

## MECHANICS, PHYSICS, AND CHEMISTRY.

For the Journal of the Franklin Institute.

*An Account of some Experiments on a Mixture of Saturated and Sur-charged Steam,* (Wethered's patent,) *made under the direction of E. K. COLLINS, Esq. By B. F. ISHERWOOD, Esq., Chief Eng., U. S. N.*

(With a Plate.)

For some months past, by the public spirit and liberality of Mr. E. K. Collins, of the Collins line of Steamships, a very extensive and thorough course of experiments has been in progress, with what is known as Wethered's patent, having for their object such a treatment of steam as to greatly increase its power without any increased expenditure of fuel. The claim made in this patent by the patentees, Charles E., John, and Sam. Wethered, of Baltimore, Maryland, dated May 25, 1853, is as follows, viz:

*"What we claim as new is, the combining steam and superheated or sur-charged steam, for actuating engines, when generated, the elasticity increased, and operated as set forth."*

From this claim it will be seen that the patent does not intend the use of steam simply surcharged with heat; that is to say, having a higher temperature than is normal to the same pressure of saturated or ordinary steam; but it intends the use of a *mixture of saturated and surcharged steam*. I prefer these terms of saturated and surcharged steam to those of hydrous or anhydrous steam, or to those of steam and stame, because they are proper, and their meaning already understood; ordinary steam being saturated with water, or of maximum density for the pressure; and surcharged steam being ordinary steam surcharged with heat, having less than the maximum density for the pressure, and therefore not being saturated with water.

The idea of the patentee is, that if a certain quantity of saturated steam be withdrawn from the boiler, and heated (out of contact with water) to a high abnormal temperature, then *mixed* with a certain quantity of saturated steam, and this *mixture* used to actuate the engine, a greater power can be derived from it with a given weight of fuel than could be derived from the use of saturated steam alone, generated by the same weight of fuel.

The mode of obtaining the "mixture" for practical use is very simple, and as follows, viz: from the steam chimney or drum of the boiler, an usual steam pipe, furnished with the necessary stop valves, conveys externally to the boiler, the saturated steam to the valve chest; another similar pipe, with stop valves, &c., from the same steam chimney or drum, but starting within the smoke chimney, conveys saturated steam down the smoke chimney, through the flues and through the furnaces, passing immediately over the incandescent fuel, and then having become highly surcharged in its passage, it is led out of the front of the boiler to the same valve chest, where it is mixed with the saturated steam. From the valve chest the "mixture" passes to the cylinder of the engine, and actuates the piston in the usual manner.

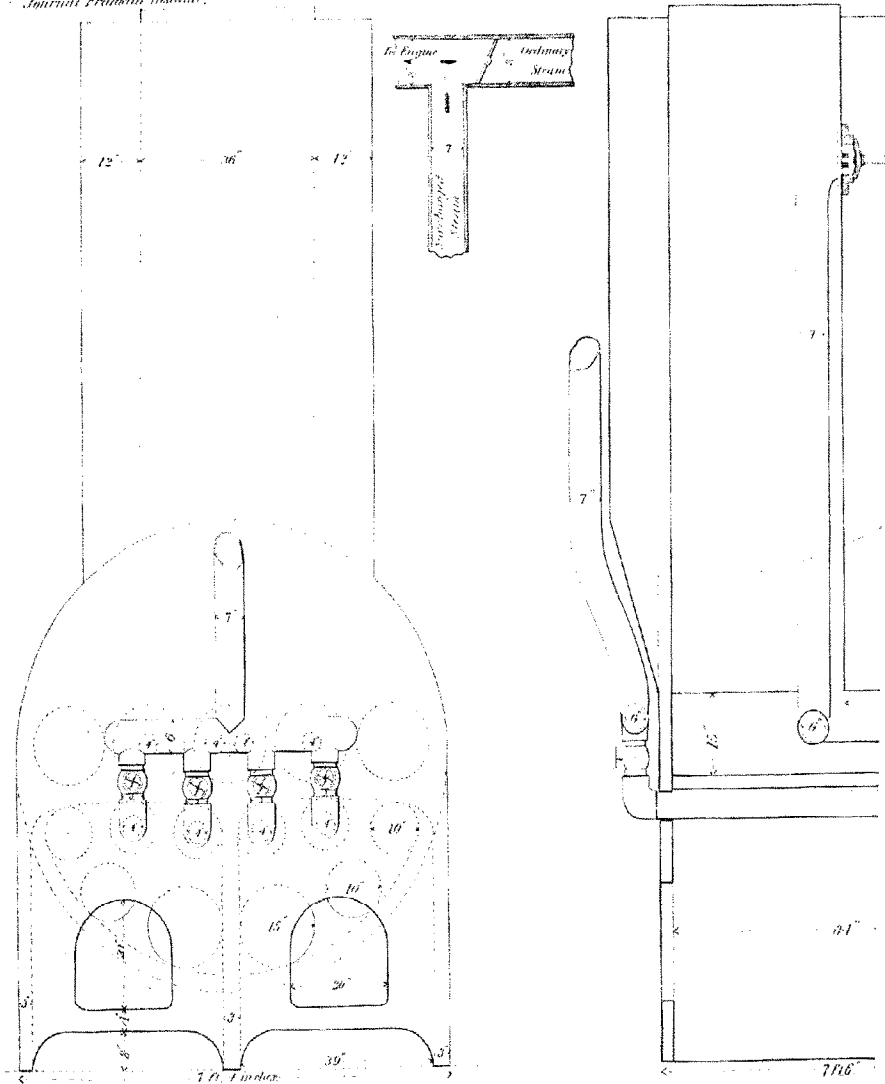
In all the comparative experiments that have been made, the same engine and boiler was experimented with in both cases, being preserved in the same condition, and the results noted from the same instrument; every precaution was taken to ensure accurate *comparative* results; the same fuel was used, and the same persons employed. The experiments were open to all, and were conducted and visited by experienced engineers, wholly uninterested, pecuniarily, in the result; among the number was Mr. Daniel B. Martin, Engineer in Chief, U. S. Navy, who superintended several of the experiments in person, and by whose advice they were principally conducted. I am indebted to him for the detailed results below given.

