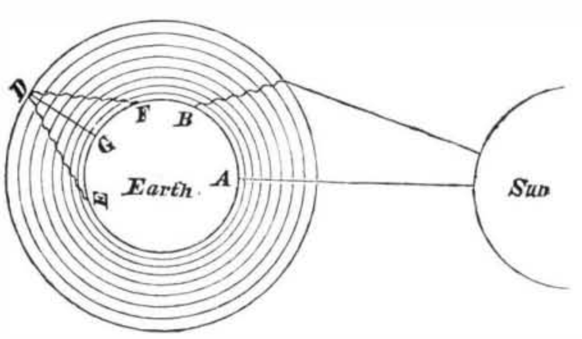
Communications.

The Undulatory Theory of Light.

To the Editor of the Scientific American:

Permit me to submit the following for the purpose of reconciling the undulatory or wave theory of light to that of the straight-line theory of Sir Isaac Newton.

Let the inner circle represent the earth, the outer circle the exterior surface of the earth's atmosphere, and the inner lines the lines of temperature of the atmosphere. An observer, standing on the earth at A, at the moment when that portion of the earth was nearest to the sun, would notice that light travels in a straight line. An observer at B would witness the undulatory or the wave motion of the light passing in an oblique direction through the various degrees of temperature of the earth's atmosphere. A light at D would travel in a straight line to G; but it would be seen traveling in waves, if an observer were at E or at F. In like manner, sound would travel in waves from E to F, but in straight lines from D to G, and in waves from D to F, D to E. It seems to me that both theories are correct. One of the two may be the general rule, and the other the exception.



Montreal, P. Q. DUGALD MACDONALD.

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Steam Economy Computations.

To the Editor of the Scientific American:

Your correspondent of Salem, Ohio, speaks in your issue of May 26 of "the proper allowance for clearance and compression" in steam engine cylinders. If the allowance referred to is for securing the highest percentage of useful effect from the steam used, the method indicated for making that allowance differs from at least one authority, which is regarded by many as the very highest on the subject of steam engineering, namely, Rankine "On the Steam Engine." On page 420 of this work, it says: "In order to represent the *most advantageous adjustment* of the compression, the quantity of steam confined or cushioned is *just sufficient to fill the clearance at the initial pressure.*" No demonstration of this is given in the work, as applying directly to this problem; but from principles set forth in the chapter. it can readily be shown to be correct. It may also be made plain by the aid of diagrams, Figs. 1 and 2. Let O E, Fig. 1, represent the atmospheric pressure, O F the absolute pressure of admission, G C the stroke of the piston, and E G the clearance, such that, if G C is the volume of the cylinder, E G is the volume of the clearance: A will then be the initial position of the piston, B the point of cut-off, B H C the curve of expansion, and A D the curve of compression. The indicator diagram will then be A B C D A.

Many assume the curve, B H C, to be a common hyperbola, with O F and O K as asymptotes; but both the theoretical and actual curves differ considerably from it. But whatever it be. it is evident that the operations going on in describing B C are simply repeated, in the reverse order, with a less quantity of steam, in D A. From this it appears that any horizontal line, L N, is cut by the curves in such a manner that FA:FB::LM:LN::ED:EC, etc.; or we may put it: AB:FB::MN:LN, etc.

Fig. 1.

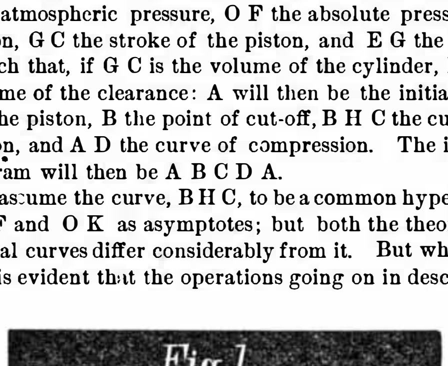
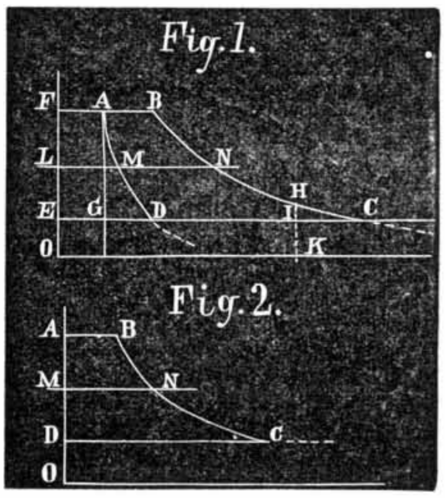


Fig. 2.



