

"(6.) It has the recommendation of absolute and entire cleanliness, the human hand not touching the dough or the bread from the beginning to the end.

"(7.) The journeymen are relieved from a circumstance most destructive to their health—that of inhaling the flour dust in the process of kneading.

"(8.) It will produce a healthier condition of the baking trade, and thereby diminish to a great extent the inducements which lead to the extensive system of fraud now practised upon the public by the production of adulterated and inferior bread.

"(9.) It will effect an immense saving in the material from another source, namely, by preventing the sacrifice of at least 10 per cent. in the nutritive portion of the grain, hitherto lost as human food by the method of grinding and dressing necessary in the preparation of flour for making white bread by fermentation.

"(10.) Together with the preservation of this large proportion of the entire quantity of wheat converted into flour, there is also the important result of the proportion preserved (the cerealin) being a most powerful agent in promoting the easy and healthy digestion of food."

It is objected by opponents of the Daughish system that the product is not really bread, but only an artificial product resembling bread. It is held that the process of fermentation has a specific influence on the constitution of bread, beyond its mechanical effect of rendering the mass spongy or porous. One of the chief hindrances to the more general use of aerated bread is the fact that it is, as compared with fermented bread, insipid and tasteless. In practice, the public have not hitherto derived any advantage from the alleged economy of manufacture, and the suitability of inferior and cheap flour for the process. Although fermented bread is hurtful in some conditions, it is not easy to supplant well-made fermented loaves in general public estimation, and aerated bread can scarcely be said to have hitherto had a fair trial, as with the necessarily expensive machinery a large trade is necessary in order to return a fair profit on the capital invested.

Unfermented Bread.—Under this head is included such bread as is vesiculated by means of carbonic acid evolved from chemical substances introduced in the making of the dough. In writing the article on "Baking" for the supplement to the fifth edition of this *Encyclopædia*, published in 1816, Professor Thomas Thomson of Glasgow stated that the only end served by fermentation was the generation of carbonic acid gas, and that this might be accomplished by the use of hydrochloric acid and bicarbonate of soda. About 1842 Mr Henry Dodson commenced to manufacture bread on this system, and obtained a patent for his process. He used hydrochloric acid and bicarbonate of soda in such proportions that while, by their reaction, they liberated sufficient carbonic acid to aerate the dough, they formed chloride of sodium or common salt enough for the bread. Liebig, in his *Familiar Letters*, says regarding this system:—"Chemists, generally speaking, should never recommend the use of chemicals for culinary preparations, for chemicals are seldom met with in commerce in a state of purity. Thus, for example, the muriatic [hydrochloric] acid which it has been proposed to mix with carbonate of soda in bread is always very impure, and very often contains arsenic." The sesquicarbonate of ammonia is also used as a source of carbonic acid in vesiculating bread, and it, on account of its highly volatile nature, is entirely driven off in the process of baking. A great amount of private or domestic baking is conducted on the same principle, butter milk and bicarbonate of soda being used for mixing the dough in making "scones." In this case the lactic acid of the milk combines with the soda, liberating carbonic acid. The baking powders and yeast powders which are sold, and the so-called self-raising flour, all depend for their action on the mixture of bicarbonate of soda with some organic acid, such as tartaric or citric acid.

Baking Machinery and Ovens.—The art of baking, al-

though it is the most important of all industries connected with the preparation of human food, is one which is still carried on in the most rude and primitive manner. While modern inventions and the progress of improvement have changed the conditions under which nearly all arts and manufactures are conducted, the baking of bread is still conducted as it was during the palmy days of ancient Greece. The nature of the processes necessary for the preparation of bread, the limited time it will keep, and the consequent impossibility of storing the product or sending it any considerable distance, tend to keep the trade in the position of a limited and local handicraft. It is, therefore, not a pursuit which attracts capitalists, and master bakers are mostly in the position of small tradesmen, without either the inclination or ability to invest money in expensive machinery and fittings. In the case of biscuit-baking the conditions are quite different, and it, as has been seen, has developed into a great manufacture, with elaborate and complex machinery and the most perfect mechanical appliances. Many forms of machine have been proposed as substitutes for the rude and laborious manual labour—always unfavourable to health, and sometimes not very cleanly—involved in baking. Many of these machines admittedly produce better bread than can be made by hand-work, and that at no inconsiderable saving of material and time, but the necessity of either steam or water power for their effective working greatly restricts their use.