The engine used was a common non-condensing one, the property of Mr. Collins, and kept by that public-spirited gentleman for making steam experiments. The diameter of the cylinder was  $12\frac{1}{2}$  inches, the stroke of piston 12 inches, and it was worked without expansion; the cylinder was a double one, or surrounded with a steam jacket; the steam pipes were  $2\frac{3}{8}$  inches inside diameter, and 8 feet long, being as direct as possible from the boiler to the cylinder. They were first covered with felt and woolen carpeting to 8 inches diameter, but the felt burning from the high temperature, it was removed, and a coating composed of a mixture of lamp black and clay, covered with felt and carpeting, was substituted. The boiler had vertical tubes, and was a working model of the boilers in the Collins line of steamships.

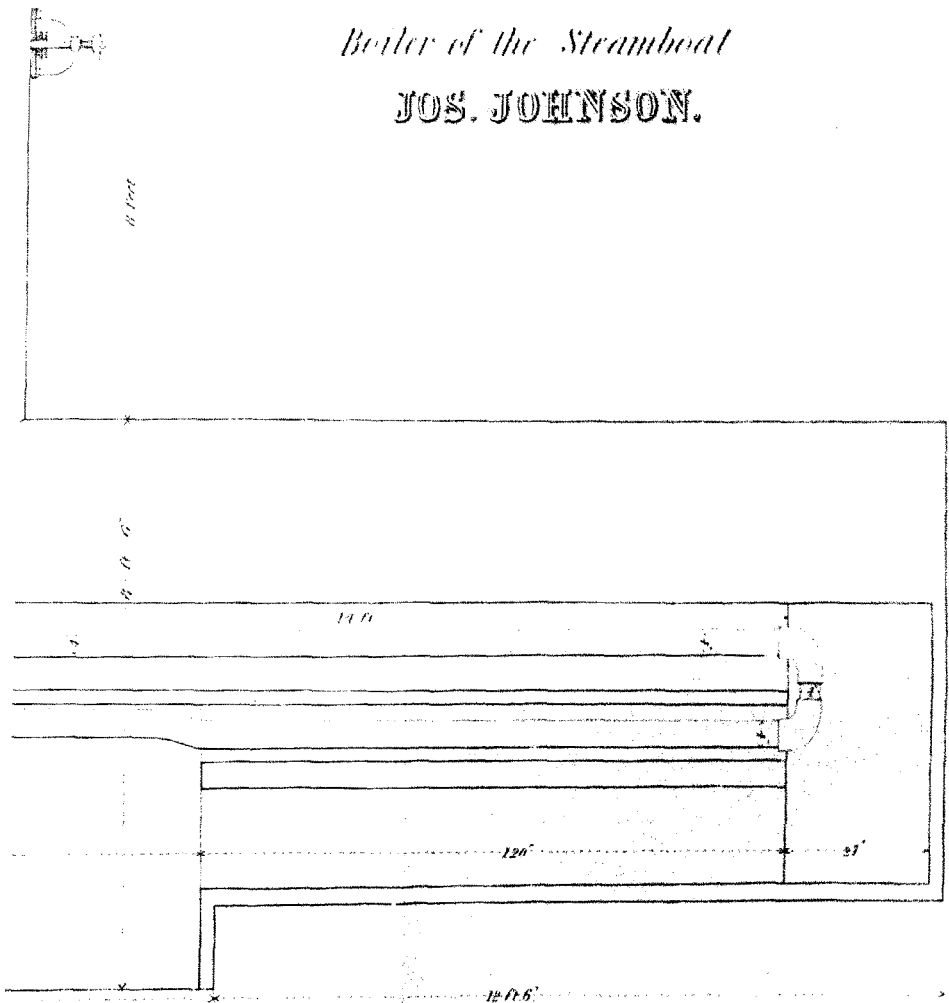
The work performed by the engine consisted in pumping up water into a tank, where it was kept at a constant level. Fitted to this tank was a very large air chamber containing compressed air, and the water was delivered from the pumps against the pressure of this air. The pumps were two in number, single acting, with 8 inches diameter, and 10 inches stroke of pistons; they had been made originally for air pumps to Mailfort's submarine apparatus, and they were worked from the shaft by means of eccentrics. The pump valves were of metal, with openings nearly as large as the pump barrel, and they were fitted up with the greatest accuracy. The pumps were set in the tanks with the water so disposed around and above them as to produce a head or pressure of  $2\frac{1}{4}$  pounds per square inch, to overcome the friction and weight of the valves, the *vena-contracta*, &c., and to prevent there being below the pistons a less than atmospheric pressure. The air pressure in the chamber, against which the pumps delivered their water, was taken by three of Lowe's patent pressure gauges, carefully tested.

