar, more readily gives him a reference to the comparative value of the same quantity of malt, made from barley of the present or any preceding year.

The accuracy of any hydrometer is to be proved most easily, and most effectually, by mixing equal quantities of two worts, both of which have been previously weighed by the same instrument. For instance, if the specific

gravity of a first wort is exhibited by the power 600, and of a second wort by the force of 300, equal quantities of the two would require just 450, to sink the instrument to the same point in their mixture, after it has been duly agitated to make such mixture complete.

This, therefore, is a certain criterion of the goodness of the instrument. And if the respective weights are graduated as they ought to be, the event will answer most precisely.

It may, perhaps, be somewhat amusing to the reader to be told, that this was the objection which Mr. Martin himself urged to the author against his own instrument. But the truth of the proposition appeared to be so self-evident, that the author had never troubled himself to make any trial of it. Startled, however, at what had been said, he stated the matter to the gentleman formerly mentioned, who the next day furnished him with the means of determining it, by directing proper quantities of a first, a second, and a third wort, to be set apart in a due state for the purpose; when, after assaying each separately, the mixture discovered, to a five hundredth part of the whole, the expected medium of the different worts; thereby proving the extreme accuracy of that very hydrometer, which its own maker had

endeavoured to depreciate *. The success of such an experiment as this must therefore be conclusive, as it must be sufficiently and fully satisfactory to the brewer, whichsoever hydrometer of the various kinds now made he may think proper to employ.

If the weights appertaining to any of these instruments are formed exactly true, and there should, nevertheless, appear a trifling difference between the calculated and the actual specific gravity of a mixture of worts; this may be imputed to the force of attraction or adhesion, occurring in this instance mostly, if not exclusively, in a first wort; which, in brew-houses where large quantities of malt and hops are used in each operation, is usually exceedingly dense. And thus, on immersion of the hydrometer in such an extract, some of the particles of this wort, adhering to the stem of the instrument, from their glutinous property, are apt to destroy the accuracy of the observation.

To remedy this inconvenience, a mixture of such rich and dense wort with a second or third extract, previously weighed, is effectual.

Whatever inaccuracy may remain after this decision, if carefully and skilfully performed,

* See Mr. Thrale's Declaration, so frequently alluded to. J. H. B.

may, as has been before hinted, serve to amuse or to employ philosophers, but is wholly unworthy the attention of the practical brewer.

Much of the accuracy of the instrument depends on the keeping every part of it, together with the weights, scrupulously clean and dry; it should always be carefully washed, and wiped with a clean soft towel, after it has been used *.

The variations occasioned in the specific gravity of the same wort, or liquor of any kind, by the different temperatures of heat, are to be noted; and additions or deductions are to be made, according to the tables of heat usually delivered with each instrument; which tables are generally sufficiently accurate, as the variations need never be considerable. Their truth may, however, be readily proved by the brewer's own experience and observation.

* I have seen some good brewers so inattentive in this respect, that their hydrometers are constantly tarnished and foul; of course, when this is the case, all accuracy and reliance on the instrument are at an end—and it is no longer capable of those nice indications which the subject requires.—J. H. B.

Section IX. *On Barley and Malt.*

The frequent and material disproportion which is by our instrument discoverable in the produce or real value of the malt made from barley, the growth of the same neighbourhood, perhaps of the same parish, arises principally from the inattention of the farmer to the state of the barley while in the field. Immense is the injury sustained by the consumer every year, from the misconduct of mowing this kind of corn a very few days before it is arrived to perfect maturity. The single and trifling circumstance of having no other immediate employ for a labourer, whose weekly pay and subsistence do not perhaps exceed twelve shillings, often outweighs every other consideration, to the excessive damage of the corn, and to the proprietor's own considerable loss, ultimately, by a deficiency in the yield or measure.

How strange does it appear, that people more attentive generally to profit than to every other concern, should escape the discovering that they sustain more injury by a servant's labour in such a case, during a part only of one day, than is to be equalled by the whole amount of his wages for the week.

Some part of the inferiority of barley is likewise owing to its being carried from the field before it is perfectly dry or withered. And, even if it should have been sufficiently ripe before it was cut, and no rain should have fallen on it afterwards, such haste, by weakening its vegetative properties, lessens the quantity of sweet or fermentable matter otherwise obtainable from its malt.

The instrument of which we have been treating, although it cannot pretend to teach us how to avoid such inconveniences, in the first instance, will, most assuredly, in the event, afford such important information as cannot fail to direct us in selecting those farmers, who, as sellers of barley, are, on account of their industry and skill, most deserving of the brewer's encouragement and attention.

Thus, if we brew to-day with malt made from barley purchased of one farmer, and to-morrow with malt the produce of another man's corn, should we find any considerable difference in the yield of the two brewings, (the malting of both being, as nearly as can be judged, similar,) hereby is afforded a direction as to the price to be given for each barley; or if, which is very probable, no difference can be obtained

in the price, the brewer will of course know which to prefer in future.

It has sometimes happened, that at the commencement of the barley harvest, a few days of very fine weather have been followed by a continuance of rain for some weeks, hence the barley has been exceedingly different in appearance; but, owing to the first part of the produce being cut some days before it was ripe, we have known an instance when the intrinsic difference in value, between the bright and the stained barley, was not more than 1s. 6d. or 2s. per quarter, although the difference made between them in price, in the markets throughout the season, was 6s. or 7s. per quarter.

This case happened within the very first year that the author had provided and turned his thoughts to the use of an hydrometer; which, therefore, was serviceable to him to the positive amount of four shillings per quarter on the remainder of his purchases of barley, during that season, or after he had, by the use of the hydrometer, according to the preceding rules, informed himself of the actual and precise value of each sort.

This was in some measure the case, likewise, with the barley, the produce of the harvest

1782. The very small portion whereof, which was free from stain, selling at a greatly increased price, compared with what could be obtained for the far greater part of the barley of that year, which indeed was remarkably dark and damp. But that which fetched the highest price was very thin, light, and unripe; consequently, the malt was very poor and unproductive.

In the beginning of that season we made some malt, which, estimated with the produce of the year 1781, was only as 29 to 54, which is an inferiority in the quality only (and not to mention the advanced price of the barley) of 46 per cent.

This however was particular; but the average value or produce of our malt in 1782, compared with the malt made from the barley of 1781, was as 39 or 40 to 54, which is an inferiority of 26 per cent.

It may be fairly presumed that this extreme difference was pretty general throughout the kingdom. Notwithstanding which, the brewers, for the most part, drew longer lengths from the malt of that bad season, than had been attempted when the quality was so much superior as perhaps to have borne such increase of quantity. This was done with a view to make

themselves some amends for the extreme high price of this malt; what then must have been the condition of the beer?

That there was a necessity either for an advance in price, or for a reduction in quality, must be allowed; but the measure of such reduction could be known only by the use of an hydrostatical instrument; because the difference in the quality of the malt, compared with the produce of former seasons, was greatly beyond what was generally imagined.

Section X. *On the Thermometer.*

Although it was not a part of our present plan to say much of the thermometer, yet frequent mention having been unavoidably made of that instrument, the use of which is necessarily involved in our present subject, as well as in other material parts of the process of brewing, it may not be superfluous to take a little farther notice of it; more especially since, notwithstanding the extreme usefulness of the thermometer is now generally known and acknowledged in the brewery, it will still be said by some, that much better beer is brewed in private families, or, as it is more commonly

called, in the home-brewed manner, without a thermometer, than is obtained by the public brewer, with all his instruments and all his art. And that, moreover, a thermometer appears to be wholly useless as to the extraction or mashing, since the boiling heat, without which some people persuade themselves they shall never procure any malt liquor which will be drinkable, or keep sound even for a few months, is discoverable in water by the eye, on the first instant that the fire has brought it to that point.

We shall answer such remarks by an assertion, which we will be confident to make, namely, that the indiscriminate use of boiling water only, applied to the malt, is an absolute waste or loss of one-fourth, and in many cases of a still greater part, of all the malt that is so treated; or that, in other words, three portions of malt wetted with water of the *proper* degree of heat, will positively produce as great a quantity of wort or beer, of any certain required strength, as can be obtained from four like portions of the same malt, if wetted with all boiling water; which, instead of extracting the valuable properties of the malt, hardens it into balls and clods, and prevents it from yielding any other extract than such as to resemble

whey, and, though turbid, greatly deficient in sweet, which is the valuable matter. For, heavy to the eye, and thick, as such a wort may be, it will be found to be of much less specific gravity, as well as less in quantity, than that which is to be obtained by a more mild and gentle infusion, which, provided the heat is proper, that is, neither too high nor too low, both of which are equally to be avoided, produces a wort clear even to transparency, rich and sweet to the taste, and duly tinged with the colour of the malt, according to the degree of heat which was observed in drying it on the kiln. The product also, provided the other parts of the process are conducted as they ought and may be, will in one instance be perfectly fine and bright at the end of a very few weeks, and continue in a state of preserv - tion or soundness as long as can be needed or required. Whereas, in the other case, the beer will have no tendency to clearness for several months; and should it eventually become bright, it will probably be harsh and stubborn to the taste, and heating and unwholesome in its effects.

This last consideration is the only one that may be likely to have any force. With the private brewer, whose humour may lead him

to wish to excel his neighbours in the occasional production of this liquor at table, the cost of it is seldom much regarded. If ten bushels of malt are not found sufficient to obtain an hogshead of very stout beer, twelve, fourteen, or sixteen bushels are allowed. So likewise, if the beer does not become fine at the end of ten, twelve, or fifteen months, it is suffered to stand untouched for the space of eighteen or twenty-four months; and the age of the beer, which is in fact nothing more than the consequence of ignorance, is then mentioned as one of its strongest recommendations.

The case of the public brewer is extremely different: under all the disadvantages of an high price for barley or malt, and loaded with an heavy excise on his beer, he is required constantly to produce a clear and nourishing liquor, at such a price as will enable the retailers to sell as cheaply as was done in most parts of the country sixty or eighty years ago, when the prices of corn and the attendant charges did not amount to one-half of the present cost. He cannot, therefore, afford to be regardless either of a waste of malt in the outset, or of a loss of time in the consumption of his beer. The sooner this can be rendered

saleable, the less will be the weight on the brewer occasioned by his stock; which, although it is in all cases in this business unavoidably great, may be made to vary, so as effectually to answer every fair and desirable intention, simply by using proper heats in the two most important parts of the process of brewing, extraction and fermentation.

And these heats, which are also to be various as the different kinds of malt used, as the seasons of the year, and as the intentions or views of the operator, may be obtained at all times by the thermometer, to the utmost precision and exactness. Yet it is not to be expected that every one who uses a thermometer can benefit by it, to any considerable degree, at the first. Put a watch into the hands of a person who has never been used to a time-piece, and he cannot tell you what is the hour. Here, however, is the best field for obtaining such right information from experience as is not otherwise to be expected; for the boasted experience of practitioners, in common, is founded on no kind of rule or basis. The eye or the touch can afford no tolerably certain direction as to the heat of water below the boiling point, or as to the heat of worts, otherwise than according to the accidental warmth

of the finger at the time it is applied. The natural heat of the human body, in health, is 96 degrees by Fahrenheit's thermometer. In the summer months, the touch applied to worts somewhat below that degree will indicate them to be cool, when, perhaps, their actual heat may be such as to be very unfit for the purposes of a profitably vinous fermentation. On the other hand, the external air, in severe weather, being at or below the freezing point, a vapour will be seen to ascend from worts, and the extremities of the body being also at such time most liable to be affected by the cold, the finger may likewise then discover a *comparative* warmth in worts, although they may be sunk considerably below that heat which might be requisite to excite and sustain a due and complete fermentation.

Section XI. *Application of the Hydrometer in directing the Extraction and Fermentation of Sweets.*

We have said that the hydrometer is of great service to all who are interested in forming liquid extracts, of whatever denominations. The process of brewing for the malt distillery

being exactly similar to the brewings for ale and beer, excepting that in the former the hops and of course the boiling are omitted; what has been observed, relative to the forming average or standard gravities in the brewery, will apply also to the malt distillery, as well as to making vinegar from malt.

In the business of sweets the case is different. The extract yielded from the usual subject, dried fruits, is obtained not altogether by infusion, but in some measure by the operation of fermentation. That is, after the water and the fruit have been so long together, as that some portion of the sweet is extracted, this extract being fermentable matter, a fermentation arises spontaneously; which fermentation acts with increasing force on the sweet remaining in the subject until the whole is extracted, as is proved by tasting the husks, which will be found to be vapid, and void of all sweetness. At this crisis the liquor should be drawn from the fruit, in order to its becoming completely vinous by such farther fermentation, time, and different rackings, as experience or the particular circumstances of the wine itself may appear to require.

This being, we believe, the process commonly observed in the making of wine from

sweets, we will venture to propose a method of applying the hydrometer herein, which appears to be practicable to considerable advantage.

The weight of the water being first ascertained, and the fruit having been infused therein a few days, it may be proper to draw a sample of the liquor or extract, and, taking the specific gravity thereof, to note it in a book kept for the purpose. Suppose, according to the scale which we have all along observed, the density acquired in this time should prove to be as 100 by our instrument—suffering the whole to remain two or three days longer, we shall perhaps find it to be as 200, on drawing and examining a like sample. Proceeding in this manner to make observations on our subject every two or three days, we shall probably find the specific gravity thereof to be in a due time as 18 or 20 days, as much as 600. The matter now becomes critical; and, therefore requires examination every twelve hours. Should we at length obtain such a density as 700, and at our next examination (twelve hours afterwards) find that the specific gravity is sunk down to 680, or in short to any number less than 700, are we hereby taught that the extraction is completed, and that the only proper office now remaining for the fermentation, is to attenuate

the extract so much as to produce a perfectly clear and truly vinous liquor; which purpose is from this time effected to greater advantage with regard to flavour and preservation, if, as before mentioned, the liquor is drawn from the husks, which can now communicate no property in the smallest degree desirable or advantageous *as to the wine*. Whether they may serve for any other purpose worth attention, as the making of vinegar, or assisting thereto, is another consideration.

The application to be made of these examinations of the liquor during its continuance on the materials employed, (but more especially of the *last* examination) is analogous to the inferences which we have drawn from the specific gravities of worts. As we are *there* taught the precise value of different lots or parcels of malt or barley, together with the means of having our beers uniform in strength; *here* we gain a clue to discover the precise value per hundred weight of fruits of all denominations, together with the opportunity of making up sweets or the wines from them, to any required or standard strength; which, as in the case of beer from worts, will be found to be in an exact proportion to the *highest gravity*, ever discovered in the different infusions or extractions.

The liquor or extract, thus impregnated with all the sweet obtainable from the fruit, and being separated from the husks or skins by racking, is now in a very high state of fermentation; which continues until the fermentable matter is thereby so far attenuated, as to change from sweetness to vinosity. Here again is a field for advantageously employing an hydrometer; first monthly, and after some time weekly. The gradation is, however, reversed; for in proportion as the sweet is lessened, the liquor now becomes more spirituous, and therefore lighter; which effect will be progressive, as the instrument will demonstrate, until the liquor *(then wine)* is reduced in gravity to an equality with, or a trifle less than water.

When the fermentation, however, has proceeded so far as to reduce the specific gravity from its highest point down to 150, or 100; it is prudent that the wine should be a second time racked from its lees, as well to give it an opportunity of fining more effectually, as to restrain in some degree the fermentation. Which might otherwise proceed from the vinous to the acetous, and thus produce vinegar instead of wine. Yet the moderate check which it receives from this second racking is not sufficient to destroy the desirable attenuation of the

remaining sweet. So long as any portion of that exists, the fermentation will continue. But, in the instance we are now putting, the operation will be so gentle as to contribute to the soundness and preservation of the wine, no less than to its clearness and spirituosity.

This method of regulating the fermentation of sweets by the application of an hydrostatical instrument, will be found to take away the necessity of adding spirits, in order to preserve or improve them. Which practice, although it is very common, is not only uselessly expensive, but also highly injurious to the flavour of the wine, and perhaps to the health of the consumer. It has, accordingly, more than any other cause, tended to bring these wines into the disrepute they generally lie under. The spirit usually introduced herein is British, and probably not always the best even of this sort; but is new, coarse, and fiery; communicating to the wine a disagreeable flavour, and a mischievous quality.

Would those housekeepers, who undertake to form this liquor for their own table, give themselves the very small trouble to make an arithmetical calculation, as to the difference in expense attending the addition or omittance of spirits, they would discover that the cost of the

portion (required to have an effect of any kind) of the cheapest brandy, would serve to present to the wine an increase of fruit, amounting to nearly two pounds per gallon; and the product of such an extra allowance of the fruit, extracted and fermented with skill and assiduity under the guidance of an hydrometer, would not fail to remove the prevailing notion that this wine is not to be made without the addition of brandy, as well as the common prejudice against it as an unwholesome liquor.

APPENDIX.

IT was very much our author's wish to avoid all occasion of noticing a late publication on the preceding subject. But, as that work may, by some, be thought to have precluded the usefulness of the present treatise, it becomes incumbent on us to make some remarks on the differences which will appear in our mode of forming average standard gravities (which is the foundation of the principal advantages to be derived from the instrument,) and in that method which is recommended in the Statical Estimates.

It may be observed from all that we have hitherto said, that in *principle* we agree with that author most entirely; in *practice* we differ from him very materially.

It is no more than justice to Mr. R. to say, that his last and former publication shew him to be possessed of more knowledge in the brewery, than any other person who hitherto appears to have written on the subject. His instrument likewise may, with some alteration, be rendered as proper for the brewer to adopt, as any other of the kind.

But, with regard to that part of the saccharometer, which is the only novelty of it as an hydrostatical contrivance, the regulator, impartiality demands of us to say that this may be dispensed with, even to the improvement of the instrument, as well with regard to accuracy as to the convenience and despatch of its application.

Having gone so far as to assert this, it will be required of us to explain our reasons for entertaining this opinion; and also, to propose some other means for discovering the differences in water, which is a circumstance allowedly essential. This then may, in our judgment be done effectually, by making the lower stem of the saccharometer fixed as the upper, and by having the whole instrument so adjusted as to sink to $^{b}\ominus$ (fig. I. in the plate engraved for the Statical Estimates) in rain-water.

Every other water will then occasion the instrument to rise in proportion as such water is heavier than rain*; whereby the differences in water might be found most precisely. And thus the regulator, which is a great incumbrance, would be rendered unnecessary.

To this it may be added, that, notwithstanding

* Vide page 62.

all the care and skill of the maker (which are not to be disputed,) it appears to be scarcely possible where the instrument is daily or much used, to prevent the regulator from being moved from its station, by very slight and unavoidable incidents.

For the friction, by frequent use, will be found to wear the piston and the tube, so much as to occasion the movement we have just mentioned. And, when this is the case, it can no longer be expected that they should be perfectly air-tight, as they are intended, and to be useful, most assuredly ought to be. If it should be asked how we can judge of the practicability, or otherwise of constructing any part of the instrument, we must answer, that our observation in this case is drawn from what we have experienced in a saccharometer; which, we doubt not, because we were so assured by the maker, was one of the best that had been constructed.

But a still more exceptionable part of Mr. R's. system, is his method of forming average and standard gravities. All the philosophical nicety and attention which he has bestowed on the regulator, even if they were of any use, are much more than counterbalanced by his manner of determining this, which is the grand essential point. It is beyond measure sur-

prising that a person of Mr. R.'s knowledge should have been so much mistaken, as to neglect a plain and easy road, and to be found wandering in the paths of doubt and uncertainty. What occasion can there be for the brewer, in order to learn the average gravity of the day, or to form the standard density of his guyle, to perplex himself with the gravity of his worts, in the under-back, or copper? Or why trust to what is supposititious, when he may, with less than a tenth part of the same time and trouble obtain a certainty? Why, instead of making a great variety of trials on the worts in the copper, and depending on calculations as to the quantity to be evaporated, and as to the expected final density of his worts; why not wait for their *actual* density when in the coolers? At which time also, *and not till then*, the quantities of each wort may be precisely ascertained; without which, all decisions as to the average gravity must be vague, and in no case to be relied on.

It may be said that the whole business is rendered certain by means of tables and calculations, formed on purpose to ascertain the final quantity and quality. We forbear to say much on this head; because Mr. R. acknowledges that these calculations do not always corre-

spond with the event. Nor is it probable that they would serve as directions in all other offices or situations, even if they were less fallible in that brew-house, where they were first formed.

In forming average standard gravities, either with two or with three worts, the foundation of Mr. R.'s system is to reduce the quantity of the last wort by evaporation, so much as to leave the quantity as well as quality, just such as will serve the intention.

Thus, in the case of a guyle compounded of two worts for strong, fixing the average at 29.8 pounds per barrel, and finding the specific gravity of the first wort to be 34.25 when cool; the second wort, on a supposition that their quantities were to be finally equal, must be of the density 25.35, to produce such average.

Now, this second wort when raw, proving to be no more dense than as 17.6 pounds per barrel, (but being improved by the hops and the first wort retained in them to 20 pounds per barrel) must be evaporated, by boiling in the copper such a length of time as serves to bring it to the density required, or 25.35. This is to be effected by evaporating 7.4 barrels out of 29.4 barrels.

Of these 7.4 barrels, 5.4 barrels are to waste

in the copper; the remaining 2 barrels are supposed to evaporate in the passage of this wort from the copper to the cooler, including its continuance therein.

Again, in the case of three worts intended to form one guyle, fixing the average at 25.55, and finding the amount of two parts (the two first worts) to be as above, 59.6; the third wort, on a like supposition that the final quantities are to be equal, must be of the density 17.05, or say 17, to produce such average.

This last wort, therefore, which, while raw, goes into the copper at a gravity of 9.25 pounds, and by the addition of hops and of second wort left in them is increased to 11.5 pounds previous to boiling, must be evaporated by such a continuance of boiling, as suffices to bring it to its required density 17.

In all these cases also, the quantity to be turned out of the copper is to be judged, not by guaging, for that Mr. R. says is here impracticable, but the whole amount of fermentable matter contained in the wort in the copper, being reduced to one sum, or aggregate, is supposed to be fixed; or, in other words, as the quantity lessens by evaporation the quality of the remainder is improved.

Thus, the present wort consists of (including

what is added to it by the hops,) 30.26 barrels at 11.5 pounds; the aggregate or whole fermentable matter whereof is, therefore, 347.99. If, after it has boiled two or three hours, we take an observation, and should find the specific gravity to be 14.5 pounds, dividing this in 347.99, the quotient says that 24 barrels only are now remaining out of the 30.26 barrels which went into the copper. And the brewer is to form his final quantity as well as quality, by means of a frequency of such examinations of his last wort, while in the copper.

The quantity of raw wort which went into the copper, was 30.26, or say 30 barrels and a quarter. To occasion a sufficient increase in the density of this wort, so as to form the average required, no less than one-third part of that whole quantity is to be evaporated.

Let the practical brewer consider well this circumstance, and, passing over the doubt and uncertainty of ever hereby obtaining the precise specific gravity required, let him observe somewhat on the great waste of time, fuel, and of so much of the pleasing qualities of the hops, as may yet remain in them, caused by this method.

Whenever it happens that the worts, all or any one of them, are inferior in gravity to the

example, (which we have taken from the Statical Estimates,) the evaporation of the last wort becomes, necessarily, still greater. And what the produce of the malt may be, no one can foresee, or venture to judge. For our own part, we should be unwilling to speak within five per cent. of the expected value of the malt used in the operation of any one day, previously to having ascertained the yield, when in the coolers, by our instrument.

Putting the case, therefore, that three worts are intended to form one equal liquor, by being fermented together, and that on examining the two first worts, already boiled off, and laying in the coolers, and taking also the third wort in its raw state, in order to attain the means of producing the average gravity required, the quantities and qualities should respectively be found to be as follows: *viz.*,

	Barrels.		Pounds.
First wort .	21.5	at	33.25
Second .	22.	at	24.5
Third (raw)	30.26	at	8.25

Pursuing the method of calculation laid down in the Statical Estimates, we find that the third wort, which in its raw state was no more than 8.25 pounds, must (in order to render the final quality of the aggregate 25.55) be im-

proved by evaporation to 16.9 pounds of fermentable matter per barrel, which will require a decrease in the quantity of 13.86 barrels out of 30.26, or 499 gallons out of 1089 gallons. Of which 499 gallons, 434 gallons are to evaporate while the wort is boiling in the copper, and the remaining 65 gallons are expected to fly off in the passage of the wort from the copper to the cooler, including its continuance therein.

We trust it cannot be said that we have here made an unfair statement, by putting a case, as to the yield or value of the malt, not likely to happen. Neither will the brewer have it in his power to prevent the necessity of such excessive evaporation, by judging previously of the quality of his malt, or by forbearing to apply the usual quantity of water in the third extract, on finding the specific gravities of the first and second worts to be inferior to his expectations. For the third wort, according to the necessary procedure, is wholly run off from the malt, and lodged in the copper for boiling, previous to the examination of the two first worts in the coolers. So that no opportunity is afforded of lessening the quantity, with a view to improve the quality of the extract, otherwise than *by* evaporation, so far as that goes.

The inferiority of the malt in the present example, compared with the actual brewing in the Statical Estimates, is not 7 per cent. And as to the probability of the brewer being mistaken in the previous judgment which he may form of his malt, to such an amount as 6 or 7 per cent., we shall not refer to what we have ourselves already said on that subject, but shall quote the remark of Mr. R., Statical Estimates, p. 73, where, speaking of two specimens of the produce of *the same kind of barley*, under the management of two different maltsters, he says, "In the former there is a superiority over the latter of 9 per cent., a considerable difference, to an amount which, in most commercial concerns, is deemed a fair profit; and yet these two parcels of malt would have passed, among common consumers, with this simple observation, that *this sample is freer than that;* the difference in sale would not, perhaps, have exceeded a shilling per quarter, and the brewer would have thrown them indiscriminately into his mash-tun, drawing his usual length from each, to the positive loss of 9 per cent., either in the quality of his liquor from the latter parcel, or in the obtainable profits of his trade from the former, whichever might happen

to tally with the general quality of the malt he used."

We agree most cordially with Mr. R. in every syllable of the above remark; as we do with him, we can with strict sincerity say, in every part of his book, excepting all that relates to the means of obtaining average and standard gravities, which, we are sorry therefore to observe, is the corner-stone of the whole.

We forbear to comment at large on the method of forming the length, by frequently taking the specific gravity of the last wort in the copper. We believe that very few brewers will trust entirely to such observations in this point, however much they may be assisted by the tables and calculations formed purposely for their direction herein.

We imagine the operator will take a single gauge of his worts in the coolers, which cannot engage him more than a minute, just to note how nearly *this actual* quantity (*which is final and certain*) corresponds with those calculations, the observance of which has necessarily required his previous attendance at the copper-side during several hours.

And what if he should then find (which is a case not at all unlikely to happen) that the ac-

tual event, both as to quantity and to quality, should be widely different from his expectations, as grounded on the tables and calculations?

Would he in such a case, we say, govern himself with regard to his length, and the standard average gravity of his guyle, by this actually final event; or would he finish the operation of the day, not regarding what his quality really and truly may be, but what it *ought* to have been according to the calculations?

To conclude. In all that has been said on the subject of Mr. R.'s saccharometer, and on the method of applying it, we trust that we cannot be suspected of having any other motives than what arise from an earnest desire to render the use of an hydrostatical apparatus less difficult, in order to its becoming general in the brewery.

With regard to the instrument, we have no maker whom we wish to recommend, or to prefer, on any other consideration, than as the instruments themselves may be well finished, and perfect of their kind. In this view Mr. Troughton stands as forward as any one we know, or have heard of. And if the regulator *must not be given up*, let the practical brewer inform himself, by a few observations, what are the

differences occasioned in his worts by the piston of the regulator being shut wholly into the tube. Suppose the difference between the fixing the regulator at the point required to sink the instrument to ♄, and between the shutting it wholly in, should be 0.6, or six-tenths of a pound. If a wort should contain 24.8 pounds of fermentable matter, as exhibited by the saccharometer when the piston of the regulator is quite closed into the tube—the brewer has only to call the specific gravity of such a wort 25.4 pounds, in order to be fully as accurate as he would be by setting the regulator.

As to the method of forming average or standard gravities, it must evidently be a matter of indifference what are the means made use of, provided the end is obtained. Our own general observations during the process of brewing, and indeed an experiment which we made, purposely with a view to judge of the propriety and practicability of excessive evaporations, are not at all in favour of that method. We choose, however, to leave the decision of this matter to the practice and examinations of other brewers, who may, perhaps, perform the operation with more success. Observing only, that although it should be found to be practicable, it must unavoidably be tedious and inconvenient.

And even if the brewer should have so much perseverance as to disregard all other considerations, one still remains which is of the utmost importance in the present concern, namely; the doubt and hazard of ever hereby obtaining the exact average or standard gravity required.

Those brewers, therefore, who may be induced to use an hydrostatical instrument constantly, will, of course, adopt that method which they may severally find to be to themselves most easy, most convenient, and, in the final event, as to quantity as well as quality, most certain *.

* See the note at the end of Section VI.

ADVERTISEMENT.

The Writer of the "Hydrometrical Observations and Experiments in the Brewery," finding that some parts of his Book have been misrepresented, judges it proper to subjoin the following few Remarks in explanation.

THE discovering of the differences in water is an essential circumstance; because a small difference in its quality, as indicated by its specific gravity, will produce effects, proportionably, far more different in the brewery. Thus 2 in 1000, in the water made use of, will be of much more consequence to the brewer's trade than 10 in 1000 in the gravity of his worts, unless some important parts of his process should be varied accordingly; to which variations a previous knowledge of the quality of the water is necessary.