The two processes to which machinery has been successfully adapted, are the mixing of the sponge and the kneading of the dough. Attempts have been made to mould loaves by machinery, but these have hitherto failed; nor has the endeavour to fire bread in travelling ovens yet been practically successful. A great variety of kneading machines have been suggested and used, since the first trial of such an implement in Paris upwards of a century ago. The various plans upon which such machines have been constructed will be seen in the accompanying illustrations. Fig. 4 is a form of dough-making machine in common use. It consists of a trough or box, the lower portion of which is semi-cylindrical, hung on a spindle, with a series of iron crossbars revolving inside. It is made to be worked by either hand or steam-power, and of various sizes, as required by bakers. In this machine the whole of the operations connected with setting the sponge, breaking the sponge, and mixing the dough, are performed. The gearing is arranged to give a fast motion for setting the sponge, and a slow motion towards the close of the

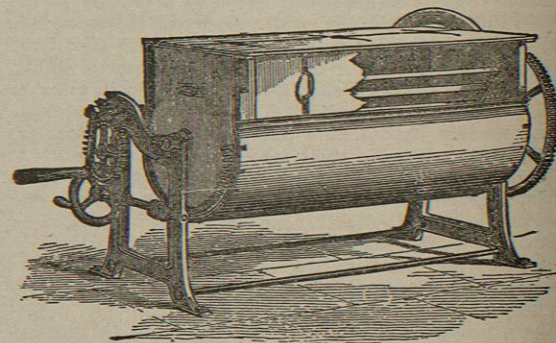


FIG. 4.—Kneading Machine.

dough making, when it is desirable to draw out the mass in order to give it a "skin," or smooth superficial texture. A worm-wheel, working in toothed gearing, tilts over the machine when the process of kneading is complete, and the dough is then conveyed to the scaling and moulding table.

Fig. 5 represents a kneading-machine, of a highly approved form, used in the great Scipion bakery of Paris, the inven-

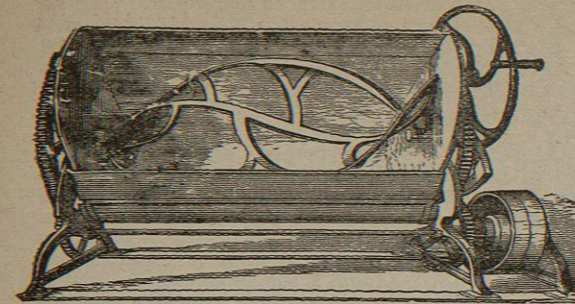


FIG. 5.—Boland's Kneading-Machine.

tion of M. Boland. Externally it is like the former, and it is also geared to move at two rates of rapidity. It has further an adjustment by which the force of the motion is increased while its rate is diminished. The main peculiarity of M. Boland's *pétrin mécanique* consists in the form of the revolving blades inside the trough. These blades are so arranged that they operate when in motion some-

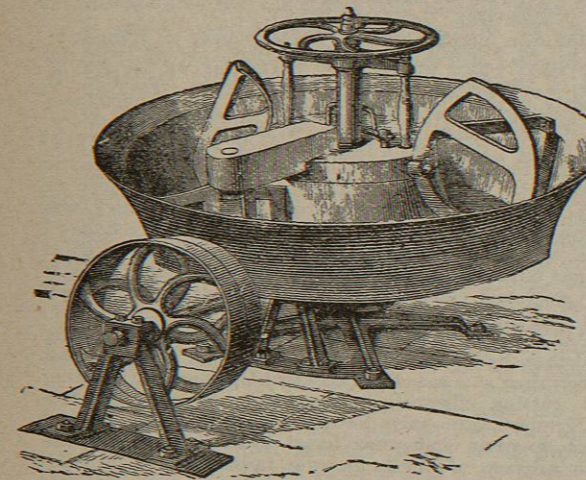


FIG. 6.—Kneading-Machine of Deliry-Desboves.