The temperatures were taken by accurate thermometers at three places; 1st, In the wrought iron steam pipe near the boiler, for the temperature of the steam; 2d, In the wrought iron pipe that carried the surcharged steam from the boiler to the valve chest; 3d, In the cast iron valve chest of the cylinder. In order to obtain these temperatures, three small cups containing mercury, and cast from the same pattern, just large enough to hold conveniently, the bulbs of the thermometers, without overflowing the mercury bath, were screwed in. The cups were about  $\frac{1}{2}$ -inch deep, and of course projected farther in the pipes than in the valve chest, where the metal was thicker.

With the apparatus just described, three distinct sets of experiments



*Boiler of the Steamboat*  
**JOS. JOHNSON.**



were made; 1st, With saturated, or ordinary steam alone; 2d, With surcharged steam alone; 3d, With the 'mixture' of saturated and surcharged steam, in which the proportions of saturated and surcharged were about as 25 to 75.

The number of double strokes of engines' pistons made, was taken by a counter. The coal was accurately weighed, and the amount given is *inclusive* of what was required to raise steam; the coal was completely burned out, and the engine operated as long as it would work. The units of work done is obtained by multiplying the number of double strokes made by the pistons, by the pressure in the air chamber against which the pumps delivered their water.

*Experiments made with Saturated Steam alone.*

DATE.	Temperatures in degrees F.		Total number of double strokes of piston made during the experiment.	Pressure in air chamber (against which the pumps delivered their water) in lbs. pr sq. in. above atmo.	Pounds of anthracite coal consumed during the experiment.	Duration of the experiment in hours and minutes.	Total number of units of work done.	Units of work done with one pound of coal.	REMARKS.
	In steam pipe near boiler.	In valve chest of cylinder.							
1853.									
Jun 11,	230°	217°	11143	25-25	336	6 21	281360-7	837-4	} Wd westerly, weather clear.
" 24,	230	—	9732	30-46	347	6 00	296436-7	854-3	
July 6,	227	220	11940	22-25	343	6 00	265665-0	774-5	
" 7,	227	219	11620	23-75	334	6 00	275975-0	826-3	
" 29,	229	224	8682	26-50	301	6 00	230073-0	764-3	} Using salt water.
Aug. 4,	231	226	10250	26-56	336	6 00	272240-0	810-2	
" 29,	228	229	5828	22-80	224	3 30	132878-4	593-2	
Totals,			69195		2221	39 51	1754628-8		
Means,	229°	222½°		25-36				790-0	