The value of most herbs, whether green or dry, may be ascertained by the specific gravity of their decoctions. And to such purposes the rules on the subject of hops, as given in the Hydrometrical Observations, will, it is conceived, be found serviceable.

With regard to the use made of the weight of water in discovering the value of worts, it has always been the rule to express water by the sum 1000. The writer found, that the water in his brewhouse would not permit Martin's hydrometer to sink to the point which Martin intended for water, by two divisions on the stem: that water was, therefore, called 1002. Where extreme accuracy is required, it is easy to allow for this addition to the weight of water, by deducting 2 from the worts. But this, as has been said before, is material as to the water, but not as to the worts.

When the brewer is provided with an instrument which sinks to any given point in water, whatever increase of gravity he obtains in his worts will be shewn by the power required to sink his instrument to the *same* point in such wort, and the amount thereof may then, surely, be as well comprehended if expressed by numbers of any kind, as by pounds or ounces. Let it, therefore, be remembered, that 563 and 311 signify *the proportions which these worts bear to each other, in valuable matter obtained by the water from the malt.* It would be absurd indeed to imagine, that if any given quantity of water weighed actually 1000 pounds, the same quantity of strong wort would weigh nearly

1600 pounds. *All* the hydrometers now made, those intended merely for spirits excepted, *speak a language* expressive of the superiority or inferiority of worts to each other; and that, besides shewing the differences in water, is all that a brewer has to require of the instrument.

In forming average gravities, to give positive directions, suitable to *every* brewhouse, is not to be expected or attempted. A general notion of the design or object aimed at ought to suffice. The plain question is, whether it is more easy, as well as more certain, to ascertain the average gravity of several worts, and to form any required standard of strength in malt liquors, by examining the worts of each day's brewing in the *copper*, or by waiting until all such worts are separated from the hops, and disposed of in the different *coolers?* This must be determined by a majority of those gentlemen in the brewery, who may be induced, by the arguments of any writer on the subject, to make the experiments. As to the objections likely to be made to the latter method by the officer of excise, none such can arise. The brewer is not compelled to declare his length, or, in other words, to say what portion of the day's brewing is strong, or what is small, beer, until long after a full opportunity has occurred

to him of determining on this matter, by examining the quantities and qualities of each wort distinctly.

The excise laws forbid mixtures of *strong* with *small* beer, when the length is once declared by the brewer, and gauged by the officer. But *until then*, the brewer may lay his worts off, or divide them in the coolers, which are (or ought to be) several in number, as he pleases. And that part which is declared to be strong, or that which is small, may, without offence, be at any time afterwards mixed with the beer or wort which has paid the same duty, of any former or succeeding brewings; the whole being presumed to be done with the knowledge of the officer.

The process of mixing crude wort with *beer* was never thought of; but it may, without injury or disadvantage, be added to other *fermenting* wort, of the preceding day's brewing; the additional wort containing a proper degree of warmth, with a due proportion of yeast, and the whole being then fermented to its just crisis.

What was said of sweets was intended, chiefly, to shew that the utility of hydrostatics is not confined to the brewery. That a fermenting power assists in extracting, may be proved by introducing a few hops in a net, into a guyle

of beer under fermentation. It has been asserted by those who have made the experiment, that a far less proportion of hops would serve as a preservative, or to communicate flavour, if it was the practice more frequently to introduce a part of the quantity allotted into the guyle-tun: such is the extensive power of fermentation.

In judging of the value of the fruit, from which sweets are extracted, if the observations are taken regularly, and more particularly towards the crisis, on comparing the greatest gravity ever observed in one infusion, with the greatest gravity ever discovered in another of equal quantity, each may be concluded to have been drawn from fruit, valuable in proportion.

With regard to the use of spirits in wines, they *may* be necessary for *foreign* wines, on their being conveyed by a sea voyage from one kingdom or climate to another: but the wines alluded to in the Hydrometrical Observations are *only English-made wines*, which, it is presumed, are not frequently, if ever, exported. And it is, moreover, proposed to make an addition to their strength by an extra allowance of fruit; as more pleasant, as well as more wholesome, than British spirits from corn.

The writer has met with no other remarks on his book, which appear to require any notice.

ALTON, Nov. 10, 1785.

THE foregoing advertisement was occasioned by some remarks which the observations, in the Appendix to the Hydrometrical Observations, on his mode of forming Standard Gravities, called forth from the author of the "Statical Estimates." What these remarks of Mr. Richardson's were, I don't know, or I would insert them; but I possess a letter from Mr. More, the Secretary to the Society of Arts, to my father, dated 3d December, 1785, on this subject, in which he says—"Your answer to Mr. R. I think fully sufficient, and am much pleased with your resolution of paying no farther regard to what *they* may say; for as one of them is, I believe, a professed pamphleteer, he will be happy in any opportunity of exercising his vocation."—J. H. B.

The following little Tract was not printed for sale, but was distributed by the Writer among his Friends and Customers.

A SHORT

ADDRESS TO THE PUBLIC,

ON THE

PREJUDICES AGAINST THE BREWERIES.

By JAMES BAVERSTOCK.

ADVERTISEMENT.

In the following attempt to remove a severely injurious impression, the writer trusts that he will not be suspected of other motives than such as arise from the fullest conviction of the public mistake in the case; and that an effort, however feeble, to correct a misconception so universal, is, at all events, excusable.

A part of this popular error is owing to the general unacquaintance with *what* matters are, and *what* are not, "*fermentable.*" And from this ignorance, some few, even of those who are deemed brewers, may not be exempt. Such uninformed persons, as well as publicans and others who brew for themselves, will perhaps derive some *new* information from the assertion, that "Malt and Hops are the *cheapest*," as well as, in every respect, the most beneficial, "articles," that can be used "in brewing Beer, Ale, or Porter." Which information may, also, be *new*, to those well-meaning gentlemen who are, at this time, promoting the establishment of Subscription Breweries, in different parts of the kingdom.

JAMES BAVERSTOCK.

ALTON, April 6, 1807.

SHORT ADDRESS,

&c.

PERSUADING myself that a communication, which may contribute to remove error, will be favourably received by the candid and unbiassed part of the community, I am induced to offer the following observations on the prejudices which prevail against the public breweries: Wherein I shall endeavour to shew, that a very wide distinction exists among the practitioners in this considerable branch of the national trade.

If, then, I am told, that "some brewers use other materials than malt, hops, yeast, and water, in making their beer, ale, or porter," I answer, most confidently, that such men are entirely unacquainted with the most valuable principles of their business, and are, also, most contemptibly ignorant of their own interest; for that all the money which is paid for such additional matters, is far worse disposed of than if it were thrown into the sea.

Every brewer of beer for sale must have two leading objects in view. First, to provide a liquor which, by obtaining a preference with the consumers, obtains, also, a ready extension of sale—and, secondly, to make that liquor of the proper and required quality, at the least possible cost to himself.—This required quality comprehends flavour, strength, and transparency.

With regard to FLAVOUR, those who are the most concerned in the sale of beer have the best opportunity of "knowing," that the flavour which is yielded by malt and hops alone, is absolutely inimitable, and unattainable by any substitute whatsoever; and so decidedly is it preferred by all ranks of consumers, that every attempt to counterfeit it must be expected to produce a sensible decrease of demand for the beer. Nor can such an attempt be concealed from those who are, in any degree, judges of malt liquor; to whom the imposture must, at once, appear so puerile, as to become highly ridiculous and contemptible.

No peppers, no aromatics, can be used, without leaving a pungent heat in the throat, and on the palate; which, if at all attended to, can never be mistaken for spirituosity. And it is as easy to distinguish between that fine flavour

which accompanies the bitter of the hop, and that of those ingredients which are said to be used as a substitute for it, as between the flavour of the finest champagne and the most ordinary cider. Besides, it is not only the peculiar bitter and fine flavour accompanying it, which render the hop so essential to the brewer, but its peculiarly *preservative* properties, which no substitute has ever been found to supply, and without which, *no* bitter can be of any real use in beer*.

As to STRENGTH in beer, as in wines, cider, and every fermented liquor, the foundation of it, in all, is "*Sugar*," viz., the sugar of the malt, of the grapes, and of the apples.

Now, the saccharine matter obtainable from well-made *pale* malt is, (under all the present high duties) positively, the *cheapest sweet* that is, by any art or in any manner, procurable from any other British or foreign production.

* A wine-glassful of beer, thrown hastily into a clear fire, will afford a certain and easy test by which we may detect whether the warmth on the palate be the effect of genuine spirit, or whether it is artificially given by aromatic drugs. If it be caused by the presence of actual spirit, it will immediately blaze through the bars of the grate; but if it be merely the effect of spices, the Beer will not burn, and will operate on the fire only as so much water.—J. H. B.

In the years 1799 and 1800, Parliament judged it expedient to allow the use of sugar in the Breweries—and, although the price of barley was then more than 4*l.* the quarter, to which was to be added the duty on malt, it was discoverable by a very cheap and easy experiment, that the saccharine matter obtainable from malt, was more than 20 per cent. cheaper than sugar, for the purposes of making Beer. So that the indulgence was of no use to the well-informed part of the trade; although a few of the most ignorant persisted in, and pleased themselves with, the use of it.

Should any confirmation be required of the cheapness of malt, compared with sugar or with molasses, it is to be found in the practice of the distillers, who are not restrained from using these or any other articles; yet they constantly prefer malt and barley only—finding these to be the most productive of spirit, in proportion to the respective costs of all the subjects.

It follows, therefore, that the introduction of any other ingredient than malt, to communicate strength to Beer, is a positive waste of money; for, it is a mark of the greatest ignorance to expect that peppers, or any "unfermentable" matter whatsoever, will contribute to vinous

spirituosity. Where then can be the temptation to any brewer, who is acquainted with his business, to substitute any matters for those highly valuable materials, malt and hops? In truth, every attempt at such substitution is a gross folly—and surely, no brewer who knows how to use malt and hops properly in brewing; (wherein lies the distinction between the well-informed and the ignorant practitioner,) would subject himself to the severe penalty, as well as disgrace, which he would be liable to, for introducing substitutes; when he well knows that the use of them must tend to the diminution of his trade, no less than to a considerable increase of his expenses; in making a less valuable, and a less saleable, commodity.

The close connexion between flavour and spirituosity, or strength, in malt liquors, may be easily discovered by an examination and comparison of the different fine country ales sold in London, where the brewer can always obtain a price equal to the strength and quality of his beer; by which he is enabled to produce an article made from the most curious extracts of the choicest malt and hops. And the superior and popular ales in demand, ought to be distinguished by their strength and fullness of flavour, in proportion to the several prices

obtained for them. For, so intimately connected and blended are spirituosity and flavour in all liquors, that the one cannot be diluted without the other, which may be exemplified by mixing water with wine; in doing which it may be observed, that the flavour and spirituosity are at the same time reduced.

The next consideration relates to TRANSPARENCY.

There are two parts of the process of Brewing, which *chiefly* require the brewer's skill, because THEY PRINCIPALLY affect both his profit and his repute. These are, first, the extraction of the fermentable matter from the malt, by the water applied in the different mashings; and secondly, the conversion of the worts, so extracted, into the desired vinous liquor, by a properly conducted fermentation. On the heats of the water so applied, and the modifications of these heats in the different infusions, it greatly depends whether *all* the saccharine matter which the malt is capable of affording, be extracted; and on these heats depends also the aptness of the produce to attain early and spontaneous fineness*: which is still farther

* The extractable parts of malt are saccharum and mucilage. Some portion of the latter is necessary—yet a superabundance prevents transparency, and induces greyness.—

promoted by suitable heats and the changes thereby produced in the subject, while under the action of fermentation. All these heats rest on the Brewer's judgment; and, when determined on, are applied with the greatest precision, by using the thermometer. While the strength of the worts is adapted to the price to be obtained for the Beer, with equal precision, by the use of the hydrometer; even to less than a thousandth part of the whole fermentable matter contained in each wort.

Beer, Ale, or Porter, brewed with the assistance of these instruments, and according to established rules gained by diligent attention, and proved in a long succession of events to be correct, will stand in need of no art to produce transparency, provided it be allowed to remain in a proper cellar, undisturbed for a reasonable time, after it is removed from the store of the Brewer. Such removal cannot take place without causing temporary turbidity; and, as in situations where the demand is the greatest, the rents are also high, and the room most generally scarce, so the retailer has it not always in his power to keep a sufficient stock of Beer, to

The soluble parts of malt are not merely saccharum and mucilage, they consist likewise of gluten and starch.—J. H. B.

avoid the necessity of some *occasional* use of isinglass. I know of no other matter as at all applicable or assisting, to fine malt liquors: and, as this article is well known to be not only perfectly innocent, but also so salubrious and nutritious, as to be given to the most delicate invalids, and to be introduced in several forms as a luxury at the tables of the most opulent, it is strange in the extreme that the use of it should not be legally admitted in the Brewery; for to many of the trade it is indispensably necessary, on frequent occasions; while to some it may not be necessary at all, or but very rarely.

It is but fair to observe here, that the complaints against the reduced quality and altered flavour of the London porter, are extremely uncandid. Let it be considered that the excise on Beer is increased 50 per cent. and the duty on malt more 200 per cent. in the last four years; and the price of barley nearly 100 per cent. since 1790.

To these must be added the great increase in the contingent expenses of labour, taxes, horses and their food, and withal, the large addition of capital required to pay for all the articles and charges. Notwithstanding all these disadvantages, the public so unreasonably, yet

so powerfully, oppose any (even small) advance on the retail price of Beer, and particularly in London and its vicinity, that the Porter Brewer can make no attempt to compensate himself, otherwise than by overwhelming his malt with four portions of water instead of three, as formerly; the effect of which on the Beer will, I presume, be sufficiently understood. And, it must hence be allowed, that the diminution in the quality or this liquor is not attributable to the Brewer, so much as to the present state of the national concerns; and to the choice of the public, in preferring a low price to a more nutritious article.

To speak now more particularly of the prejudices against all the public Breweries. It is extremely unjust and a great misfortune to them, that those Brewers, who, by study and well-directed observation, have attained a more scientific, and therefore a more successful, practice than some others, should be, generally, the first objects of suspicion and distrust—while those remain unsuspected, who are of inferior education and knowledge. Whose minds being unused to subjects of so comprehensive and intricate a nature, as constantly occur in a Brewery, are utterly incapable of conducting the process; and who do not, therefore, make

a wholesome, palatable, and transparent liquor, oftener than as the wildest chance may lead them to success.

It requires the laborious study of a whole life to establish an uniform practice in the Brewery —such as may be, generally, successful. The whole process requires to be watched, from the infusion of the malt to the cleanse from the fermenting tun, and to be conducted by the means of the best instruments and the nicest calculations, through all the various changes and modifications to which worts, beers, and all fermentable subjects are liable. They cannot be wholly left by night more than by day, until the effect to be produced is completed in them, and until they are brought to a perfection equal to the practitioner's wishes.

After all his labour and success, how intolerable must it be to the ear of such a Brewer to be told, that some low fellow (probably connected with a neighbouring publican who brews his own beer,) is taking every means in his power to raise an odium against *his* Brewery. That such a man goes into a house supplied by the Brewer, and orders some other sort of liquor—declares " he is particularly fond of malt liquor, but can never drink (such a) brewer's beer, on account of some matter being

put into it, which always disagrees with him—but that the home-brewed beer of his friend is particularly fine and good, and never hurts him in any respect, *&c. &c.*"

Should curiosity or accident afford the Brewer an opportunity to examine this celebrated "Home-Brewed" Beer, he finds it nineteen times out of twenty to be foul, and of every hue that is unnatural to good malt liquor—offensive to the smell, harsh, and every thing but well-flavoured to the taste; and withal, so strongly tinctured with other ingredients, as evidently not to be manufactured from malt, hops, yeast, and water only. Yet, as such beers are made by an ignorant hand, and bear the name of "Home-Brewed," they are out of the way of suspicion—although a liquor, containing not half the like ill qualities, would be, speedily, destructive of a public brewer's trade.

It is not then the intelligent and successful Brewer who is a proper object of suspicion, but the ignorant; and those who are in so small a way of business as to be capable of introducing their nostrums with their own hands. Utterly incapable of using the necessary instruments, and too ignorant of the principles of arithmetic, to work the intricate and nice cal-

culations which are required, they at once attribute the successful practice of the Brewer to the use of drugs; and, in a false and fancied idea of following his process, attempt to imitate *his* beers, by introducing all sorts of trash into the composition of their own. For which they have the opportunity, without suspicion; owing to the implicit and improper confidence which is, too generally placed in all malt liquors, sold under the name of "Home-Brewed Beer."

I would not be understood to insinuate that *every* retail Brewer, or man in a small way of business, is an unfair trader; or that the extent of a man's trade should be at all a criterion of his intelligence and rectitude. For, there are many of the former description without doubt, who are men of character and reputation; while there are, unfortunately, *some few* engaged in considerable country Breweries, who, from want of education and want of common abilities, are extremely ignorant, however opulent. Between men of this description, and the intelligent, well-informed, and truly respectable Brewers, a distinction ought to be made.

For, a man who is not possessed of some other sort of information than generally serves to conduct most of the trades, is no more capable of brewing uniformly (without which

all is hazard,) than a country bargeman is qualified to navigate a vessel through the ocean, to any proposed port or point without a compass; or if he had one, without a right knowledge of its application.

From what has been said it may be judged, that a successful practice in the Brewery is not a matter of chance, but of valuable knowledge. Which is also useful to the public, in providing them a wholesome, palatable, and spontaneously clear liquor, made from the choicest malt and hops; but without that most serious waste of these costly articles which constantly attends the placing them in the hands of an ignorant practitioner; whether in public or private Breweries.

Yet it has, most unfortunately, and most unjustly, happened, that in proportion as such described malt liquors have been most generally produced by any public Brewer, what should be deemed creditable and meritorious, is by the ignorant perverted, by being imputed to sophistications, which malicious calumny often decides to be of a deleterious nature.

But I trust it will be perceived, that the great number of very respectable and well-informed gentlemen who are now engaged in this branch of trade in every part of the kingdom, ought to

stand in the public opinion, far above all such suspicion. Seeing that it can be no more their inclination *than it is their interest*, to substitute in the manufacture of their beers, *any* ingredient *for malt and hops, because no matter can be procured of equal value to them, at so cheap a rate;* nor can *any* extraneous matter be introduced in any way into the Brewer's practice, without causing a diminution of his trade, his profits, and his repute.

POSTSCRIPT.

THE imputations against the Breweries are greatly owing to the artful practices of some travellers for the druggists. Who intrude themselves by first offering isinglass for sale; and take that opportunity to watch, according to the reception they meet with, how far they may be likely to succeed, in imposing upon the ignorance and credulity of a Brewer, when they tell him they can supply him with an ingredient, which is a most cheap substitute for malt and hops. Now, second to malt, no *dry fermentable* matter can be so valuable to a Brewer, as sugar—nor can any matter be so likely to answer the intention of the Druggist, in the case, as sugar; disguised probably by some mixture of quassia, and ground together Hence the combined sweet and bitter serve to persuade an ignorant publican, who brews his own beer, (and perhaps at some times an ignorant public Brewer) that this ingredient will save him largely, both malt and hops. The temptation is great on both sides. The Druggist "knows" that if he can sell such a matter,

he gains a profit of more than cent. per cent.—while the weak and credulous purchaser hugs himself under the impression, that he is indebted to this "*most civil and kind*" gentleman for a secret, which will make him a rich man "in no time."

He proceeds accordingly to lessen the allowance of malt, but not of water. The result of which is, that his beer is poor and thin, from a want of spirituosity, and so ill-flavoured from the portion of quassia introduced, as to be utterly unsaleable. And this without the smallest recompense for the money expended.

This, however, is but a part of the injury occasioned by these men. In their pressing solicitations for orders, some of them will not scruple, most falsely and basely, to adduce the example of some eminent Brewers, as purchasers of their trash. And, it is this very description of persons, who, more than all others, contribute to promote the popular prejudices; it being their interest to persuade every ignorant Brewer, whether public, retail, or private, of the usefulness and cheapness of their drugs. Whereas, I will assert, that the entire stock in trade of any druggist, although the value of it may amount to 20,000*l.* for other uses, is not worth the cost of a single shilling to any Brewer, for the

purposes of improving the flavour, or in any way contributing to the strength, of malt liquors, otherwise than as the articles may be saccharine.

And what may be the inducements to a Brewer to exchange malt for any other saccharine matter, will be seen in the following statement (if it be credited) of the result of various and repeated experiments, on a great number of the different sweets in domestic use. According to which, I have found that a quarter of middling pale malt, such as may now be bought at Mark-lane for 70s., will make as much wort, beer, or vinous spirit, of certain given qualities, as 180 lb. of sugar; such as, I learn, may be bought for 60s. the 112 lb. But the best pale malt, such as a brewer would cause to be made, under his own directions and inspection, at the cost of 76s. the quarter, is equivalent to

200 lb. of sugar, at	60s.	112 lb.
226 of honey, at	80s.	
240 of treacle, at	42s.	

I do not think it possible to find cheaper (fermentable) matters than malted corn, and the other articles above mentioned. If, therefore, I am correct in the prices of the last three, (and the error, if any, is not, I presume, very

material,) the following will be found to be the relative costs of their saccharine matter, when equalized with a

Quarter of Malt, at	. . .	76s.
viz., Treacle	. . .	90s.
Sugar	. . .	107s.
Honey	. . .	161s.

The public, therefore, can be at no future loss to decide on the sort of temptation, which can lead an intelligent Brewer to listen to an insinuating druggist.

To conclude. The Brewer who does not "know" that all substitutes for malt and hops are, "very far, worse than useless," cannot be otherwise than too ignorant, also, to conduct a single day's process in a brewery, with any probability of deriving adequate profit or repute from his labours.—J. H. B.

CORRESPONDENCE

BETWEEN

OUR AUTHOR, UNDER THE SIGNATURE OF "A HAMPSHIRE BREWER," AND A GENTLEMAN, WHO SIGNED HIMSELF "CANDIDUS."

PRINTED IN COBBETT'S POLITICAL REGISTER, IN 1808.

THE following controversial Correspondence, between our author and a gentleman in the North of England, appeared in Cobbett's Register, during the months of November and December, 1808.

I have given the letters of "Candidus," as well as those of the "Hampshire Brewer," in order to explain the latter; and in candour I must admit, that the remarks of Candidus are extremely forcible. This public correspondence led to a private one, in their real names; and Candidus at length applied for instruction from the Hampshire Brewer, which, however, was not communicated. I possess this gentleman's letters to my father, but I do not consider myself at liberty to publish them.—J. H. B.

CORRESPONDENCE,

&c.

To WILLIAM COBBETT, Esq.

Sir,

Persuading myself that a communication, which may contribute to remove error of any sort, will be favourably received by you, I am induced to offer the following observations on a subject of general concern, inasmuch as it relates to the purity, and other good qualities, of the national beverage, beer.—What I am desirous to impress on the minds of the community is, that the production of *uniformly* good beer is not an arbitrary matter, as is commonly supposed, and which may be accomplished by any and every person who chooses to take on himself the office of a brewer. For a man may be willing to sacrifice a large allowance of the choicest materials, without having the power, after all, to make a palatable, early, and spontaneously fine, and consequently a *wholesome*, malt liquor, unless he is provided with, and fully understands

all the uses of some far more secure guides, than the discriminations of his own senses alone will prove. A studious observation of the powerfully different effects of the different degrees of heat in the water used in the several extractions, and of the heat in fermenting the worts, so extracted from the malt, is of the very first importance and necessity.—The last is an operation of such influence in the case, that, in conjunction with the precautions required to be observed in the mashings, fermentation determines the early or the later period of *natural* fineness, as well as a distinction of flavour, according to the several stages of its progress, and, withal, fixes the principles of preservation in beers. Hops afford the basis of this last-mentioned and desirable property; but all the benefits of the hops are destroyed by a few hours only of too long protracted, or otherwise erroneous, fermentation.—The several degrees of heat critically suitable to these two leading parts of the process, rest on the brewer's experience and judgment; and, when discovered and determined on by him, are applied, most precisely, by the use of properly-constructed thermometers. But these heats cannot be judged of, to any tolerably sufficient degree of correctness, by the perceptions of the touch

alone. Neither is the exact quantity of saccharine matter, afforded by the malt, which is the foundation of all the strength in the beer, to be discriminated by the taste. It is, however, necessary that the precise amount of such *sweet* should be constantly ascertained; because, without a knowledge of this product, (which varies surprisingly according to the different quality of the barley, and the method of malting it) the brewer cannot maintain that *uniformity* in the strength and flavour of his beer, which is the only true criterion of a well-regulated practice.—This valuable information is afforded by a suitable hydrostatical instrument; which shews, by the specific gravity of small portions or samples of the different worts, and by their several gauged quantities, the total amount of such saccharine or fermentable matter contained in each brewing of malt, to a thousandth part, or less.—It will be evident to every reflecting mind, that, without a knowledge of the uses of these two instruments, so often as a practitioner succeeds in producing good beer, he is indebted to chance alone—and that he retains no *sure* means to repeat his fortunate operation. Time, indeed, will produce much change, and, generally, some improvement in beers brewed at such random; a remedy

which may be afforded, and is, also, greatly relied on in family brewings. But this cannot be otherwise than highly disadvantageous to the public brewers in the present state of their trade, by causing a necessity for a burdensome stock of beer, prepared from barley at an excessive price, and loaded with enormous duties on the beer, and on the malt.—The employment of the two instruments is now become pretty general in the trade; yet the advantages derived from them are but partial—always varying with the degree of experience and judgment possessed by the different practitioners, in establishing a set of rules for conducting the operations. It is, therefore, severely injurious that, owing to the generally prevailing opinion, that the business of brewing is merely practical, and therefore performable by persons of the meanest education, those who have been somewhat more successful than some others, in discovering the beneficial points and uses of the instruments, have become the objects of misrepresentation and detraction; and this, directly through the ignorance of the uninstructed part of the trade, or of other persons who are equally uninformed in the matter. Much calumny has been disseminated in a charge of their using other articles than "malt, hops,

yeast, and water," or it is chiefly pointed at a supposed use of substitutes for the two first. I shall endeavour to shew that the brewer, who expends his money in any such substitutes, or in any extraneous matters whatsoever, is most despicably ignorant of every advantageous principle of his business, and of his immediate interest in a pecuniary point of view; for that malt and hops are not only the most *beneficial*, in every respect, but, also, the *cheapest*, *articles* that can be used in a brewery.—It is well known to the Distillers, as well as to the intelligent among the Brewers, that it would be no more futile to attempt to make saleable bread from sawdust, than to make any sort of vinous liquor (such as beer) from any matters whatsoever, except from some matter which is saccharine. For no other subjects will yield an extract which is capable of the vinous fermentation; without *such* fermentation no strength or spirituosity can be produced; and the quantity of ardent spirit, (provided the fermentation has been properly conducted) is *ever* in proportion to the quantity of *sweet* contained originally in, and therefore extractable from, the subject or matter employed; and so very exact is this proportion of the spirit to the sweet, that the distillers can ascertain, to mathematical cer-

tainty, the precise number of gallons of proof spirit which will be yielded by their fermented liquor, (called by them *wash*,) previously to committing the latter to the still. The same rule extends also to, and is practicable in, the brewery. Of all the saccharine matters, whether domestic or foreign, procurable in this kingdom, the three cheapest, comparing the produce with the cost, are malt, treacle, and sugar. The proportions which these bear to each other, are as eight bushels of malt, so are 196 lbs. of sugar, or 240 lbs. of treacle.—The introduction of the smallest quantity, of either of the last two, subjects the common brewer, by the excise laws, to the penalty of 200*l*. If then it were even desirable to substitute such sweets for malt, could, let me ask, any useful quantity of such bulky matters be introduced into any considerable brewery, without the knowledge of every individual employed on the premises, who, as informers, would partake of the penalty? Would, therefore, any prudent man render himself liable to such mean tyranny, or to such exposure and such penalty? With regard to treacle, must not every person, however unacquainted with the practice of brewing, perceive, that a very small portion of this coarse and black article could not fail to destroy the

sale of all beer required to be *pale;* and as to sugar, the *cost* of 196 lbs. is 107s.*, while a quarter of the very best pale malt is to be made or purchased at 20 per cent. less; even under the present unusually high price of barley. Which, therefore, of all the saccharine matters, is the most desirable one to a brewer, in producing the most saleable beer, at the least cost to himself?—The use of hops in brewing, exclusively of their desirable flavour, is to preserve the worts from becoming acid; as they would, without this preventive, at some seasons, even in the first stage of the fermentation. For, the introduction or the omission of this ingredient constitutes the chief difference between the operations of making beer and vinegar from malt. More powerful bitters than hops may, perhaps, be procured, but the bitter is of no use without the preservative property. Gentian and quassia are wholesome and useful *as medicines;* but, if introduced in beer, they cannot fail to cause a rapid decrease in the brewer's trade; owing to their total want of the fine aromatic flavour, as well as of the preservative qualities discovered, hitherto, in hops alone. Hence there can be no inducement to an understanding brewer to use any substitute what-

* In the year, 1808.

soever for hops; since it must be plain to every one, that a prosperous trade is no otherwise to be gained, or to be preserved, than by pleasing the palates of the consumers; and no other matters will afford *so saleable* a flavour in beer, as choice hops united with well-made malt.—But, the most important of all the considerations connected with the case, relates to the wholesomeness, or otherwise, of the different malt liquors, brewed in the kingdom.—It is owing to the general ignorance among the majority of practitioners that scarcely any beers which are brewed by them will become naturally fine in less time than twelve months; *when*, they are, most commonly, hard, perhaps crabbed, and are, accordingly, deemed by all the medical men unwholesome. On the other hand, that species of malt liquor is allowed, and found to be the most wholesome, which becoming spontaneously bright at an early period, will so continue, without tendency to acidity, during as many months as may be required for consuming it. These desirable properties are to be obtained, constantly, only by a knowledge of the proper heats which are suited to the critical parts of the process. While uniformity in strength, proportionate to the price obtained for the beer, is gained by the right use of an

hydrostatical instrument. It will, probably, be remarked, that the well-known importations at the custom-houses, of certain articles, supposed to be used in the brewery, establish the proof that such matters are used in beers. It may be so. I am not attempting, nor am I at all desirous, to defend the practices, of the grossly ignorant. What I affirm is, that no truly intelligent brewer would *so* waste his money to no other object than to deteriorate his beer, and thereby impede the sale of it. In situations where public breweries abound, it is little imagined how very scarce they are in other parts of the kingdom; insomuch that it was stated to a committee of the House of Commons, about eighteen months ago, by Mr. Jackson, one of the commissioners of excise, that the number of common brewers amounted only to 1,400, while the *brewing publicans* were so numerous as 23,700!!—If the community could be prevailed on to believe, that a generally successful practice in brewing is really and truly a matter of science, and not attainable without laborious study, and the constant assistance of accurately made instruments, which last can be of no use whatsoever, unless they are accompanied with some portion of mathematical knowledge, it would be evident that the greater

bulk (if not all) of the 23,700, together with very many of the 1400, in the country, must be utterly incapable to apply the instruments, and to conduct such an intricate process, with any approach to certainty; and, that, unable to account for the disappointments, which they *must* incur, wholly ignorant, also, of any correct means to judge of the comparative values of *the very best* materials for brewing, and *the very worst*, they are open to the insinuations of the venders of the drugs alluded to, who, it is well known, hesitate at no falsehoods to persuade these uninformed people that the success of the reputable practitioners is owing to the use of the contemptible trash for which they pressingly solicit orders. These, therefore, if any, are the brewers who, through the grossest ignorance, become the purchasers of ingredients, utterly inapplicable to the purpose; and which can have no other effect than to increase their difficulties, as well as their expenses. On the other hand, the most wholesome, and generally preferable, malt liquors, are chiefly to be expected from the efforts of men of better education, engaged in considerable breweries, wherein the principal himself, and not an ignorant deputy, directs the process. To such men the study of the practice affords a pleasing amuse-

ment, which leads them to ascertain the qualities of, and rightly to distinguish between, *the four only articles* which are useful and necessary, and *all* others which are *very far worse than useless.* Besides, it is not in the power of *any* brewer, however well experienced and instructed in the business, to obtain so large a proportion of vinous strength, as well as some other of the most desirable qualities in beer, from small as from larger brewings.—This is no chimera; for a powerful cause might be deduced from theory, if that were wanting, to explain the fact. This disadvantage, together with the general want of system among the inferior brewers, cannot fail to occasion the very serious waste of one-fourth part of all the malt committed to their injudicious treatment. Any remarks on the effects of this *annual* loss, amounting, as might be shewn, to 400,000 quarters of barley, from the national stock of corn, would lead me farther than I intended, and would also intrude more on your valuable paper than I could expect will be allowed.