what like alternate screws, and so toss backward and forward the dough when it is thin, and lift and draw it out when stiff, passing it to each side of the trough alternately. An entirely different form of kneader is seen in fig. 6. This also is of French origin, the invention of M. Deliry-Desboves of Soissons (Aisne). Its construction and operation are thus described:—"The trough is a cast-iron basin, which turns on a vertical axis. The interior is provided with a kneader, shaped like a lyre, which first works up the dough and then divides it during the entire period of operation. Two other implements are also used, of a helical form, to draw out and inflate the dough in all directions, part by part, as is practised in kneading by hand. . . . The baker in charge can regulate the paste without stopping the mechanism. The water and leaven are first introduced, the trough is then set to work, the 'workers' employed to manipulate the dough are put in gear, and the leaven being diluted and flour added, the kneaders are also put in gear. After the lapse of twelve or fifteen minutes the dough is sufficiently kneaded, and, by turning the hand wheel fixed to the screw on the vertical

shaft, the three kneaders are thrown out of gear. The implement which effects the cleaning of the trough is then removed, and its place supplied by a balance-hook, by which the dough may be weighed in the trough itself. It is simply necessary to turn the basin on its axis as required, until the whole of the dough is weighed."—(Villain, *Etudes sur l'Exposition de 1867.*)

The fourth form of mechanical kneader we shall describe is that invented by Messrs Vicars of Liverpool, who are extensive makers of all forms of machinery connected with bread and biscuit making. This machine (fig. 7) consists

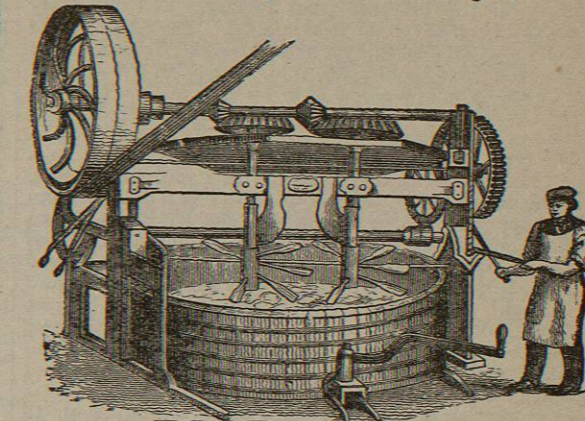


FIG. 7.—Patent Vertical Mixer.

of two vertical shafts, carrying radial arms. These arms pass each other in opposite directions, so that, in addition to a tearing action on the dough, which the knives have on passing each other, they have a screw action, pressing the dough down on one side and up on the other. The vessels containing the dough are made of wood, of an oval form, to correspond with the action of the machine. One considerable advantage connected with Messrs Vicars's machine is, that any number of troughs can be worked by the same pair of mixing shafts, as the troughs are movable, and are raised to, or lowered from, the blades of the mixer by means of friction wheels and spur gear. A baker can thus have several troughs containing sponges in different stages of advancement, all mixed by one pair of shafts, and all in their turn being made into dough by the same shafts.

Much thought and skill have been expended in the endeavour to effect improvements in the ordinary form of a baker's oven, but hitherto no plan has been devised which produces bread of a quality superior to that fired in the oven which is commonly used. A baker's oven of the common description is a low vaulted chamber, about 10 feet long, by 8 feet wide, and 30 inches high. It is built and floored of stone or brick, and has a small door in front by which the moulded dough is put in and the loaves withdrawn. At one side of this door, in the extreme corner, are placed the furnace and fire-grate, opening into the oven, and at the opposite corner, the smoke flue by which smoke escapes from the interior. The heat is by this arrangement carried throughout the entire oven, and when the temperature is sufficient the fire is withdrawn, the flue shut, and the dough is quickly introduced on a "peel," or long wooden shovel. Various efforts have been made to effect the heating of ovens by fire external to the chamber itself, but they fail to produce that radiation of heat which is found essential to good baking. Perkin's hot-water oven for some time met with favour in Great Britain, and a modification of it was employed in France.