Now if the piston could start from E F, the engine would virtually have no clearance; and the indicator card would be F B C E F. All engineers would say that this diagram has no loss due to clearance. But when the piston starts from A G, the diagram is A B C G A, the compression being suppressed, and the clearance supposed to be A F E G. The same steam is used as before; but the work done is less than before, in proportion to the decrease, A F E G, of card area. In other words, a diagram indicating no loss due to clearance should have its back line stand in the same relation to the expansion curve as E F does to B C; and A G is not thus conditioned. But the above proportions show that A D would be thus conditioned, if A D and B C could be so modified as to make A D vertical, and preserve the horizontal secants, M N. On another set of right-angled axes, we may do this by laying off A B, M N, etc., as indicated in Fig. 2: when we get a card shorter, but the same in kind exactly, as F B C E, Fig. 1, already shown to be free from clearance loss. Hence, when an engine must have clearance, it can only be compensated for by cushioning in such a manner that the terminal pressure of compression equals the initial admission pressure. The above discussion supposes that the expansion is carried to C; but if the release occurs at H, there will be a loss, H C I, due to earlier exhaust. If the release line, H I, could be made parallel to D M, the corresponding line in Fig. 2 would be vertical, giving the same kind of a diagram in Fig. 2 as E F B H I E, Fig. 1, and as good as is obtainable from an engine without clearance and a square release line.

In designing common D slide valves of engines, the clearance, A F, should be known, so that the point, D, may be found; G D being greater, evidently, as A F is greater. The practical effect of giving large clearance, and hence early cushioning, is to increase the inside lap of valve, increase the angular advance of eccentric, and increase the expansion by making the cut-off earlier. With a clearance of a tenth or twelfth of the cylinder volume, the cut-off may be brought back to half-stroke with all the other points favorably conditioned.

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Fast and Slow Grinding.

John M. Truax, a prominent and practical New England miller, in a recent communication on the above subject, writes as follows:

"I have heard and read a great deal about slow and fast grinding, and how to dress and how not to dress a mill, etc., etc. Many good millers have related their experience, and made elaborate arguments to prove their theories, and have done much to enlighten their brethren in the milling science, all of which is commendable. But to say who has hit the nail on the head would be hard to tell. If the nail has been hit, who has counted the effect of the blow? To my mind, the reasons given for fast or slow grinding have not been shown. The quantity to be ground must depend upon the texture or density of the stone, the draft, the number and depth of furrows, and the grinding without heating. No more grinding should be done than can be done without heating. The heating is the stopping spot. The quantity that every mill ought to grind is that quantity that can be ground and not heat, whether it is 5, 10, or 20 bushels per hour. If every miller will observe this as his guide, he will do the best work that he is able to do.

"In speaking of heating, I mean to say that the grain should not be so heated by pressure or rubbing, as will start the juice or essential oils of the grain. If the grain oil is started by friction, that friction produces heat, and that heat dries and evaporates the grain juice, and the virtue of the flour is impaired. Any amount of cooling will not repair the damage done by heating. The steam that rises from the hot running mill is the vapor from out of the essential oils of the grain, and is lost in the bread. To recommend the grinding of 10, 15, or 25 bushels of wheat per hour is bad advice, imprudent. Millers differ in the selection of stones, and differ about their dress and the motion of their mill. One will have one kind and way, and another another kind and way; but whatever way they select, when they go to grinding, their quantity per hour should be that which they can grind and not heat, whether it is 3, 5, 10, or 20 bushels per hour. Do not impair the substance for the bulk per hour. Blood heat is as high as can be warranted without impairing the product. It may be an ambition to grind fast, but an old adage is 'haste makes waste.' If millers are ambitious, let that ambition be applied to the making of a perfect running mill. Select the very best buhrs, and put in a thoroughly common-sense dress, a dress that will granulate the whole kernel as nearly as possible. Keep the stones as far apart as possible, and keep the texture or grain of the stones clean. Let this be the miller's ambition. But stop adding to quantity wnen the mill is at blood heat, and let the breadmakers and eaters have in their flour all the virtue that Mother Earth has produced.