I am, very respectfully,
Sir, yours, &c.,
A HAMPSHIRE BREWER.

Nov. 4th, 1808.

BREWERIES.

SIR,

In your Register of the 12th inst. I was much pleased with the perusal of a paper signed "A Hampshire Brewer," the production of a person evidently competent to the discussion of the subject he has brought before the public: and I have only to wish that the paper might have a circulation commensurate with its importance to the community. His general ideas on the production of an uniformly good and wholesome malt liquor are such as can only have been derived, either mediately or immediately, from an extensive practice, aided by a close and philosophical course of observations. From such a writer I am sorry to differ in any thing; but a strict regard to truth, and especially a truth in which men are practically interested, induces me to trouble you with a few observations on some remarks in the gentleman's paper; and for which, I trust, he himself will not deem it necessary to offer any further apology.—It is stated by the writer that the relative value of malt, sugar, and treacle are, "as eight bushels of malt, so are 196 lbs. of sugar or 240 lbs. of treacle." I wish the writer had furnished us with the precise grounds of this stated ratio of value,

and of the method by which he formed it. As it is, we are left to infer, from other parts of his paper, that his conclusions are built on hydrostatical experiments: and I am the more inclined to suppose so from repeated trials, in which a given quantity of saccharine substance put in solution, when examined by the instrument, has not increased in density scarcely one third of the gross weight of the substance dissolved: a proportion, I believe, that will nearly correspond with the statement which he has furnished us with. But I entertain serious doubts whether any instrument we now have in use is adapted to shew us the *relative value* of two musts, the one prepared from malt and the other from either sugar or molasses. My reasons are these: In the extract from malt a considerable portion of mucilage or viscous matter is blended with the saccharine which is obtained, while the extract from molasses, for instance, is nearly a pure saccharine liquor. Now, as the action of any statical instrument must be in proportion to the specific gravity of any liquid on which the experiment is made, it is evident that the spissitude of the malt extract must far exceed that of the other. But is it philosophical to conclude from thence, that the one *must necessarily* be richer and superior

to the other? I appeal to the Hampshire Brewer himself. Does he consider that his last wort, which, for the sake of argument, we will suppose to weigh 10 lbs. per barrel, equal in point of quality to a one-third portion of his first wort, which we will conclude to weigh 30 lbs. per barrel? Why not? Because, though the latter possesses an abundance of mucilage, yet it possesses a much greater proportion of saccharine also. It is with justice that he considers "sweet" as the basis of vinous fermentation; for it is very certain, that the vinosity of any liquor, (the fermentation, *&c.*, being equal) will be in proportion to the quantity of the original base which it possesses. I may, therefore, be allowed to doubt whether the instrument alluded to, be capable of that extent of application which is attributed to it, and whether the value of the three sweets he has mentioned be correct. I would be very far from being understood as intending to depreciate the merits of the instrument. I know its value too well. But though it will answer every useful purpose to a brewer, where the extract is from malt alone, yet philosophical precision requires it to be stated, that the one which is generally used cannot with any very great propriety of term be called a "Saccharometer." If in a solution of

sweets it can only indicate about one-third of the value, we may ask, what becomes of the remaining two thirds? Are they evaporated? Or do they remain in the liquor, enriching its quality, though in such a rare elastic form as to elude the test of the instrument? I think the fact cannot possibly be doubted. Mr. Reynoldson, somewhere speaks of a friend of his (I think a Mr. Bent) having a method of separating the mucilaginous from the saccharine parts of a wort. Could such a method be generally adopted, we then might have some certain data, from which we might fix a scale for the valuation of any extract. The penalty on the use of either sugar or molasses in the brewery is too serious to risk the actual employment of them, though were the circumstances of the times to make a revision of the act expedient, I think that they might be partially used to advantage. I say partially, because, if used in too great a proportion they would destroy the characteristic taste and quality of the beer itself. The principal obstacle to their use would be in the want of a proper apparatus for estimating their value. Could that be effected, I should have little doubt but a fair comparison would evince an advantage of 40 per cent. in a limited use of them, instead

of a loss of 20 per cent., according to the estimate of the Hampshire Brewer. And so far from deteriorating the beer, they would contribute to its excellence, and be a means of remedying the defects of beer brewed from inferior and ordinary malts. But on the use of every narcotic drug, let just censure fall in due vengeance; and the trade perish, that cannot subsist, but with the use of materials, the natural tendency of which is to bring on debility and disease! The evil has of late been considerably increasing, and calls for some effort to avert its baleful effects. I am glad of the testimony that has been borne by this gentleman on the subject, and only regret that in a paper of so much merit any opinion should be advanced that will not bear the test of rigid examination. To you, Mr. Cobbett, I owe an apology for the length of this letter; but when I say, that the subject has some considerable importance attached to it, in a chemical, as well as political and economical, point of view, I trust that such a consideration will be deemed a sufficient one, both to yourself and your readers, from

Sir, yours, &c.,

CANDIDUS.

Malton, 15th Nov., 1808.

BREWERIES.

SIR,

IN writing the letter on the Breweries, inserted in your Register of the 12th November, my view was to rescue the intelligent part of the trade from the aspersions thrown on all of them, through the ignorant practices of many, (therein described,) who are engaged in that business; and this, chiefly by shewing that there could be no temptation to a man of understanding, to substitute any articles for malt and hops, because the latter are not only the most suitable, but *undeniably the cheapest*, that can be procured. I am so desirous to avoid obtruding on your valuable paper, that it is with no small degree of reluctance I once more, and, as I hope and intend, for the last time on this subject, solicit your indulgence to notice, as concisely as in my power, the remarks of a gentleman who signs himself "Candidus" in your Register of the 26th ult.—He wishes I had stated the grounds and the methods, whereby I formed the ratio of the value of malt, compared with sugar and with treacle. My answer is, by hydrostatics, as he supposes. He doubts the competency of any instrument to shew the exact difference between the sac-

charine matter extracted from malt, and that which is afforded by a solution of sugar, or of treacle, in pure water, on account of the mucilage in the first, which, he concludes, affects the accuracy of the rule. This is the (now fully exploded) objection which was urged against the hydrometer so long ago as in the year 1770, by the *then* principal brewer in London, in a conference which I obtained with him on the subject; but who changed his opinion a few years afterwards, and adopted the constant use of the instrument, in which he was gradually followed by the other considerable brewers. But the proof of this, and also the following question between us rests in distillation, of which I shall speak hereafter. I stated that malt was 20 per cent. superior to sugar, on a comparison of the produce of each with their respective costs. This gentleman *thinks there must be* an advantage of 40 per cent. in favour of sugar; without, however, offering any other grounds for this opinion, than his doubts beforementioned, as to the effect of the mucilage combined with the sweet of the malt on the different gravities of the two musts, there is the very serious difference of 60 per cent. in our opinions. One of us must be under a very great error. I could, if it were not rendered

unnecessary by their being the same, as he will hereafter find described by a scientific and practical gentleman, Mr. Martineau, to a committee of the House of Commons, give a series of experiments on sugar and treacle, made many years ago, accompanied, also, with a set of twelve distillations (in a still of a suitable size which I procured to be made for the purpose,) of small portions of beer formed from as many different original specific gravities in the worts; which experiment I then entered on, with the view to ascertain the fact of the accordance, or not, of the final proportion of proof spirit with the original gravity, as shewn by the hydrometer; due reference being had to all the circumstances. The results of each, and of all, of these examinations did so remarkably correspond with the several circumstances, as to afford the most convincing testimony to my mind, that every hydrometer, now in use, is truly and correctly, *a measure of sweets*, although that appellation is given to one only, among the several sorts now constructed. But I must not expect that my own experiments, and consequent decision will be deemed of sufficient authority to be conclusive with others. I am happy, therefore, in the opportunity to adduce far superior proof, premising,

that the average value of each 8 bushels of malt is known annually to every brewer who has employed an hydrometer, for a sufficient time to understand its uses. I say, annually, because the produce of saccharine matter varies with the favourableness of the harvest and season to the barley; as well as very materially according to the method of malting it. But a quarter of malt, weighing from 300lbs to 336lbs., usually yields from 75 to 80lbs. of saccharine matter. A like quantity and no more is afforded by 185lbs. to 196lbs. of sugar, or by 224 to 240lbs. of treacle. The produce of the last two is found merely by a solution of them in waters; and finally, the separate value of all the three is found *by the production of spirit, uniformly corresponding with the gravities of their extracts or solutions.* The evidence I have alluded to is taken from a parliamentary "Report of the Sugar Distillery Committee," ordered by the House to be printed 17th of February, 1807. The object being to inquire how far relief might be afforded to the West India proprietors by the use of sugar in the breweries and distilleries, the committee after having examined (from the 2nd to the 13th January, 1807,) the persons most competent to give them information, say

in page 4 :—"It appears to the committee that "taking the price of the quarter of malt, capa- "ble of producing 80lbs. of saccharine matter at "82s., the quantity of sugar, necessary to pro- "duce an equal proportion of saccharine matter, "must be 1 cwt. 3 qrs. 1 lb. (197lbs.) which at "58s.* the cwt. would amount to 101s. 6d. in "price, making a difference, in favour of the "malt, of 19s. 6d. in that given quantity. It is "stated, besides, in evidence, that the beer pro- "duced from sugar, even if the prices would "admit of it, is not equal in any degree to that "produced from its equivalent quantity of malt; "and, consequently, that *the brewers would not "use sugar in their manufactory, unless they were "prohibited by law from using grain.*"—In page 16, Mr. Jackson, commissioner of excise, examined by the committee, says, "I recollect that about the year 1800 or 1801, when sugar was by law permitted to be used in the brewery, on account of the scarcity of grain at that time, very little sugar was used. One or two brewers in London, two at Manchester, and some at Liverpool, were the only brewers I recollect

* My estimate of the price of sugar was 61s. and my quantity 196lbs., the cost of which would be 106s. 9d. I believe it is now dearer than 61s.

to have used it, and they very soon discontinued it. The price of malt at that time was, as far I recollect, five guineas a quarter, and sugar, including the duty, about 52s. the cwt."—In page 20, Mr. Martineau, an eminent porter brewer in London, examined, and to questions put to him, says, "I have never brewed beer from sugar, but have made such experiments as to convince my own mind, completely." And being desired to state the opinion he had formed in consequence, said: "I have a very short statement shewing the comparative value of malt with sugar, and of molasses with malt." Mr. Martineau then delivered in the following paper to the committee, which was read.—"December 14, 1799, experiments on a sample of brown Muscovado sugar at 53s. 3d. per cwt., and the same on a sample of molasses at 40s. per cwt. One pound of the above sugar was dissolved in a gallon of water, and then boiled half an hour; it lost by evaporation rather more than a quart, which quantity being restored with cold water, and reduced to the heat of 60 degrees, it then weighed by Quin's hydrometer 14lbs. 8-10ths.; (consequently) 75lbs. of the same extract, which is about the fair average produce of a quarter of malt, would consume 185lbs. of sugar, which, at 53s. 3d.

per cwt. is 87s. 5d. One pound of molasses, treated exactly as the sugar had been, weighed by the same instrument 12lbs. 4-10ths; therefore 75lbs. of the same extract would consume 216lbs. of treacle, which at 40s. the cwt. is 77s. 1d." To other questions put to him by the committee, Mr. Martineau answered, "that he took not the best malt; that such malt as would yield 80lbs. of saccharine matter per quarter would require an equivalent of 197lbs. of sugar, and 230lbs. in treacle; that he never tried either sugar or molasses in brewing, being so perfectly satisfied, by the result of the experiments, that they made so completely against the use of sugar, that he never was induced to try it in the brewhouse."—Candidus may still think "that it is not philosophical to conclude, (even from this useful examination by Mr. Martineau,) that the extract of malt must necessarily be richer and superior to the others." Such, however, was the conclusion of the committee, in their report to the House; and who will depreciate the further proof that is afforded by distillation? In pages 22—24 of this report will be found the examination of Mr. Smith of Brentford, and of Mr. Benwell of Battersea, both very eminent and extensive distillers. They state "the then prices, (in

January, 1807,) of the different materials suitable to their use, to be barley at 44s. and malt 81s. the quarter, and sugar 61s. to 68s. the cwt.; but that the price of sugar *should be* from 32s. to 33s., to induce the distillers to use that article in their trade; and that even then the spirit distilled would not be either of so good a quality as that distilled from malt and barley, or so disposable in the market. Also, that to tempt the distillers to use molasses, *it should* (to bear a proportion to barley at 44s. and malt at 81s. the quarter) bear the price of 24s. the cwt., and even then the molasses is considered a worse article in the distillery than sugar." Now the judgment of these gentlemen, and by which they govern their practice in business, is founded on the actual produce of ardent spirit obtained from the different quantities of the several materials, and which, as was observed in my letter, at page 770 of your Register, is well known to them to be ever in a ratio to the original gravity of their worts, and of their wash, as acertained by hydrostatics, from whatsoever saccharine and fermentable matters such musts and wash are drawn. —Other parliamentary inquiries and reports on the same subject might be adduced, in confirmation, particularly the first, second, and third

reports of the committees on the distillation of sugar, ordered to be printed 15th of June, 1808, any part of which it must be unnecessary to quote. I cannot, however, refrain from stating the following proof that the mucilage is of no consideration, to destroy the brewer's confidence in the competency of hydrometers to exhibit a just comparison between sweets. In the years 1805 and 1806, three gentlemen, distinguished for their abilities, and well-known acquirements in chemistry, (viz., Drs. Thompson, Hope, and Coventry,) were selected by Government to inquire into the differences in value between the English and Scotch barleys and malts; for which purpose they took with them some practical assistants to conduct the operations of both brewing and distilling. I have unfortunately parted with their very valuable report, printed by order of Parliament, containing the particulars of numerous trials made by them. I recollect enough, however, to be able to say that their uniform rule, for finding the differences between the two grains, was by the gravity of their extracts, as shewn by the hydrometers of various constructions. From which gravities, and the constant agreement of the produce of spirit with them, they formed a numerical rule for ascertaining at once the

proportion of alcohol, and, consequently, of spirits of every degree of strength, produceable from every given gravity of must. The operation of their thus discovered (decimal) multiplicator on the gravity of must, taken with the attendant circumstances, as the multiplicand, affords such *very* close agreement with the evidences in the above "parliamentary reports" as to remove every particle of doubt, as to the conclusions to be drawn in the present question. One other remark calls on me to be noticed, "that a third wort of 10lbs. per barrel cannot be so valuable as a third part of the first wort of 30lbs. per barrel, because the latter contains a less proportion of mucilage to the sweets than the last worts." Agreed; but what then would be the produce of a *fourth* liquor on the grains, which, according to the inference, would contain a still *larger proportion of mucilage to the sweet?* I say that this produce from the previous exhaustion of the grains would not exceed, in mucilage and saccharine matter combined, 2 or at most 3lbs. per quarter, which is a quality that is inapplicable to form any sort of beer. And even in these 2 or 3lbs., *not the mucilage*, but the remnant of saccharum, constitutes the whole of the nutritive quality, without which the refuse (usually left

in the grains) would not deserve the low price at which it is sold. With every sentiment of respect towards this evidently able, though mistaken, gentleman, I appeal to himself whether the testimony of the several scientific, practical, and truly respectable men I have quoted, from such unquestionable authority, is or is not conclusive? And if so, it is surely fair to ask, what becomes of the alleged advantage of 40 *per cent*, in favour of sugar; and, also, which of us is it who "has advanced an opinion that will not stand the test of rigid examination?"—

I am, Sir, yours,
very respectfully,
A HAMPSHIRE BREWER.

Dec. 5, 1808.

P. S. On your account, Mr. Cobbett, as well as my own, I decline all future public discussion of this subject. But if this respectable gentleman wishes to know me, he may satisfy his curiosity by addressing a letter to M. B., (with his own name and address,) at No. 11, Princes Street, Cavendish Square, which shall be noticed in return to him, with all respectful attention.

BREWERIES.

SIR,

ON the perusal of controversial writings, we may observe that a general pertinacity attaches to most of them. We defend a position merely because we have advanced it; and are ingenious in framing arguments, by which our favourite hypothesis may be supported. It was under a full persuasion that there is in the human mind a tendency to this sort of obstinacy, that I ventured my remarks on the first paper of the Hampshire Brewer. And as we are all desirous of taking credit to ourselves, for our full share of candour and ingenuousness, I trust I may be entitled to a presumptive credit for my own openness to the full force of my respondents' arguments, and a readiness to acknowledge my conviction, should they be able to effect it. There can be no reason sufficient to induce an honest man to persist in error, after he is convinced of it; neither can there be any, for renouncing an opinion without its being fully confuted. Had the reply of the Hampshire Brewer been such as to satisfy my mind, it should have been followed by an ample acknowledgment; but I should deem it worse than folly, to admit the force of arguments, of

the illegitimacy of which I am firmly persuaded. That gentleman has shrouded himself under the protection of names, the greatness of which no one will dispute. To some of them, particularly to Dr. Thompson, I own myself under considerable obligations, for the satisfaction and pleasure I have received from his writings. And when, from a comparison of dates, I learn that the writer himself was able to confute a "now long-exploded" doctrine, several years before I was born, I almost feel how unlucky a wight I am to venture into the field against so much age, so many great names, such long experience, and such unquestionable abilities. The Hampshire Brewer appears to me to mistake the question at issue between us, as all the experiments he produces either prove what I readily admit, or what with me prove nothing to the purpose. When he speaks of me as reviving the long-exploded opinion, as to the inadequacy of a statical test of a *malt extract*, I can assure him that he is entirely mistaken; and I cannot conceive from what part of my paper he has drawn such a conclusion. Competent experience will prove the accuracy of the instrument for the general purposes of the brewery; but it is no reflection on any human invention, that it is not capable of an application

to *every purpose*. A malt and a molasses extract are very different; and as the original qualities of which they are composed, and which they possess in common, are combined in different proportions, they must require a different mode of valuation as any one quality prevails in the combination. Where mucilage prevails, there will be an increase of spissitude without an increase of value; and there may be a liquor of greater tenuity, which possesses more saccharine virtue, and is capable of becoming an article of superior flavour and vinosity. I am not so fortunate as this gentleman in having a *number* of learned authorities to quote; but, however, I have one, and that in itself a host;—it is the Hampshire Brewer himself. When he admits that a third part of a wort of 30lbs. per barrel, is superior to another of 10lbs. per barrel, merely because of the greater prevalence of mucilage in the latter, does he not by this concession establish that opinion which he is labouring to overthrow, and prove that the instrument, indicating in both instances an equal gravity, is insufficient to shew their relative value?—Mr. Martineau's experiments nearly coincide with my own, as to the final gravity which will appear by the instrument in a *separate* solution of either malt

or sugar; but, I think, neither of them, sufficient to form the basis of a decision. From many experiments which a private friend of mine has made on the subject, and which have been frequently repeated under my own eye, with the most critical exactness, I draw a conclusion very different from that gentleman's. In two gyles, the one brewed from malt only, and the other having in it a solution of sugar, in the proportion of one-tenth part of the total aggregate of fermentable matter under operation;—the malt in both instances being from the same flooring, the fermentation similar, and the final gravity equal, per the instrument; and yet the latter product has been found uniformly superior to the other as an agreeable and vinous beverage: it possessed a greater fulness on the palate, and was a liquor to which the best judges would give the preference. That the superiority of the one was owing to the sugar that was used, there can be no doubt; nor can there be any, that the instrument was incapable of shewing that superiority. It was with this fact in view, that I wrote my former letter; but I do not know that it will have the same weight with the Hampshire Brewer, that it has with me. As to the result of distillation, however conclusive he may deem it, I must

beg leave to differ from him. The question is not as to the production of the greatest quantity of ardent spirit, but as to the value of either sugar or molasses used in a limited proportion in the brewing of *malt liquor*. The production of a wash suitable to the distiller's purpose, will certainly require a mode of management different from that which will be pursued by an intelligent brewer. Will not two worts, of equal gravity, yield a different quantity of proof spirit, as they are fermented either in the best way for beer, or as they are usually fermented for wash! Next to *potency*, two of the most desirable qualities in malt liquor are *early transparency and fulness;* but were the distiller's method of fermentation to be followed in the brewery, I think we should be hardly able to obtain either. While it must be acknowledged, that the particular method, which is most proper for obtaining them, would be inimical to the production of spirit by the still. As the two purposes, then, require two different methods of treatment, what may be an infallible test of value in one case may not be so in the other. And as the quantity of ardent spirit will depend upon the fermentation of the wash, as well as upon its previous gravity, its product cannot be a certain criterion of the value of its

original materials, any further than a similar treatment obtains, but will be unavailing when treated in a different manner and for a different purpose. As to the testimony of Drs. Thompson, Hope and Coventry, which the gentleman has introduced, I consider it as quite irrelevant, as it has no bearing on the question immediately at issue. Their manner of estimating the differences between English and Scotch barleys and malts was certainly judicious. And what does that prove? Why nothing, but what I am as well convinced of as the Hampshire Brewer himself. But though I am compelled thus to differ from a gentleman of such abilities, experience and information, yet it will be impossible for such difference to lessen that respectful sentiment I felt towards him on the perusal of his first valuable paper. I now close the correspondence on the subject by thanking him for the frankness with which he has communicated his sentiments, and by claiming for myself a right to dissent from the greatest authorities when I have reason to doubt whether their arguments are founded on legitimate reasons. To you, Mr. Cobbett, I am indebted for your impartiality, and for the space you have allowed for the discussion, and am obliged

by the readiness you have shewn in giving insertion to the correspondence—

I remain, Sir, &c.—

CANDIDUS.

MALTON, 19th December, 1808.

BREWERIES.

SIR,

IT is rather unfair to make your valuable Register a medium of discussion on any particular art or manufacture, but as you have already admitted the subject, I am induced to trouble you for a small space in a paper of such general instruction, for a few observations on the statement of the gentlemen who sign themselves "a Hampshire Brewer" and "Candidus" in your Registers of the 12th and 26th of November, and 10th of December.—The difference in the opinions of these gentlemen, on a subject which the former has so laudably brought before the public, seems to arise solely from Candidus' supposing that nothing but a saccharum is capable of the vinous fermentation, and that therefore the instrument used in the brewery cannot be an accurate "measure of sweets;" so far he is right, for although it

cannot possibly express the quantity of sweets contained in any extracts, it ascertains exactly their *relative* value, or amount of *fermentable matter*, under which term is comprehended saccharum, mucilage, and perhaps a little oil; in short, whatever is extractable from corn or grain, or soluble from other substances, where a small portion of saccharum is present—from all which, experiment proves that equal specific gravities will give equal quantities of ardent spirit, thereby exploding the commonly received opinion that sweets *alone* are capable of producing alcohol.—Candidus, however, had great reasons for his inquiries on the subject, which I presume will be farther elucidated when it is explained (if explanation be necessary to gentlemen who handle the subject so ably) why the saccharometer in general use will not indicate above one-third of the "gross weight of the substance dissolved;" for as it is impossible that either of those in question can undergo solution without increasing the bulk of the solvent, therefore a saccharometer, (I wish I could find a better term for the instrument,) indicating the difference of weight between a barrel of water and a barrel of wort, on which scale those in general use are, I believe, formed, can by no means express the quantity of fer-

mentable matter in pounds avoirdupois, contained in such barrel of wort; which may however be discovered, very nearly, by multiplying the amount per saccharometer by 2, 7; as is proved by ascertaining the weight of malt before brewing, and the grains (being completely dried) afterwards. Instead, therefore, of a quarter of malt weighing from 300 to 336 pounds, yielding from 75 to 80 pounds of saccharine (fermentable, I presume,) matter, it really produces from 202 to 216 pounds avoirdupois. —As to the brewery in general, sugar cannot be introduced to advantage, for it is by no means a superabundant saccharum which is there required, but an extract where mucilage bears the greater proportion.—With every apology for continuing a subject which can interest so few of your readers,

I am respectfully, Sir, &c.

I. H.

GUERNSEY, December 19, 1808 *.

* I have not the slightest suspicion by whom the letter signed I. H. was written; it is not I think the production of any gentleman in the Brewery, but it bears such evident marks of intimate acquaintance with the subject, and evinces altogether so much science, that I cannot withhold it.—J. H. B.

PRACTICAL OBSERVATIONS

ON

THE PREJUDICES AGAINST THE BREWERY.

WHEREIN

THE TRUE PRINCIPLES OF THAT PROCESS, WITH THE CAUSES OF THE UNCERTAINTIES EXPERIENCED BY PRIVATE FAMILIES AND OTHERS IN BREWING, ARE POINTED OUT.

Difficilem oportet aurem habere ad crimina.

TO

HIS BRETHREN IN THE BREWERY,

THIS

ATTEMPT TO REFUTE THE CALUMNIES AGAINST THEM,

BY

APPEALING TO THE FUNDAMENTAL PRINCIPLES OF THE PROCESS,

IS RESPECTFULLY OFFERED BY

THEIR OBEDIENT SERVANT,

J. BAVERSTOCK.

Alton, January 1, 1811.

INTRODUCTION.

THE following few pages are submitted to the consideration of the candid and more discerning part of the community, as an humble endeavour to rescue the Public Brewery from the aspersions which are thrown on it, owing to the *misconceptions* of persons unacquainted with the true nature of that concern: for, if the plain and elementary principles of the process were rightly understood, it would be seen, clearly, that *no benefit can be derived, by a Brewer, from the use of matters "not fermentable,"* and that all, or any of such, instead of being serviceable; must be preventive of the most desired intents in the business.

That branch of chemistry, which chiefly merits the inquiries of the Brewery, teaches

First—That *all* the spirituosity or strength

in beer, (wines, and cider,) is the production of *vinous* " fermentation" only.

Secondly—That no *such* fermentation *can exist*, except in a liquor that is drawn from some subject that is " saccharine."

Thirdly—THEREFORE, peppers, spices, and matters of every kind, not saccharine, being " *utterly unfermentable*," tons of them are not worth the cost of a single shilling, for use in any way, or to any purpose, in a Pale-Beer Brewery.

The writer does not except even Isinglass; so far as relates to *any* part of his own practice; but this article is generally deemed necessary to fine Porter*.

Further—If the public at large could be prevailed on to believe, that among the numerous discoveries and improvements in the arts and manufactures of the kingdom, during the present reign, a more *sure* system of brewing, as founded on rational, unvarying, and strictly correct principles, has been *gradually* unfolding and extending itself in the trade, the imputations ought to cease; at least with respect to those who may be observed to produce, most commonly, similar (and approved) beer—Be-

* See pages 185 and 186.

cause, such similarity is not attainable otherwise than by a systematic and uniform practice; the rules for conducting which are not comprehended by those who are usually employed to brew in private families. And even, if such system were fully understood, it cannot be acted upon adequately, and in every point, in any brewings of small quantities.