On this system the oven is heated by superheated water, conveyed from a stove through closed pipes, which are coiled round the entire interior of the oven. This oven has the recommendation of perfect cleanness, and the temperature in it is easily regulated; but it is costly in construction, and the method has not commended itself in practice. Among ovens heated from the exterior, that of M. Rolland takes a high place for ingenuity and novelty of construction. Its characteristic peculiarity consists in the possession of a revolving sole, which not only allows the easy introduction and withdrawal of the bread, but the bringing of the different parts regularly and uniformly under the influence of the heat applied. The revolution of the sole is accomplished by a handle worked from the front of the oven; and besides this rotatory motion the sole can also be raised or lowered so as to bring either the upper or under side of the bread close to the heat as desired. The heating of M. Rolland's oven is effected by means of flues, which pass radially under and over the revolving sole. The chief objection urged against this form of oven is, that the air within it becomes too dry, which detracts from the flavour of the loaves fired in it. The use of the Vienna oven is general in Germany, and is extending in Paris for the baking of small or Vienna bread. It is egg-shaped in form, with an inclined sole, a very small aperture, and a low roof.¹ Its average internal dimensions are 12 feet in depth, 10 feet wide, and 18 inches high. In the best of these ovens glazed tiles are used for the sole. The inclination of the sole facilitates the filling and emptying of the oven; and the confined space of the interior retains a large proportion of moisture, which gives a fine colour to the crust and flavour to the crumb of the bread.

Qualities of Bread.—The process of baking changes the structure of the crust or outer part of a loaf, and, according to Reichenbach, develops in it a substance termed *assaman*, which he says has an influence in retarding the waste of tissue. It does not alter the starch of the crumb or internal part, but only swells the granules, and by the induced sponginess of the mass renders it readily digestible. Well-baked bread should have a yellowish-brown crust; the crumb should be uniform in texture, permeated with minute cavities, and without "eyes" or large air-cells. The colour of the crumb, unless in the case of whole wheat bread, should be white; it should be free from acidity and sourness. It should keep sweet and eatable for several days; and when stale it will be found to become soft and pleasant by again heating it in an oven, after which, however, it rapidly changes. According to Dr Frankland's determinations, "1 lb of the crumb of bread, if digested and oxidised in the body, will produce an amount of force equal to 1333 tons raised 1 foot high. The maximum of work which it will enable a man to perform is 267 tons raised 1 foot high. 1 lb of crumb of bread can produce, at the maximum, $1\frac{1}{10}$ oz. of dry muscle or flesh."

The adulteration of bread, and its detection, are treated under the heading **ADULTERATION**, vol. i. p. 170. (J. P. A.) **BAKU**, or **BADKU**, the chief town of the government of the same name, in the Russian province of Transcaucasia (Daghestan), situated in the peninsula of Apsheron, on the west coast of the Caspian, and possessing one of the most spacious and convenient ports in that sea. Long. 49° 53' E., lat. 40° 23' N. It is built in the form of an obtuse triangle, on the slope of an arid hill, and is defended by a double wall and ditch constructed during the reign of Peter the Great. The general appearance of the town is decidedly Oriental, with its flat-roofed houses rising one behind the other, often in so close proximity that the top of the one

¹ The Vienna oven is figured in Knapp's *Technology*, vol. iii. p. 102.

forms the courtyard of the next. The hill is crowned by a castle, which dates from the 15th century, and the mosque of Shah-Abbas, still in good preservation. At the entrance of the harbour stands the Maiden's Tower, now used as a lighthouse, which derives its name from a tragedy like that of the Cenci. Baku is not only a principal station of the Russian fleet, but it carries on a very extensive trade, exporting naphtha, iron, linen, and woollen goods, and receiving in return cotton, grain, fruits, &c. The numerous naphtha wells in the neighbourhood, and the remarkable escape of inflammable gases, rendered Baku a favourite resort of the fire-worshippers, who for long maintained their temples in the district; but, though the natural phenomena display themselves as abundantly as ever, they are now almost entirely deserted by devotees. The Arabian Masudi, in the 10th century, is supposed to be the first to mention "Baki" and its fire-breathing mountain; and the naphtha wells are probably those alluded to by Marco Polo. In 1509 it was taken by the Persians, who lost it to the Turks, but recovered it under Shah-Abbas. Captured by the Russians in 1723, it was restored to Persia in 1735, but after various vicissitudes it was finally incorporated with the Russian empire in 1806. (See Goldschmid's *Telegraph and Travel*, 1874; Filippi's *Viaggio in Persia*, 1865; *Hist. des découvertes faites par div. sav. voyageurs*, Lausanne, 1784; *La Tour du Monde*, 1863; "Baku" in *Zeitschrift der Deutsch. Geol. Gesellsch.*, 1874.)