*Experiments made with Surcharged Steam alone.*

DATE.	Temperature of the surcharged steam in the pipe leading it from the boiler to the valve chest, in degrees Fahr.	Total number of double strokes of pistons made during the experiments.	Pressure in air chamber (against which the pumps delivered their water) in lbs. per sq. in. above atmos.	Pounds of anthracite coal consumed during the experiment.	Duration of the experiment in hours and minutes.	Total number of units of work done.	Units of work done with one pound of coal.	REMARKS.
1853.								
Jun 25,	352°	11514	38-50	328	6 00	443289-0	1351-5	} Wind westerly and weather clear.
July 2,	357	15220	28-33	348	6 00	431182-6	1239-0	
" 5,	348	14875	27-83	313	6 00	413971-2	1322-6	
Totals,		41609		989	18 00	1288442-8		
Means,	352½		30-97				1302-8	

## Experiments with the Mixture of Saturated and Surcharged Steams.

DATE.	Temperatures in degrees Fah.			Total number of double strokes of piston made during the experiment.	Pressure in air chamber (against which the pumps delivered their water) in lbs. per sq. in. above atmos.	Pounds of anthracite coal consumed during the experiment.	Duration of the experiment in hours and minutes.	Total number of units of work done.	Units of work done with one pound of coal.	REMARKS.
	In steam pipe near the boiler.	Surch'd steam in pipe leading from boiler to valve chest.	Mixture in the valve chest of cylinder.							
1853.										
June 13	233°	373°	—	15190	34·70	336	6 48	537815·3	1600·6	
" 30	237	379	304°	14630	31·20	272	6 00	456456·0	1678·2	
July 1	244	380	288	14736	28·40	256	6 00	418502·4	1634·8	
" 8	233	—	289	14810	32·60	288	6 00	482806·0	1676·4	} W'd easterly & weather clear.
" 9	234	—	312	11676	28·20	289	6 00	413863·2	1432·1	
" 26	241	398	300	13310	41·10	280	6 00	547041·0	1953·7	Using salt water.
" 27	—	341	311	11772	38·10	299	6 00	448513·0	1500·0	" "
" 28	238	388	290	12671	38·14	268	6 00	483271·9	1803·2	" "
" 30	242	418	291	13520	30·21	248	6 00	408439·2	1646·9	" "
Aug 30	242	414	303	7171	40·00	210	2 20	286840·0	1365·9	Brke pump & lever
" 31	238	391	303	8213	43·70	227	3 19	358908·1	1581·1	" "
Sep. 12	240	328	303	19855	38·20	467	10 00	758461·0	1624·1	
" 13	236	360	281	21214	34·70	459	10 00	736125·8	1603·8	
Totals,				182077		3899	80 27	6337042·9		
Means, 238½	379½	298½			34·84				1625·3	

## Summary of the Experiments with the Pumps.

	With saturated steam alone.	With surcharged steam alone.	With the mixture of saturated and surcharged steams.
Duration of the experiments, in hours and minutes,	39 51	18 00	80 27
Temp. in deg. F. { Saturated steam in the steam pipe near the boiler,	229°	—	238½°
{ Surcharged steam in the pipe leading from boiler to valve chest,	—	352½°	379½°
{ Mixture in the valve chest of the cylinder,	—	—	298½°
Total number of double strokes of pistons made during the experiments,	69195	41609	182077
Number of double strokes of pistons made per minute,	29·84	38·53	37·72
Pressure in air chamber (against which the pumps delivered their water) in pounds per square inch above atmosphere,	25·36	30·97	34·84
Total amount in pounds of anthracite coal consumed during the experiments,	2221	989	3899
Amount of anthracite, in pounds, consumed per hour,	55·7	55·0	48·5
Total number of units of work done,	1754628·8	1288442·8	6337042·9
Units of work done with one pound of coal,	790·0	1302·8	1625·3
Units of work done with one pound of coal reduced to proportionals,	1·0000	1·6491	2·0573

From this summary, it will be seen that, using the steam simply surcharged, produced, with the same fuel, an increased effect of 65 per centum over what was obtained with the saturated or ordinary steam alone; while an increased effect of 106 per centum was produced by the use of the "mixture." Also, the increased effect of the "mixture" was 25 per centum over what was obtained from the surcharged steam alone.