On a subject, which must be new to many, the aim has been to render it intelligible, rather than to be studious as to any other manner of treating it. This intention will, it is trusted, be accepted, in excuse for such repetitions, or other inaccuracies as may, without doubt, be noticed by the reader.

The design of the writer, in this publication, being liable to be misconceived, he begs it may be observed, that in no part is it asserted, that, foreign matters are not introduced by *some practitioners*, in the Brewery.

It would be taking too great a burden on himself, were he to assume to say, what may be the conduct, or the *judgment*, of each individual, engaged in this concern, in every part of the kingdom.

What he endeavours to shew is, that, "*all such matters are much worse than useless;*" that,

the Brewer who employs them defeats his own purposes; and must, also, be totally ignorant of the true principles of the process. See Pages 191, 192.

Alton, 1812.

PRACTICAL OBSERVATIONS,

&c.

Section I.

So much prejudice has prevailed, of late years, against the Brewery, as to create an almost universal belief, that this business is *no where* carried on, without the use of certain adventitious or foreign matters; and which are further concluded to be of an injurious nature to the human constitution.

This wild and unjust notion has the effect to deter some persons, who otherwise are fond of Malt Liquor, from indulging themselves in the use of it, in situations where the supply is afforded from the public Breweries only. It would, therefore, be serviceable to the community, if this matter could be so clearly explained, as to be rightly understood; and the minds of the people be relieved from a suspicion, which is attended with inconvenience, because with privation, to many among them. While a process, which requires the unceasing researches of many years to develope *all* the intricacies of

it, is degraded in the opinion of the public in general, and considered as no more than a merely practical operation, requiring no farther qualifications to conduct it, than are possessed by the meanest description of persons.

In attempting to correct these unfavourable impressions, I must not expect to produce that full degree of conviction, which the case justly deserves. Assertion, alone, is but a weak advocate, in whatever cause it may be employed, and the persuasions against all the public Breweries are so deeply rooted, that the most acute writer, perhaps, would not be able, at the present time, to remove them entirely.

Since, however, the truth must be best known to those who have been long engaged in the concern; and, especially, if the time has been assiduously devoted to an endeavour to discover, and to establish, such a system of uniform practice, as might, most commonly, produce a uniform beer; it may not be wholly useless to lay the result of such observations, as are connected with the subject, before the public, who have a claim that their minds should be set at rest, if possible, herein. For, next to food, an wholesome, palatable, and clear malt liquor, is desirable to the bulk of the inhabitants of these kingdoms.

In no undertaking is a wider distinction observable among the practitioners, than in Brewing; as is shewn in the numerous and strange varieties of the beers produced; and especially in the small brewings of the publicans, and of private families, all of whom are amazed at the dissimilarity in their beer from the same choice of the materials, and, *as they imagine*, from the same method of treating them. But therein lies the error.

Brewing is a branch of technical chemistry; and in this, as in every chemical operation, variations occur continually, which have a decisive influence, although the circumstances be so minute as not to be distinguishable by ordinary means of observation.

And, the process consisting necessarily of separate parts, and each of them dependent on the others, an error in either one of these parts materially prevents the desired effect in the whole.

It is, then, a widely mistaken, although a commonly prevailing, notion, that the brewing of any sort of Malt Liquor is entirely optional, and that it may be performed successfully, and at all times, by any and every person who chooses to assume the office, provided he be not limited in the quantity and quality of the ma-

terials: for a man may be willing to sacrifice a large allowance of the choicest of these, without having the power, after all, to make a palatable, early and spontaneously fine, and, consequently, an wholesome malt liquor; unless he be provided with, and perfectly understands all the uses of, some far more secure guides, than the discriminations of his own unassisted senses will prove.

A studious observation of the powerfully different effects of the different degrees of heat, in the water used in the several mashings, and of the heat in fermenting the worts when drawn from the malt, is of the very first importance and necessity,

The last is an operation of such great influence in the case,—that (besides the principal action of converting the sweet of the worts into vinous spirit) fermentation, in conjunction with the precautions required to be observed in the mashings, determines the early or the late period of natural fineness. The wholesomeness, or the unwholesomeness, of Malt Liquors depends chiefly on this, the most interesting part of the process; it creates a distinction in the flavour from the same materials alone, according to the several stages of its progress; and, withal, fixes the principles of preservation in

beer. Hops afford the basis of this last mentioned and desirable property; but all the benefits of the hops are destroyed in a few hours only, of too long protracted, or otherwise erroneous, fermentation.

The various degrees and modifications of the heats, (as being severally and critically suited to the two leading parts of the process,) rest on the experience and judgment of the Brewer; and when known, or determined on, may be applied most precisely, by the assistance of properly constructed thermometers. But these heats are not to be judged of to any nearly sufficient degree of correctness, by the perceptions of the touch alone. Neither is the exact quantity of the saccharine and fermentable matter obtained from the malt, (which is the foundation of all the strength in the beer,) to be discriminated by the taste. It is, however, absolutely necessary to a public brewer, that the precise amount of such "sweet" should be constantly ascertained; because, without a knowledge of this produce, (which varies surprisingly, according to the quality of the barley, and the method of malting it,) he cannot maintain that uniformity in the strength and flavour of his beer, which is a chief criterion of a well-regulated practice.

This valuable information is afforded by an hydrostatical instrument, adapted to the purpose; and which shews by the specific gravity of small portions, or samples, of the worts, as compared with water, and by their several (as accurately gauged) quantities, the total amount of such fermentable matter contained in each wort, and consequently in any given quantity of malt, to a thousandth part, or less. It will be obvious to every reflecting mind, that without a knowledge of the uses of these two instruments, all attempts to obtain uniformity in beer must be unavailing; and, that if an untaught person succeed, occasionally, he is but indebted to chance, and can retain *no sure* means to repeat his fortunate operation.

Age is the apparent remedy for all the errors of a random practice. But this would be highly disadvantageous to a public Brewer, in the present oppressed state of the trade, by causing a necessity for an increased and burdensome stock of beer, prepared from barley at an extravagant price, and loaded with excessive duties on the beer and on the malt. And, although such age is usually boasted of in private families, and among the publicans who brew, they may rest assured, that the liquor is not nearly so wholesome as that, which having been brew-

ed and fermented, according to established and confirmed principles, becomes naturally fine at an early period; and continues so, without tendency to acidity during as many months as may be necessary to its consumption. Which is a further proof of a correct practice.

Besides, as is well known to chemists, it is not practicable to produce *such wholesome* beer from a fermentation of two or three hogsheads, because it cannot be so complete, as from the much larger quantities usually fermented at one operation in any respectably sized Brewery. This is no chimera—nor an unfounded assertion—for it is to be satisfactorily accounted for on theoretic principles. And hence, the medical men are justified in prohibiting, as they often do, the use of the family Malt Liquors to invalids, and in recommending London Porter in its stead. The superior wholesomeness of which consists in the generally uniform correctness of the fermentations.

These two instruments, the Thermometer and Hydrometer, are now in the hands of almost every common brewer; yet the advantages derived from them may be presumed to be various, as the degrees of experience. and judgment, shewn in forming rules for the application of them. It is, then, severely unjust, that those

who, by incessant observation, have discovered the beneficial points and uses of them, and to the attainment of a more sure system of practice, should be the first objects of misrepresentation—while those are unsuspected, or even preferred, who are destitute of all knowledge in the matter. I allude, here, to the home-brewing publicans, and to those who are intrusted with this office in private families; whose minds being unused to subjects of so intricate a nature as constantly occur in a Brewery, they are utterly incapable of conducting the process; and do not make a wholesome, palatable, and clear Malt Liquor, oftener than as the wildest chance may lead them to success.

It requires the laborious study of a whole life, to establish a system of practice in the Brewery, such as may be, most generally, successful. And, even when such a system is discovered, or known, it is necessary to the application of it, that the whole process should be attended and watched from the infusion of the malt, to the cleanse from the fermenting tun; and that the liquors should be conducted, by the help of the most accurate instruments, and the nicest calculations, through all the various changes, to which worts, beers, and *all fermentable subjects* are liable.—They ought not to be

left wholly by night more than by day; until the effect to be produced is completed in them, and they are brought to a perfection equal to the practitioner's wishes.

After all his anxious labours, how painful must it be to such a brewer, to learn, that all his success in practice is imputed not to fair and hardly-earned knowledge, but to mean, and worse than useless, sophistications. And this, partly through the ignorance (perhaps not unmixed with worse motives) of the "*home-brewing*" publicans; and partly through the misconstructions of others, who are equally uninformed in the matter: who, entertaining no idea whatever of a rational system; either as existing, or as at all required in the case, attribute the successful, and to them mysterious, practice of the public brewers, to any and every cause, but the true one. Whereas, whether a right system is, or is not, known; there is not, at any rate, and *there cannot be*, the smallest inducement to introduce any matter whatsoever, other than malt, hops, yeast, and water, to make *or to mend* beer. For, a rightly-instructed brewer knows that the two first are not only the most serviceable, but undeniably the *cheapest*, articles he can use. And that, if other matters *are* introduced, they can only be by persons of no

judgment; and who must be as despicably ignorant of their own interest, in a pecuniary point of view, as of a true practice.

As will be endeavoured to be shewn, more fully, in the following section.

Section II.

Every brewer of beer, *for sale*, must have two chief objects in view:

First—to make a liquor which, by gaining a preference among the consumers, produces a continually-increasing demand for it.

Secondly—To make such liquor from the cheapest materials, that can be found to effect the purpose.

The qualities required in beer, to promote the consumption of it, are a pleasant flavour—a degree of vinous strength, exactly proportioned to the different prices obtained for it—and, finally, transparency, without flatness or acidity.

With regard to flavour—that which is yielded from malt and hops alone, is positively inimitable, and unattainable from any other matters whatsoever. And so decidedly is it preferred, by all ranks of consumers, that whenever it comes in competition with beer, wherein other matters may have been introduced, an imme-

diate increase of demand for the first, and decrease for the latter, are sure to ensue. To this test, the brewer may securely refer his cause, and all his claims to credibility. For, as far as other matters give any effect *at all* to beer *they must pervert* the genuine flavour; and if they should be peppers, or spices, they may cause a pungent heat on the palate, and in the throat; but which is of a quite different nature from, and never can pass for, *vinous spirituosity*.

It is as easy, also, to distinguish between that fine flavour which accompanies the bitter of the hop, and that of those ingredients which are reported to be substituted for it, as between the flavour of the finest champagne, and the most ordinary cider. Besides—the use of hops, in brewing, is to prevent the worts from becoming acid—as they would, at some seasons, even in the very first stage of fermentation, without a sufficient allowance of this corrective. For, the addition, or the omission, of this article constitutes the chief difference between the operations of making beer and vinegar from malt. More powerful *bitters* than hops may, perhaps, be found; but the bitter can be of no use, without the preservative property. Gen-

* See Note p. 109.

tian and quassia may be wholesome and useful when taken as medicines; but, if introduced in beer, they would not fail to cause a rapid decrease in the brewer's sale; owing to their being totally destitute of the fine aromatic flavour, as well as of the preservative qualities, discovered hitherto in hops alone.

Hence, there can be no inducement whatever, to a man of judgment in the business, to use any substitute for hops; since it must be plain to every one, that a prosperous trade is no otherwise to be gained, or to be preserved, than by pleasing the palates of the consumers; and no articles *can* communicate so saleable a flavour to beer, as choice hops, combined with well-made malt.

As to *strength* in beer, it has already been observed, that every particle of it is the creature of *vinous* fermentation; and that no such fermentation can be excited, except in a liquor that is drawn from some species of *sweet*.

"*No earthly production that is not more or less sweet, can be of more use to communicate strength to beer, than if sand or chalk were taken for the purpose.*"

And, provided the fermentations are similarly conducted, the quantity of vinous spirit obtained, is ever in proportion to the "sweet,"

contained originally in, or extracted from, the subject or matter employed.

So very exact is this proportion of the spirit to the sweet, that the distillers can always ascertain to a single gallon, what will be the produce of proof spirit from 10,000 gallons, or more of their fermented wash, previously to committing the latter to the stills. Which calculation is founded on an ascertainment of the exact quantity of fermentable matter, contained in a given quantity of their worts, whether from sugar or from malt. The same rule extends to, and is practicable in, the Brewery.

The inquiry then is—*which*, of all the saccharine matters procurable in this kingdom, and at all applicable to make beer, is the *cheapest*, on a comparison of the produce with their costs.

Omitting, for the present, to notice the prohibitions by the excise laws; the four cheapest sweets, obtainable in England, are "malt, treacle, sugar, and honey."

In stating the proportions which these bear to each other in fermentable matter, it should be observed, that sugar, being manufactured *uniformly* by being boiled down to a given and equal consistence, very trifling or no va-

riation is found in a given quantity of the *same sorts* of it; although the quality of the cane juice, from whence it is made, varies very greatly, according to the dryness, or the wetness, of the season in the West Indian Islands; and the same may be said, or nearly so, of the treacle.

But the malts made in England differ greatly in their value and usefulness; insomuch, that 8 bushels of malt, made from well-ripened barley, and in the Hertfordshire method, are equal in fermentable matter, to (and, consequently, will make as much beer, or vinous spirit, as) 195lbs. of clean and dry powder sugar, 224lbs. of honey, or 240lbs. of treacle. While the same portion of malt, if made from inferior barley, or in the west country, or other coarse manner, is not more useful, for the same purpose, than 170 to 176lbs. of the same sugar, or 196lbs. of honey, or 210lbs. of treacle.

Which is a matter well worthy the serious consideration of the consumers, and also of the makers of malt. The majority of the last not being aware, as I am willing to believe, of the injury and loss they occasion to the public; through the persisting in a wrong practice. For which, some excuse may be allowed, on

the ground of their being wholly unacquainted with the rules for discovering the precise differences between the two methods.

Taking then, *not the best malt* into the computation, but that of a middling quality, and estimating the cost of it at 80 shillings the quarter, in comparison with 180lbs. of sugar at 9d., 224lbs. of treacle at 4½d., and 208lbs. of honey at 9d., the costs of an equal quantity of fermentable matter, producible from each, will be —malt—say 80—treacle 84—sugar 135—and honey 156 shillings.

The reader may rely on the justness of this statement, as to the proportions, (or as nearly so as can be required) which these articles bear to each other, in the costs of such quantities of each, as will prove of no more than *equal usefulness* to a Brewer.

It is then submitted to him to decide, WHICH is the material, or the ingredient, that is the most desirable to be employed, to make the *cheapest* and at the same time the most readily *saleable* beer.

Although the prices of all the four are continually fluctuating, the advantage has always been in favour of the malt; as may be proved by every one who will take the trouble to make calculations on the temporary prices of the

several articles. And this, either with, or without, taking into consideration, that if sugar, treacle, or honey, were to be used, in but a very trifling proportion, in the Breweries, the prices of them would be immediately, and very greatly advanced; and malt would be in a proportionate degree cheaper.

The next consideration relates to transparency; to attain which desirable property in beer, it is necessary that the malt be *fairly* made, and that it be perfectly cured, or dried. For the methods used by some of the makers, to evade the duties, are preventive of those properties in the malts, without which neither fine nor sound beer can be made. A similar disadvantage arises to the brewer, from the malt being watered after it is dried off; which is practised by some of the makers for sale, with the view to increase the quantity of it.

But if this, the chief material, be properly made and chosen, a constant tendency to speedy fineness in beer depends, as has already been intimated, on the correct and established heats of the several portions of the water used in the mashings; and on the heats employed to conduct the fermentations. For similar effects may be expected only from similar causes. It is by fermentation only, that the

saccharine parts of the malt are changed to spirituosity; and the worts rendered light, vinous, and intoxicating. Not a particle of which last-mentioned property exists in *unfermented* worts; however sweet and rich they may be.

The expressed juices of grapes, apples, and other garden fruits, ferment spontaneously; and thereby become wines, or cider. But the worts from malt being much boiled, and with a considerable quantity of hops, require yeast, to excite that fermentation, without which, as already observed, the liquor would be neither spirituous, fine, nor sound. When, therefore, the whole process is finished, some particles of the yeast will, from their lightness, be floating in the liquor, and cause it to be cloudy. Some heavier matter than these particles is then required, to compel them to subside; and, especially, when beer is removed, as in the public Brewery, from one situation to another, and at a considerable distance. The article used for the purpose in the London, and in many of the country, breweries, is isinglass, dissolved in old beer; to which there can be no objection, on the score of wholesomeness; nor does it affect the *taste of porter*; because this liquor being made from very highly dried and very brown malt, the flavour of such malt predominates in

the beer over all. Isinglass, however, produces *flatness*, and that speedily, in *all* beers; and hence, it is found, that the freshest porter is procured from those public-houses, wherein the consumption is so quick, that the cask is broached, and emptied in the course of one day. But, applied to *pale* beer, isinglass injures the flavour very materially, especially of the choice ales; and, also, induces a disagreeable flatness, which is quickly followed by acidity. The article, then, which is the most suitable to reproduce fineness *on removals*, and with every advantage, in *pale* beer, is a small quantity of boiled and loose hops, which, imbibing the liquor, become thereby so heavy as to sink from the top to the bottom of the cask, collecting and carrying down with them, the light feculencies above mentioned; and, thus, leaving the body of the liquor clear, without the aid of other matter, whatsoever, than that which is a necessary part of beer—hops; and which cost the brewer nothing for the purpose of fining—because those, which have been boiled in the worts, are more immediately efficacious than the dry hops. They will not, I am aware, act so *expeditiously*, as the dissolved isinglass; and some days must be allowed for the liquor to rest, after being removed to a distance, and

while these loose hops are gradually sinking, and thereby performing their office: when this is effected, the superior benefits of them, as compared with isinglass, for the same purpose, will be shewn, undeniably, in the superior flavour and soundness of the beer.

Section III.

I have hitherto abstained from noticing the prohibitions, by the laws of Excise, on the Brewers, to use any substitutes for malt and hops, under different and most severe penalties; one of which is the forfeiture of *all* the utensils, viz., Coppers, Tuns, Backs, *&c.*, which would put a stop to the concern. If what has been already observed should be insufficient to produce conviction, as to the inutility of such substitutes; it may be submitted, to the incredulous, how it would be practicable in an establishment, wherein numerous servants are employed, (and in different parties, according to the various departments of the business,) to introduce *bulky, or any* articles, without the knowledge, at some time or other, of some one or more among them, who, on information, would partake of the penalties. The same difficulty does not occur to a "Home-brewing Publican," whose

extreme ignorance, in the case, might lead him to waste his money and time in such a contemptible way.

The state of utter darkness in which the Brewery lay, so lately as until the latter part of the eighteenth century, placed the then principal brewers in London, in the same uncertainties, as to the practice, that are still experienced by the uninformed practitioners. Without instruments to guide them through the process, isinglass was not always sufficiently powerful to produce fineness in the *Porter* which is at all times more difficult than in pale beers. Recourse was, therefore, at sometimes had, by the ignorant "*abroad coopers*," who were the beer doctors of those days, to stuff of their own inventing, to assist the isinglass. These practices, which were open and notorious, gave occasion for introducing a clause in the Act, 1st of Geo. III., 1761, prohibiting the use of several articles therein named, in the Breweries, under the penalties alluded to.

The various regulations and additions to the duties, since that time, have caused a necessity for new Acts on the subject; in which, as in renewed Acts relating to other public affairs, all the old clauses are retained, excepting those which would affect the intended alterations. It

would be difficult to account, on any other grounds, for the continued mention in those Acts of the worse than useless articles, which are thought necessary to be prohibited in the present day; the gross futility of them being, now, so well known to every rational practitioner.

Yet this, so grave authority, tends unfortunately to strengthen the stigma; and to level the distinction between every brewer, in the minds of the community.

The colouring, which is occasionally used in porter, is of a different description. It is sanctioned by the King's Patent—permitted by the Excise—and verified by the worthy manufacturer, Mr. Alderman Wood, to be made from malt and water only. This process is extremely easy and simple: it consists in nothing more than evaporating the water from an infusion, or wort, drawn from the brownest malt, which is thereby brought to the consistence of treacle in a very few hours *.

The intent of this article is to enable the Brewers to use a large portion of pale and rich malt in making porter, instead of compelling them to use the brown malt wholly, which is

* Since this was written there have been several alterations in the excise laws respecting porter brewing, and no substance is now permitted to be used for the purpose, except the roasted or burnt malt.

extremely weak, because it is deprived of the greatest part of its saccharine and fermentable matter, by the particular methods used in the making and drying it, to obtain the colour and flavour required in that species of malt liquor.

The first dawn of light was thrown on the Brewery by Dr. Shaw*, in his Chemical Lectures and Essays. From whence, Mr. Combrune took the hint to introduce the thermometer into his brewhouse; and, about the year 1760, he published a quarto volume on the subject, which he inscribed to Dr. Shaw. But neither the publication, nor the instrument, were much attended to by the brewers of that time. Indeed, *it was not practicable* to form a complete system of Brewing, by the aid of the thermometer alone, any more than it is possible to form such a system *without* that instrument.

In 1768, an hydrometer was used with the thermometer, by the writer, in his own Brewery, in the country. This was so unthought of, at the time, that even the maker of the instrument (Mr. Martin, of Fleet-street, who had designed it to shew the strength of spirits only,) was with great difficulty persuaded that it could be made useful in the Brewery.

The same incredulity prevailed among some

* A Physician to the late King George II.

of the very principal brewers, in London, to whom the matter was communicated in 1770; but, about the year 1780—(through the activity of another maker, who had got the hint, and went among the brewers in London to sell them,) hydrometers became nearly as generally used as the thermometers; and each of these instruments throwing light on the other, a system of practice *has been gradually forming*, which fairly entitles the Brewery to more estimation, as a science, than the public have hitherto been willing to suppose can be due to it; because the rules, by which alone an uniform practice can be conducted, are not comprehensible by uneducated minds, nor thought of by such as are unaccustomed, or disinclined, to studious inquiries. And as far as this may be perceived and credited, it will not be difficult to distinguish the persons who give occasion for the imputations which are so prevalent against the Breweries.

I would not be understood as attempting, or desiring, to defend the practices of the ignorant or the indolent, whether they may be engaged in a large, or in a small, way of business; nor as insinuating, that the extent of a man's trade is decisive of his intelligence in it; for, without doubt, in the Brewery, as in other occupations

or professions, the qualifications of the principals are various as their propensities, or as their opportunities to acquire information.

What I chiefly assume is, that no rightly-instructed brewer will be so weakly unjust to himself, as to expend any part of his money in articles, which *can have no other effect* than to deteriorate his beer, and, consequently, to lessen the demand for it.

In the situations where public Breweries abound, it is but little imagined how very scarce they are in other parts of the kingdom; insomuch, that it was stated to a Committee of the House of Commons, in February, 1807, by Mr. Jackson, then a Commissioner of the Excise, that the number of the Common Brewers did not exceed 1400, while the Brewing Publicans were so numerous as 23,740!! Of the 1400, so denominated, many are brewers of Table Beer only; or of very trifling quantities of strong; and such may, therefore, be classed with the 23,740.

As the two instruments can be of but very little or no use to any one who is not possessed of some portion of mathematical knowledge, it may be reasonably presumed, that the far greater part of these persons must be utterly incapable to apply them, and to conduct such

an intricate process with any approach to certainty: and that, unable to account for the disappointments which they *must incur;* wholly ignorant, also, of the means to discriminate between the very best materials for brewing, and the very worst, they are open to the insinuations of the travellers for the druggists; some of whom, it is well known, hesitate at no falsehoods, to persuade these uninformed men, that the success of the reputable brewers is owing to the useless stuff, for which they pressingly solicit orders. Such, if any, are the purchasers of matters, utterly inapplicable to the purpose, and which only serve to increase their difficulties as well as their expenses.

How cruelly unjust, then, must it be, to degrade a large number of respectable and intelligent men, on no better grounds, than merely on account of the absurdly ignorant practices of some persons of a quite different description, who are engaged in a similar occupation.

Indeed, the very nature of the Brewery, considered as a commercial concern only, is strangely mistaken by the public in general. It is sometimes seen, that a man, who has acquired a capital in another occupation, or branch of trade, embarks it in this business—conceiving that nothing more is required to ensure his

success, than to purchase a large stock of the materials and utensils, with roomy premises; and among the rest, a number of public-houses; *resolving* also, that the quality of his beer shall excel that which is produced by any of his competitors; which effect, he concludes, necessarily follows an increased allowance of the materials. But he soon finds, that without a correct knowledge of the leading principles of the process, all his endeavours to produce a readily saleable beer, are defeated—that his public-houses are forsaken by the consumers, and his store-houses filled with a stock of liquor, that cannot be sold for half the costs of it. In truth, no trading concern can be more intricate, more difficult, and consequently more hazardous, to a novice, than the Brewery.

Section IV.

It will be said, after all, that much better beer is brewed in private families, than by the Public Brewer, with all his instruments, and all his pretensions to knowledge; and that a thermometer appears to be unnecessary as to the mashings; since boiling heat, without which some persons imagine the liquor will not be

drinkable, nor continue sound, is discoverable in water by the eye, as soon as the fire has brought it to that state.

To this, it may be replied, that the indiscriminate application of boiling heat, or but nearly so, to the malt, causes a waste of one-fourth part of all that is so treated; for, that three portions of malt, if wetted with water of the proper degree of heat, will produce as much wort of any given strength, as can be obtained from four like portions of the *same* malt, if boiling water is used in the mashings; which, instead of reaching all the parts of the malt, forms very much of it into (nearly dry) balls, impenetrable by such water; whence the worts are not only deficient in sweetness, but also in quantity; for, these clods being, as before observed, but partially wetted, withhold the greater part of the water which they may have imbibed; and hence the quantity of the wort is diminished; while the interiors of them, being untouched by the water, yield no sweet at all.

A like effect, although in a less degree, ensues whenever the heat of the water, in the first mashing, is nearly, although not quite, boiling. The correctly suitable heat, therefore, is neither to be discovered, nor accurately applied, without the assistance of a thermometer.

In private families, however, the *cost* of the beer is very little regarded. If ten bushels of malt are found to be insufficient to produce an hogshead of *stout* beer, twelve, fourteen, or even sixteen bushels are sometimes allowed. If, likewise, the beer does not become fine, and drinkable, at the end of twelve or more months, it remains unbroached for two, three, or four years; when the age, the necessity whereof is occasioned by want of system, is announced, as a principal recommendation of the liquor.

The situation of the Public Brewer is very widely different. Under all the disadvantages of a (long continued) high price of barley; and loaded with duties on the malt, and on the beer, amounting, together, to more than 40 per cent. on the price, at which the last is sold by the brewer to the publican; he is required to produce, constantly, a clear and nourishing liquor—for such a price only to himself, as will enable the retailing publicans to comply with the demands of the populace, who, most unreasonably assume to dictate "*what* that price shall be," and which *they* will not suffer to be increased; although the most necessary ingredient, "barley," may be from 50 to even 100 per cent. dearer than when the present retail price of beer was established, viz., in 1803.

The unreasonableness of this assumption, and of the consequently inadequate prices allowed to the Common Brewer will be yet more apparent, when it is considered that private families, and also the publicans, who brew at home, acquiesce (as they ought) in the increased price of the malt; and, (which is equally just,) every one submits to the additional prices of bread, and of all provisions—and, even of the far less necessary article than beer, distilled spirits—the price of which the populace do not attempt to control.

The Common Brewer, therefore, cannot afford to be wasteful of the malt, in the outset, nor of time in the consumption of his beer. The sooner the last can be rendered saleable, the less will be the weight on the brewer, occasioned by a burdensome stock of beer, and of casks to contain it. For, although these two articles are, in *all* breweries, unavoidably heavy and expensive; yet, much part of both may be dispensed with, or saved, simply by using proper heats in the two most important parts of the process—extraction, and fermentation. And these heats, which should vary with the sorts of the malt, with the seasons of the year, and with the views of the practitioner, may be obtained constantly by the thermome-

ter, to the utmost exactness; as decided on by, and corresponding with, the judgment of the brewer.

It is not to be expected, that the mere possession of the instruments imparts all the benefits of them. Here, however, is the proper ground, from whence to gain right information through practice—since the experience of those, who are unused to these instruments, is founded on no rule or true basis. The eye, or the touch, can afford no sufficient direction as to the heat of water below the boiling point, or as to the heat of worts; otherwise, than according to the accidental warmth of the hand at the time it is applied.

The natural heat of the human body, in health, is 94 to 96 degrees, by Fahrenheit's thermometer. In the summer months, the touch applied to worts, somewhat below that degree, will indicate them to be cool; when, perhaps, their actual heat may be such, as to be very unfit for the purposes of a profitable fermentation.

On the other hand, the external air, in severe weather, being at, or below, the freezing point, a vapour will be seen to arise; and the extremities of the body being also at such time, most liable to be affected by the cold, the hand may

then discover a *comparative* warmth in worts, although they may be sunk considerably below the requisite heat to excite and sustain a complete fermentation, the great importance of which operation has been endeavoured to be shewn.

Section V.

The variety of uses and subjects to which an hydrostatical instrument may be advantageously applied, appears not to have been hitherto considered or exemplified, with that attention which the matter would be found to deserve. For, besides the articles already treated on, viz., malt, sugar, treacle, and honey—grapes, apples, and all the garden fruits may be far more correctly judged of (as to their value and usefulness in forming wines, or cider,) by such an instrument, than by conjectures founded on the perceptions of the taste alone.