"One of the great evils in milling is low grinding, and its evil effects are only second to those produced by fast grinding. Wheat is composed of two parts—an inner and an outer part. The inner part is meaty, and the outer is a shuck, or skin, or hull; the meaty is pulverizable, while the hull or covering is a leather-like substance, and has thickness, which thickness equals the meshes of No. 14 or 15 bolting cloth. Now, the question arises, how shall the miller grind this compound kernel and clean this leather-like covering, and granulate the inner meat to a proper fineness for bread purposes, and not over-rub or grind to dust a part of the hull? This is the question. And how is wheat being ground all over the world to-day? I need not answer, for all know that heavy grinding has been the order. The lands or faces of one buhr rub the other, or nearly so. So much so that that portion of the bran which is caught between the face of the mill near the skirt is more than twice overground, and this overgrinding or rubbing the bran makes a brown dust, and blackens the flour. It is like brown paint, and bolts with the flour and goes into the bread.

"This is a mistake, and should be avoided. Bran may make bread, but not the bread millers feel proud of. And to avoid this, millers must run a light mill. Heavy grinding is an evil. It not only powders a portion of the bran and blackens the flour, but grinds at the same time a portion of the kernel to dust, also destroying its juicy substance; and at the same time the fine ground dust is rubbed into the texture of the stone, and the face of the stone becomes glazed and smooth, and of course dull.

"Millers, so dress your mill as will enable you to grind the inner part of the kernel to flour, and avoid making brown paint dust from the bran. A miller that runs a heavy mill is like to look for a medicine to doctor his flour. Medicine for flour is a poor substitute for a good dress and clean stones. Bread-eaters much prefer the full life of the cereals, not a doctored article. Grain once killed by overgrinding and heating will not be brought to life by the best medicines. All the flour doctors in the world cannot repair the life that is first produced in natural growth. They may help a deadened flour, but a whole reparation is impossible. Throw away the dregs! Let us have a pure flour."—*Mill Stone.*

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Production of Salt in England.

Of the many minerals raised in the kingdom few play a more important part, or are less noticed, than that which is found in every household throughout the land—salt. It is an essential that we could not dispense with, not only as a culinary ingredient, but in many other ways. Our resources, too, are such that they have not only been fully equal to the wants of our own population, but we have been able to spare yearly from 200,000 to 250,000 tons to other countries that are not so favored as ourselves. There are districts in many parts of the country where salt could be met with were such necessary, for, some time since, whilst boring near Middlesborough, in the expectation of meeting with the coal measures, rock salt was met with at a depth of 1,800 feet. At the Moira Colliery, near Ashby-de-la-Zouch, in Leicestershire, at a depth of 593 feet, salt water, beautifully clear, trickles down from the fissures where the coal is being worked. The brine is taken to Ashby, and has been in good repute for rheumatic and other complaints. As to the origin of salt, there are many theories, but it may be stated that in nearly all substances, wherever found, it is in the new red sandstone. By many it is believed that the formations are due to the evaporation of the water from inland salt lakes or parts of the sea severed from the main body of the ocean by volcanic action, the evaporation causing the deposit of the salt held in solution by the sea. Writing more recently on the subject of the great European salt deposits, Mr. T. Ward propounds a rather different theory. He considers that the salt deposits owe their origin entirely to the elevation of the mountain chains with which they are so intimately connected, during which small valleys and ravines would be cut off from connection with the sea by ridges of land, and would form salt lakes and lagoons. Cheshire is still the main source from which we draw our own supplies, and export to the United States, Russia, and other countries. There we have had considerable landslips in working it, but there are the red rocks showing keuper or saliferous marl, with thin beds of limestone, and then 200 eet of rock salt. In Worcestershire, at Droitwich and Stoke Prior, the salt is made from brine alone. A large proportion of what is made at Norwich, Middlewich, and Winsford, in Cheshire, is sent down the river Weaver. the quantity in 1857 having been 772,175 tons, and in 1866 it had increased to 1,118,991 tons. During the last 20 years, however, the increase in the production has been of a most marked character, whilst the price has gone down very much. In 1855 the salt raised in the kingdom was 1,094,770 tons, the average price at the works being about $6 per ton. In 1875 there was raised 2,316,644 tons of salt, the price being barely $3.60 per ton. The value of the salt exported in 1855 was $1,738,570, and in 1875 it was only $860,255, when our exports were 916,468 tons, or nearly as much as the entire produce of the kingdom in the former year. Our principal customers include the United States, British India, British North America, and Russia. From the figures given it will be seen that nearly 40 per cent of the salt produced in the kingdon is exported to other countries.—*Mining Journal.*