*Experiments with Saturated Steam alone, and with a Mixture of Saturated and Surcharged Steam, on board the Steamboat Joseph Johnson.*—After the experiments just described, made with the small stationary engine and pumps, it was considered still necessary to verify their results by operating with a steamboat under the ordinary condition of practice. For this purpose the *Joseph Johnson*, a tug steamboat, was obtained, and the experiments hereafter detailed were made with her on the Hudson River, at New York. These experiments were strictly comparative—the same instruments in the same positions—the same fuel, persons, &c., being employed, and every precaution was taken to secure accuracy. The weather, tide, &c., was also selected as nearly alike as possible.

The *Joseph Johnson* had one engine, with the cylinder  $31\frac{1}{2}$  inches diameter and  $6\frac{3}{4}$  feet stroke of piston. The steam was cut off in the supply pipe by a fly-valve and cam-board at  $\frac{5}{8}$ ths the stroke of piston from the commencement. (Plate VII.)

There was one iron boiler, with the furnace and direct flues below and single return ascending flues above. A steam chimney surrounded the smoke chimney, and the average temperature of the latter was  $600^{\circ}$  Fah.

The steam for the "mixture" was surcharged by taking it from the steam chimney inside the smoke chimney, leading it down the latter, then through the upper flues, then returning through the lower direct flues, and through the furnace over the incandescent fuel to the front of the boiler, whence it was led to the supply pipe, and there mixed with saturated steam, brought by a pipe externally to the boiler from the same steam chimney.

The following tables, furnished by Mr. Martin, who witnessed the experiments, contain, in detail, all the observed facts:—

*Experiment with Saturated Steam alone, Jan. 9th, 1854. Air calm. Water smooth.*

TIME.	Steam pressure in boiler in lbs. per sq. in. above atmosphere.	Vacuum in condenser per gauge in inches of mercury.	Mean temperature of the metal of the cylinder in degrees Fahr.	Temperature of the exhaust steam in degrees Fahrenheit.	Number of double strokes of piston made.	Number of double strokes of engine piston made per min.
HS. MIN.	atmosphere.					
A. M.						
9 35	20	(Started engine, having used 1200 lbs. of coal in raising steam.)				
9 45	19	26 $\frac{1}{2}$	223°	133°	Not noted.	
10 00	21	27 $\frac{3}{4}$	222	121	278	18-53
10 15	22 $\frac{1}{2}$	"	222	121	294	19-60
10 30	22	"	218	120	296	19-73
10 45	22	"	220	122	298	19-86
11 00	21 $\frac{1}{2}$	"	218	125	304	20-26
11 15	18 $\frac{1}{2}$	27 $\frac{1}{2}$	216	125	289	19-26
11 30	16	"	212	125	282	18-80
11 45	18	"	215	127	295	19-66
12 09	20	"	220	125	308	20-53
12 15	18 $\frac{1}{2}$	"	214	119	293	19-53
12 30	15 $\frac{1}{2}$	"	208	119	267	17-80
12 45	18	"	214	125	Stop'd 8 mn.	Not noted.
1 00	18	"	218	129	291	19-40
1 15	19 $\frac{1}{2}$	"	226	125	299	19-93
1 30	21 $\frac{1}{2}$	"	228	125	288	19-20
1 45	22 $\frac{1}{2}$	"	222	125	297	19-80
2 00	16	28	208	121	288	19-20
2 15	12	28	216	115	266	17-73
Stopped 39 minutes.						
3 00	19	28	240	160	111	18-50
3 15	18	27 $\frac{1}{2}$	240	125	273	18-20
3 30	18	27	238	128	276	18-40
3 45	18 $\frac{1}{2}$	27 $\frac{1}{2}$	241	127	285	19-00
4 00	18 $\frac{1}{2}$	27 $\frac{1}{2}$	240	123	290	19-33
4 15	20	27	244	127	299	19-93
4 30	21	27 $\frac{1}{2}$	246	128	296	19-73
4 45	21	"	244	127	299	19-93
5 00	20 $\frac{1}{2}$	"	242	125	310	20-66
5 15	20	"	240	123	288	19-20
5 30	22	"	244	125	272	18-13
5 45	21 $\frac{1}{2}$	"	244	125	284	19-00
6 00	20	"	242	125	300	20-00
6 15	21	"	242	125	303	20-20
6 30	20	27 $\frac{3}{4}$	240	125	292	19-46
6 45	20	27 $\frac{3}{4}$	244	125	290	19-33
7 00	20	28	244	125	299	19-93
7 15	20	27 $\frac{1}{2}$	244	125	292	19-46
7 30	20	"	244	125	296	19-73
7 45	19	"	242	125	289	19-23
8 00	19	"	242	125	297	19-80
8 15	18	"	240	125	284	18-93
Totals, 9 53					11447	19-303
Means,	19-5	27-5	231-1	125		