In these, as in every vegetable production, the *annual* differences in their richness (which are considerable in the produce of the same soil) must be owing to the more or less degree of warmth, and the dryness of the season, at the time of their ripening. And hence, chiefly, proceeds the differences observable in the

strength of the wines, made from these our native fruits, with the addition of sugar, the allowed portion of which last, is usually *fixed*, without any regard to the real and varying quality of the juices expressed from the fruits. But if this were precisely ascertained, a rule would be gained, whereby to make *just* such an addition of sugar as would make the unfermented liquor, or stum, of an equal quality in every season.

The superiority of the Devonshire cider, compared with that which is made in the eastern part of England, is very distinguishable; and although the differences in the soil may be supposed to cause a part of such superiority, the more southerly climate, of three degrees only, may be concluded to contribute materially to the effects—not only to add to the richness, but also to heighten the flavour, of the fruit; for in every fermentable liquor, flavour and strength go hand in hand.

The above remarks may be applied also to the differences in the wines produced in the southern provinces of France, compared with those made from the vintages nearer to Paris.

A remarkable equality is found in the fermentable matter contained in the juices of our fruits; such as mulberries, currants, grapes, *&c.*,

in the *same* season; but none of them are sufficiently sweet to make wine without a large addition of sugar. In numerous examinations of them, and including the apples in an eastern county, the amount of their saccharine and fermentable matter has been no more, generally, than of that quality which is understood by those who are acquainted with the instrument, when expressed by the term of twenty pounds per barrel: and which is well known to them to be insufficient to make a fermented liquor, other than of a very weak and thin quality. While it is equally well known, that the dried grapes brought hither from Malaga and Smyrna, may be made to yield wines equal in strength, or nearly so, to those made abroad—without the assistance of sugar, or of brandy; and provided a sufficient quantity of the fruit be allowed to no more than a suitable quantity of water, a stum of 50 lbs. per barrel may be obtained, which will form very strong wine.

In the sugar houses, in salterns, in tanning, and in ascertaining the strength of the ley used by the soap-makers, (all of which are parts of technical chemistry,) it is most reasonable to conclude, that this instrument may be so applied, as to remove much of the uncertainty which must attend such operations.

I am not attempting *more, than to offer hints* to those practitioners in the above-mentioned occupations, who, possessing judicious minds, may respectively be disposed to prosecute the inquiries.

With the same view, I recommend it to the consideration of the planters, and proprietors of estates, in the West Indies; whether an hydrometer may not be advantageously employed in the forming of sugars, by ascertaining the *precise* value of the cane juice, and by leading to other information, tending to the construction of a series of rules freed from the uncertainties of the usual practice; on which subject I purpose to treat a little more fully.

In the sugar colonies, "the ripe sugar canes are ground down in a mill, between iron rollers kept continually feeding, so that the expressed juice runs in a constant stream into its proper receiver; from whence it is soon committed to to the first boiling pan, where it is boiled, scummed, and cleared of its feculencies*."

From all that I have been able to learn, in conversation with gentlemen interested in the matter, and who are acquainted with the process, generally observed, by an occasional resi-

* Dr. Shaw's Chemical Lectures, page 277.

dence on their own plantations; this cane juice has a near resemblance, in its nature and properties, to the extract which is, in England, obtained from malt, with the exception, that the cane juice is abundantly richer than the worts from malt.

Such, however, is the material disproportion in the richness of the cane juice, that sometimes a pound of sugar is obtained from a gallon of it, and at other times, not more than half a pound of sugar is gained from a gallon of juice, on the same plantation.

Accordingly, as the cane juice is more or less rich, the process is to be diversified, and a greater or less quantity of quick lime, or of lime water, is to be used in it. Without the use of such lime the sugar cannot be brought to granulate, and yet a very small proportion of it is sufficient; when the juice is rich, a two thousandth part will serve; if the juice is very thin, it will require twice as much lime, or one thousandth part.

This difference, and all the intermediate quantities between these extremes, I have been told, are hitherto ascertained only by the eye, or by tasting the cane juice. And as the quality and quantity of the sugar depend greatly, on the proportion of the lime being duly regulated to

the richness of the juice, a rule to ascertain this, with precision, must be of much importance. For, if such a small quantity of lime determines whether there is to be sugar, or not, a very inconsiderable deviation from the just proportion, whether more or less, must have a bad effect.

That any one of the hydrometers, commonly used in a brewery, will shew all the differences in the quality of the cane juice, (and the intermediates,) from the thin which produces half a pound of sugar from a gallon of juice, to the richest producing a pound, may be safely pronounced.

In the first boiling-pan the object is, to clear the juice, by scumming off the dirty matters collected with the canes in the fields. After which, it is removed into a second pan: to be further prepared; and this seems to be the proper time for taking a sample of the juice for the purpose of deciding on the quality of it, and on the portion of lime which may be necessary, and the most advantageous.

There appears not to be the smallest difficulty in this—for, should the consistence of it, in this state, be out of the reach of the instrument, that inconvenience is remedied effectually; and the proof is made, with increased ex-

pedition, by diluting a pint of the juice of the first boiling in a pint, or in two or three pints, of clean water; and then estimating the juice doubly, or more, according to the proportions in which it was so diluted.

And hence, after a few trials, a fixed rule might be formed for constantly adjusting the proportion of lime to the quality and quantity of the juice.

But this is on a presumption, that the lime itself is always of the same strength, which is not to be expected; for it is well known, that this article, in common with other alkali, cannot be preserved from slacking, when kept but a short time, whereby a considerable part of its strength must be lost. And, from what I have understood of the state of this article, after its importation to the islands, and of the mode of keeping it when there, little doubt can be had of there being a difference, equal, in some cases, to three and four to one in its quality, when used. Hence, while the planter has been imputing the bad quality of his sugar, or the small produce of it from the juice, to the impoverished state of the canes, in all probability, the miscarriage may have been chiefly owing to a defect in the lime.

This uncertainty, as to the lime is, however,

removable in two ways; and, (which is further satisfactory,) the one method contributes to confirm the accuracy of the other.

To twelve ounces of clean spring water, I added one ounce of new and very strong stone lime, which occasioned so great an effervescence, and sensibly increased heat, that I was induced to apply a thermometer to the liquor; and found that the heat was increased 23 degrees, viz., from 54, the original state of the water, to 77 degrees. On proving the clear liquor by an hydrometer, after the agitation had ceased, it exhibited an increased gravity of 19½ lbs. per barrel.

Another ounce of the same lime was added to the liquor of the first experiment, which, by standing, was sunk in heat to 68 degrees. A very strong ebullition again ensued, and the heat increased to 92 degrees.

Suffering it to stand to settle, as before, and taking the gravity, at the same temperature as the former, it exhibited exactly 39 lbs.—thereby shewing, to mathematical certainty, the justness of the rule; which was confirmed, on subsequent trials, by the less heats and gravities of slacked and inferior lime.

It is hence presumed, that (after a proper number of trials) fixed rules might be formed

for constantly apportioning the lime, of whatever degree of strength, to the quantity and quality of the cane juice—by the use of this instrument, in the hands of a judicious and diligent practitioner. Or, if the method by the hydrometer (which, however, need not to occupy more time than a few minutes) should be thought too troublesome, the most indolent person might derive an easy rule from the effervescence, and increased heat, caused by one parcel of lime, on a comparison with another, as measured by a thermometer; which, although not so much to be relied on as by the hydrometer, must be preferable to *no rule at all*, other than conjecture.

It may be suspected, that the corrosive quality of strong lime water must injure the hydrometers made of the usual metals. In the few trials I made, no such injury ensued—care being taken to rinse the instrument in clean and warm water. At any rate, this objection is removable by procuring an hydrometer to be made of glass, for use in this or other strongly saline liquids; which is very practicable, the glass manufactories having long been brought to such perfection in this kingdom, that glass may be, and is, formed to the nicest accuracy of size, shape, and weight. I have seen such an

instrument in glass 25 years ago. The hydrostatical balance was the first invented of these instruments, and the ball of this is of glass. Hydrometers are of later date, and are more convenient because they are very far more expeditious.

Glass bubbles, on the same principle as those used in the islands to prove the rums, might probably be so formed as to accomplish every purpose, relating either to the cane juice or to the lime.

It has been suspected, that in the solutions of saccharine, and also of saline articles, other matters may be so much combined with the subject of the inquiry, as to destroy the conclusion, that the specific gravity of such solutions is correctly decisive of their actual values. For instance, that in malt worts, there is much of the mucilage of the grain, and in the cane juice, earthy matter; or, perhaps, through accident, actual earth. To the objection as to malt worts, it might be sufficient to observe, that the distiller constantly finds the produce of proof spirit to be precisely apportioned to the gravity of the worts; whether from malt or from sugar—and that the brewer can, also, obtain a more or less price for his beer, according to the average gravity of his worts, under

strict uniformity in the other parts of the process.

But it may be further and plainly asserted, that matters which are neither saccharine, nor saline, do not give any effect, at all, to the hydrometer, worthy of notice*. To 20 ounces of clean spring water, I put eight ounces of fine and black garden mould, the whole was well stirred and mixed—and suffered to stand 24 hours—when, although the water was still turbid, the increase in gravity by the instrument was scarcely discernible—(not ½lb. per barrel) and this trifling addition may fairly be attributed to the *salt of the earth*, rather than to the mucilage.

On dissolving only 2 ounces of powder sugar in the same quantity of water, the increased gravity, by the instrument, was in the proportion of somewhat more than 14lbs. per barrel; which serves to shew the different effect of saccharine, compared with other matters on the instrument.

* This is not strictly correct. To a pint and a half of river water, I put one ounce of fine gum arabic, which produced very nearly the same gravity as one ounce of sugar dissolved in the like quantity of water; this experiment I made in August, 1821, in the presence of the gentleman to whom I have alluded, in the note in Sect. 3, of the Hydrometrical Observations, and I must confess the result was very different from what I expected.—J. H. B.

In the case of malt worts; if after three plentiful mashings a fourth liquor be turned on, and if it be boiling or nearly so, it might be presumed that this would extract much more of the mucilage of the malt than was contained in the first worts of 30lbs. or upwards. And it would be so—as the greyness of the liquor would shew. Yet this last would not shew more gravity than 1 or 2lbs. per barrel; the whole of which I should impute to the remnant of saccharum in the grains, rather than to any other matter.

If these hints, relative to the cane juice and the lime, should prove worthy the consideration of those who are interested; every intent of the writer, in thus venturing to offer them, will be fully answered.*

* See some letters from Mr. Bogle in 1785, which will be found in the Appendix.—J. H. B.

ON THE QUESTION OF CORN AGAINST SUGAR.

THERE is another matter in which the colonies are interested, on which I shall take the present opportunity to offer a few thoughts—namely, the question whether corn, or sugar, ought with the greater regard to justice to be used in the British distillery—and which I shall consider, as it affects the interests of the revenue, and of the majority of the public in general.

To make a tun or 252 gallons of spirits, of the strength of one to ten above hydrometer proof, requires either 23 cwt. of good and dry sugar, or 14 quarters of barley—of which last 6 quarters are malted, and 8 quarters are raw. The several duties on the manufacturing of each have hitherto, stood thus:

	£.	s.	d.
The customs' duty on 23 cwt. of sugar at 27s. .	31	1	0
Excise on 252 gallons of *sugar* spirits at 5s. 11d. .	74	11	0
Sugar and spirits' duty on each tun	105	12	0

	£.	s.	d.
Excise duty on 6 quarters of malt, at 34s. 8d. .	10	8	0
Ditto on 252 gallons of malt spirits at 7s. 3d. .	91	7	0
Malt and spirits' duty on each tun	101	15	0
Less on ditto	3	17	0
	105	12	0

The Chancellor of the Exchequer* on proposing the budget, in May, 1806,—stated that the consumption of malt in the distillery, while no prohibition against the use of corn existed, was 250,000 quarters annually.

The proportions of the sugar, and of the two sorts of grain, are taken from the testimony of the principal gentlemen, engaged in that concern; who were examined before the Lords Committees in March, 1810,—and as 8 quarters of barley are used with each 6 quarters of malt, it follows that the whole consumption of grain, in this way, must be *very nearly* 600,000 quarters, annually, and the quantity of these spirits made—42,000 tuns.

The advantage to the revenue on which quantity is somewhat more than 160,000*l.*—on the distillation from sugar compared with that from corn.

But this is on the presumption that the malt duty on the 250,000 quarters is lost—which does not yet appear to have been the case, in any material degree.

The distillation from corn was prohibited in June 1808, when the distillers had finished working for the season; at which time, also, the

* Lord Henry Petty, now Marquis of Lansdown.

account of malt duty is annually made up at the Excise office.

The whole duty on the malt made in the kingdom from the 24th June, 1808, to the 24th June, 1809, was only 11,274*l.*---(viz., on not 6,400 quarters) *less than in the preceding year, when the distillers worked fully on grain*—although the average price of barley was (50*s.*) 10*s.* per quarter higher in the last period than in 1807, to 1808.

It is evident, therefore, that more beer was brewed, and consequently that both the revenue and the landed interest received an equivalent, as far as regards the consumption of 244,000 quarters of malt. Which circumstance therefore causes the aggregate advantages arising to the revenue from the distillation of sugar to be 580,000*l.* more than from corn.

As to the 300 or 350,000 quarters of raw barley, it has not been found that any has remained undisposed of—nor is it at all probable that this will happen, so long as a necessity of importing grain so largely as of late exists. If the whole population of Britain were to eat wheaten bread, the scarcity of that species of corn would be still more lamentably felt, than has yet been the case. But fortunately, a large portion of the people have not been accustomed

to other bread than that which is made from barley, oats, or rye, and they are therefore well contented with such. This is the case in Scotland and the northern and other distant counties, to the amount, as it has been said, of a fourth part of the population of the kingdom, Yet while we are relying on foreign importation of corn to the large amount of 1,500,000 quarters annually (the necessity of which is not only acknowledged but insisted on by the landholders themselves;) what an outcry has been raised against the stoppage of an *absolute waste* of a *part* of that quantity!

At the time the distillers were permitted to work from corn, the accumulated surplus of sugar in 3 years, (being the difference between the importations and the sales, from the 1st of January 1804, to the 1st of January 1807,) amounted, according to a Parliamentary Report, to 1,435,609 cwt. This immense quantity of sugar remained wholly useless, under locks in the King's warehouses in London, and in the Out Ports, *because there was no demand for any part of it.* Consequently, all the customs' duty thereon, amounting to 1,938,000*l.*, were lost to the revenue; and all the costs of the cultivation and expenses in the plantations, with the freight and shipping charges to England, *ex-*

ceeding altogether a further sum of 2,500,000*l*., were lost to the West Indian proprietors.

Any proposition more boldly unreasonable than that such serious sums, amounting to 1,500,000*l*., *yearly* should be so sacrificed, and yielded up, was surely never yet offered to minds, supposed capable to distinguish between what is just and what is unjust. And for what purpose, or on what pretence, is this required? Or what cause have the farmers to complain?

Since the prohibition took place, and during the two years from June 1808 to June 1810, the price of barley in the interior parts of the kingdom has averaged at fully 50s. the quarter. And taking the whole of the last six years to the present time, including three months after a most favourable harvesting of an abundant crop of *barley*, the average price through the kingdom has been 45s., which, I conceive, will be found to exceed by many shillings on each quarter any rate, at which this species of grain has hitherto been estimated, in the letting and taking of farms.

It has been urged that an high price of grain is necessary to promote the growth of it. The farmers are, assuredly, as much entitled to a fair recompense for their skill and the employ-

ment of a considerable capital, as those who engage in other pursuits, with a view to profit; but not more so.

It is difficult to believe, that a renter of lands would suffer them to lie uncultivated or neglected, from no better motive, than, that the price of corn, (although beyond the rate at which he took the farm,) is not *constantly excessive*, as for the last six years. Wealth, when gained easily, leads more usually to indolence, than to increased industry. A man, who can live at his ease on half a crop, will be the less anxious to add to the growth of his corn. It is a well known maxim among farmers, that the half, or three-fourths of a crop, is more profitable than a full one; and there is more reason to believe, that the produce through the kingdom is lessened, than that it is increased by high prices.

But is all consideration to be entertained for the farmers, and none for others? Some have been so bold as to assert, that the price of corn signifies nothing to the poor, because they are maintained by the farmers. Do the farmers alone support the poor of the towns and cities through the kingdom?—or are the numbers of the actual paupers in the villages to be compared with those in the towns? Passing these—

is no attention due to the multitudes of working artisans and others employed in the various trads and manufactures in the kingdom—are the prices of bread and other provisions of no interest to them, or even to their employers, with the families of all who are so occupied *?

Some regard is surely due to the interests also of the colonists, who contribute largely to the support of the government, by duties on their produce, and by returns which they take of British articles; not only for consumption in our own, but in the Spanish and Portuguese, islands, as well as in other various parts of America.

The British distillery is a concern in which men of the first respectability, in every point of view, have embarked capitals equal in value to considerable estates in land. These gentlemen are, it must be allowed, entitled likewise to consideration, on the ground of their usefulness, in paying immense sums to the revenue for duties on sugar and spirits, amounting to about half as much as the common breweries pay on malt and beer.

In substituting sugar for grain, the cost of every fermented liquor is increased; and the

* Since this was first published, viz., in 1811, the agricultural interest has undergone a severe reverse of fortune. —J.H.B.

distillers have, accordingly, advanced the prices of their spirits 2s. per gallon since the prohibition. They, therefore, receive an equivalent of 30 per cent. for the additional cost of the raw material, or 15 per cent. on the entire manufacture, viz., including the duty *on the spirits*. If this were to lessen the consumption among the lower order of the people,—*who* could (justly) complain? Might it not tend to national amelioration, and is not beer a more wholesome and nutritious, as well as a cheaper, liquor? In point of necessity, or of usefulness, ought gin to be placed in competition with bread; or is it consistent with reason, that the absolute waste of 3 or 400,000 quarters of a valuable species of corn should, for a moment, be defended and advised by the same people, who assert the necessity of importing, annually, a foreign supply of four times that quantity—and which is now to be obtained only from our inveterate foes?

So far as it may be desirable to the occupiers of lands that barley should be wasted, they are amply assisted (although it may be chiefly unknowingly) by the makers of malt for sale, and also unavoidably by the publicans and others in brewing small quantities; as has already been touched upon.

Each bushel of the best pale malt, such as is

made after the Hertfordshire manner and from well ripened barley, is equal to 24 or 25lbs. of good powder sugar; but more than half the malt, commonly made, is equal to only 21 or 22lbs. of sugar for each bushel. More than *another* eighth part is lost in the brewings of bushels, instead of as many quarters, at each operation—and, therefore, no more fermentable matter is usually obtained from each bushel of inferior malt than would be yielded by 16 or 18lb. of sugar. For there is no skill required in dissolving the sugar, as in mashing the malt, and therefore, not an ounce of the first is wasted. Hence, the disadvantage of using sugar, instead of malt, is not nearly so great to private families as to the common brewers, and the liquor, being free from all farinaceous matter, would become transparent and drinkable in much less time than the worts from malt. No loss could ensue to the revenue from such a practice; because the customs' duty on 18lbs. of sugar is equal to the excise duty on a bushel of malt.

The annual growth of barley in the kingdom is now estimated at 4,800,000 quarters; of which 3,200,000 quarters have been usually malted—600,000 are wanted for seed, and the remainder is consumed in food for man and cattle.

Of the 3,200,000 quarters of malt, the common brewers use 1,600,000; the home-brewing publicans 800,000; and the private families 800,000. It may be fairly said, that nearly three parts in eight of the last two portions (or 500,000 quarters at the least) are wasted; owing to the two causes so often mentioned!

An experience of the costs of malt liquors in private families, (without any duty on beer,) and by the brewing publicans, who are somewhat more heavily charged with that duty than even the common brewers are, operates on their minds as a full persuasion, that the latter cannot afford to make beer from *malt and hops*, without higher prices than they still sell it for.

It would put these people to extreme difficulty, *even to name* any other matters, as at all applicable to supply the properties required in *beer;* and, among all the insinuations against the brewery, no one scarcely attempts to point out the supposed substitutes. If any such were used in any considerable concern, it is impossible that they should be concealed, or that they should not be most publicly and universally known. It is, however, very true, that if the public brewers possessed no more knowledge in the two operations of making malt, and of using it, than to waste three bushels or quarters

in every eight of that costly article, inevitable and speedy ruin must be their lot.

From what has been said, it is hoped it will appear that a successful practice in brewing is neither a matter of chance nor of artifice, but of valuable knowledge, which, when attained, is useful to the community, in providing them a wholesome and pleasant liquor, made from the choicest malt and hops; but without that most serious waste of these valuable articles which constantly attends the placing them in the hands of an ignorant practitioner.

Yet it has unfortunately and unjustly happened, that in proportion as such described malt liquors have been produced by any public brewer, what should be deemed creditable and meritorious is, by the ignorant, perverted, and imputed to the introduction of matters so entirely unknown, that neither the names nor the uses of them are attempted to be described. But I trust it will be perceived, that the number of very respectable and well-educated gentlemen, now engaged in this branch of trade, in various parts of the kingdom, ought to stand in the public opinion far above all such suspicion; seeing that it can be no more their inclination than it is their interest to substitute, in the manufacture of their beer, *any* article for *malt*

and hops, because *no articles can be procured, that are of equal value to* THEM, *at so cheap a rate;* nor can *any* extraneous matter be introduced in any way, into the brewer's practice, without causing a diminution of *his trade, his profit, and his repute.*

THE PRINCIPLE OF THE HYDROMETER.

The term, "specific gravity," being more familiar, in relation to hydrostatics, than "pounds per barrel," it may be useful to some, that what is meant by each should be explained. Specific gravity is the weight of a cubic foot, or 1728 inches of liquor, *viz.*, 7.48 gallons wine measure, or 6.127 gallons beer measure; which quantity of rain-water has been reckoned to weigh 1000 ounces or 62.5lbs. avoirdupoise, and hence the specific gravity of water has been set down at 1000. The same measure of alcohol (or the most highly rectified spirits of wine) weighs only 823 ounces*. Proof spirit is

* Dr. Thompson describes standard alcohol to be .825 specific gravity; though I understand it is sometimes so highly rectified as to be no more than .813 or even less, especially at a temperature of 60° Fahrenheit.

The specific gravity of proof spirit, as established by Sykes's Hydrometer, and by the Act 58, Geo. III, is .92308 at 50° temperature, or about 919 at 60°.—J. H. B.

formed of these two, and is deemed the mean of them or 911.5 ounces. And so, of every liquor that is lighter than water, and heavier than alcohol; according to the proportions of these two in such liquor.

As 1728 cubic inches of water weigh 1000 ounces, it follows that 231 inches (the contents of a wine gallon) weigh 133.68 ounces, and that 282 inches (the beer gallon) weigh 163.19 ounces*.

When hydrometers were first thought of, as applicable to the brewery, the gravities exhibited by them were merely comparative, and without reference to any fixed quantity of fluids. This, however, did not detract from their real usefulness to any computist.

Mr. Richardson first adopted the idea of forming an instrument to shew the difference between a barrel of water and a barrel of wort, each of 36 gallons, beer measure, in 1784. In which, he was followed by the other and former makers of these instruments. The weight of such a barrel of water should be 367lbs. and 3 ounces, at the rate of 1000 ounces for each

* The new imperial gallon, as recommended by the Committee of the House of Commons on Weights and Measures, in their report, printed in May 1821, is to consist of 277.276 cubic inches; consequently, a cubic foot contains 6.232 such gallons, weighing 160.462 oz. each.—J. H. B.

cubic foot. Mr. R. found the actual weight of the water, he tried by beam and scales, to be 369lbs., which is sufficiently near to afford satisfaction in the case, because of the differences in water, and other circumstances, among which I should be disposed to give Mr. R. credit for exactness. The next step was to take the real weight of a barrel of 36 gallons of a good malt wort; which proving to be 399lbs. such was called a wort of 30lbs. per barrel, as being that number of pounds heavier than water. He then formed a weight to sink the instrument to the water point in this wort, which weight became the exact representative of 30lbs. of fermentable matter in each 36 gallons of wort of that quality. After which, it was easy to form other weights to correspond with, and to shew every degree of richness in the worts, from 50lbs. to 1lb.

I am led to mention these particulars, which I am aware are not new to the gentlemen in the Brewery, with the view to introduce an example which will serve as a rule to prove the correctness, or not, between any hydrometer that sinks to a given point in water, and its attendant weights.

The actual weight of one of Mr. R.'s instruments, in my possession, is 811 grains. This

sinks, of course, to its just point in water. The weight marked 30 weighs 66 grains: then say

811grs : 369lbs. :: 66grs. : $30\frac{24}{811}$
Or 811 : 369 :: 877 : 399

The *specific gravity* of such wort is found easily.

Say 30lbs. = 480 ounces
If 36 gall. : 480 ounces :: 6.127 gall. : 81.7 ounces
add for the water 1000
specific gravity 1081.7 *

POSTSCRIPT.

Since the preceding sheet was printed off, the writer has learned that the malt duty of the kingdom, from Midsummer 1809 *to* 1810, *(viz., in the* SECOND YEAR *after the prohibition to distil from malt and barley took place)* EXCEEDED *the malt duty from* 1807 *to* 1808 *(while grain was used* fully *in the distilleries) so much as* 357,625*l., being the duty on* 206,360 *quarters of barley* malted, more than in the last year of the corn distillation; *which is an undeniable proof of the increased consumption of malt in the breweries,*

* For further information respecting specific gravity, see the paper on that subject.—J. H. B.

and of the consequent surplus to the revenue; by so much as the custom's duty on the sugar used in the distilleries.

These considerations shew also more fully the unreasonableness *of the discontents among the land occupiers, on the ground of the prohibition.*

OBSERVATIONS

ON

THE STATE OF THE BREWERY, AND ON THE SACCHARINE QUALITY OF MALT.

BY JAMES BAVERSTOCK, ESQ.,

ALTON, HANTS.

The following Pamphlet was written expressly for, and published by, Mr. Valpy, in his valuable collection called the *Pamphleteer*, in 1813.

It contained in its original shape many repetitions of what has already been given in the present volume, in the other pamphlets; these I have struck out as far as I could, without destroying the connexion with the more original matter; if, however, in the perusal some repetitions should still be discovered, I trust the reader will bear in mind that the several pamphlets were published at different times, and without any intention on the part of the writer of their being collected together in the present form.—J. H. B.

OBSERVATIONS,

&c. &c.

THE very considerable decrease in the consumption of malt liquors in every part of the kingdom, within the last two years—(which is proved by a deficiency in the taxes on beer and malt, to the amount of several millions sterling) is well worthy the serious attention of all who interest themselves in the health and welfare of the people, or in the concerns of the national revenue. The chief cause of this decrease must be imputed to the very heavy costs of the proper materials for brewing; which check the consumption of malt in private families, and compel the public brewer to reduce the quality of his beer, to such a degree as to render it less saleable. The continued high prices of corn of every description of late years, and particularly of barley, are too well known to need remark; but the very heavy duties, together with the various contingent expenses attending the brewery are but little known, or

thought of, by the public in general. Not longer ago than in June 1802, the whole amount of the duties on malt was 10s. 6d. per quarter, or 8 bushels of Winchester measure. The present duty is 34s. 8d. for the same quantity*. In 1802, also, the excise on porter, and on ale, was 6s. 4d. and on small beer, 1s. for each barrel of 36 gallons. The present duty is 10s. per barrel on porter and ale, and 2s. on the weakest small beer. Hence, the beer duty is increased 60 per cent. and the malt duty more than 200 per cent. since the 5th July 1802. And although the expenses of labour, taxes, repairs, horses, and numerous other charges, are not the same, in every situation, it may be safely said, that they alone are equal to the duty on malt per quarter, or on beer per barrel, on an average, in the breweries, through the kingdom. This accumulation of burdens, together with the unreasonable and ill-judged opposition on the part of the consumers in the country, to some reasonable advance in the retail price of

* Since this was published, in 1813, the duties on malt have varied considerably: in 1816, what was called the war-duty (being 2s. per bushel) was taken off, but in 1819, a new duty was again imposed, which raised it to 28s. per quarter. Since which, the 3rd Geo. 4, Cap. 18, reduces it 8s. per bushel, leaving it at present 20s. per quarter.

J. H. B.

beer—has driven the brewer of late, to the necessity of withdrawing a fourth, and in some situations a still greater part, of the usual allowance of malt. Hence, the duty which is paid by the public brewer for each barrel, or 36 gallons of porter, or ale, amounts to as much as the malt duty on each 8 bushels of the latter —and, consequently, the brewer is taxed twice as much for the same portion of malt, as the householder who brews for his own use; which, when duly considered, points out a cruel partiality in taxation, inasmuch as the poor man, who has not the means, because he does not possess the necessary utensils to brew, if he drinks beer, must buy it of the brewer or the publican; and thus he pays twice as much tax for the same quantity as the wealthy farmer or trader, the landed gentlemen, or the splendid nobleman.

The erroneous notions, entertained of the brewery by the public, tend materially to diminish the consumption of malt liquors, by deterring many, who otherwise are fond of them, from indulging themselves in their use, in situations where the supply is afforded from the public breweries only. Such notions are owing chiefly to an ignorance of the real and truly valuable properties of malt, for if these were

fully known and considered, it would be seen clearly, that no benefit can be derived to a brewer from the use of any other substance, (hops excepted,) to give that strength and flavour which are sought for and required in beer. It would, therefore, be serviceable to the community if this matter could be so justly explained as to be rightly understood; and the minds of the people be relieved from a suspicion, which is attended with inconvenience, because with privation, to many. While a process, which requires the attentive observation, and studious inquiry of many years to develope all its intricacies, is contemned in the estimation of the public; and considered as no more than a merely practical operation, requiring no better qualifications to conduct it, than are possessed by the meanest description of persons.