BALA, a market-town of Wales, county of Merioneth, and hundred of Penllyn, at the northern extremity of the lake of the same name, 17 miles N.E. of Dolgelly. It consists principally of one wide street. Its manufactures are flannels, stockings, gloves, and other woollen hosiery. There is an endowed grammar school, founded in 1712, and a theological college, belonging to the Calvinistic Methodists. The Rev. Thomas Charles, well known in connection with the religious literature of his country, was long a minister at Bala. Population, 1539. The Lake of Bala, which is 4 miles long and about half a mile broad, is subject to sudden and sometimes dangerous floods. It is very deep and clear, and abounds with pike, perch, trout, eels, and the *gwyniad*, or *Coregonus fera*.

BALAAM, or rather **BILEAM**, the son of Beor, belonging to Pethor, by the River Euphrates in Aram, is represented in Scripture as a seer who possessed the power of blessing and cursing effectually. According to the narrative in Numbers xxii.—xxiv., he was invited by Balak, king of Moab, to come and curse Israel, in order to ensure the latter's defeat. Jehovah, however, forbade him to go as he was requested, and therefore he refused to accompany the deputation of elders, who had been sent to invite him, "with the rewards of divination in their hand." After the arrival of a second embassy more imposing than the first, he received divine permission to go, but only on condition that he should adhere strictly to what Jehovah should tell him. He set out accordingly, and in his journey experienced the anger of the Lord, an angel being sent to stop his progress, who was perceived only by the ass on which the prophet was riding. After Balaam's eyes had been opened he saw the angel, and declared his willingness to go back, but received permission to continue his journey on condition of saying nothing but what was suggested to him by God. His reception by Balak was honourable and imposing, yet he continued faithful to Jehovah, and told the king he would only announce what Jehovah revealed. Standing on the height of Baal-Bamoth, and surveying the tents of Israel, he declared his inability to curse a people so peculiar and righteous. Brought next to the top of Pisgah, and beholding thence a part of the Israelite camp, he announced that Jehovah saw no iniquity or perverseness in Jacob; that He was with them; that they were therefore strong and

victorious. Conducted afterwards to the top of Peor, he surveyed the army of Israel, and predicted their future, their goodly dwellings in Canaan, and their successful wars against the nations down to Saul's time. Though Balak was angry and interrupted him, Balaam continued his prophecy, announcing Israel's valiant deeds, from David down to Hezekiah. Upon this he returned to his home.

Another account of Balaam appears in Numbers xxxi. 8–16, Joshua xiii. 22, where we learn that he advised the Midianite women to seduce the Israelites to the licentious worship of Baal, and that he was slain in a war with the Midianites.

The character given to Balaam in the first account is a favourable one. He is a worshipper of Jehovah the true God, receives divine revelations, and repeatedly declares that he will not go beyond or against them. Faithful to his calling, he steadfastly resists temptations sufficiently powerful, and therefore God communicates His Spirit to him, enabling him to predict the future of Israel.

The second account is unfavourable. In it he appears as a diviner, *ἰσχυρ*, a heathen seer, who tempted the worshippers of the true God to idolatry. Instead of being a prophet of Jehovah, receiving visions and revelations, a man to whom the Almighty came by night, giving him instructions what to do, he is an immoral soothsayer. Of the two accounts, the latter, brief as it is, seems entitled to greater consideration. The former is elaborate and artificial, the theme being the glorification of the chosen people by the mouth of one of their enemies. An inspired seer from the far distant land of Aram is called in to bless the Israelites. He does so reluctantly, but like a true prophet, announcing nothing but what came to pass. The way in which he is taught the high destiny of the chosen people is instructive. Ignorant at first of Israel's relation to the true God, and thinking they were like others, he was disposed to curse them, but is enlightened, and forcibly impelled to follow the divine revelations. From a heathen *mantis* he is converted into a true prophet by revelations and visions which he cannot resist. The seer is taken to three places in succession, whence he surveys Israel, and utters oracular sayings concerning them. Three times the angel of the Lord stands in the way, and three times the ass is smitten by Balaam. There are four prophetic announcements—xxiii. 7–10, 18–24; xxiv. 3–9, 15–24. The first refers to the separate condition of Israel, their numbers, and their worship of the true God amid the idolatry of the surrounding nations. The second declares that God blesses Israel because there is no iniquity or perverseness in them, that He dwells among them, reveals himself to them, and makes them powerful and victorious. Both these refer to Mosaic times, or at least to times not later than Joshua. But the third announcement has the character of prediction, and refers to future events. Hence Balaam is introduced as a man whose eyes are opened, who hears the words of God, and sees visions of the Almighty. The condition of the people down to the time of Saul is glanced at, their secure settlement in Canaan, and victorious wars with the native races. The fourth prophecy apparently carries down the history to the time of Hezekiah; and a future ruler is distinguished as the star out of Jacob, the sceptre out of Israel, the conqueror of the Moabites and Edomites. The mention of the Kenites and Assyria in ver. 22, the former of whom were allies of Edom, shows, in the opinion of some recent critics, that the writer was acquainted with the Edomite wars under Amaziah and Uzziah, and hoped that the latter power would permanently subjugate the restless Edomites. This would bring the composition down to the first half of the 8th century. Verses 23 and 24 are obscure, but probably refer to no event later than