*Experiment with a Mixture of Saturated and Surcharged Steam, January 5th, 1854.*

*Air Calm. Water perfectly Smooth.*

TIME.		Steam pressure in boiler in lbs. per sq. inch above atmosphere	Vacuum in condenser per gauge in inches of mercury.	Mean temperature of the metal of the cylinder in deg. Fahr.	Temperature of the surcharged steam before its mixture with said steam in deg. F.	Temperature of the mixture of saturated and surcharged steam in deg. Fahr.	Temperature of exhaust mixture in degrees Fahr.	Number of double strokes of engine piston made.	Number of double strokes of engine piston made per minute.
HS.	MIN.								
A. M.									
7	40	16							
8	00	22	27½	286°	435°	308°	137°		
8	15	21½	28	248	455	315	139	306	20.40
8	30	21½	28	246	468	320	137	296	19.73
8	45	21½	27½	256	475	324	139	317	21.13
9	00	21½	"	265	500	332	143	319	21.26
9	15	20	"	275	500	346	150	317	21.13
9	30	20	28	277	530	336	148	300	20.00
9	45	20½	28	283	515	334	143	318	21.20
10	00	21	27½	283	525	340	145	330	22.00
10	15	20	28	286	540	350	147	309	20.60
10	30	20	28	294	560	358	145	310	20.66
10	45	21	28	294	580	358	145	323	21.53
11	00	21	28	299	600	364	149	318	21.20
11	15	16	28	Stopped 2 minutes.		Data not noted.		Not	
11	30	15	27¾	280	490	322	153	noted	—
11	45	15	27½	290	505	330	145	"	—
12	00	16	"	290	530	348	150	"	—
12	15	18	"	294	572	366	152	"	—
12	30	17	"	292	560	356	145	"	—
12	45	15	28	297	615	360	150	"	—
1	00	13	28	304	670	370	155	"	—
Stopped 45 minutes.									
2	00	12	28½	254	488	310	137	281	18.73
2	15	15	28½	262	500	325	135	272	18.13
2	30	18	28	280	535	344	154	291	19.40
2	45	18½	27½	290	545	350	160	309	20.60
3	00	19	"	298	582	370	140	319	21.33
3	15	20	"	304	605	378	155	323	21.53
3	30	19½	"	303	615	378	155	310	20.66
3	45	20	"	314	685	382	155	314	20.93
4	00	19½	"	314	680	370	153	312	20.80
4	15	19	"	312	685	375	145	304	20.26
4	30	19	28	313	680	370	155	312	20.80
4	45	19	27¾	308	670	360	150	314	20.93
5	00	19	28	302	690	360	145	312	20.80
5	15	19	28	303	720	376	140	307	20.50
5	30	18½	28	303	720	356	155	307	20.50
5	45	18	28	310	720	360	155	320	21.33
6	00	17	28½	300	550	350	150	310	20.66
6	17	13	28½	294	650	340	145	Not noted.	

*Summary of the Results obtained from the Experiments made Jan. 5th and 9th, 1854.*

	Saturated steam alone.	Mixture of saturated and surcharged steam.
Duration of the experiment in hours and minutes, . . .	9 53	9 50
Steam pressure in boiler in lbs. per sq. in. above atmosphere, . .	19·5	18·5
Vacuum in condenser per gauge, in inches of mercury, . .	27·5	27·8
Mean temperature of the metal of the cylinder, in degrees F., . .	231·1	289·2
Temperature of the exhaust, in degrees Fahrenheit, . .	125·0	147·6
Temperature of the surcharged steam before its mixture with the saturated steam, in degrees Fahrenheit, . .	—	577·1
Temperature of the mixture of surcharged and saturated steams, in degrees Fahrenheit, . . . . .	—	350·7
Total number of double strokes of piston made during the experiments, . . . . .	11447	11904
Number of double strokes of piston made per minute, . .	19·303	20·176
Pounds of anthracite coal consumed per hour, . . . .	666·664	440·824