In attempting to correct these unfavourable impressions, I must not be understood as vouching for the conduct, and judgment, of every individual engaged in this branch of business, in the various parts of the kingdom; nor as asserting whether foreign matters are, or are not, introduced by some practitioners, in the brewery; for of this I know nothing; but this I will assert, that whatever may be the practices of brewers, and whether they may be en-

gaged in a large or in a small way of business, there is no temptation to a man of understanding to introduce any other matters than malt, hops, yeast, and water, to make or to mend beer; that the two first are not only the most useful, but undeniably the cheapest, articles a brewer can employ; and that, if other matters *are* introduced, it can only be by men of no judgment, and who defeat their own purposes, even in a pecuniary point of view, for that all the money, which is paid for such a use, is far worse disposed of than if it were thrown into the sea.

It is well known to chemists, to distillers, (and to the rightly informed among the brewers,) that it would not be more futile to attempt to make bread from chalk, than to make any sort of vinous liquor, (such as beer, wine, or intoxicating spirits,) from any matters whatsoever, except from some substance that is "saccharine." For no other matters will yield an extract, or solution, that is capable of the vinous fermentation. Without such fermentation no spirituosity, or strength, can be produced; and, provided the fermentations be properly and similarly conducted, the quantity of vinous spirit obtained is ever in proportion to the quantity of "sweet," contained origi-

nally in, or drawn from, the subject or matter employed.

Of all the saccharine and fermentable matters, whether native or foreign, that are procurable in these kingdoms, the three cheapest are "malt, treacle, and sugar." The portion of the desirable matter for producing beer, or spirit, from these three subjects, is discoverable with ease, and to certainty, by the specific gravity of the solutions of any given quantity of each or either of them. And the question, as to which is the cheapest, is then decided by the "quantum of fermentable matter yielded, in conjunction with a consideration of their respective costs."

Barley, in its raw or unmalted state, consists chiefly of mucilage, with but a very small portion of saccharine matter. By the germination in malting it the greatest part of the mucilage is converted into sugar, which then becomes so abundant as to form six parts in ten of the actual weight of the malt. The remaining four parts consist of mucilage, with the husks, or draff, of the grain.

The saccharine property in malt is so much more readily extracted, in brewing, than the mucilage, (under due precautions with regard to the heats of the water applied in the several

mashings), that the latter may be disregarded, as affecting the gravity of the solution. Wort may, therefore, be considered as consisting of sugar dissolved in water, and the strength of wort is always proportioned to the quantity of the saccharine matter contained in a given measure of the liquid. And hence the gravity of worts, when compared with the gravity of water, may, in all cases, be received and trusted to, as the measure of their value; which is confirmed, incontrovertibly, in the practice of both distillers and brewers. The first of whom find the proportion of proof spirit, obtained from any given quantity of their wash, to be in an exact ratio to the gravity of such wash, under correct uniformity in all the parts of the process. And under the same circumstances, the brewer obtains a greater or less price for his beer, according to the gravity of his worts; or, (which is the same,) according to the quantity of malt allotted to make such worts.

A bushel of ripe and well-cleaned barley will weigh from 50 to 52lbs.; of which weight one-fifth part is lost by germination and evaporation in malting, and not more, provided it be malted with a view to the quality, rather than to an injurious increase of measure. In the latter case, a full fourth part of the original weight of the barley is lost in the malting.

From a bushel of perfect malt, weighing 40 to 42lbs. may be drawn 25lbs. of solid extract, of equal value for the purposes of making beer and distilled spirits, as 25lbs. of dry powder sugar, or 30lbs. of treacle. Or, each and either of them will make a barrel of wort, of 10lbs. to 11lbs. heavier than water, because the water, which is displaced by the extract, (viz., six quarts,) weighs 15lbs.

Estimating the costs of the several quantities at the wholesale prices of each article, and according to the terms on which a brewer can, at this time, (September, 1813,) purchase 100 or 500 quarters of malt, viz., at 96s. the quarter, treacle at 48s., and sugar at 90s., the 112lbs. of each, it will be found that to equal a quarter of malt, at 96s. will require 240lbs. of treacle, costing 103s., or 200lbs. of sugar, costing 165s.

Until this statement can be disproved, or until some article, equally saccharine and fermentable as malt, can be discovered, and obtained at less cost, it may be submitted to the reader, whence can arise any temptation to a brewer to exchange malt for any other matter to make beer.*

* Sugar is, by act of parliament 1812, permitted to be used in the breweries, but treacle is still prohibited, under such penalties as would be ruinous. No *pale beer* brewer could use treacle without discovery, by the colour and taste of the beer.

Sugar being manufactured uniformly by boiling it to a given and equal consistence, very little or no variation is found in a given weight of the same sorts of it, although the quality of the cane juice, from whence it is made, differs greatly, according to the wetness, or dryness of the season in the West Indian Islands; and the same may be said, or nearly so, of the treacle: but the malts from barley differ very much, according to the condition of the grain, and the skill and integrity of the maltster. The prices also of all the three are, we know continually fluctuating, yet the advantage will be found to remain with the malt, by those who will take the trouble to make calculations on the cotemporary prices of each. And this, either with or without, taking into consideration, that if sugar or treacle were to be used, in but a trifling proportion in the breweries, the prices of them would be immediately and greatly advanced, and malt would be in a proportionate degree, cheaper. But, although sugar has been allowed to be used in the breweries for more than a year past, (as also on some former occasions,) it has not been found that any consumption of it takes place among the well-informed part of the trade, to make beer.

The statement here given of the comparative value of the three "sweets," differs so widely from the notions generally entertained by the public, that it is to be expected the correctness of it will be doubted. The truth of it, however, is proved by distillation; for, so very exact is the proportion of vinous spirit producible from the wort, to its gravity in its first state, that the practical distillers may ascertain to a single gallon, what will be the produce of proof spirit, from 10,000 gallons, or any greater or less quantity of their fermented liquor, previously to committing it to the stills; which rule is founded on the *known* number of pounds of fermentable matter required to produce each gallon of spirit, whether the fermentable matter were drawn from malt, from sugar, or from treacle. The whole of which would be impracticable, if there were any distinction in the vinous properties of the different extracts; or, if the gravity of the worts were not, in all the cases a correct criterion of their value. This rule extends also to, and is practicable in, the Brewery.

The second necessary article in brewing is the hop, the uses of which are to communicate both flavour and preservation to malt liquors.

It is a very mistaken conclusion, that because

hops are bitter, any species of bitter will supply the same useful properties in beer; nor is it likely that hops were selected, in the first instance, for the sake of the bitter; for, why should that, which is not a very pleasant sensation to the palate, be thought acceptable in beer more than in every other potable liquor? But it was found that the hop is the only plant which serves to restrain the fermentation of malt worts within proper bounds, without which they would proceed to the state of vinegar rapidly; for it is the addition, or the omission, of this article, which constitutes the chief difference between the operations of making beer or vinegar from malt: and, abstractly from the consideration of preserving beer in a sound state for a reasonable time, *no bitter* can be desirable, or at all useful, therein. And since no other vegetable than the hop has hitherto been discovered to answer this purpose, all the money that is expended on other bitters, is utterly thrown away. Nor is this all the objection to a substitute for hops; for the fine aromatic flavour, which accompanies the preservative property in them, (and which forms a principal desideratum among the constituents of malt liquors,) is easily distinguishable from

the inert and nauseous bitter of the supposed substitutes.

An essential property in malt liquors is fineness. There are two parts of the process in brewing, which more particularly require the skill and attention of the practitioner. These are first, the extraction of the fermentable matter from the malt by the water applied in the mashings; and secondly, the conversion of the worts, so extracted, into the desired vinous liquor by a properly conducted fermentation. On the degrees of heat in the water so applied, and on the modifications of those heats in the different mashings, it greatly depends whether all the saccharine and fermentable matter, which is contained in the malt, be extracted; and on these heats depends also the aptness of the produce to attain early and spontaneous fineness, which is still farther promoted by suitable heats in the worts while under the action of fermentation. All these heats rest on the experience and judgment of the brewer, and, when known or decided on, are applied most correctly by the use of properly constructed thermometers: while the strength of the worts is adapted to the price obtained for the beer, with equal precision by the direction of an hy

drometer, even to less than a thousandth part of the whole fermentable matter contained in each wort. A studious observation of the very different effects of different heats in these the two leading parts of the process, is therefore of the first importance and necessity. Similar effects can be expected only from exactly similar causes, and without strict uniformity in the process, the liquor must vary in its qualities with each distinct operation.

It must, then, be obvious to considerate minds that these heats are not to be judged of to any sufficient degree of correctness by the perceptions of the touch, nor the degree of sweetness in the worts by the palate; and that without the assistance of the two instruments above referred to, all attempts to obtain uniformity in beer must be unavailing; for the eye or the touch can afford no tolerable direction as to the heat of water below the boiling point, which is such a superabundant degree as would prevent any solution of the fermentable parts of the malt, by forming the meal into (nearly dry) balls, impenetrable by water of such heat: and the same uncertainty must prevail with regard to the most advantageous degree of warmth to be employed in the fermentation, which is an operation of such ruling

influence in the case, that (besides the principal action of converting the sweet of the worts into vinous spirit, as well as producing other useful effects) the wholesomeness or the unwholesomeness of malt liquors depends chiefly on this interesting part of the process; and hence the medical men are justified in prohibiting, as they often do, the use of the family malt liquor to invalids, and recommending porter in its stead; the wholesomeness of which consists chiefly in the uniform correctness of the fermentation; for it is not practicable to ferment a small quantity of wort so completely and with so much precision, as the larger quantities usually fermented together in a public brewery of a respectable size.

If the fermentation be conducted with judgment, and under proper degrees of heat, there will be no necessity to introduce any other matter than a few boiled and loose hops to secure fineness; some of the latter are found useful, and especially on removals of beer, to collect the light yeasty particles, and compel them to subside. Should any matters possessing different properties, be introduced, they must pervert the genuine flavour, which is so desirable in malt liquors, and which is not to be attained or equalled, by the use of any

matters whatsoever, other than by a judicious combination of "malt, hops, yeast, and water."

By simple evaporation, malt wort is brought first to the consistence of treacle, and finally to a fixed and solid extract. Dicas's hydrometer shows the exact number of pounds of such extract, which is contained in 36 gallons of wort, each pound whereof occupies the space of .06 parts of a gallon of the water. Quin's, Richardson's, and Dring's instruments shew, merely, the addition of gravity in a barrel of wort, caused by the difference between the weight of the extract, and the weight of the water so displaced. All of the last three instruments differ in a slight degree from each other in their indications, yet not so materially but that all of them may be made similarly useful in the hands of judicious practitioners in the distilleries or breweries.

Taking the average indications of Quin's, Richardson's, and Dring's Hydrometers, each pound of additional gravity (to the water) shows the existence of 2-6lbs. of extract according to Dicas's Rule. And thus, a wort of 30lbs. per barrel heavier than water contains 78lbs. of saccharine extract, which is shown, at one view, by Dicas's Instrument*.

* Dring and Page's improved instrument constructed

A barrel, or 36 gallons, beer measure, of rain water, should weigh 367.2lbs. at the rate of 1000 ounces for each cubic foot, which is concluded to be the precise specific gravity of such water. But that which is in general use being somewhat harder and heavier, it will be nearer the truth to fix on 369lbs. as the weight of a barrel of water in the breweries. Hence, what is called a barrel of wort of 30lbs. weighs actually 399lbs.: *viz.*, 369lbs. the water, and 30lbs. additional for the wort.

Dicas's Instrument shows that the constituents of a barrel of such wort are 78lbs. of fermentable extract, which, occupying the space of 4.68 gallons of the liquid, at .06 for each pound leaves 31.32 gallons of water, the weight whereof, at 10.25lbs. per gallon, amounts to 321lbs., to which, adding the extract, 78lbs., we find the total weight to be 399lbs. as by the others.

An exact quart of raw wort, 76.5lbs. by Dicas, was evaporated to dryness; and as the extract could not be cleanly separated from the vessel employed, the whole was put into

according to the principles laid down by Dr. Thompson in the valuable report before alluded to, shews by means of a sliding rule, given with it, the quantity of dry extract *per cent.*, contained in any given quantity of malt.—J. H. B.

a scale and weighed 24.25 ounces. The vessel (when perfectly cleaned with hot water, which brought the extract again to the state of sweet wort) weighed 15.75 ounces, thereby showing that the actual quantity of extract contained in the quart of wort was 8.5 ounces, which, multiplied by 144, the quarts in 36 gallons, gives 1224 ounces, which, divided by 16, gives 76.5lbs.: four ounces of powder-sugar, on being dissolved in a glazed earthen vessel (previously weighed) and brought to a solid extract, lost one eighth part of its weight, by evaporation in the process. We may hence reasonably conclude that each pound of malt extract is of equal value and usefulness to a distiller or to a brewer, as one pound of sugar, in the state as the last is sold in the shops. For the saccharine matter, contained in the extract of malt, is not more (if so much) diminished by the very small portion of mucilage, which mingles with it, when running from the mashing-tun, than the sugar is weakened by its hydrogenous or watery particles: and, if this be granted, it follows that Dicas's Hydrometer shows, at once, the number of pounds (or half-pounds) of "sugar," contained in each 36 gallons of malt wort.

Further, if the exhausted grains in a brewing of malt were deprived of their moisture, by

drying them on a kiln, it would be found that a bushel of them would be so much lighter than the malt (in its dry state) as the amount of the extract, drawn from each bushel: *viz.*,

Say *Malt.* *Extract.* *Grains.* } per bushel.
40lbs. 25lbs. 15lbs. }

This has been proved satisfactorily, and may be experienced in little time, and without much trouble, because on a small scale. And such examination of the separate parts of a bushel of malt is further satisfactory, inasmuch as it confirms the amount of fermentable matter extracted from this, or any given quantity of malt, as the same may have been shown by Dicas's Hydrometer.

It is well worthy of observation that the imputations against the breweries were not, in any degree, so prevalent before the introduction of the instruments, as they have been since that time. The state of darkness in which every practitioner lay, until that discovery, placed them all on a level; and each part of the process, being devoid of any rule, the whole was as well conducted by a labourer as by his principal. It is not disputed that good beer was made in those times, and is still, without such instruments, but not without a *profuse waste* of malt, hops, and of time in keeping the beer, to

remedy the absence of all system. Such remedies would be speedily ruinous to a public brewer, under the late and present circumstances attending the concern. But when the minds of some in the pursuit were turned to the forming of a fixed and rational system, in lieu of the uncertainties to which the practice had been exposed for more than 200 preceding years, the office of conducting such system could not be left to men incompetent to mathematical computations; for just as wisely might a country barge-man be intrusted with conducting a vessel through the ocean to any particular point, without a knowledge of the uses of the compass. And, in proportion as an improvement in the beer, through the guidance of the instruments, became apparent to the consumers, that uniformity in the strength and flavour of the liquor, which was the natural effect of uniformity in the heats and gravities of the worts, excited, first the surprise, next the jealous enmity, and finally the calumny, of those to whom any idea of fixed rules in the process was utterly incomprehensible. Hence arose surmises of secret (and therefore, to *such* minds, *improper*) practices, with insinuations of the superior wholesomeness of "home-brewed" beers, over the

produce of those breweries, which appeared to be seriously conducted.

According to the returns to the General Excise Office in 1807, the "home-brewing" publicans in the kingdom amounted to 23,740 persons; while the number of the common brewers did not exceed 1400.

It may be submitted to the considerate part of the community to judge, which of the two classes is the most likely to adopt, and which to neglect, *a rational system only*, in conducting an intricate and truly a scientific operation.

It is not, however, meant to be insinuated here, that *every public* brewer, merely as such, is necessarily, or by consequence, a perfect judge of what materials are the most useful to himself. Among the 1400 are to be found men incompetent to discover the constituent properties of the articles they employ. And such persons are as liable to be led astray by the druggists, as those of the more numerous class. Some there are also to be seen among the 1400, who although of superior education, and of superior abilities in other affairs, yet (possessing ample fortunes) do not trouble themselves in the details of their brewery concerns; which are therefore consigned to a deputy. Hence it

may be perceived how unreasonable it is to condemn the whole in a mass, for the ignorance or the inattention of a part, among a number of persons differing so widely in their habits and attainments.

From a view of those habits, an observing mind may not be altogether at a loss to discriminate between the different individuals engaged in this pursuit in the various parts of the kingdom.

Bearing in mind that it is *not* the successful practitioner who departs from the *four only* proper and necessary articles to make the most approved beer, *viz.*, "Malt, Hops, Yeast, and Water," but the ignorant; whether such may be engaged in a small, or in a large, way of business. For no man, who possesses a just knowledge of the constituent and truly valuable properties of the two first, would forsake them for such as are less useful, and yet more expensive.

ON THE

SPECIFIC GRAVITY OF WORTS, *&c.*;

AND ON

THE VARIOUS KINDS OF HYDROSTATICAL INSTRUMENTS

NOW USED IN THE BREWERY.

By J. H. BAVERSTOCK.

ON THE

SPECIFIC GRAVITY OF WORTS,

&c.

THE subject of specific gravity and the principles upon which hydrometers are constructed, having been very slightly treated on in the "Observations on the Prejudices against the Brewery," and it being a matter of some curiosity, if not of importance, to Brewers, I have thought it might be satisfactory to the reader to add the result of my own observations and experiments in a separate paper.

Specific gravity has been defined to be "*the absolute weights of different bodies of the same bulk.*"

This bulk has been fixed by mathematicians at a cubic foot, because a cubic foot of pure water at a temperature of 60 degrees on Fahrenheit's thermometer, weighs 1000 ounces, or so nearly as to be sufficient for all practical purposes; water, therefore, has been called 1000, and it is indifferently expressed 1000, (one thousand) integrally, or 1.000 decimally;

and it is used as the standard of comparison for all subjects whether solid or fluid.

I shall here notice only the specific gravity of fluids, and of those regard, chiefly, such as are heavier than water. I shall not stop to examine the question whether specific gravity be, in every instance, an expression of the value of the fluid; I am, myself, satisfied that it is, at least so far as concerns those subjects, which more immediately interest the Brewer and Distiller.

A cubic foot contains 1728 inches, a beer gallon as established by law is 282 such inches, and a wine gallon 231; consequently, $\frac{1728}{282} = 6.12765$ the beer gallons in a cubic foot and $\frac{1728}{231} = 7.480$ the wine gallons in a cubic foot *.

The specific gravity of any fluid may therefore be found by merely weighing a known portion, say a quart, in any balance, and multiplying the weight by the number of quarts in 6.12765 gallons if a beer quart be used, or in 7.48 gallons if the fluid has been weighed in a

* It is proposed that the new imperial gallon shall contain 277.276 cubic inches, consequently, a cubic foot will be 6.2325 such gallons. As this measure is not yet established by law, I have made the calculations throughout the present paper according to the legal standard measure, but the reader will have no difficulty in calculating factors in the imperial measure, if he is desirous to know them.

wine quart; but as a quart is such a quantity as to require a strong scale beam, it cannot be weighed with such accuracy as is essentially necessary, and therefore it is customary to use a phial, containing a much smaller quantity, (perhaps about a tenth or twelfth of a quart is as convenient a size as any,) and which should be constructed with a long narrow neck of a small aperture that it may be filled to a greater nicety. Such a bottle may be weighed in a scale that will turn with the tenth, or less, of a grain and will of course be more accurate; and a factor may be found as follows: Suppose it to weigh when filled with distilled water at 60° F., 1490.2 grains, we have seen that 6.12765 beer gallons of pure water weigh 1000 ozs., say therefore

Beer Galls. oz. Gall. oz.
6.127 : 1000 :: 1 : 163.2=71,400 grains, then $\frac{71400}{8}$=8925 grains, the weight of a pint, consequently $\frac{8925}{1490.2}$=5.9891, by which the weight of any fluid being multiplied, the product will give the weight of a beer pint of such fluid; which being again multiplied by 49.0212, the number of pints in 6.12765 gallons, the product is the specific gravity. But a shorter operation will produce the same result, for as a cubic foot or 6.12765 beer gallons weigh 437.500.0 grains, it is clear that this number being divided by 1490.2 grains, the weight of water which we

suppose our phial will contain, the quotient 293.58476 or 293.65 is a factor by which the weight of our bottle full of fluid being multiplied, the product, divided by 437.5 (the grains in the oz. avoirdupois,) is the specific gravity. From what has been said it will be easy to calculate factors for any bottles that may be used, and thus nothing more is wanting than an accurate scale-beam, so nice as to turn with $\frac{1}{10}$ grain at most.

But as this is necessarily attended with considerable trouble, where its use is required frequently, instruments have been invented, upon the principle, that bodies immersed in a fluid, meet with a resistance proportioned to the specific gravity of such fluid. These instruments are of very ancient invention, and are said to have been used for ascertaining the strength of spirituous liquors, so long as 200 years ago.

It would seem, however, that their use was not much known, until Martin, about the year 1768, constructed his hydrometer which he advertised, as Mr. Richardson ironically tells us, as "useful for discovering the strength of "domestic liquors, such as beer, ale, punch, *&c.*" Martin's instrument however, was very useful for the distillery, its scale being calculated, so

as to shew the exact weight in grains of a wine gallon, of the subject under examination.

Martin was followed by Quin and others; but Mr. Richardson, I believe, has the merit, and a high one it is, of having first conceived the idea of constructing an instrument, whose scale should be expressly calculated to shew the excess of weight, which a Barrel of the Examen possesses, over and above the same quantity of pure water. Mr. R.'s experiments, as he has described them, are curious and interesting, and particularly those which are detailed in the Appendix to his Essay on the Saccharometer.

Since this time a variety of instruments have been constructed, all professing a superiority over each other, but Dr. Thomson in the Scotch report, has shewn that they are, almost, all mathematically incorrect, and he invented one himself, which is made by Allen of Edinburgh, and contrived to shew the actual specific gravity of the subject; it is accompanied, however, by a sliding rule, by which its indications may be reduced to the language of Richardson's Saccharometer, *viz.*, pounds per barrel.

Dring and Fage, upon the idea thrown out by Dr. Thomson in the report, have constructed an instrument, whose indications are

the same as Richardson's, pounds per barrel; and which by means of a sliding rule, is made to shew several interesting results. Dicas, of Liverpool, likewise, is the inventor of a very excellent instrument, calculated upon the principle, that the body in solution displaces a portion of the solvent; for instance, if a quantity of shot, say 50lbs., were thrown into 36 gallons of water, weighing say 367lbs., they would not weigh 50lbs. heavier than they did before the shot was put in, because a portion of the water equal to the bulk of the lead would have been displaced, and, therefore, the actual weight of the 36 gallons would be 367lbs. + 50lbs. = 417lbs. less, the weight of the water displaced by the 50lbs. shot. Dicas's instrument shews the quantity of solid extract which is held in solution, and which may be obtained by evaporating the subject to dryness. All the above instruments are contrived so as to sink to a given point in water*, at a certain temperature, which in some is 50°, in others 60°, and in Dicas's 160° Fah., and they have a number of small weights which

* This is not, strictly speaking, the case with Quin's, or Dring and Fage's instruments; for they have each three weights corresponding with a scale engraved on the stem, which is calculated to range through about 10lbs. or 12lbs. on each face of it. These instruments, therefore, partake of the imperfections noticed below

are required to be added, as the density of the subject increases. But hydrometers are sometimes so constructed, as to possess always the same weight, and then the specific gravity of the fluid is shewn by a scale engraven on the stem of the instrument; of this kind is an instrument invented by Mr. Harris, who conducts the brewing at Messrs. Coombs' brewery. In this case it is evident, that it is the variation in the bulk, and not in the weight, of the instrument, which affords the data for finding the specific gravity: and that the bulk immersed varies in an inverse ratio with the density of the fluid, for the lighter the subject under examination is, the deeper the instrument will sink in it, and, consequently, more of its bulk is immersed in, and it displaces more of a light, than it does of a heavy fluid. Such instruments are not considered so accurate by mathematicians, as those which, possessing always an uniform bulk, displace always the same portion of the fluid, be it a light or a dense subject, and where the additional weights which may be required to sink the instrument in different fluids, become an exact representation of the difference in weight of such portion of the respective fluids. Hence the larger the bulk (or ball) of the

nstrument, the more accurate will be its indications.

By the following formulæ, the indications of any hydrometer, whatever may be its construction, or however arbitrary its scale, may be translated into the language of either pounds per barrel, or specific gravity; and likewise may be calculated the quantity of standard alcohol .825 specific gravity, and also of proof spirit, which may be obtained from 100 gallons of wort of any density, supposing the fermentation carried to the farthest possible point; to which I shall add a table compiled by Dr. Thomson and printed in the Scotch report, shewing the quantity of solid extract per cent. in wort of any density. These are, in fact, the most material results which Dring and Fage's sliding rule indicates, and thus when it is deemed an object either of curiosity or for any practical purpose, such as the proving different instruments, any saccharometer, which is accurately adjusted, will be sufficient to afford the data. I am assuming that the reader is provided with a tolerable balance, which ought to be so nice, as to turn with a tenth of a grain when loaded with 1500 or 1600 grains at each end.

And first for reducing the indications of any

hydrometer to the pounds per barrel of Richardson, put

A—The weight of the instrument in grains, as it sinks in water.
B—The weight of a barrel of water, in pounds avoirdupois = 367.2
C—The additional weight (in grains) required to sink it in the fluid.

then $\frac{B \times C}{A}$ will give the gravity of the fluid in pounds per barrel—for instance, an old hydrometer of Quin's in my possession, whose scale is unintelligible to me, weighs 1603.7 grains, the additional weight required to sink it in a certain wort, was 158.9grs.; we may, therefore, using the above letters, say,

A = 1603.7grs.
B = 367.2lbs.
C = 158.9grs. then according to the formula $\frac{367.2 \times 158.9}{1603.7}$ = 36.32lbs.; now this wort was actually 36.2 by one of Richardson's saccharometers, the slight difference I attribute to my scales which are not sufficiently delicate—the additional weights belonging to the instrument which were required to sink it in this wort, amounted to 1063: what this was intended to indicate I do not know, nor does it signify, for by the above formula, I make the instrument speak in the language of Richardson, although its own is unintelligible to me.

Dicas's instrument is differently constructed, it is in itself lighter than water, and it requires

a weight to sink it, even in water at 160°. There are 18 weights to it, numbered 0—10—20, up to 170; one of these instruments which I have with its accompanying weights weighs as under.

Hydrometer unloaded, 484.9grs.

The weight	0 = 10.43 grs.	The weight	90 = 43.35 grs.
	10 = 13.98		100 = 47.14
	20 = 17.55		110 = 50.96
	30 = 21.11		120 = 54.81
	40 = 24.74		130 = 58.68
	50 = 28.40		140 = 62.57
	60 = 32.88		150 = 66.52
	70 = 35.80		160 = 70.51
	80 = 39.56		170 = 74.48

The hydrometer has 10 divisions on its stem, and as these are just equal to the difference between the weight 0 and the weight 10, it follows that every division on the stem is equal to 0.355 of a grain.

The instrument with the weight 0, sinks to 0 on the stem in water at 160° F., so that 484.9 + 10.43 = 495.33grs., become the representative of a barrel water, at that temperature; but in water of 50° F., it requires the weight 20, and then stands at 7 divisions on the stem; consequently, 504.93grs. as under, are the representative of a barrel water at 50°., *viz.*,

Hydrometer unloaded	484.9
The weight 20	17.55
Divisions on stem, *viz.*, 7 × .355 . .	2.48
	504.93

The same wort as in the preceding example was

tried by this instrument, and required the weight No. 160 = 70.51grs.

Now, to apply the above formula to this instrument, we must deduct 20 grains from the weight No. 160, because we have seen above, that the instrument requires 20 grains in addition to its own weight, to sink it in water of this temperature; consequently, using the same letters as before, we must say,

A = 504.93 or say 505 grains.
B = 367.2
C = 70.51−20=50.51grs.

then we shall find $\frac{367.2 \times 50.51}{505}$=36.71lbs. per barrel, which is sufficiently near to prove the rule. Dicas's scale is so very delicate, that it requires a very nice balance to weigh the instrument.

The specific gravity of any fluid heavier than water, may be found with any, correctly constructed, saccharometer, as under, put,

A = the weight of 36 gallons water beer measure, at 60° temperature, in ounces avoirdupois = 5875.2

B = a barrel, or 36 gallons beer measure.

C = the weight per barrel of the fluid as indicated by the saccharometer, reduced into ounces avoirdupois.

D = beer gallons in a cubic foot = 6.12765 – then $\frac{\overline{C + A} \times D}{B}$

the specific gravity of the fluid, thus taking the above wort as an example, and which by

Richardson's saccharometer was 36.2, the above formula will stand thus in figures,

A = 5875.2 ounces.
B = 36 gallons, B. M.
C = 36.2lbs. = 579.2 ounces.
D = beer gallons in a cubic foot = 6.12765 then

$$\frac{579.2 + 5875.2 \times 6.12765}{36} = 1098.6 \text{ ounces.}$$

from whence by dividing 98.6 by 36.2, we get the following general factor 2.724; by which the indications of any saccharometer (whose scale is made to shew pounds per barrel) being multiplied, the product added to 1000.00, will at once shew the specific gravity, thus,

$$36.2 \times 2.7232 = 98.579$$
$$1000$$
$$1098.579 \text{ &c.}$$

I would be understood, however, as speaking very diffidently of this factor, as I have had no opportunity of consulting any one upon it, and it differs in some degree from one given by Dr. Thomson in the valuable and elaborate report, which has been so frequently alluded to.