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GAUGES.

Since the introduction of special machines and tools designed to produce and reproduce the various parts in quantities, and of exactly uniform size and shape, the importance of standard gauges has been greatly increased; and in establishments where this system is followed, the best of skill and the greatest of care and watchfulness are necessary to maintain the exact standard. It is obvious that, when the various parts of a piece of mechanism are made separately in large quantities, and are not assembled until the whole are finished, a slight variation of size or form would soon impair the fit of the various parts, and therefore the value of the whole system. Now, theoretically, a new tool decreases in size from the moment it commences to perform cutting duty until it is worn out; and the point at which the wearing-out process may have arrived at its greatest permissible limit is, under light duty, more often determined by the reduction of its size than of the loss of its keenness or other cutting properties. Many firms prescribe a definite permissible limit of wear to certain tools, such as the one thousandth or two thousandth of an inch, and make two sets of gauges, one of the precise size and the other showing the extreme limit to which the range of size is permitted; and when that limit is reached, the tool maker or foreman is notified that the tool may be restored to its standard. For the purpose of this restoration a standard gauge is required; and this gauge even is subject in some degree to wear, especially if it be not handled with extreme delicacy. No more delicate proof of this fact can be shown than in the following: If we take a pair of cast iron surfaces, having an area of 100 inches, and clean them thoroughly with alcohol, and then, after freely lubricating them with the best sperm oil, rub one a few strokes upon the other, we shall find that (though, from the existence of the oil, neither the eye nor the sense of feeling gives the least indication that the surfaces have had the least contact) still the oil will have become so darkened, or rather blackened, in color as to clearly demonstrate that abrasion has, to some practical extent, taken place. From this we may perceive that, in trying hardened steel tools with gauges, the latter, though of hardened steel themselves, may very easily become worn if rudely handled.

The gauges used as standards for male and female cylindrical forms are usually after the pattern shown in Figs. 1 and 2. They are made of steel; and after being hardened they are ground to size, the grinding process being so delicately performed as to leave a polish. In testing such gauges the heat imparted to them by holding them for any length of time in the hand will cause a perceptible difference in the size; hence, to insure the greatest practicable accuracy, it is necessary to test the whole set at an equal temperature. As a test of accuracy, we may take a female gauge and place therein two or three male gauges, whose diameters added together will equal that of the female. Thus in Fig. 3, the size of the female gauge, A, being 1½ inches, that of the male, B, may be 1 inch, and that of C ½ an inch, and the two together should just fit the female. On the other hand, were we to use, instead of B and C, two males, ⅞ and ⅝ inches, respectively, they should fit the female; or a ½ inch, a ⅝ inch, and a ⅜ inch male gauge together should fit the female. By a series of tests of this description, the accuracy of the whole set may be tested; and by judicious combinations, a defect in the size of any gauge in the set may be detected. A notable fact with reference to these gauges is that, if we take a male and female of corresponding sizes, and slide the one continuously through the other, it will pass through at a proper fit; but if we arrest the progress of the male and allow it to rest a few moments, it will become fast in the female and require considerable force to remove it again. The wear of these gauges takes place most rapidly at and near the ends, because it is difficult in using them to keep them in lines true with the bores into which they are tried; and the movement due to the adjustment to line causes abrasion. It is indeed an excellent method of testing to place one in the other to the depth of about $\frac{1}{16}$ of an inch, as shown in Fig. 4; and holding the female firmly, lightly press the male first in the direction of A and then of B. There are few gauges which will not, under such a test, show some slight movement, denoting defect.