*Relative Economical Efficiency of the two modes of using Steam, as applied to the Steamboat Joseph Johnson, January 5th and 9th, 1854.*—As the conditions under which the two experiments were made were sensibly the same, the cubes of the number of double strokes of engine piston, made per minute, will be taken for the expression of the useful effect obtained, and the consumption of coal per hour will be taken for the expression of the cost. Hence we have the following, viz:—

Double strokes of engine piston per minute.	Useful effect.	Lbs. of coal consumed per hour.	Cost.	Relative economical efficiency.
---	----------------	---------------------------------	-------	---------------------------------

Saturated Steam alone.

$$19\cdot303 = 1\cdot00000 \text{ and } 1\cdot00000^3 = 1\cdot00000. \quad 666\cdot664 \text{ or } 1\cdot00000 \text{ and } \frac{1\cdot00000}{1\cdot00000} = 1\cdot00000$$

Mixture of Saturated and Surcharged Steam.

$$20\cdot176 = 1\cdot01523 \text{ and } 1\cdot01523^3 = 1\cdot14192. \quad 440\cdot824 \text{ or } 0\cdot66124 \text{ and } \frac{1\cdot14192}{0\cdot66124} = 1\cdot72694$$

Whence appears that the economical efficiency of the “mixture” is 72·694 per centum greater than that of the saturated steam alone.

The piston pressure in the two cases will be in the ratio of the squares of the number of double strokes of piston made per minute, or as 1·0000 to 1·0925; and the powers exerted by the engine will compare as the product of the piston pressures multiplied by the number of double strokes of piston made per minute, or as 1·00000 to 1·14192, or as the cubes of the number of double strokes of piston made per minute.

Experiment with Saturated Steam alone, Nov. 22, 1853. Air Calm. Water Smooth.

TIME.		Steam pressure in boiler in pounds per square inch above atmosphere.	Temperature in the steam pipe near the boiler, in degrees Fahrenheit.	Temperature of the steam in the valve chest of the cylinder, in degrees Fahrenheit.	Temperature of the exhaust steam, in degrees Fahr.	Number of double strokes of piston made by counter.	Number of double strokes of engine piston made per minute.	Total pounds of anthracite coal consumed.	Pounds of anthracite burned per hour.
HS.	MIN.								
10	21	24	210°	178°	130°				
10	51	23	218	180	139	590	19.67		
11	21	25	251	185	139	635	21.17		
11	51	24	240	174	130	578	19.27		
12	21	24	240	195	135	620	20.67		
12	53	21	250	209	135	589	18.41		
1	23	27	257	210	134	618	20.60		
1	53	24	252	210	132	688	22.93		
2	23	18	245	200	128	605	20.17		
2	53	20	245	205	130	613	20.43	2055	453.3
Totals, 4 32						5536		2055	
Means,		22.55	219.7°	195°	133.6°		20.352		453.3

Experiment with a Mixture of Saturated and Surcharged Steam, November 23, 1853. Air Calm. Water Smooth.

TIME.		Steam pressure in boiler in pounds per square inch above atmosphere.	Temp. of surcharged steam in pipe conducting it from boiler to valve chest, (before mixing,) in degrees Fahrenheit.	Temperature of the mixture in the cylinder valve chest, in degrees Fahrenheit.	Temperature of the exhaust of the mixture in degrees Fahrenheit.	Number of double strokes of engine piston made by counter.	Number of double strokes of engine piston made per minute.	Total pounds of anthracite coal consumed.	Pounds of anthracite burned per hour.
HS.	MIN.								
12	08	21				596	19.87		
12	38	23	484°	342°	From 130° to 140°.	625	20.83		
1	08	20	552	348		611	20.37		
1	38	18	566	342		592	19.73		
2	08	18	600	330		590	19.67		
2	38	16	564	326		616	20.53		
3	08	18	600	326		617	20.57		
3	38	18	592	322		590	19.67		
4	08	20	600	331		618	20.60	1300	288.9
4	38	17	620	342					
Totals, 4 30						5455		1300	
Means,		18.94	578.3°	333.4°	135°		20.204		288.9

*Summary of the Results obtained from the Experiments made Nov. 22 and 23, 1853.*