Of course, the same factor, employed as a divisor instead of a multiplier, will serve to reduce the indications of an instrument, which is calculated to shew the specific gravity only, into the pounds per barrel.

On the sliding rule, given with Dring and

Fage's saccharometer, there are laid down, the quantity of alcohol .825 specific gravity, and also of proof spirit which may be obtained from 100 gallons beer measure, of wort of any density, and which may be found by means of any saccharometer, as under, say in a wort of 30lbs. original density by Richardson's instrument. First: It was ascertained by the learned gentleman who drew up the Scotch report, that every 5.75lbs. lost in the fermentation, produces one wine gallon of alcohol, which, supposing the 30lbs. to be wholly attenuated, will give 5.2 *wine* gallons, in a barrel beer measure which is 44 gallons, W. M. Then say, if 44 gallons of wort produce 5.2 gallons of alcohol, what will 100 gallons of wort produce, as under,

44 : 5.2 :: 100 : 11.9 gallons, alcohol of .825 in every 100 gallons Wine measure.

Now alcohol of .825, is about 68 per cent. above hydrometer proof: therefore say,

100 : 11.9 :: 168 : 19.992 gallons proof spirit.

again say, in a wort of 20lbs.,

$\frac{20}{5.75} = 3.47$ then — 44 : 3.47 :: 100 : 7.88 alcohol,

and — 100 : 7.88 :: 168 : 13.2384 proof spirit.

The following Table compiled by Dr. Thomson, and inserted in the Scotch report, shews the quantity of dry extract by weight contained in 100 parts, by weight of wort of every specific gravity at the temperature of 60° Farenheit:—

Specific Gravity.	Extract per Cent.	Specific Gravity.	Extract per Cent.	Specific Gravity.	Extract per Cent.
1.000	0.00	1.048	11.50	1.096	22.31
1.001	0.22	49	11.74	97	22.52
2	44	1.050	11.97	98	22.72
3	66	51	12.20	99	22.92
4	88	52	12.43	1.100	23.13
5	1.09	53	12.66	101	23.36
6	1.31	54	12.89	102	23.62
7	1.53	55	13.12	103	23.84
8	1.75	56	13.34	104	24.05
9	1.96	57	13.57	105	24.24
1.010	2.17	58	13.83	106	24.46
11	2.38	59	14.04	107	24.68
12	2.59	1.060	14.32	108	24.89
13	2.81	61	14.53	109	25.11
14	3.06	62	14.75	1.110	25.31
15	3.32	63	14.96	111	25.52
16	3.57	64	15.18	112	25.75
17	3.84	65	15.39	113	25.97
18	4.05	66	15.60	114	26.18
19	4.25	67	15.81	115	26.38
1.020	4.45	68	16.02	116	26.59
21	4.65	69	16.24	117	26.79
22	4.85	1.070	16.48	118	27.
23	5.12	71	16.67	119	27.21
24	5.36	72	16.90	1.120	27.41
25	5.58	73	17.13	121	27.61
26	5.93	74	17.37	122	27.80
27	6.19	75	17.65	123	28.00
28	6.54	76	17.86	124	28.19
29	6.80	77	18.09	125	28.39
1.030	7.06	78	18.32	126	28.57
31	7.33	79	18.53	127	28.82
32	7.58	1.080	18.78	128	29.00
33	7.83	81	19.01	129	29.27
34	8.09	82	19.24	1.130	29.51
35	8.34	83	19.47	1.140	31.74
36	8.59	84	19.71	1.150	33.88
37	8.84	85	19.94	1.160	35.95
38	9.09	86	20.17	1.170	37.94
39	9.34	87	20.31	1.180	39.95
1.040	9.58	88	20.54	1.190	41.89
41	9.83	89	20.81	1.200	43.90
42	10.07	1.090	20.03	1.210	45.67
43	10.31	91	21.26	1.220	47.31
44	10.55	92	21.47	1.230	49.11
45	10.79	93	21.73	1.235	50.00
46	11.03	94	21.89		
47	11.27	95	22.10		

Dr. Thomson tells us that "to verify this "Table, a portion of the wort of each brewing "was evaporated to dryness after its specific "gravity had been ascertained," and that "the "quantity of dry residue was found to cor- "respond very well with the numbers in the "Table."

I shall conclude these remarks by an hydrometrical analysis of the constituent parts of unfermented wort and of beer in a drinkable state, according to the indications of Richardson and Dicas's instruments, and which afford several data, which, in the hands of a person of leisure and skill, may be made to produce some valuable practical results.

It has been shewn in the observations on the state of the brewery, written for the *Pamphleteer*, that a barrel of wort of 30 lbs. heavier than water, according to Richardson's saccharometer, consists actually of 78 lbs. solid extract, which are held in solution by 321 lbs. water, making together 399 lbs *.

But beer in drinkable state contains but a small portion of extractable matter, the greater part of it having been converted into spirit during the operation of fermentation, and the actual constituents of a barrel, beer measure,

* See page 244, *ante*.

of such beer are a moderate portion of malt extract, with about a 10th or 12th part alcohol, held in solution with about 32 gallons water.

The exact proportions of the extract, the alcohol, and the water may be discovered by the easy process of evaporating the alcohol, and correctly replacing the deficiency caused by such evaporation, with pure water, for

1st. It is found that each pound of increase on the hydrometer, caused by dissipating the spirit and replacing it with water as above, shews the presence of one gallon wine-measure of strong spirit in a barrel of 44 gallons wine-measure.

2dly. That each gallon of such spirit is the produce of either 6lbs. apparent, or 5lbs. of real attenuation.

Taking then a sufficient quantity of ale for the hydrometer to act in, and supposing it to have been fermented to 7lbs. from 25lbs. originally, and evaporating it in a proper vessel over a brisk fire for 50 or 60 minutes, more than two thirds of the whole will be dissipated; great care and minute attention are necessary in conducting the evaporation, in order to collect every particle of the extract which adheres to the vessel used to evaporate it, by rinsing it with the water intended to supply the deficiency; and to be particularly careful and exact

in observing that the measure or quantity be the same after the water is added as at the commencement.

The extract of malt is fixed and may be discovered in small lumps, which are again easily dissolved in the water, and thereby give that addition to the gravity of the subject which is the object inquired into.

Ale, of the above original strength, *viz.*, 25lbs. fermented to 7lbs. will be increased to 10lbs. by the dissipation of the spirit and refilling the same measure with water, *viz.*, 3lbs. per barrel. If the same had been fermented to 4lbs. the above process would increase the gravity to 7.5, and it would then contain half a gallon more spirit with less of the extract.

Assuming, therefore, that each pound of increase caused by evaporation, *&c.*, as above, shews the existence of one gallon of spirit, it follows that the spirit must be such as to weigh exactly 16 ounces per wine gallon, lighter than water. Estimating the latter at 133.68 ounces, the weight of the spirit is 117,68 ounces, which is of so very strong a quality that 2 gallons of it mixed with one of water, will make the three 123 ounces each, or full hydrometer proof; and this estimate is confirmed by its agreeing with the actual produce in the malt distillery as

stated by Mr. Jackson, then a commissioner of excise, to a Committee of the House of Commons, in February 1807. See Parliamentary Report 1807-1808, fol. 234-235, *&c.*

Dicas's hydrometer shews the actual quantity of extract contained in a barrel of beer. Each pound of which has been ascertained to occupy the space of .0714 wine gallons of the liquor.

If we take the above ale of 25lbs. original, and 7lbs. final, density, by Richardson's, equal to 62.5 original and 17.5 final gravity by Dicas's instrument, the following will be the quantity of extract water and spirit contained therein. And first of the unfermented wort.

By Richardson.

	lbs.
The weight of 44 gallons water at 133.68 ounces per gall. is	367.63
The excess of weight of the wort as shewn by saccharometer	25.
	392.63

By Dicas.

lbs. 62.5 Extract, which at .0714 gallons per pound occupies the space of . . .	Wine Galls. 4.4625
330.13lbs. water at 133.68 oz. per wine gallon	39.5375
392.63lbs. the weight of 36 gallons beer measure equal to	44. W. Galls.

Proceeding to examine the component parts of the above after it has been converted into beer, and supposing its final density as before, to be 7lbs. Richardson, and 17.5 by Dicas, and having evaporated the spirit and supplied its

place with pure water, as before described, we shall find it increased to 10lbs. Richardson, and 25 Dicas, shewing an increase of 3lbs. by the former, and 7.5 by the latter, instrument; and that 3 wine gallons, (allowing that each pound on Richardson's instrument shews the presence of one gallon,) of very strong spirit of the quality of very nearly one-half alcohol, and one-half of hydrometer proof spirit, have been dissipated; consequently, a barrel of such beer in a drinkable state really consists of

	W. G.	lbs.
Extract really unattenuated, occupying the space of . . .	1.785, and weighing	25.
Spirit at 117.68 oz. per gallon, or .880 specific gravity . . .	3.	22.065.
Water at 133.68 oz. per gallon	39.215	327.555.
	44. W. G. weighg.	374.620.

And which is proved by Richardson's instrument as under, *viz.*,

	lbs.
3 gallons spirit at 117.68 per gallon	22.065.
41 do. water at 133.68 per gallon . . .	342.555.
Gravity, as shewn by saccharometer after evaporation, &c.	10.
	374.620.

It is hoped that the foregoing remarks may not be altogether uninteresting to the reader; the writer claims no merit for them, they are drawn from the perusal of Dr. Thomson's very valuable Scotch report, and on experiments founded thereon.

J. H. B.

MALTING.

MALTING.

The philosophical principles of malting appear to be even less understood than those of brewing; and yet it is an operation of the very first importance, both to the consumer and to the revenue.

On the mode of working the barley during its progress on the floors, depends the profit of the maker, which, unfortunately, is in every case, in direct opposition to the interest of the consumer. On this operation, it wholly depends how much the bulk of the malt when made, shall exceed that of the barley from which it is produced, and in exact proportion to this increase, which generally constitutes the chief part of the profit of the maltster, when it exceeds a certain quantum, is the value of the malt lessened to the consumer. In some cases this increase will not exceed 3 per cent., and in others it is made to amount to 25 or even more. I have no hesitation in saying, that about 3 to 5 per cent. is sufficient for the best malt, and that any increase beyond this is a deterioration of

the quality of the malt in exact proportion to such increase; where a brewer malts for his own consumption, I consider it of little importance whether he works for an increase, or on what is called the close system, because he will gain in quantity, exactly what he loses in quality: but where he purchases the malt, he uses, it is of the utmost consequence to him, to select such as is sufficiently malted at the least possible increase. Malt being specifically lighter than water, an easy test is afforded, which will at once shew the degree of perfection with which it has been made: if a few grains be thrown into a tumbler full of clean cold water, such as are well malted will swim on the top, whilst those that are less so, will fall to the bottom of the glass, the specific gravity of barley being greater than that of water, and such corns as are partially converted into malt, will stand upright in the bottom of the glass or swim at different depths according to the respective degrees of perfection. With this, which is always at hand, we may form a tolerably accurate comparison of the value of different samples—next to this, the weight is a good criterion, for the heaviest malt, supposing it to have been well made, will always prove the most valuable.

Malting is an operation generally confided to an ignorant labourer, who steeps his barley and turns his floors mechanically, and without regard to any other rule, than a certain number of hours, for each operation. The law unfortunately shackles the maker in some measure, by prescribing the duration of the steeping, the couching and the flooring, and although it gives a sufficient latitude for general purposes, yet there are cases in which a relaxation would be desirable. In the following pages, in which I have borrowed largely from the report of Drs. Thomson, Hope, and Coventry, I have endeavoured to give some practical directions for making malt, which I hope will not be unacceptable. The reader need not of course, be told, that the process of malting consists in inducing grains to germinate, and stopping the progress of vegetation, (after it has proceeded to a due length,) by exposing the malt to heat. Grain can be made to yield both ale and spirits without being malted, but the liquors so produced are of inferior quality; the ale especially, though not deficient in transparency, has a taste which renders it exceedingly disagreeable. The whole process of malting may be divided into four stages.

I. The grain is steeped in water.

II. It is placed in a heap called the couch.

III. It is spread thin upon the malt floor, and regularly turned several times a day.

IV. It is dried upon the kiln.

I. In steeping the grain, the best practice is to fill the cistern to a certain height with water, and then throw the barley into it, stirring it about until it is sufficiently levelled and even; by these means, the heavy grain directly sinks to the bottom, while the refuse and light seeds swim upon the surface, and should be immediately skimmed off, as well to save duty, as to prevent their mixing with, and impoverishing the malt.

The time which different maltsters allow the grain to remain in the steep, varies considerably, and not a few seem to be regulated more by custom and caprice, than by any determinate plan. When any rule is followed, the barley is usually suffered to remain until it is so soft, that its ends can be squeezed together between the fingers. The time necessary to produce this softness, differs considerably in different specimens, and hence the severity of the excise restrictions.

New barley requires to be steeped longer than old. Some maltmen change the water once or twice while the grain is in the steep,

and upon the whole I am inclined to think this a good plan.

"In less than 24 hours after the commencement of the steeping, the water gradually acquires a yellow or brown colour, and likewise the peculiar smell and taste which straw imparts to that liquid. If this water be evaporated to dryness, it leaves behind it a blackish brown residue of a disagreeable bitter taste. This is the matter taken up from the grain. A particular account of its nature and properties would be foreign to the present investigation. Suffice it to say, that a part of it is analogous to the substance called *extractive* by Chemists, but that it also contains other bodies, and that the salt called *nitrate of soda*, is always present. The matter taken up by the water, appears to proceed from the husk of the grain, rather than the kernel; for if the husk be removed, the water takes up scarcely any thing, and does not acquire the high colour communicated by the entire grain. The quantity of this matter varies considerably in different parcels of grain; but it is seldom less than $\frac{1}{100}$th of the weight of the grain steeped, and seldom exceeds $\frac{1}{50}$ of that weight. Bigg always gives a much higher colour, and a greater quantity of matter to water than barley, owing we presume, to its

having a greater proportion of husk, and a darker colour."

II. After the barley has been steeped a sufficient time, the water is let off; some maltmen let an additional quantity of water flow into the cistern, and immediately draw it off again, in order to wash the barley, and cleanse it from a slimy matter which usually appears in warm weather. The grain is then thrown out of the steep upon the floor, where it is carefully formed into a rectangular heap, about 16 to 20 inches deep, called the couch. In this state it is commonly suffered to remain for 26 hours. The form is made as regular as possible, and the sides confined by sliding boards, to enable the exciseman to ascertain the quantity; for it is by the bulk of the couch that the malt duty is usually levied. The barley in the couch always occupies more space than before, the weight of the grain preventing the swell in some measure, from reaching its full extent in the cistern. The increase of bulk however, in the couch, diminishes in proportion as the quantity of grain increases; in very small quantities, the difference is enormous.

III. After it has lain its given time in the couch, it is spread and turned upon the floors in order to check the too rapid progress of tem-

perature, and also to expose the whole of the grain equally to the influence of the air. It is spread thinner as it advances upon the floor, and according to the heat of the weather, until it is at last brought to the thickness of 3 or 4 inches. Every part of it should be kept at as equal a thickness as possible, and turned over regularly twice, thrice, or four times a day, or indeed oftener, according to circumstances, the object being to keep the heat as nearly as possible of the same degree. This treatment should be continued until the grain is sufficiently malted, which is known by its producing a soft meal on pressing it between the fingers.

"While the malt is on the floor, a variety of interesting changes happen. 1. The grain, at a certain period, becomes moist and exhales at the same time an agreeable odour. 2. Soon after this period, the roots begin to make their appearance. 3. The *plumula*, *future stem*, or *acrospire*, begins to swell, and gradually advances under the husk from the same end of the seed where the roots are observed to spring, till it reaches the other extremity. 4. The kernel becomes drier, friable, opake, white, and sweet-tasted. 5. Each grain of corn loses a certain portion of its weight.—The whole secret of malting depends upon the proper regulations of

these changes. This is done chiefly by, 6. Keeping the temperature as equal as possible; which, again, depends on, 7. The time and number of the turnings. It will be necessary to take a short view of each of these particulars, in order to form precise notions of the nature of malting.

"1. After the grain has been cast out of the steep, and put into the couch, it gradually becomes dry externally, the moisture that adhered being either dissipated, or absorbed. The temperature in the mean time gradually rises, and in about 96 hours, will usually be found to have increased about 10 degrees, This rise of temperature in the heap, depends in some measure on the state of the atmosphere. If the air has become colder since the period of *casting*, the malt does not become so warm as it would otherwise do; while, on the other hand, if the air has become milder, the temperature of the malt experiences a corresponding increase. Ten degrees may be stated as nearly the medium of the different experiments. The smallest rise observed was 5°, the greatest 18°; the most common from 8° to 12°. It must be observed, however, that the rise of temperature depends greatly upon the choice of the maltster, who can check it at pleasure, by turning over

the grain, and spreading it thinner upon the floor.

"About 96 hours after 'casting,' the grain which had become seemingly quite dry on the surface of the husks, turns again so moist, that it will wet the hand if we thrust it into the malting heap. The appearance of this moisture, which happens regularly after the malt has been some days on the floor, is called *sweating* by the maltsters: it continues for one day or two, and then disappears. During its continuance a pretty strong odour is exhaled, rather agreeable, and not unlike that of apples. If at this period, a portion of the malt be distilled in a steam bath, a little spirits will be found in the liquid which comes over. They may be made more apparent by mixing this liquid with sulphuric acid, and distilling a second time.

"Unless the malt be turned pretty frequently, as soon as the sweating comes on, the temperature increases with great rapidity. In one case, the turning was omitted for about 14 hours, and the temperature was observed as high as 80°.

"2. It is just about the time of the sweating that the roots begin to make their appearance; each, at first, like a small white prominence at the bottom of the seed, which soon divides itself into three rootlets, and at last into four,

five, or even seven. Those roots are, at first, very soft and tender; but, in a few days, they begin to wither and to acquire hardness. Many of them are broken off during the turning of the malt, and, in that case, new roots generally succeed them, at least in the earliest stages of the process of malting.

"When the radicles have divided themselves into three roots, and have acquired some length (which usually happens in one, two, or three days after their appearance, according to circumstances,) the apple-like smell goes off, and is succeeded by another not unlike that of the *common rush*, when newly pulled. This smell continues during the whole time that the malt is on the floor; unless it be overpowered by a peculiar mouldy smell, which happens only when the grain is bad, and contains seeds incapable of germinating; or when a part of the malt has been bruised, during the turning, from the carelessness of the workmen.

"The length, number, and progress of the roots called '*commings*' by the maltsters, vary much according to circumstances. It is well known that, when barley is sown in a good soil, of a proper texture, the roots continue moderately short, and the chief effort of vegetation seems to be directed to the advancement of the stem;

but, in loose ground, the former shoot out to a greater length, and the latter makes a less rapid progress. In malting again, the roots have a much greater tendency to lengthen than even in the poorest or most open soils. Accordingly; if allowed to take their course on the malting floor, in a moist, warm heap, they grow to a great length; in some cases, not less than two or three inches.

"The prime object of the maltster is to check this inordinate length, and this he accomplishes by frequently turning over the malt. By such treatment, its temperature is kept uniform, and the moisture is equally exhaled. There is, however, a considerable difference in the practice of maltsters in this respect. Some allow the roots to get to 7-8ths of an inch long; others never wish to see them above half that length. As the roots are afterwards separated from the malt and thrown away, and as their length does not contribute to the progress of malting, the latter method seems preferable.

"3. The fourth or fifth day from the 'casting,' and about a day after the sprouting of the roots, the rudiment of the future *stem* may be seen to lengthen. It rises from the same extremity with the root, and advancing within the husk, at last issues from the opposite end of the seed,

and assumes the form of a green blade of grass. But the process of malting is brought to a conclusion some time *before* the stem has made so much progress as to burst the husk. This rudiment of the stem is called by botanists *plumula*, but maltsters give it the name of *acrospire*.

"The progress of the acrospire is, at first, very rapid, like that of the roots. By the eighth day after 'casting,' it will have usually reached rather more than one-half the length of the grain. But after this time, its progress becomes much more slow, so that frequently another week elapses, or even more, before it has made its way to near the end of the seed, when it is understood to be proper to finish the malting; were the malt allowed to lie longer on the floor, the progress of the acrospire becomes again rapid, so that it soon pushes its way out of the husk and puts on a leafy appearance. When grain is in the earth, the progress of the acrospire is much more uniform and rapid. In that case, the supply of nourishment is abundant and constant, whereas, on the malt floor, the very contrary is the case.

"4. As the acrospire shoots along the grain, the appearance of the kernel, or mealy part of the corn, undergoes a considerable change. The glutinous and mucilaginous matter, which

perhaps bind together the starchy particles, is taken up and removed. The colour becomes white, and the texture so loose that the kernel crumbles to powder between the fingers. This change is progressive, it begins at that end of the seed where the roots are, and gradually proceeds onward to the other extremity; so that one portion of the kernel often appears in a friable state, while the other still retains the appearance of raw barley. It is the common opinion of maltsters, that this change of the grain always keeps pace with the acrospire; each seed being altered as far as the point of the acrospire extends, and *no further*. And this opinion has been rather confirmed by our observation.

"The whole object of malting is to produce this change in the kernel. As soon as it has taken place, the seed is no longer in the state of raw grain, but of malt. The kernel is originally composed chiefly of starch, the particles of which seem to be enveloped by a species of gluten and mucilage. This cement, (or, perhaps, cellular membrane,) is taken up and expended, in the first place, for the purposes of vegetation, and thus the starch is set at liberty, not, however, in the state of common starch, for its taste is somewhat sweetish, and it is com-

pletely soluble in water, which is not the case with the other. The object of malting being to procure this modified or altered starch, the process ought to be stopped as soon as it is fully disengaged and prepared. If the process has been rightly conducted, this object will be attained, as already mentioned, by the time the acrospire has come within a little of the end of the seed; but if it proceed farther, a sudden and very considerable loss occurs. Shortly after the acrospire has made its way out of the seed, the starchy matter undergoes a farther change, becomes milky, and is very soon absorbed; leaving nothing but the empty husk.

"5. While the malt lies on the floor, each corn loses a certain portion of its weight. A part of this loss is only apparent, and occasioned by the exhalation of the moisture which had been imbibed in the steep; but besides this, there is also a real loss of weight.

"If a given weight of the corn, 500 grains troy, for example, while malting, be taken daily from the floor, weighed accurately, and then dried upon a steam bath till it ceases to lose weight, the loss at first will be considerably more than two-thirds of the weight; but as the malting advances, the loss becomes less, and, at last, approaches very nearly to two-thirds."

If the malting be continued after the acrospire has reached the farthest extremity of the corn, the loss of weight sustained is still greater than what has been stated above, and it proceeds at a much greater rate. Hence appears the great impropriety of allowing the acrospire to advance too far. It is in the power of a maltster, merely by permitting his grain to remain a day or two longer on the floor than is necessary, to make the malt of any sort of grain whatever, as unproductive as he pleases.

"6. The loss of weight, as well as the progress of the malting, depends much upon the temperature; two things respecting which require attention. 1. To keep it as equal as possible; and, 2. To keep it at the proper pitch, neither too high nor too low. Unless the first precaution be attended to, the progress of the malt is very unequal, some parts being fully ready, before others have advanced half way. This inequality is attended with a great loss of weight, because many of the farthest advanced corns must be sacrificed to the progress of the rest. It is chiefly prevented by keeping the thickness of all parts of the malt as equal as possible, and by turning it over without delay, whenever an inequality of temperature can be detected in any portion of it.

"A high temperature is more injurious at the beginning 'of the flooring,' than after the malt has made some progress. Should the heat be in excess, the radicles advance too rapidly while the kernel does not undergo the wished-for change, but becomes clammy, like birdlime, a condition which is most apt to supervene in the early stage of the process, when the grain is very moist. Hence the proper temperature may be judged of pretty correctly, from the rootlets or 'commings.' If they be pretty equal, and do not exceed half an inch in length, we may consider the temperature as having been proper; but when they lengthen suddenly and unequally, there must have been an excess of heat."

In the experiments made by the Scotch reporters, the heat varied considerably; the best malt they made had 56° for its average temperature, varying between 52° and 60°, and they were of opinion that the smaller the grain, the lower is the temperature at which it should be kept to make the most of it.

"IV. Such are the most remarkable circumstances that happen while the grain is on the floor, the most important part of the whole process of malting. When the grain is thought to be sufficiently malted, the farther progress

of vegetation is stopped by putting it on the kiln. The kiln consists of a chamber floored with plates, full of very small holes, or with wire, or haircloth. The malt is spread upon this floor to the depth of from 3 to 6 inches, and a very moderate fire of charcoal is kindled in an apartment below it. The heated air passes up through the malt, and makes its escape by the roof of the kiln, where there is an aperture for the purpose. During its passage, it becomes loaded with moisture, and thus gradually dries the malt for a considerable time; the fire is kept so low as not to heat the malt higher than the temperature of the human body. As the drying advances, the temperature is gradually raised till it rises to 140° or even higher, according to the object in view. The colour of the liquor to be produced from the malt depends upon the temperature at which the latter is dried. If that liquor is wished to be pale, the malt is dried at a low heat; but if brown, like *porter*, the heat is considerably increased. We have observed the temperature of the malt often as high as 160° and 170°, and on one occasion at 186°. Indeed we have reason to believe that malt is sometimes dried at a heat little less than that of boiling water. Even pale malt may have been

exposed to a heat of 170°, and malt may be made brown at a lower temperature: for it is not so much the temperature, as the suddenness with which it is raised, while the malt is still moist, which alters the colour: the ease with which the soluble part of malt alters its colour and its taste, when exposed to heat, constitutes one of its most remarkable characters. This facility of change or decomposition is considerably increased by the presence of moisture. If pale malt be properly dried, it does not lose the power of vegetating; but this power is destroyed if the heat be too suddenly urged.

"The time during which the malt is on the kiln, varies with the temperature and the quantity of malt dried, from forty to eighty hours, which were the extremes in our experiments. While upon the kiln, the malt is occasionally turned.

"V. The last process is the cleaning of the malt. While still warm upon the kiln, it is usually trodden upon by the workmen, to separate the radicles or *commings;* which are at that time brittle, but soon become tough by absorbing moisture. The commings, thus detached, are afterwards separated by passing the malt through the common fanners; or, instead of this mode of cleaning, an instrument called

a *harp*, well known to the brewers, is employed. The quantity of rootlets and broken parts of husks, thus detached from the malted grain, varies according to circumstances, but is always considerable.

"The malt thus obtained weighs about one-fifth less than the raw grain from which it was produced; but this diminution of weight varies somewhat according to the temperature of the kiln; the least in our trials was 19 per cent., the greatest 27, the average, about 23.

"A great part of this loss of weight is to be ascribed to the kiln-drying; and consists of nothing else than the moisture which previously existed in the raw grain, and of which it would have been deprived by the heat of the kiln, as well as the malt. In order to ascertain how much of the loss was owing to this cause, the raw grain should have been kiln-dried and weighed just before it was put into the steep. In that case, the difference between the weight of the malt and of the kiln-dried grain, would have indicated the quantity of loss of substance really sustained by grain during the process of malting. As this method was not practicable in pursuing trials on a large scale, we had recourse to another, less precise indeed, but sufficient to give us a notion of the loss of weight

actually sustained by the malt. Portions of the raw grain, and of the newly-dried malt, were exposed to the same temperature upon a steam-bath. The loss of weight sustained by the grain being called *a*, and that by the malt *b*, it is obvious, that *a*—*b* represents the loss of weight which the grain would have sustained, had it been dried on the kiln at the same temperature as the malt. This subtracted from the difference between the weight of the raw grain and the malt, gave the real loss of weight sustained by the grain during the process of malting.

"The difference between the raw grain and the malt may be called the *apparent loss*, as much of it was owing to moisture, which the malt gradually imbibes again when exposed to the air.

"In the trials made by the learned authors of the Scotch report, the loss of weight proceeding from the dissipation of moisture, varied from 8 to 18 per cent., and the real loss from 6 to 12 according to the process. The average loss from the dissipation of moisture, may be considered as 14 per cent., and the average real loss may be stated at 8 per cent.

"About $\frac{4}{10}$ ths of this loss must be ascribed to the commings which are separated by cleaning

the malt. If they be deducted, the loss sustained in malting does not exceed an average of 5 per cent. If we reckon the loss in the steep at 1½ per cent., there will remain 3½ per cent. for loss upon the floor; but of this, 1½ per cent. may be safely reckoned for waste, consisting chiefly of small corns and commings, lost during the kiln-drying, and the transporting of the malt from place to place. From this statement, it follows that, at an average, 100lbs. of barley will yield 78 of newly dried malt; so that there is a loss of about 22lbs. Of this loss, 14 pounds are to be ascribed to moisture, a considerable portion of which the malt receives again by standing. The real loss consists of the remaining 8 pounds, which are thus accounted for:

Lost in steep	1½
Lost on floor	3
Commings	3
Waste	½
Total	8

"The bulk of the malt generally exceeds that of the raw grain, though this does not always happen. The average, for instance, of all our maltings of Scotch barley gave almost exactly bulk for bulk, yet, in some instances, 100 bushels of barley yielded 109 of malt. Others, of course, must have fallen as much short. The

average of the English barley was 105 bushels of malt from 100 of grain; that of the bigg 99. The greatest produce was 112 bushels of malt from 100 of barley; the least 93. Probably, too, the inequality might be owing partly to the unequal degrees in which, in different cases, the malts, or both the grain and malts, had been cleaned. In our trials, the bigg did not deviate so far from equality as the barley.

"The weight of the malt varies also considerably; but in general a bushel of good malt, when newly dried, weighs about three-fourths of a bushel of the raw grain."