Hezekiah. A fleet from the Phœnician Cyprians seems to have attacked the Canaanitish and Phœnician coasts, threatening the Syrians farther north.

The writer of Num. xxxi. 8, 16, Joshua xiii. 22, is the Elohist, whose account is very brief. Meagre, however, as it is, it is probably historical. A heathen soothsayer, connected with the Midianites, perished in one of their battles with Israel. The writer of Numbers xxii.—xxiv. is, in this view, the Jehovist, who, under the name of Balaam, gives expression to his ideas and hopes in the elevated diction of an inspired prophet. As Jacob and Moses had pronounced blessings on Israel under the immediate inspiration of the Almighty, so Balaam is summoned from a distant land to eulogise the same people.

The character of Balaam has been apprehended very variously. Such diversity must exist according as the Elohist or Jehovist is followed. The Old Testament writers who mentioned him afterwards were influenced by the Jehovistic notice, and pronounce no judgment upon the seer (Deut. xxiii. 5, 6; Joshua xxiv. 9, 10; Micah vi. 5; Nehemiah xiii. 2); but the New Testament authors followed the Elohist account, and speak of him disparagingly, attributing to him love of "the wages of unrighteousness," madness, idolatrousness, and impiety (2 Peter ii. 15, 16; Jude 11; Rev. ii. 14). Josephus calls him *ἄριστος τῶν ῥήτρων*, "the best prophet of his time," supposing him to be a prophet of the true God, but with a disposition ill-adapted to resist temptation. Philo describes his character more critically: "There was a man at that time celebrated for divination, who lived in Mesopotamia, and was an adept in all the forms of the divining art; but in no branch was he more admired than in augury; to many persons, and on many occasions, he gave great and astounding proofs of his skill. For to some he foretold storms in the height of summer; to others drought and heat in the depth of winter; to some scarcity succeeding a fruitful year, and then again abundance after scarcity; to others the overflowing and drying up of rivers, and the remedies of pestilential diseases, and a vast multitude of other things, each of which he acquired great fame for predicting." The unfavourable character drawn of him by Philo is that which is generally taken by the later Jews. The later Targumists call him a sinner and an accursed man, while the Talmudists make him the representative of the godless, in contrast with Abraham, the representative of the pious. Yet they do not ignore his prophetic gift. The Midrashim about him are hardly worth mentioning, such as that he was one of Pharaoh's counsellors, that he was governor of a city in Ethiopia which he excited to rebellion, but was unable to defend against Moses at the head of an army who stormed the place and put Balaam to flight. In Yalkut (§ She-moth) he is said to have been identified by some with Laban, Jacob's father-in-law; by others with Elihu, Job's friend; while others say that Jannes and Jambres were his sons. In Sanhedrin (§ Chelek) he is said to have been blind of an eye. These, and other rabbinical fables, are entirely worthless; and Origen's belief that the Magi from Persia, who came to worship the infant King of the Jews, learnt the meaning of the star from Balaam's prophecies, is of the same character.¹

Most of the Fathers, including Augustine and Ambrose, judged him to be a soothsayer or magician, a prophet inspired by the devil. A few, as Tertullian and Jerome, took a more favourable view of his character. The Mahometans have various fables concerning Balaam. They say that he was of the race of Anakim, or giants of Palestine, and that he read the books of Abraham, where he got the name Jehovah, by virtue of which he predicted the

¹ See Fabricius's *Codex Pseudepigraphus Vet. Test.*, p. 807, &c.