	Saturated steam alone.	Mixture of saturated and surcharged steam.
Duration of the experiment in hours and minutes, . . . .	4 32	4 30
Steam pressure in the boiler in pounds per square inch above atmosphere, . . . .	22.55	18.94
Temperature of steam in the steam pipe near boilers, in degrees Fahrenheit, . . . .	247.7°	—
Temperature of steam in valve chest of the cylinder, in degrees Fahrenheit, . . . .	195°	—
Temperature of surcharged steam in the pipe conducting it from the boiler to the valve chest, (before mixing,) in degrees Fahrenheit, . . . .	—	578.3°
Temperature of the mixture in the cylinder valve chest, in degrees Fahrenheit, . . . .	—	333.4°
Temperature of the exhaust, . . . . .	133.6°	135°
Number of double strokes of engine piston, made by counter, . . . .	5536	5455
Number of double strokes of engine piston, made per minute, . . . .	20.352	20.204
Total pounds of anthracite coal consumed, . . . . .	2055	1300
Pounds of coal consumed per hour, . . . . .	453.3	288.9

*Relative Economical Efficiency of the two modes of using Steam, as applied to the Steamboat Joseph Johnson, November 22d and 23d, 1853.*—As the conditions under which the two experiments were made were sensibly the same, the cubes of the number of double strokes of engine piston, made per minute, will be taken for the expression of the useful effect obtained, and the consumption of the coal per hour will be taken for the expression of the cost. Hence we have the following, viz:—

Double strokes of engine piston per minute.	Lbs. of coal Useful consumed effects. per hour.	Cost.	Relative economical efficiency.
---	---	-------	---------------------------------

Saturated Steam alone.

$$20.352 \text{ or } 1.00732 \text{ and } 1.00732^3 = 1.02212. \quad 453.3 \text{ or } 1.56916 \text{ and } \frac{1.02212}{1.56906} = 0.65142.$$

Mixture of Saturated and Surcharged Steam.

$$20.204 \text{ or } 1.00000 \text{ and } 1.00000^3 = 1.00000. \quad 288.9 \text{ or } 1.00000 \text{ and } \frac{1.00000}{1.00000} = 1.00000.$$

Whence appears that the economical efficiency of the "mixture" is  $\left( \frac{1.00000}{0.65142} - 1. = \right) 53.51$  per centum greater than that of the saturated steam alone.

The object in the above trial was to make the same number of revolutions of the wheels in equal times, so as to give the boat the same speed. The same distance was run (from Canal street wharf, New York, City, to Cold Spring, 56 miles,) with the "mixture" and with the steam

alone; and to keep the speed about the same, the time was noted at corresponding points along the river, so that the difference should tell in the fuel only. But with the "mixture," in order to keep the pressure sufficiently down, to obtain the same speed as with the steam alone, it was necessary to carry the fires ruinously low, so that at times portions of the grate bars would be entirely bare. It is to this fact that the lower result, comparatively, obtained from the "mixture" in the above trial is to be attributed.

From the experiments thus far made, no difficulty has been experienced from the burning out of the pipes conveying the surcharged steam. The data as given may be relied on as truthful, and the reader can account for the results in any way he chooses—of the practical facts there exists no doubt. I have given all the experiments that have been furnished me, and they include, I believe, all, or about all, that have been made.

---

For the Journal of the Franklin Institute.

*Note on Dr. Wetherill's Remarks upon a Process for Organic Analysis.*

By J. H. ALEXANDER and CAMPBELL MORFIT.

All contributions which tend to make us acquainted with the resources of science or to extend its domain, are ever welcome; but all personal questions of individual laudation or criticism, unless connected with some point of scientific ethics, are generally unhappy, and always unimportant to the public.

If we understand Dr. Wetherill's remarks rightly, they are intended for the establishment of two points relating to the apparatus which we had occasion to describe in the February Number of the Journal, viz: 1st, That said apparatus is not new; 2d, That it is not an improvement, as we had supposed.

The first point is without interest to us, inasmuch as we have not raised it. Habitually careful of the possible rights of others as of our own, we forebore to claim an invention or to allege novelty. In our view, any process is to be appreciated in proportion to its convenience and utility. The fact of its not having been thought of or practised before, is of value solely to the individual concerned; and to him, in proportion to his aspirations after cotemporary celebrity or posthumous historical eminence. The last motives could not, at least they certainly did not, operate with us in devising or giving account of the process in question.

And the second point raised is nearly as indifferent to us as the former; since, after all the interesting references furnished by Dr. Wetherill, which show that the divers foreign processes and our own are not the same, the solution of the question of improvement must necessarily remain for some time a matter of mere opinion.

If any practical chemist is disposed to consider that the use of oxide of copper is always necessary, and that the cut-off at the reservoir instead of the combustion tube is the most convenient and fecund, and