The foregoing is little more than an abridgment of the most important part of the Scotch Report: to such readers as may desire to see more on the subject I would recommend the perusal of the report itself; or if that cannot be procured, Dr. Thomson's article on Brewing and Malting in the Encyclopædia Britannica.—J. H. B.

APPENDIX.

APPENDIX.

No. I.

From Mr. Thrale.

Southwark,
13 *Feb.* 1770.

Dear Sir,

I received the favour of your letter and the sample of pale malt, for both of which I think myself highly obliged to you. I like your malt very well, and yet I believe I can shew you some parcels from Burlington and Norfolk, that are greatly superior to them; I am using some at present that yield from the first extract 770 specific gravity, and the mean not less than 500.

I hope when you try the experiment I recommend, you will continue to do it in the exact proportion of one quarter in ten quarters, for reasons I will tell you when we meet next, and when done, I shall be glad to hear the result of the process.

If I can be at all serviceable to you here, you may freely command,

Dear Sir,
Your most obedient,
humble Servant,
H. Thrale.

No. II.

From Mr. Thrale.

Southwark,
13 *March,* 1770.

Dear Sir,

I am a good deal surprised to find that your brewing with one in ten of barley did not outweigh that with all malt, but should imagine you will find it some time hence more spirituous and much softer. I dare say you will taste it frequently, and observe the difference of quality, if any should appear in colour as well as taste. The wheat weighs pretty near what I expected, and if the colour is not injured, will certainly answer in all other respects; I should be glad to know whether the barley or wheat turns out sufficiently to your satisfaction to induce you to reduce it into practice. Mr. Martin has not finished the hydrometer, or you should have had it before now; I now use both hydrometer and hydrostatic balance, and find them to vary the least in the world, in short, hardly worth notice in our way.

I hope to see you soon in town, and wish you would always give me a line, and tell me when you intend calling, that I may take care to be in the way. Pray write if you don't intend coming soon, and if I can do any thing for you here you may at all times command.

Dear Sir,
Your obedient Servant,
H. Thrale.

No. III.

From Mr. Thrale,

London, 24 *April*, 1770.

Dear Sir,

I was this morning at *Martin's* and saw the silver hydrometer complete, which they promised me should be sent this night by coach, and I hope you will do me the favour to accept of it. I have lately taken much to the hydrostatic balance, which you know is more nice and determinate, and when once made familiar, is an agreeable instrument, and I generally try the wort with both. I hope to see you soon in town, and am, in the mean time,

Dear Sir, your most obedient, humble servant,

H. Thrale.

No. IV.

From Mr. More.

Adelphi, *May* 19*th*, 1785.

Dear Sir,

I had the pleasure of laying before The Society for the Encouragement of Arts, Manufactures, and Commerce, at the meeting held last night, your Treatise, entitled, "Hydrometrical Observations and Experiments in the Brewery," and read to them your polite dedication.

A work calculated to improve so capital a branch of business as the brewery, could not fail of meeting with the approbation of the Society; and I am directed to return you their thanks for this instance of your regard, and to assure you that the copy of the work which you have been pleased to present to them, is directed to be carefully preserved.

I have the honour of subscribing myself,

Sir, your most obedient,

and most humble Servant,

Mr. Baverstock. Sam. More, Secretary.

No. V.

From Mr. More.

Adelphi,
Dec. 3d, 1785.

Dear Sir,

Permit me to return you my thanks for the cask of ale I received a few days since, and which I should have acknowledged sooner had I not waited to see some friend who was a member of one of the Houses, that I might not burthen you with further expense. Your answer to Mr. R. I think fully sufficient, and am much pleased with your resolution of paying no further regard to what they may say; for as one of them, I believe, is professedly a pamphleteer, they will be happy in any opportunity of exercising their vocation.

I shall, (however contrary to my usual practice,) take a bumper of ale as soon as it is tapt, to your health and that of your friends at Windsor, *&c.*, with success to the brewery there, in which and in every good wish, Mrs. More desires to be considered as joining cordially with,

Dear Sir, your obliged, humble Servant,

Sam. More.

No. VI.

From Mr. Bogle.

Sir,

I am persuaded you will forgive the trouble of this address to you, in consequence of the publication of your "Hydrometical Observations and Experiments on the Brewery. The public spirit which is exhibited in that work is strongly marked, and does you honour; and I trust the same public spirit will induce you to wish that your theory may be reduced into practice in other branches of manufacture.

You must know, Sir, that I am a West India planter, and having resided many years in that climate, I attended very much to the process of boiling the sugars upon my own estate.

It is a remarkable and singular circumstance, that about two months ago, an idea came into my head that a hydrometer or hydrostatical balance might be used to great advantage in ascertaining the quality of our cane juice. I repaired immediately to a mathematical instrument maker, to ask his opinion upon the subject, and I was told by him that experiments of a similar nature had been made with the hydrometer in the brewery. This was perfectly new to me, as I had never had any intimation of that discovery, nor had I ever thought upon the subject till the very day on which I waited on the mathematical instrument maker.

I have had several conversations with him, but I have not been able to get him to bestow any degree of attention to the subject.

Observing your work advertised, and supposing it congenial to my own pursuit, I applied for it at your bookseller's; and on looking into it, I flatter myself that, with your assistance, great improvement may be made in boiling sugars in the West Indies.

The cane juice is of very different qualities, sometimes a pound of sugar is obtained from a gallon of cane juice, and sometimes is so thin that not more than half a pound is obtained from a gallon.

According as the cane juice is more or less rich, the process in boiling must be diversified, and a greater or lesser quantity of quick lime is to be used in it.

The point then, on which I shall be much obliged to you for your opinion, is,

If your hydrometer, or any other that you can devise, or any hydrostatical balance, would ascertain the different degrees of the richness of the cane juice?

If you think it would, I shall be very happy to receive your answer as soon as may be convenient to you, as I shall probably leave London very soon.

I have the highest expectations that your great knowledge and long experience may accomplish by practice, what with me is only a theory in embryo.

I remain with much respect,

Sir, your most obedient and

very humble Servant,

London, 23*d May*, 1785. ROBERT BOGLE.

No. 34, Arundel Street, Strand.

P. S. The foregoing was written before I had read your Appendix. Perhaps Mr. R——'s saccharometer may answer my purpose. You will be pleased to observe that without the use of unslacked or quick lime, we cannot bring our sugar to granulate, and that a very small proportion of *it* is sufficient. When the juice is rich, a 2000dth part will do; if the juice is not so, but very thin, it will require a 1000dth.

This difference, and all the intermediate gradations between those extremes are ascertained only by the eye, or by tasting the cane juice. And as the quality of our sugar depends very much on the proportion of lime being duly regulated to the density of the juice, the application of the hydrometer to ascertain it with precision, might be of great importance; because if such a small quantity of lime as we use, determines whether we are to have sugar or not, a very inconsiderable deviation from the just proportion, either more or less, must have a bad effect.

On considering your experiments on hops, it occurs to me that the hydrometer might be of use to the tea-dealers, and that even in physic, it might be applied to discover the relative strength of medicines. Perhaps it might lead to valuable discoveries by ascertaining the density of the urine, or the blood. I wish to be acquainted with Mr. Troughton, but much more ardently with yourself.

ROBERT BOGLE.

No. VII.

From Mr. Baverstock.

Sir,

I am favoured with your letter of the 23d, requesting my opinion relative to the application of an hydrostatical instrument, in ascertaining the value of cane juice. It is a pleasing circumstance to me to find that your every idea on this subject is perfectly consonant to my own, and that I can venture to pronounce that the introduction of such an instrument in the manufacturing of sugars, will answer your utmost wishes and expectations. You say you have consulted a mathematical instrument maker, but cannot get him to bestow any attention to the subject. The fact is, that they can make instruments, but can give *very* little information respecting the use of them. You think Mr. R's. saccharometer might answer your purpose. Probably it would, but I would not advise you to pay much regard to his regulator. From what I have said of Mr. Troughton, it may appear that I am acquainted with him. But I have never yet seen him. He lives in Fleet Street, and is the maker of the saccharometer which Mr. Richardson, a brewer at Hull, invented. When I ordered a saccharometer of him, with it he sent me a note, which note justifies what I have said respecting the instrument.

Finding myself under a necessity of taking some notice of Mr. R's. publication, (entitled statical estimates of the materials of brewing,) in a manner not likely, perhaps, to be altogether pleasing, to prove that I had no interested or ungenerous motive, I said what you will there read, intimating that Mr. Troughton *made* instruments as well as any one. But this has nothing to do with the invention.

While my Treatise was printing, I met with a mathematical instrument maker, whom I had known some years ago as the principal assistant of the late Mr. B. Martin. His name is Wright. He lives at No. 148, Leadenhall Street. He is

making an instrument for me, on a new principle, which, I think, bids fair to exceed all others in accuracy. He is intelligent, assiduous, and obliging. If you think proper to apply to him, and to use my name to him, I have reason to believe your every wish respecting a proper instrument will be answered. It may be some direction to Mr. Wright, as well as to yourself, Sir, to be informed that so far as I can judge, from what you mention of the produce of sugar from the cane juice, this last is in quality or specific gravity, much about equal to a first or strong wort. Consequently, the instrument which serves for the brewery, is well enough adapted to your purpose. If you wish for any further explanation by letter, you may freely command me; or if your occasions should lead you to, or through, this town, I should be happy to wait on you at my house.

In my own particular branch of business, prudence requires that I should not be indiscriminately communicative, farther than may be necessary to elucidate what I have already published. In *your* case I can have no motive for reserve, in any degree.

I am respectfully,
Sir,
Your most obedient Servant,
J. B

24th May, 1785.

No. VIII.

From Mr. Boele.

London,
9 June, 1785.

Sir,

I am exceedingly obliged by your kind favour of the 24th ult., and thank you for the very extraordinary degree of attention, with which you have replied to it. I am also much flattered to find, that my ideas, with regard to the purposes to which the hydrostatical instrument may be applied, are so perfectly consonant to your own; and that you are of opinion it may be applied with success in fixing the strength of the cane juice.

I freely confess, I had no other object in view, when I first thought on this subject; but after having read your treatise and considered with attention, the many useful purposes to which this instrument may be applied, I have not a doubt of its being adopted in many branches which have hitherto been unthought of, and, that in common life, an hydrometer will be found almost as necessary as a pair of scales with weights.

In consequence of your recommendation to Mr. Wright, I did myself the pleasure of waiting upon him, and received very great satisfaction in examining the improved instrument he is making for you.

Although the degrees were not marked on the scale, yet I had an opportunity of making some experiments with sugar and water, which afforded me a most perfect conviction that it will be of great use in ascertaining the strength of our cane juice; it marked the effect of six grains weight of sugar in ten ounces of water, with the utmost degree of accuracy.

I had an opportunity of writing to the person who has the charge of my sugar plantation in Grenada, before I received your favour, and I beg leave to send you a copy of my letter to him, because it may give you a better idea of the object of

my pursuit, than you can obtain from my first letter. If a standard can be ascertained for the cane juice, for fermented liquor, and for quick lime, by means of the hydrometer, it will be very valuable indeed, and I have no doubt but it may, for them all. I am convinced this instrument may be of great use in shewing the strength, or, in other words, the density, of every thing that is soluble in water, or from which a decoction is made. In chemistry, it must be productive of great improvements.

I waited upon Mr. Troughton, and examined his saccharometer, but I found it much inferior in point of accuracy to the improved instrument, made by Mr. Wright for you. I beg leave to return you my best thanks for having introduced me to Mr. Wright, by whom I was received with every degree of civility and attention, and I found him to answer, in every respect, the character you have bestowed upon him.

The kind offer you make me of giving me further information on this subject, as well as your obliging invitation to visit you at Alton, merit my most grateful acknowledgments. I regret that some business of importance, which detains me in town at present, puts it out of my power to fix upon a time for accepting of your hospitable invitation, but I still indulge myself with the hopes that I shall be able to accomplish such a jaunt.

If in the meantime your business should occasion your taking a journey to London, I shall be happy to be informed of your arrival, that I may embrace the opportunity of thanking you in person for the very great obligations you have conferred upon me.

I remain with much respect,
Sir,
Your most obedient and
Very grateful humble Servant,

34, Arundel Street,
Strand.

ROBERT BOGLE.

I beg leave to subjoin the following list of articles, of which I think the instrument may be useful in ascertaining the relative strength.

Milk,	Drugs,
Dyeing stuffs,	Sugar,
Tobacco,	Tea,
Coffee,	Chocolate,

Various other groceries,
Painters' colours,
In all chemical processes,
Soap, *&c.*, *&c.*,

Besides what you take notice of in your Treatise, such as grain of all kinds, hops, wine and vinegar.

No. IX.

(*Copy.*) To Mr. Mac Sween.

London,
24*th May*, 1785.

Dear Sir,

Enclosed you have a copy of mine of the 5th instant, since which I have no letters from you, but Mr. Hay writes me of the 30th March, that you had made about 140 hhds. sugar at Mount Craven.

I now set down to write to you, upon an idea which has struck me as to the process of making sugar, and I entreat of you to consider of it attentively.

When I reflect upon the very small proportion of temper lime that is used in making sugar, and that without even that small quantity of lime it would not form into a grain, I am apt to think it is not attended to with such a degree of accuracy as the subject deserves. When I also reflect on the

difference there is in the quality of the cane juice, some of it so very strong that less than a gallon of it will yield a pound of sugar, and others so poor that double that quantity will not yield a pound. I have been wishing that some method could be devised of ascertaining with a perfect degree of accuracy, the quality of the different sorts of cane juice.

I suggested an idea to Mr. Shaw, (a gentleman from Jamaica, to whom I gave a letter to Mr. Hay,) before he left this place, that I was of opinion the quality of the cane juice might be ascertained by a hydrometer constructed on some new principle for that purpose; and we went together to Mr. George Adams, who is a maker of those instruments: he told us he considered it as practicable, and he also promised to think upon the subject, but although I have called upon him often, I find he has not paid any attention to it.

The foundation of my theory is, that if the very small proportion which is used of lime, in a copper of 300 gallons, makes such a difference, as that without it you cannot get the juice to granulate, a very small deviation from that quantity, either more or less, (suppose one tenth part,) must make a very material difference in the quality of the sugar. I also suppose that in nature there is such a thing as the best possible proportion of temper lime for a certain quality of cane juice, because I recollect the quantity used was different according to the richness or to the poorness of the juice; and I also recollect that there was no accurate method of discovering the different qualities of it, but only by looking at or by tasting it, or by observing the canes which produced it. Since Mr. Shaw's departure I have fallen in with another mathematical instrument-maker, who has undertaken to furnish me with an hydrometer, which will ascertain with the nicest degree of precision, the different qualities of the cane juice. This I confess, will in my opinion be a very great point gained, because being furnished with it, you can as easily form a judgment of the strength of the juice, as you now

prove rum with the glass bubbles, and by some previous experiments made with attention, you can fix a true proportion of temper lime for each different quality of it.

If this is accomplished it will make such a difference in judging of the juice as the difference would be in proving rum, if there was no other method than by looking at or tasting it. I think it may also be of service in fixing on the canes which are most proper to cut, because the hydrometer will show what proportion of sugar they will produce, and a pint of juice will be sufficient for the experiment. In order to illustrate my thoughts on this subject, I will state the matter thus:

The hydrometer will show the very richest quality of the juice, this I will call No. 1. After making several experiments to ascertain what is the just proportion of temper lime for that number, you can in all time coming fix on that proportion of lime for that quality of juice, and in the same manner for other qualities of less richness. In short, I think if the richness and poorness of the juice can be ascertained with the utmost degree of accuracy, which I am convinced it can by means of this instrument, the process of boiling sugars will be reduced to a much greater degree of certainty than has hitherto been the case.

Yesterday I put the hydrometer into a quart of water, it swam to a certain height on the scale. I mixt about a tea-spoonful of Muscovado sugar in that quantity of water, and it rose very perceptibly. I then mixed another tea-spoonful of sugar, and it still rose further. Now you will observe that two tea-spoonfuls of sugar in a quart of water, bear but a small proportion to the quantity of sugar in your poorest cane juice, for a quart of water weighs 32 ounces, and I am persuaded the sugar did not weigh a quarter of an ounce.

A gallon of your juice weighs suppose 8lbs., it is very poor indeed if it yields only half a pound sugar; this then is the difference between $\frac{1}{16}$ and $\frac{1}{128}$th part. My plan is only in its

infancy. Pray write me your thoughts on the subject as soon as you can. Something may be done against next crop.

Yours very sincerely.

I beg you will send me the weight as near as you can guess, of the quantity of lime you use for 300 gallons of your richest juice, and also for the poorest; for the richest I don't think it exceeds a pound, and 300 gallons of juice will weigh 2400lbs. I suppose 2700lbs., if so $\frac{1}{2700}$th part makes the difference, whether you are to have sugar or not. A small deviation, therefore, in the quantity of lime more or less, must occasion a great difference in the quality, and perhaps, in the quantity, of the sugar.

It strikes me, that a hydrometer may be so constructed as to show the strength of the lime also, and that having ascertained accurately the richness of the juice, you may be able to determine as to the propriety of boiling any particular quality, high or low, so as to produce the best sugar.

This is certainly a standard process in nature, and a course of experiments and observations after obtaining the accurate proof of the juice, may lead to great improvements in the whole process, and may rescue it from the present sort of guess work in which it is now carried on. I am also convinced that an hydrometer may be so constructed as to be of great use in making rum, because it certainly will ascertain, most accurately, the specific gravity of the fermented liquor, and enable you, by that criterion, to turn it into the still while it is in a state to produce rum to the best advantage, and having once got that standard, you can fix upon it in all future distillations with an absolute certainty

Mr. Alex. Mac Sween.

No. X.

From Mr. Baverstock.

Sir,

On considering the particulars of your letter to Mr. Mac Sween, and having, also, with a further view to inform myself, in some measure, of the process of boiling sugar, consulted "Dr. Shaw's Chemical Lectures for "the Improvement of Arts and Trades," &c., on this subject, I am fully persuaded that your cane juice has a remarkable and near resemblance in its nature and properties, to the extract which we obtain from malt. And so far as I can judge likewise from a slight experiment which I have made by boiling 2 ounces of raw or moist sugar, in 8 ounces of water, the specific gravity of your juice appears to be not far distant from that of some of our worts. I conceive the material disproportion in the richness of the cane juice, as proved by its product of sugar being so different at different times, to be owing (like the intrinsic value of our barley and malt) to the favourableness, or otherwise, of the seasons, to the growth and perfection of the canes. Cold and rainy seasons during a few critical weeks, occasion an inferiority of 20 or more per cent., in our barley, and the difference between a long continuance of rain, and the excessive force of the sun in the climate of Grenada, appears to be a sufficient reason to expect that the value of your juice will thereby vary in a still greater proportion, or to the degree which you mention, one half.

In the distillery the actual weight of a wine-gallon of alcohol, or the purest spirit, is 113 oz., of water, 133 oz. The proof spirit of the Custom House is supposed to contain equal quantities of alcohol and water. Consequently, a wine gallon of such is deemed to weigh 123 ounces.

For the sake of forming some rule, let us suppose that the

specific gravity of your *richest* cane juice exceeds the weight of water 16 oz. per gallon, and that your poorest juice weighs only 8 ounces per gallon more than water. Having an hydrometer, constructed for the purpose of assaying fluids *denser* than water, (or, in the language of the hydrometrical observations, with the water weight fixed on it,) let us presume that the richest juice, or the additional 16 ounces per gallon, will be expressed by the sum 800, on such an hydrometer, and the poor juice by the sum 400.

Now supposing that to 300 gallons of juice, the specific gravity whereof is as 800, you apply 16 ounces of lime, the same quantity of a juice of 400 density, 32 ounces, the quantity of lime for the juice of different qualities appears to be for

800 gravity . . .	16 ounces.
700	20
600	24
500	28
400	32

An exact table might thus be formed, to shew at a view, the precise number of ounces, or proportions of an ounce, required for the intermediate numbers. For instance, 650 would demand 22 ounces of lime; 625, 23 ounces; or 675, 21 ounces.

Perhaps the proportion of lime ought to increase somewhat *in an increasing ratio*, as the specific gravity of the juice becomes inferior. If so, a small, or due allowance is easy to be made. But I am inclined to think that a table, formed on the above system, would be sufficiently accurate for practical purposes. Granting this, what is next required is to consider *your quantity*, or number of gallons. If the gauge thereof is not properly attended to, a material difference still occurs. But when this is carefully observed and justly taken, the rule becomes again certain. If 300 gallons of juice require 24 ounces of lime, 330 gallons require 26.4 ounces, or 26 ounces

and 8 pennyweights. And thus, again, a table might be formed to shew, to the 20th part of an ounce, the quantity of lime required for any certain number of gallons of juice, of whatever quality.

Your idea of determining, by an hydrometer, on the canes which may be most proper to cut, is perfectly just, and the adoption of it cannot fail to be highly useful and advantageous, because you are thereby enabled to fix on the canes when they are *exactly* in their highest state of perfection. But in taking the specific gravity of the quantity of juice required for your copper, say 300 gallons, you should not determine on the proportion of lime to be used from the quality of the juice which runs at any time, from the mill. Because, it is highly probable that this quality may be, in some degree, various during different periods of grinding, for the same copper. Your observations as to the specific gravity of the juice ought, therefore, to be deferred until the whole quantity, intended for each operation, is rendered uniform, or equable, by being boiled together for 10 or 15 minutes.

Which delay in taking the density cannot, I presume, be attended with any inconvenience as to the main point, the determining on the quantity of lime.

With regard to applying the hydrometer to the fermented liquor, intended for the distillation of Rum, it will most assuredly prove extremely beneficial. But this is a matter of so delicate and pregnant a nature that I would wish to be excused from saying more respecting it, on paper. If I should ever have the pleasure of seeing you, I can have no objection to explaining my sentiments more fully to you on this subject.

The value of the lime may, also, be found most precisely by such an instrument, but in the case of lime water, and some other particular solutions, such as of pot-ash, or other lees for making soap, *&c.*, it seems to be requisite that the instrument should be formed of other materials than of the usual metals. Because the corrosive quality of such solu-

tions might be apt to injure the common hydrometers so very materially as in time to destroy the accuracy of them. This inconvenience might, in my judgment, be remedied by having an hydrometer constructed of *cut glass* for these nicer purposes. I am persuaded that this is practicable. The glass manufactory is now brought to extreme perfection in this kingdom, inasmuch that the workmen can not only blow it into any shape, but what is still further necessary in the present concern, glass may be formed to an extreme accuracy of size and weight. *Cut* glass is also tolerably durable and strong, and, with proper care, would be likely to serve a very considerable time, since the instrument made with *it* need never to be made use of but on a few particular occasions. The weights of such an hydrometer or those parts of it which never touch the solutions, might still be made of the usual materials. I conceive enough is said on this subject, to you, Sir, whose own ideas on all that relates to it are so perfectly just that you require nothing more than to pursue them to practice, in order to obtain every object and advantage which you propose therefrom.

In every instance and article which you have thought of for the application of this instrument, I fully agree with you, except on the article of blood. The coagulation which so speedily takes place therein, must, I think, prevent the forming any precise judgment respecting its real density. But the taking the specific gravity of urine being certainly practicable, promises, in my opinion, to afford some highly material information in the art and practice of physic.

J. B.

No. XI.

From Mr. Bogle.

34, *Arundel Street, Strand,*
22d June, 1785.

Sir,

Your much esteemed favour of the 14th came to hand in due course, and I return you my hearty thanks for the pains you have taken in investigating my theory for improving the art of making sugar in Grenada, which is the island where my property is.

The reasons you give for the cane juice not being of an equal density, are perfectly well founded, and the inferiority of some kinds of it proceeds from the causes you have assigned; other kinds which are also inferior in density, become so, by a very long and severe drought and scorching heat attacking the canes and making them wither before they are ripe: in such cases as this last, the cane juice acquires a great degree of acidity, and produces sugar of a bad quality, in many instances it will produce little, or no sugar at all. I mean to consult some able chemists in hopes of their being able to suggest some improvements on our process of making sugars from juice which has become acid from the scorching heat; perhaps, some other article may be more efficacious than quick lime, or something else may be superadded to the lime for such juice. Quere, salt of tartar, or an increase of lime.

I am much obliged to you for the hints you afford me as to the constructing of a scale which may be of great importance to me, but as I foresee that the new improved instrument constructing just now by Mr. Wright, will not be so proper for common use in our sugar works, I have thought upon another method of proving the cane juice with glass air bubbles, as we prove our rum in the West Indies. Mr. Wright's Hydro-

meter, however, will be of the most essential advantage in the adjusting such air bubbles.

With respect to the gauge, we always fill our 300 gallon copper to a certain height; but, perhaps, even that circumstance is not so accurately attended to as it ought to be, because from the shape of our coppers, a very small difference at the top will greatly increase or diminish the quantity. It occurs to me at this instant, that it may be ascertained very accurately by filling the copper till it begins to run over, and then withdraw from it a certain number of gallons.

The observation which you make on the juice being of different qualities, while it is running from the mill, is perfectly just, and I would therefore propose to take the proof of the strength of it in the manner you suggest. In your remark on your notions respecting the process of boiling sugars, you do yourself great injustice; for believe me, Sir, from your manner of expressing your thoughts, I could not have discovered but you had been an experienced sugar planter.

There can be no doubt but the corrosive quality of many articles which are soluble in water, will injure an hydrometer made of metal; but I am not so scientifically informed as to know if that is the case with regard to lime; if it should, the expedient proposed by you will fully answer the purpose and remove that difficulty.

My theory with regard to proving the lime, (for indeed, Sir, I can only call it a theory,) is this: I have understood that there is a standard strength of lime-water, beyond which it cannot be carried, in the same manner as there is in the heat of boiling water. I would, therefore, propose to take that strength by the hydrometer; and when that is accurately ascertained, (I mean, the ultimatum strength of the lime water,) the lime, of which the smallest quantity will render a given quantity of water of that standard strength, must be the most powerful; or it may also be done by fixing on a given quantity of lime, and judging of the relative strength

of the different kinds, by trying which of them will produce the greatest quantity of standard lime water. The kind which yields the greatest quantity of standard lime water, I should think must be the most valuable, but I may be mistaken, because I have not had any practice, or experiments on this subject.

While my thoughts are employed on this topic, it occurs to me that this accurate and precise proof of the lime is equally important, (if not more so,) as the proof of the juice is, because there is very great inequality in the strength of it in the materials from which it is originally made, also in the manner of burning it, and of preserving it: if it is exposed to the air even under cover, it falls *per deliquium*, and in that case a great deal of its value is lost. I can have no doubt of there being a difference in the quality of lime used by the sugar planters, equal to 3 or perhaps 4 to 1, which is much greater than in the juice which we even attempt to boil; if I am right in this conjecture, you may easily judge, Sir, in what a blindfold, blundering manner, we have been proceeding. While we have been imputing the bad quality of our sugar, or the small produce from the juice, to the weak or vitiated quality of our canes, in all human probability the miscarriage in the process was chiefly owing to a defect in our lime. In short, Sir, it is a most important theory on which we are engaged, and I consider it as a most peculiar fortunate circumstance, that I have been so happy thus accidentally to establish a correspondence with a gentleman who possesses such just and clear perceptions as you do, and who is at the same time so able and so willing to explain and elucidate this subject to one who considers himself a mere novice in the practice of it, and just beginning to dip into the theory of it.

It affords me great pleasure to find you are of opinion the hydrometer will most assuredly prove extremely beneficial when applied to fermented liquor; from the way in which you

have expressed yourself, I judge it appears to you an idea of more importance than I am aware of.

The more I reflect on the general uses to which this theory of hydrostatics may be applied with advantage, the more forcibly I am impressed with the clear conviction, that when men of science, who are accustomed to experiments in chemistry and natural philosophy, are possessed of such ideas as you and I entertain on this subject, it will be productive of innumerable benefits to mankind.

I am perfectly ignorant of even the principles of chemistry, but I think I can foresee very great advantages will accrue to the chemists from the use of such an instrument as Mr. Wright has made for you. I can conceive that many of their processes may miscarry from their not having the means of ascertaining, in the same accurate manner as Mr. Wright does, the relative strength of each *simple* material which forms their compound. I say *simple*, because I confess that my speculation is confined to the idea, that the hydrometer is to be applied chiefly to each distinct uncompounded article by itself, in order to decide on its relative strength.

I have already stated that lime is of very different qualities; allow me to suppose that pot-ash, or salt of tartar, also varies in its quality; it must surely be of the utmost importance to be able to fix on a standard strength of each ingredient.

In judging of the strength of simple articles of medicine, such as Jesuits bark, rhubarb, *&c.*, it appears to me to be of still greater importance than in any other branch: for example, one pound of bark, of one kind, contains the same salutary powers that two pounds of another kind does: the value of the strong bark is not merely double that of the weak; it is infinitely more, because the stomach of the patient nauseates such a quantity of the weak as is necessary to be taken as a febrifuge, but can easily retain the quantity which is necessary of the strong kind.

I am very impatient to have the pleasure of an interview

with you. I will take the very first opportunity I can find to wait upon you, but in case I should come to Alton (as it will be on purpose to see you,) I should be very much disappointed if you should be from home. I beg therefore, to know if there is any chance of my missing you, or if there are any particular times when you are at home, or any when you are absent.

I would wish, if possible, to make it next week, after Monday, unless you have a prospect of being soon in town.

I entreat your pardon for the very incorrect manner in which this is written, as I have run it off in a hurry lest I miss the post.

I remain with much respect,
Sir,
Your most obedient and
Much obliged humble Servant,
ROBERT BOGLE.

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