Fig. 1.

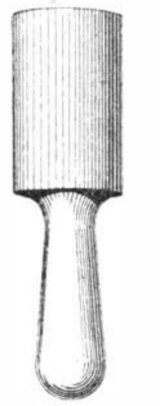


Fig. 2.

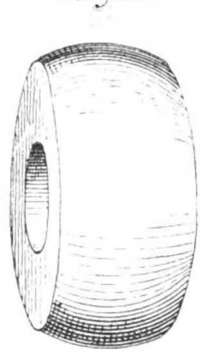


Fig. 3.

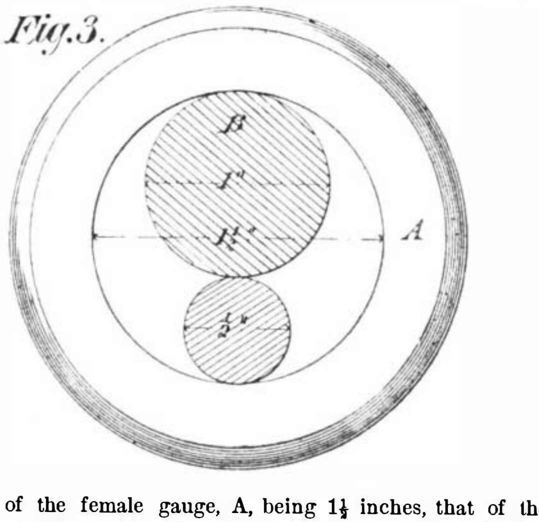
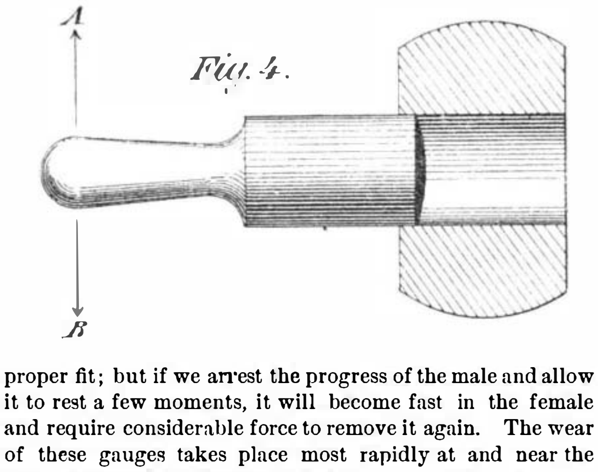


Fig. 4.



Solid cylindrical tools are often made of steel wire drawn to gauge, and to great accuracy of diametrical size. There is, however, a slight degree of variation due to the wear of the drawing dies. In the table below will be found the gauge numbers, and the sizes in decimal parts of an inch of the celebrated Stubs wire. The first column is the size according to the Stubs wire gauge; the second is the size in decimal parts of an inch, as given by Mr. Stubs; and the third column represents the average sizes obtained from actual measurements of the wire, taken during a period of several years by the Morse Twist Drill and Machine Company, whose drills are made to great diametrical accuracy.

DIAMETER OF STUBS' STEEL WIRE IN FRACTIONAL PARTS OF AN INCH.

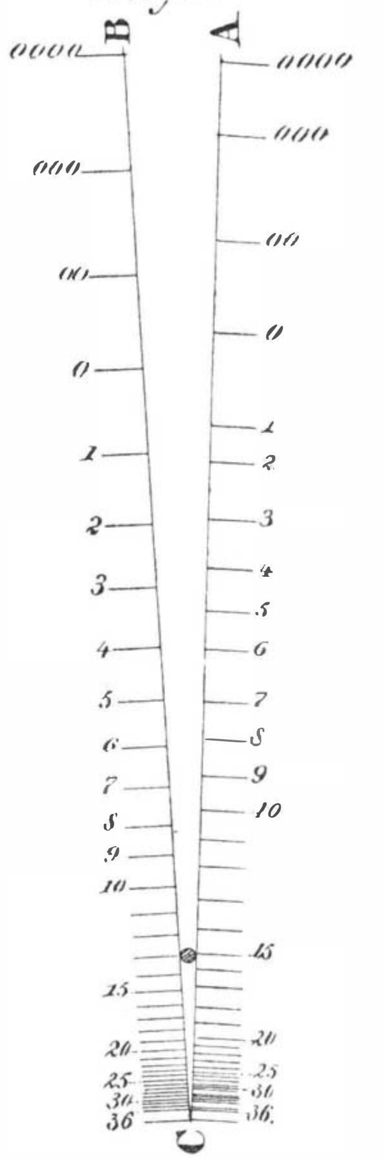
No. by Stubs' Wire Gauge.	Stubs' Dimensions.	Measurement by Morse Twist Drill and Machine Co.	No. by Stubs' Wire Gauge.	Stubs' Dimensions.	Measurement by Morse Twist Drill and Machine Co.	No. by Stubs' Wire Gauge.	Stubs' Dimensions.	Measurement by Morse Twist Drill and Machine Co.
1	0·227	0·228	23	0·153	0·154	45	0·081	0·082
2	0·219	0·221	24	0·151	0·152	46	0·079	0·080
3	0·212	0·213	25	0·148	0·150	47	0·077	0·079
4	0·207	0·209	26	0·146	0·148	48	0·075	0·076
5	0·204	0·206	27	0·143	0·145	49	0·072	0·073
6	0·201	0·204	28	0·139	0·141	50	0·069	0·070
7	0·199	0·201	29	0·134	0·136	51	0·066	0·067
8	0·197	0·199	30	0·127	0·129	52	0·063	0·064
9	0·194	0·196	31	0·120	0·120	53	0·058	0·060
10	0·191	0·194	32	0·115	0·116	54	0·055	0·054
11	0·188	0·191	33	0·112	0·113	55	0·050	0·052
12	0·185	0·188	34	0·110	0·111	56	0·045	0·047
13	0·182	0·185	35	0·108	0·110	57	0·042	0·044
14	0·180	0·182	36	0·106	0·106	58	0·041	0·042
15	0·178	0·180	37	0·103	0·104	59	0·040	0·041
16	0·175	0·177	38	0·101	0·101	60	0·039	0·040
17	0·172	0·173	39	0·099	0·100	61	0·038	0·039
18	0·168	0·170	40	0·097	0·098	62	0·037	0·038
19	0·164	0·166	41	0·095	0·096	63	0·036	0·037
20	0·161	0·161	42	0·092	0·094	64	0·035	0·036
21	0·157	0·159	43	0 088	0·089	65	0·033	0·035
22	0·155	0·156	44	0·085	0·086			

The following table represents the letter sizes of the same wire:

LETTER SIZES OF WIRE.

A	0·234	J	0·277	S	0·348
B	0·238	K	0·281	T	0·358
C	0·242	L	0·290	U	0·368
D	0·246	M	0·295	V	0·377
E	0·250	N	0·302	W	0·386
F	0·257	O	0·316	X	0 397
G	0·261	P	0·323	Y	0·404
H	0·266	Q	0·332	Z	0·413
I	0·272	R	0·339		

Fig. 5.



The American standard wire gauge was introduced by Messrs. J. R. Brown and Sharpe, the object being to introduce greater uniformity in the progression of the sizes. This will be clearly understood by reference to the diagram shown in Fig. 5, in which the two lines, A C and B C, meeting at C, represent the opening of an angular wire gauge. The divisions on the line, A C, show the size of wire by the common gauge; those on the line, B C, the sizes by the new American standard. Wire to be measured by such a gauge is passed into the angular opening until it touches on both sides, the line of division at the point of contact denoting the size by wire gauge number. Thus No. 13 by the old gauge is No. 15 by the new. The difference between the two gauges, known respectively as the Birmingham or English and the American, is shown in the table below:

	AMERICAN OR NEW STANDARD.		BIRMINGHAM OR OLD STANDARD.	
No. of Wire Gauge.	Size of each Number in decimal parts of an inch.	Difference between consecutive Nos. in decimal parts of an inch.	Size of each Number in decimal parts of an inch.	Difference between consecutive Nos. in decimal parts of an inch.
0000	0·460		0·454	
000	0·40964	0·05036	0·425	0·029
00	0·36480	0·04484	0·380	0·045
0	0·32495	0·03994	0·340	0·040
1	0·28930	0·03556	0·300	0·040
2	0·25763	0·03167	0·284	0·016
3	0·22942	0·02821	0·259	0·025
4	0·20431	0·02511	0·238	0·021
5	0·18194	0·02237	0·220	0·018
6	0·16202	0·01992	0·203	0·017
7	0·14428	0·01774	0·180	0·023
8	0·12849	0·01579	0·165	0·015
9	0·11443	0·01406	0·148	0·017
10	0·10189	0·01254	0·134	0·014
11	0·09074	0·01105	0·120	0·014
12	0·08081	0·00993	0·109	0·011
13	0·07196	0·00885	0·095	0·014
14	0·06408	0·00788	0·083	0·012
15	0·05707	0·00702	0·072	0·011
16	0·05082	0·00625	0·065	0·007
17	0·04526	0·00556	0·058	0·007
18	0·0403	0·00495	0·049	0·009
19	0·03589	0·00441	0·042	0 007
20	0·03196	0·00393	0·035	0·007
21	0·02846	0·00350	0·032	0·003
22	0·02535	0·00311	0·028	0·004
23	0·02257	0·00278	0·025	0·003
24	0·0201	0·00247	0·022	0·003
25	0·0179	0·00220	0·020	0·002
26	0·01594	0·00196	0·018	0·002
27	0·01419	0·00174	0·016	0·002
28	0·01264	0·00155	0·014	0·002
29	0·01126	0·00138	0·013	0·001
30	0·01002	0·00123	0·012	0·001
31	0·00893	0·00110	0·010	0·002
32	0·00795	0·00098	0·009	0·001
33	0·00708	0·00087	0·008	0·001
34	0·0063	0·00078	0·007	0·001
35	0·00561	0·00069	0·005	0·002
36	0·005	0·00061	0·004	0·001
37	0·00445	0·00055		
38	0·00396	0·00049		
39	0·00353	0·00043		
40	0·00314	0·00039		

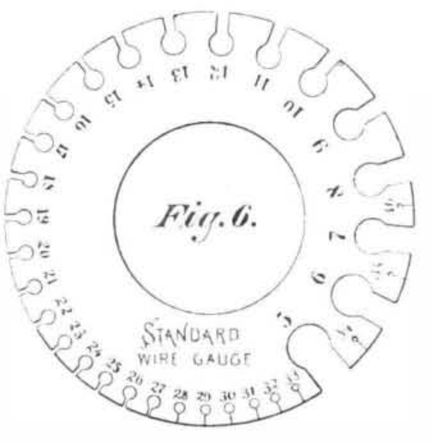


Fig. 6.

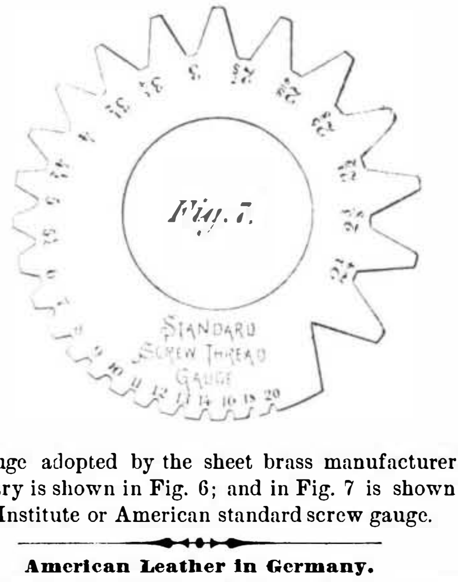


Fig. 7.

The gauge adopted by the sheet brass manufacturers of this country is shown in Fig. 6; and in Fig. 7 is shown the Franklin Institute or American standard screw gauge.

American Leather in Germany.

The United States Consul at Berlin, under date of May 1, in view of the fact that from its superior quality American leather is gradually finding its way to Germany, submits a prospectus of an exhibition of leather manufactures, to be held in that city from September 8 to 29 next. The Consul thinks an observance of the provisions of the documents would be beneficial to American interests.